CITY OF Burlington

West Aldershot Creek Erosion Control Municipal Class Environmental Assessment

PROJECT FILE REPORT

October 2019

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

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Executive Summary

INTRODUCTION

West Aldershot Creek is located within the North Shore Watershed, West Aldershot Creek subwatershed, under the jurisdiction of Conservation Halton (CH). The Study Area is defined as an approximately 500 metre (m) section of West Aldershot Creek extending from Fairwood Place to Lake Ontario.

West Aldershot Creek exhibits accelerated erosion along its bed and banks, evidence of the effects of an urbanized hydrologic regime, largely without the benefits of stormwater management controls. The creek has a relatively small watershed, with a high proportion of impervious surfaces, so it is predisposed to rapid routing of surface runoff and floodwater during even modest rainstorms. Widespread instability along the creek and the base of its confining valley walls reflects an unnaturally rapid, or 'flashy,' hydrologic response and the unconsolidated, erosion-prone materials comprising the bed and banks. Anomalous accumulations of sediment at the mouth of West Aldershot Creek, which the City had to dredge to maintain boat access, are a testament to the local severity of erosion.

Erosion is most severe along the upstream portion of the study corridor, where the channel is confined along the bottom of a nearly V-shaped ravine with little to no floodplain to attenuate flow energy. Significant bed scour and down-cutting has occurred, which in turn has led to undercutting and collapse of the banks. Several small slope failures have occurred recently along the lower valley walls in response to the fluvial erosion. Trees have fallen into the channel once their root masses have been undermined, which, in turn, has exacerbated erosion by forcing flows over, under and around the woody debris jams that form. The downstream portion of the creek, where the valley bottom is wider and a narrow floodplain is more accessible, exhibits fewer, less severe erosion sites.

The City of Burlington has prioritized the assessment and management of erosional processes along the creek, through the development of erosion control solutions, in order to mitigate further risk to private property, infrastructure and aquatic and riparian habitats. Associated Engineering (AE) and Palmer Environmental Consulting Group (PECG) were retained by the City of Burlington to complete a Municipal Class Environmental Assessment (EA) to identify the needs and opportunities for the implementation of erosion control measures along West Aldershot Creek between Fairwood Place and Lake Ontario in the City of Burlington.

STUDY OBJECTIVES

The purpose of this study is to develop alternatives to mitigate excessive erosion along West Aldershot Creek. In developing these alternatives, the Study Team took into consideration the objectives of the Study:

- Prevention of further, excessive erosion along West Aldershot Creek;
- Restoration and enhancement of aquatic and riparian habitat, where feasible;
- Protection of private property alongside the creek;

- Protection of existing infrastructure (sanitary infrastructure, stormwater outfalls, pumping station facility and roadways);
- Improvement of the quality of West Aldershot Creek; and
- Maintenance or enhancement of aesthetics for surrounding landowners.

PHASE I: IDENTIFICATION OF PROBLEMS AND OPPORTUNITIES

The various analyses (e.g. hydrologic, hydraulic, aquatic, fluvial, terrestrial, geotechnical) inform the identification and description of the problems and opportunities. The overarching issues along West Aldershot Creek can be summarized by the following statements.

Problem Statement

Ongoing, excessive erosion along West Aldershot Creek has been identified between Fairwood Place and Lake Ontario. Continuous down-cutting of the creek bed and undercutting of the banks present a risk to public and private property, municipal infrastructure, and aquatic and riparian habitat.

Opportunity Statement

This project presents an opportunity to increase the environmental and social benefits offered by the Study Area. It will help characterize and, once its preferred erosion control solutions are implemented, combat excessive erosion along West Aldershot Creek to mitigate risks to public and private property, municipal infrastructure, and aquatic and riparian habitat. Creek stabilization and restoration will ultimately also improve aesthetics.

In order to address the issues described above, a range of practical, cost-effective alternative solutions was identified to solve the Problem.

PHASE II: IDENTIFICATION AND EVALUATION OF ALTERNATIVE SOLUTIONS

For the purposes of assessment and planning erosion control solutions, West Aldershot Creek was divided into three (3) reaches, as illustrated in **Figure E-1**. Each of the reaches exhibits different erosion-related issues that pose risks to stormwater and/or sanitary sewer infrastructure, as well as aquatic and riparian habitats.

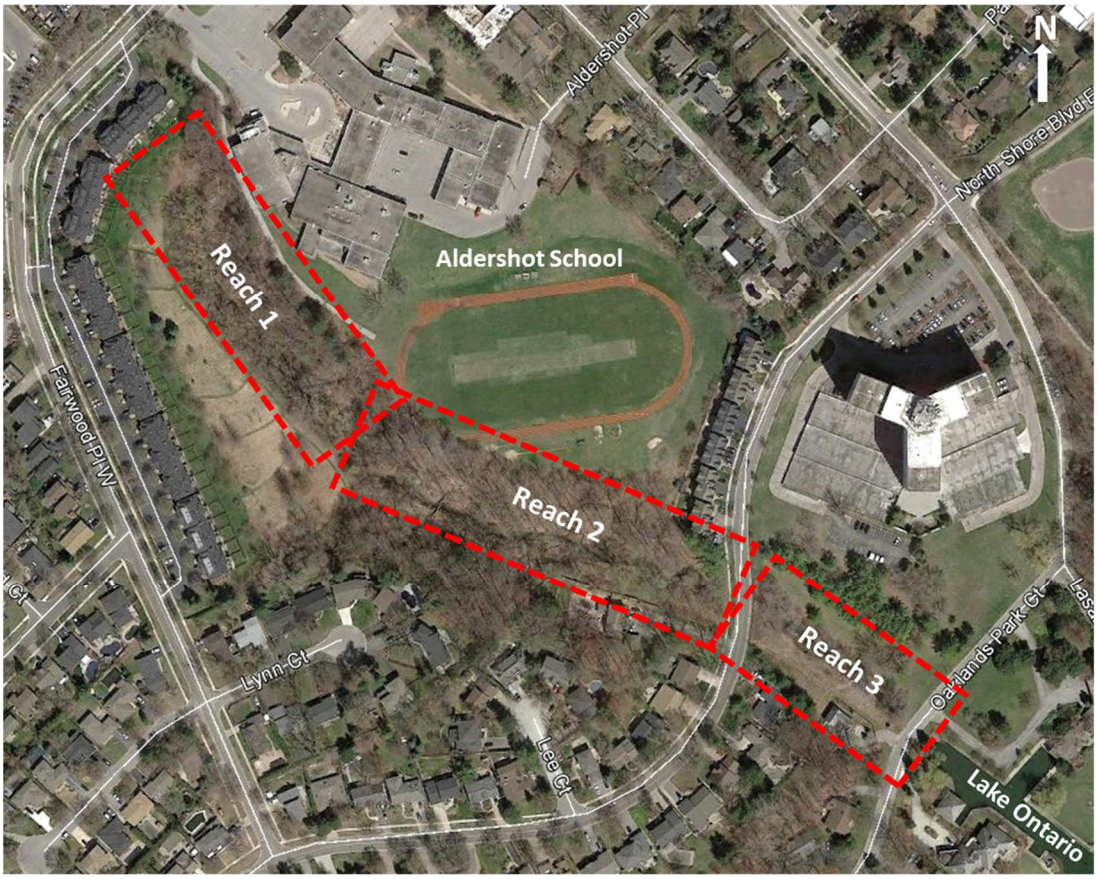


Figure E-1: West Aldershot Creek Reach Designation

A range of erosion control concepts was developed including 1) Do nothing, 2) Site-specific erosion control measures, 3) Sub-reach erosion control measures, and 4) Reach-scale erosion control measures. Each of the alternatives was given separate consideration along the three (3) study reaches.

<u>Reach 1:</u>

- *Alternative 1: Do Nothing*
  - Undertake no works and allow condition of the reach to continue to deteriorate, which risks the need for future emergency works to mitigate impacts.
- *Alternative 2: Site-specific Erosion Control Measures*
  - Undertake localized measures within three site-specific areas of the reach to address severe down-cutting, unstable banks and exposed infrastructure.
- *Alternative 3: Sub-reach Erosion Control Measures*
  - Undertake localized measures of Alternative 2 with extended measures to improve bank stability and help moderate erosion.
- *Alternative 4: Reach-scale Erosion Control Measures*
  - Undertake complete reconstruction and restoration of the channel to re-establish its capacity to convey stormwater without excessively eroding its bed and banks.

Reach 2:

- *Alternative 1: Do Nothing*
  - Undertake no works and allow condition of the reach to continue to deteriorate, which risks the need for future emergency works to mitigate impacts.
- *Alternative 2: Site-specific Erosion Control Measures*
  - Undertake localized measures within two site-specific areas of the reach to address unstable banks and exposed infrastructure.
- *Alternative 3: Sub-reach Erosion Control Measures*
  - Undertake localized measures of Alternative 2 with implementation of raised riffles to help restore floodplain access.
- *Alternative 4: Reach-scale Erosion Control Measures*
  - Undertake complete reconstruction and restoration of the channel to re-establish its capacity to convey stormwater without excessively eroding its bed and banks.

Reach 3:

- *Alternative 1: Do Nothing*
  - Undertake no works and allow condition of the reach to continue to deteriorate, which risks the need for future emergency works to mitigate impacts.
- *Alternative 2: Site-specific Erosion Control Measures*
  - Undertake targeted measures to address channel erosion at an anomalous bank blow-out.
- *Alternative 3: Sub-reach Erosion Control Measures*
  - Undertake localized measures of Alternative 2 with implementation of riffles to improve long-term stability of the bed.
- *Alternative 4: Reach-scale Erosion Control Measures*
  - Undertake complete reconstruction and restoration of the channel to re-establish its capacity to convey stormwater without the risk of excessive erosion along its bed and banks.

Evaluation of Alternatives

To evaluate the alternatives, the following set of criteria was developed. Each criterion was evaluated for the four (4) alternative solutions along each of the three (3) reaches.

Social:

- Property Protection
- Benefit to Community
- Public Safety
- Aesthetic Value
- Archaeological Features

Environmental:

- Hydrology & Hydraulics
- Fluvial Geomorphology
- Aquatic Habitat
- Terrestrial Habitat

- Geotechnical & Hydrogeological

Technical:

- Existing Infrastructure
- Regulatory Permitting and Approval and Acquisition Requirements
- Constructability

Economic:

- Capital Costs
- Maintenance Requirements and Costs

Selection of Preferred Alternatives

Within Reach 1, Alternative 4, reach-scale erosion control, was selected as the preferred solution. This solution will mitigate severe erosion and unacceptable risks to infrastructure along the reach and will provide an opportunity for aquatic and terrestrial habitat improvements. A complete reconstruction and restoration of the channel and valley bottom, a length of approximately 250m, will occur from the undermined storm outfall structure upstream to the storm outfall outflanked along the western bank.

Within Reaches 2 and 3, Alternative 3, sub-reach erosion control, was selected as the preferred solution. This solution will implement extended measures to mitigate excessive erosion and protect City and Region infrastructure at key areas. Alternative 3 yields a more positive net effect for both Reaches 2 and 3, as implementing bio-engineering and hardening solutions present a lower cost than Alternative 4, while still addressing the problem and opportunity statements.

Conceptual Design and Costing

Conceptual design drawings were prepared to illustrate the preferred solutions. The drawings show the plan and profile for the Study Area and typical treatments to be implemented throughout the reaches. Details, such as exact channel dimensions, riffle distribution and stone sizing, will be determined during the detailed design stage. Guidance is also provided with respect to further investigations and analyses required to inform detailed design. The estimated total cost for the implementation of the preferred solutions along all three reaches is $1,290,000.

Public Consultation

Throughout the project, stakeholders, including the public, property owners, First Nations, municipality, regulatory agencies and utility companies, were given opportunities to review and comment on the project process, key findings, proposed alternatives and recommended solutions. The following opportunities for public and stakeholder review and/or comment were provided:

- Notice of Study Commencement;
- Notice of Public Information Centre;
- Public Information Centre; and
- Notice of Study Completion.

A Public Information Centre (PIC) took place on December 3, 2018 to present Study details. The PIC presented the following elements:

- Background information on the Study;
- Background information on the Class EA process;
- Problem/opportunity being considered for the Study;
- Key considerations and issues associated with the Study;
- Description of the alternative design concepts; and
- Next steps in the Class EA process.

Comments were received before and during the PIC from several neighbouring residents supporting the overall Study approach and proposed alternatives.

CONCLUSIONS AND RECOMMENDATIONS

The preferred alternative includes reach-scale erosion control measures along Reach 1, sub-reach erosion control measures along Reach 2 and sub-reach erosion control measures along Reach 3. The preferred alternative achieves the Study goals to mitigate excessive creek erosion through naturalized approaches to stabilization and restoration, enhance aquatic habitat and reduce the risk to public and private property. Following completion of the Class EA Study, detailed design and construction will be undertaken to implement the preferred solutions and alleviate the identified problems.

A number of important recommendation for site investigations and implementation measures should be taken into consideration during detailed design:

- Obtain easements where creek traverses privately owned property;
- Update hydraulic model of creek;
- Complete a geomorphic analysis of channel hydraulics and tractive forces to inform the design of channel works;
- Complete Stage 2 Archaeological Assessment;
- Prepare Arborist Report to develop a Tree Preservation and Removal Plan;
- Complete additional consultation with Conservation Halton to secure approvals and permitting;
- Coordinate with the Region of Halton the implementation of the proposed erosion control works with planned Regional infrastructure works; and
- Determine appropriate construction staging and erosion and sediment controls.

Approvals will be required from Conservation Halton, Ontario Ministry of Natural Resources and Forestry (MNRF), and Ontario Ministry of Environment, Conservation and Parks (MECP). Engagement of Fisheries and Oceans Canada for project review will also be required.

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1 Introduction

Associated Engineering (AE) and Palmer Environmental Consulting Group (PECG) were retained by the City of Burlington to complete a Municipal Class Environmental Assessment (EA) to identify the needs and opportunities for the implementation of erosion control measures along West Aldershot Creek between Fairwood Place and Lake Ontario in the City of Burlington. The Study developed and evaluated a variety of remedial measures to address erosion issues, property and infrastructure protection, and enhancement of aquatic and riparian habitats. In accordance with the Municipal Engineers Association's (MEA) Municipal Class Environmental Assessment process, this Study follows the planning process for a Schedule B.

1.1 DESCRIPTION OF STUDY AREA

The Study Area is defined as an approximately 500 metre section of West Aldershot Creek extending from Fairwood Place to Lake Ontario (**Figure 1-1**). The Creek runs through City-owned property as well as the adjacent school property, private property and Region of Halton property. Within the Study Area the creek crosses North Shore Boulevard West and Oaklands Park Court through a 1900mm diameter culvert and 3.3m wide elliptical culvert, respectively.



Figure 1-1: West Aldershot Creek Study Area

The Study Area is located within the North Shore Watershed, West Aldershot Creek subwatershed, under the jurisdiction of Conservation Halton (CH). The Study Area occurs within high-density residential and low-density residential land uses (City of Burlington Official Plan, Schedule B). The West Aldershot Creek corridor is designated as a key feature of Halton's Regional Natural Heritage System. The Study Area contains Aldershot Creek, a portion of the Lake Ontario Shoreline and significant valleyland. No provincially or locally significant wetlands, Areas of Natural and Scientific Interest (ANSI) or Environmentally Significant Areas (ESA) have been identified within or immediately adjacent to the Study Area.

West Aldershot Creek exhibits accelerated erosion along its bed and banks, evidence of the effects of an urbanized hydrologic regime, largely without the benefits of stormwater management controls. The creek has a relatively small watershed of 0.63km^2, with a high proportion of impervious surfaces, so it is predisposed to rapid routing of surface runoff and floodwater during even modest rainstorms. Widespread instability along the creek and the base of its confining valley walls reflects an unnaturally rapid, or 'flashy,' hydrologic response and the unconsolidated, erosion-prone materials comprising the bed and banks. Anomalous accumulations of sediment at the mouth of West Aldershot Creek, which the City had to dredge to maintain boat access, are a testament to the local severity of erosion.

The creek is largely fed by two storm sewers, a 750mm diameter pipe and 1430mm diameter pipe, outletting through a single outfall structure at the upstream end of the Study Area (**Figure 1-2**). Locally severe down-cutting along the creek bed has undermined the outfall structure at its head and severely undercut the channel banks along portions of the creek.



Figure 1-2: Existing Erosion within Creek (*left*); Upstream Outfall Structure (*right*)

Erosion is most severe along the upstream portion of the study corridor, where the channel is confined along the bottom of a nearly V-shaped ravine with little to no floodplain to attenuate flow energy. Significant bed scour and down-cutting has occurred, which in turn has led to undercutting and collapse of the banks. Several small slope failures have occurred recently along the lower valley walls in response to the fluvial erosion. Trees have fallen into the channel once their root masses have been undermined, which, in turn, has exacerbated erosion by forcing flows over, under and around the woody debris jams that form. The

downstream portion of the creek, where the valley bottom is wider and a narrow floodplain is more accessible, exhibits fewer, less severe erosion sites.

Without intervention, the channel will continue to deepen and widen its cross-section through incremental fluvial scour and mass wastage until it re-equilibrates with its new hydrologic regime – a process that could take decades. The City of Burlington has prioritized the assessment and management of erosional processes along the creek, through the implementation of erosion control solutions, in order to mitigate further risk to infrastructure and local and downstream aquatic and riparian habitats.

1.2 STUDY OBJECTIVES

The purpose of this study is to develop alternatives to mitigate excessive erosion along West Aldershot Creek. In developing these alternatives, the Study Team took into consideration the objectives of the Study:

- Prevention of further, excessive erosion along West Aldershot Creek;
- Restoration and enhancement of aquatic and riparian habitat, where feasible;
- Protection of private property alongside the creek;
- Protection of existing infrastructure (sanitary infrastructure, stormwater outfalls, pumping station facility and roadways);
- Improvement of the quality of West Aldershot Creek; and
- Maintenance or enhancement of aesthetics for surrounding landowners.

The alternatives proposed to address the erosion concerns are outlined in Section 5 as are the evaluation of the alternatives and the identification of the preferred alternative.

1.3 PLANNING AND POLICY

The Study Area is outside of key Ontario policy areas, including the Oak Ridges Moraine Conservation Plan, Niagara Escarpment Plan and Greenbelt Plan. Additional relevant policies that have been reviewed during the course of the Study include:

- Provincial Policy Statement (2014);
- Halton Region Official Plan (2016);
- City of Burlington Official Pan (2017);
- City of Burlington Zoning By-Law (2007);
- Conservation Authority Regulation (O. Reg. 162/06);
- Fisheries Act (1985);
- Endangered Species Act (2007); and
- Migratory Birds Convention Act (1994).

A brief discussion of the listed policies is provided in the *Terrestrial and Aquatic Ecology Report* prepared by Palmer Environmental Consulting Group and included in **Appendix D**.

1.3.1 Hamilton Harbour Remedial Action Plan

The Hamilton Harbour Remedial Action Plan (HHRAP) was created in response to Hamilton Harbour being identified as one of 43 locations around the Great Lakes where environmental degradation has led to the decline of ecosystem health locally and to the Great Lakes Basin more widely. Damage done to the Hamilton Harbour through industrial development and population growth has resulted in the area's designation as an "Area of Concern (AOC)". The delisting of Hamilton Harbour as an AOC requires that various water quality and natural habitat requirements are achieved for Hamilton Harbour, including lowering phosphorous and sediment levels in urban runoff entering the Harbour.

An Urban Runoff Task Group for Burlington was formed which completed an overview of local stormwater management practices and provided recommendations for opportunities to change, primarily source control and Low Impact Development (LID). Since the *Hamilton Harbour Remedial Action Plan: Urban Runoff Burlington Report and Recommendations* was issued in October 2016, the City has committed to and implemented numerous initiatives to address urban runoff quality and quantity.

As West Aldershot Creek discharges into Hamilton Harbour, any works proposed for the watercourse should be in keeping with the HHRAP and consider the recommendations made in the Urban Runoff report.

2 Study Process

The *West Aldershot Creek Erosion Control* Class EA is considered to be a Schedule 'B' undertaking pursuant to the Municipal Class Environmental Assessment (MCEA) document (MEA, 2000 as amended in 2007, 2011, and 2015). The Class EA process is a process used for the planning of municipal infrastructure projects (roads, water and wastewater, and transit) to ensure that project planning and predesign proceeds in accordance with the *Environmental Assessment Act*. A Schedule 'B' project includes public and review agency consultation, an evaluation of alternatives, an assessment of the impacts of the preferred solution, and identification of measures to mitigate any adverse impacts.

Figure 2-1 is an excerpt from the MCEA document and illustrates the process followed in the typical planning and design of projects covered by a Class EA. A further description of the Class EA process is provided in the following sections.

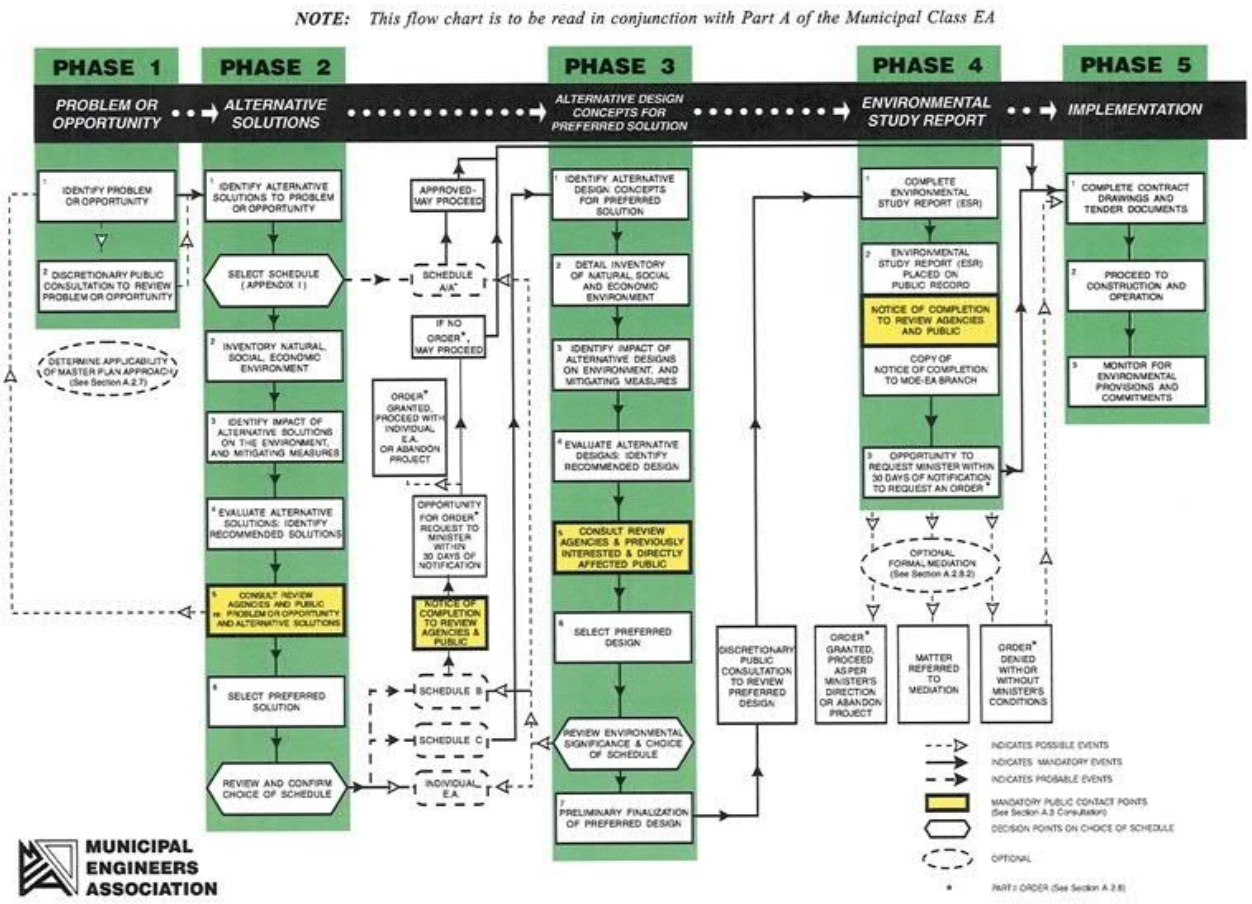


Figure 2-1: MEA Class EA Process

2.1 THE CLASS ENVIRONMENTAL ASSESSMENT PROCESS

Every municipality in Ontario is subject to the provisions of the *Environmental Assessment Act* (EAA) and its requirements to conduct an Environmental Assessment for most public works projects. The MEA's MCEA document provides municipalities with a five-phase planning procedure approved under the EAA, which provides direction on how to plan and undertake all municipal projects that recur frequently, are usually limited in scale and have a predictable range of environmental impacts. Projects considered by the Class EA process include municipal roads and bridges, wastewater, storm water management, water and transit. The MCEA document also requires that the decision-making process followed by the municipalities in the planning and implementation of infrastructure is transparent and provides opportunity for public and stakeholder involvement.

Table 2-1 illustrates the steps followed in the planning and design of projects covered under the Class EA process. This table summarizes steps considered essential for compliance with the requirements of the EAA. With increasing complexity and higher likelihood for adverse environmental impacts, projects are

required to complete additional planning steps, termed 'Phases' by the MCEA document, prior to obtaining approval to proceed with a proposed project. The MCEA document provides the following description of the five phases potentially requiring completion before Class EA projects can be approved.

Table 2-1: Phases of the Class EA Process

Phase	Description
Phase 1	Identify the problem (deficiency) or opportunity.
Phase 2	Identify alternative solutions to address the problem or opportunity by taking into consideration the existing environment, and establish the preferred solution considering public and review agency input.
Phase 3	Examine alternative methods of implementing the preferred solution, based upon the existing environment, public and review agency input, anticipated environmental effects and methods of minimizing negative effects and maximizing positive effects.
Phase 4	Document, in an Environmental Study Report a summary of the rationale, and the planning, design and consultation process of the project as established through the above phases and make such documentation available for scrutiny by review agencies and the public.
Phase 5	Complete contract drawings and documents and proceed to construction and operation; monitor construction for adherence to environmental provisions and commitments. Where special conditions dictate, also monitor the operation of the completed facilities.

Based on the MCEA document, projects are classified as either Schedule 'A', 'A+', 'B' or 'C' projects. Each of these classifications requires a different level of review to complete the requirements of the Class EA, and thus comply with the EAA, as noted below.

Schedule 'A' projects are limited in scale, have minimal adverse environmental effects and include a number of municipal maintenance and operational activities. These projects are pre-approved and may be implemented without following the Class EA process.

Schedule 'A+' projects are limited in scale and have minimal adverse environmental effects. These projects are pre-approved and may proceed directly to Phase 5 for implementation without following the other phases. However, the public is to be advised prior to project implementation though there is no ability for the public to request a Part II Order.

Schedule 'B' projects have the potential for some adverse environmental effects. The proponent (i.e. The City of Burlington in the case of this Class EA) is required to undertake a screening process involving mandatory contact with directly affected public, First Nations groups and relevant government agencies to ensure that they are aware of the project and that their concerns are addressed. A Schedule 'B' activity

requires the proponent to conduct two mandatory points of public contact during Phase 2. Additionally, the proponent may elect to undertake a discretionary public consultation at the end of Phase 1 to present the problem or opportunity identified.

Phases 1 and 2 of the Class EA process must be followed and a Project File Report (PFR) must be prepared and submitted for review by the public. A Notice of Completion must be submitted to review agencies and the public and a period of 30 calendar days are provided for comment and input on the PFR.

As long as no outstanding concerns are raised by the public and/or relevant government agencies, the proponent may proceed to project implementation. However, should a person or party have a concern or objection, they are expected to consult with the proponent to try to resolve the concern. Alternatively, if concerns cannot be resolved, the person or party with the objection may request a Part II Order from the Minister of the Environment, Conservation and Parks. Further details on the process of requesting a Part II Order can be found in Section 2.3.

Schedule 'C' projects are those that have the potential for significant adverse environmental impact and must proceed under the full planning and documentation procedures (Phases 1 to 5) specified in the MCEA document. A Schedule 'C' project is required to complete an Environmental Study Report (ESR), as opposed to a Project File Report for Schedule 'B' undertakings.

The proponent is required to undertake consultation during multiple phases during the Class EA involving mandatory contact with directly affected public, First Nations groups and relevant government agencies to ensure that they are aware of the project and that their concerns are addressed. Schedule 'C' projects involve 4 points of mandatory public contact: twice during Phase 2, once during Phase 3 and again during Phase 4 after the ESR document is placed on public record. Schedule 'C' projects require that an ESR be prepared and submitted for review by the public. If concerns are raised that cannot be resolved, then a Part II order can be invoked.

2.2 STUDY DOCUMENTATION

The Project File Report (PFR) documents the planning and design process followed to determine the recommended undertaking and environmentally significant aspects for the *West Aldershot Creek Erosion Control* Class EA Study, in accordance with the procedures for Schedule 'B' projects, setting out the planning and decision-making process, including consultation with stakeholders, technical agencies and the public, which has been followed to arrive at the preferred solution. The PFR also sets out the mitigating measures proposed to avoid or minimize environmental impacts.

The PFR is organized chronologically in such a way as to clearly demonstrate that the appropriate steps in Phases 1 and 2 have been followed. The report is intended to be a traceable and easily understood record of the proponent's decision-making process. The PFR generally describes the following:

- The problem or opportunity and other background information;
- A description/inventory of the environment;

- The alternative solutions considered, and the evaluation process followed to select the preferred solution;
- The mitigating measures and follow-up commitments, which will be undertaken to minimize environmental impacts including any monitoring necessary during construction; and
- The consultation process and an explanation of how concerns raised by the public and review agencies have been addressed in developing the project.

2.3 PART II ORDER

Public, review agency and First Nations consultation is a key part of the Class EA process. In a Schedule 'B' project, such as the erosion control and remediation measures considered under this Class EA Study, the proponent is required to provide opportunity for the public to be consulted about the proposed project. Consultation is intended to inform the public and other stakeholders about the proposed project, the various alternative solutions considered and their anticipated environmental impacts, as well as the preliminary preferred solution. It is also intended that the public be given opportunity to provide input or raise concerns prior to completion of the Class EA process. It is intended that issues be identified early into the project by means of public involvement and that resolutions between the proponent and the person or party with the objection be achieved through consultation.

It is incumbent on the public that concerns about the environmental effects of a proposed project or the planning process being followed are brought to the attention of the proponent early in the planning process, when the proponent has greater flexibility to accommodate changes in the project development and the process.

If the consultation process raises a concern that cannot be resolved between the proponent and the person or party raising the objection, then a Part II order can be invoked. However, prior to a Part II Order being requested, the person or party with the objection may request the proponent to voluntarily elevate a Schedule 'B' project to a Schedule 'C' project, or to elevate a Schedule 'B' or 'C' project to an individual environmental assessment. If the proponent declines this request, the person or party raising the objection may write to the Minister of the Environment, Conservation and Parks or delegate to request a Part II Order. A request for a Part II Order must be copied by the requester to the proponent at the same time that it is submitted to the Minister or delegate.

A Part II Order can be requested after the proponent issues the Notice of Completion and within the specified review period outlined in the Notice (30 calendar days from issuance of Notice of Completion). As of July 1, 2018, a person or party wishing to request a Part II Order must use a *Part II Order Request Form* which can be found on the Forms Repository website (http://www.forms.ssb.gov.on.ca/) by searching "Part II Order" or "012-2206E" (the form ID number). The form will require you to provide the following information:

- Your name and address;
- Project name;
- Proponent name;
- Specific reasons why the request is being made - concerns and issues;
- Why a higher level of environmental assessment would address your concerns;

- Information about efforts to date to discuss and resolve concerns with the proponent;
- The outcome you are seeking from the Minister; and
- Other matters relevant to the request.

Unless you state otherwise in your request, any personal information you provide will become part of the public record and will be released, if requested, to any person.

In your request, you must:

- focus on potential environmental effects of the project or the Class EA process;
- not focus on decisions outside the Class EA process (e.g., land-use planning decisions made under the Planning Act or issues related to municipal decision-making about the process); and
- not raise issues unrelated to the project.

Once completed, the form is to be sent to the Minister of the Environment, Conservation and Parks, the Director of Environmental Assessment and Permissions Branch and the Proponent at:

Minister
Ministry of the Environment, Conservation and Parks
Floor 11
77 Wellesley St. West
Toronto, ON M7A 2T5
Minister.mecp@ontario.ca

Director, Environmental Assessment and Permissions Branch
Ministry of the Environment, Conservation and Parks
135 St. Clair Ave. West, 1st Floor
Toronto, ON M4V 1P5
enviropermissions@ontario.ca

Umar Malik, M.Eng., P.Eng.
Stormwater Engineer
City of Burlington – City Hall
426 Brant Street; PO Box 5013
Burlington, ON L7R 3Z6
Umar.malik@burlington.ca

2.4 STUDY ORGANIZATION AND PROJECT TEAM

The City of Burlington (City) retained Associated Engineering (AE) and Palmer Environmental Consulting Group (PECG) to conduct the *West Aldershot Creek Erosion Control* Class EA study. The Project Team, as outlined in **Table 2-2**, consists of City of Burlington staff, Associated Engineering staff, Palmer Environmental Consulting Group staff and sub-consultants providing specific knowledge and expertise to address the requirements for this project in accordance with the *Environmental Assessment Act.*

Table 2-2: Study Team

Team Member	Role	Organization
Umar Malik, M.Eng., P.Eng.	Proponent (Project Manager)	City of Burlington
Stan Mathew, P.Eng.	Prime Consultant (Project Manager)	Associated Engineering
Andrea LaPlante, P.Eng.	Environmental Assessment Coordinator	Associated Engineering
Robin McKillop, M.Sc., P.Geo., CAN-CISEC	Fluvial Geomorphologist	Palmer Environmental
Angela Wallace, M.Sc.	Aquatic Ecologist	Palmer Environmental
Austin Adams, M.Sc., EP	Terrestrial Ecologist, Certified Arborist	Palmer Environmental
Chi Cheng (Dennis) Tseng, M.Sc., P.Eng.	Geotechnical Engineer	Palmer Environmental
Don McBrayne, P.Eng.	Water Resources Engineer	Associated Engineering
Lisa Merritt, M.Sc.	Archaeologist	Archaeological Services Inc.
Shawn Price	Survey	Groma Technical Services

2.5 CONSULTATION PROCESS

As part of the planning process, several steps have been completed to inform government agencies, affected landowners and the local community/ general public of the nature and scope of the project and to solicit any comments.

Throughout the Study, public, stakeholder, First Nations and agency notification included:

- Notice of Study Commencement — July 26, 2018
- Notice of Public Information Centre — November 15/22, 2018
- Public Information Centre (PIC) — December 3, 2018
- Notice of Study Completion — October 17, 2019
- Project File Report 30 Day Review Period — November 15, 2019

Further consultation process details are provided within Section 8 of this report.

2.6 STUDY SCHEDULE

The following table (**Table 2-3**) outlines the key milestone dates of the project thus far and projected to completion.

Table 2-3: Key Milestone Dates

Schedule Item	Date
Initiate Class EA Study	June 2018
Notice of Study Commencement	July 26, 2018
Public Information Centre No. 1	December 3, 2018
Completion of Project File Report	May 2019
Notice of Study Completion	October 17, 2019
Completion of Public Review Period	November 15, 2019
Detailed Design	Fall 2019
Construction	2020

Phase I: Identification of Problems & Opportunities

3 Problem and Opportunity Statements

The Problem and Opportunity Statements provide a clear statement of the problem and opportunities that need to be addressed for a specific undertaking. The various analyses (e.g. hydrologic, hydraulic, aquatic, fluvial, terrestrial, geotechnical) inform the identification and description of the problems and opportunities. The overarching issues along West Aldershot Creek can be summarized by the following statements.

Problem Statement

Ongoing, excessive erosion along West Aldershot Creek has been identified between Fairwood Place and Lake Ontario. Continuous down-cutting of the creek bed and undercutting of the banks present a risk to public and private property, municipal infrastructure, and aquatic and riparian habitat.

Opportunity Statement

This project presents an opportunity to increase the environmental and social benefits offered by the Study Area. It will help characterize and, once its preferred erosion control solutions are implemented, combat excessive erosion along West Aldershot Creek to mitigate risks to public and private property, municipal infrastructure, and aquatic and riparian habitat. Creek stabilization and restoration will ultimately also improve aesthetics.

In order to address the issues described above, a range of practical, cost-effective alternative solutions was identified to solve the Problem. The development and evaluation of the alternative solutions is the subject of Section 5 of this report.

Phase II: Identification & Evaluation of Alternative Solutions

4 Existing Conditions

For the purposes of assessment and planning erosion control solutions, West Aldershot Creek has been divided into three (3) reaches, as illustrated in **Figure 4-1**. Each reach poses risks to stormwater and/or sanitary sewer infrastructure. Reaches can be defined as lengths of channel that display similar physical characteristics and have a setting that remains nearly constant along their length. Reaches display relative homogeneity in channel form, functions and process, and are influenced by similar controlling (discharge, slope) and modifying factors (bank treatments, vegetation). Each of the reaches exhibits different erosion-related issues as briefly described below. Further erosion-related details of each reach are provided in Section 4.1.3.

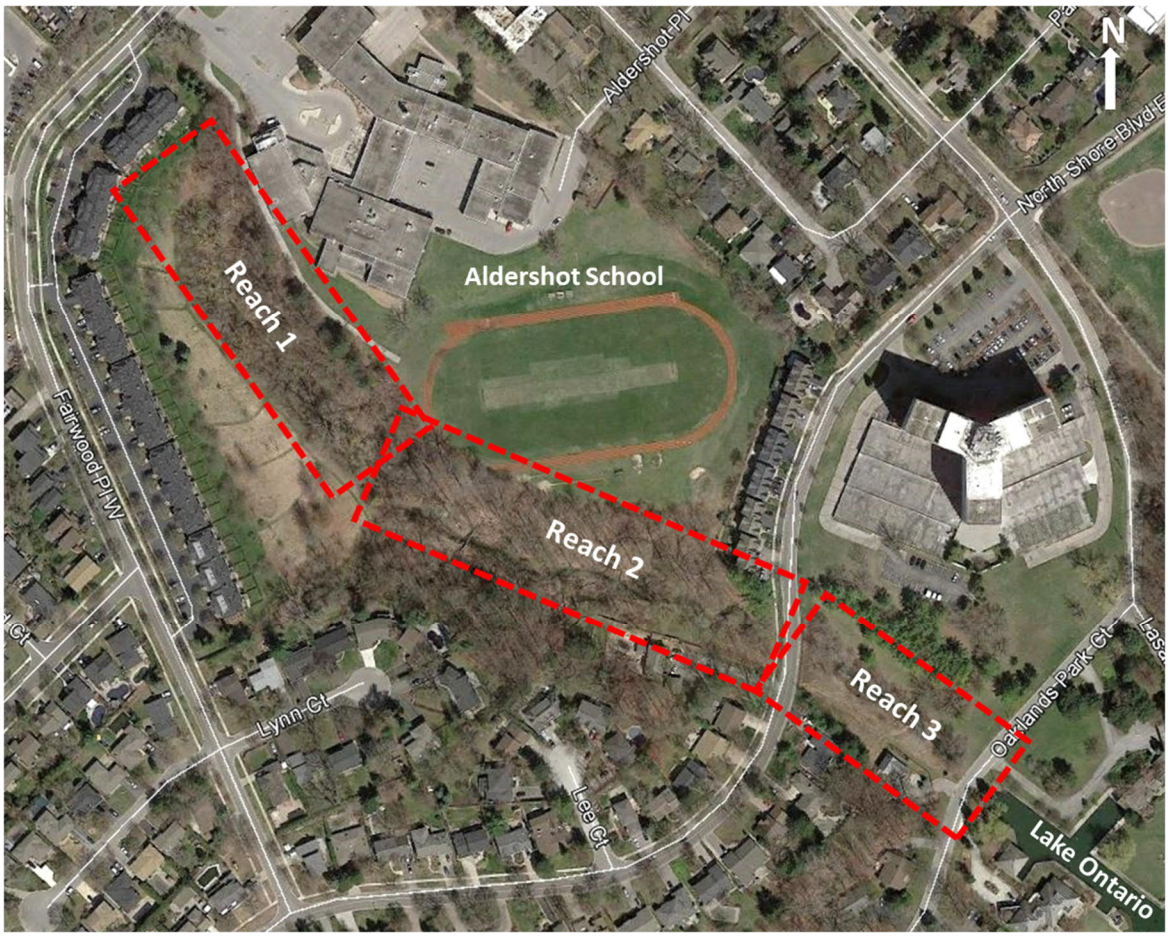


Figure 4-1: West Aldershot Creek Reach Designation

Reach 1

Reach 1 extends from the main outfall south of Fairwood Place downstream to a valley widening adjacent to the southern limit of the access road along the west side of Aldershot School. This reach, which is confined along the bottom of a deep, narrow valley, exhibits the most extensive and continuous erosion, and will require the greatest amount of mitigative and restorative work. **Figure 4-2** identifies key existing issues along Reach 1.



Figure 4-2: Key Issues along Reach 1

Reach 2

Reach 2 extends from the valley widening downstream to the crossing of North Shore Boulevard. The valley is broader and shallower along this reach, with the channel abutted by low terraces and eventually a contemporary, active floodplain. The channel is wider and gentler, so erosion is less continuous and severe. **Figure 4-3** identifies key existing issues along Reach 2.

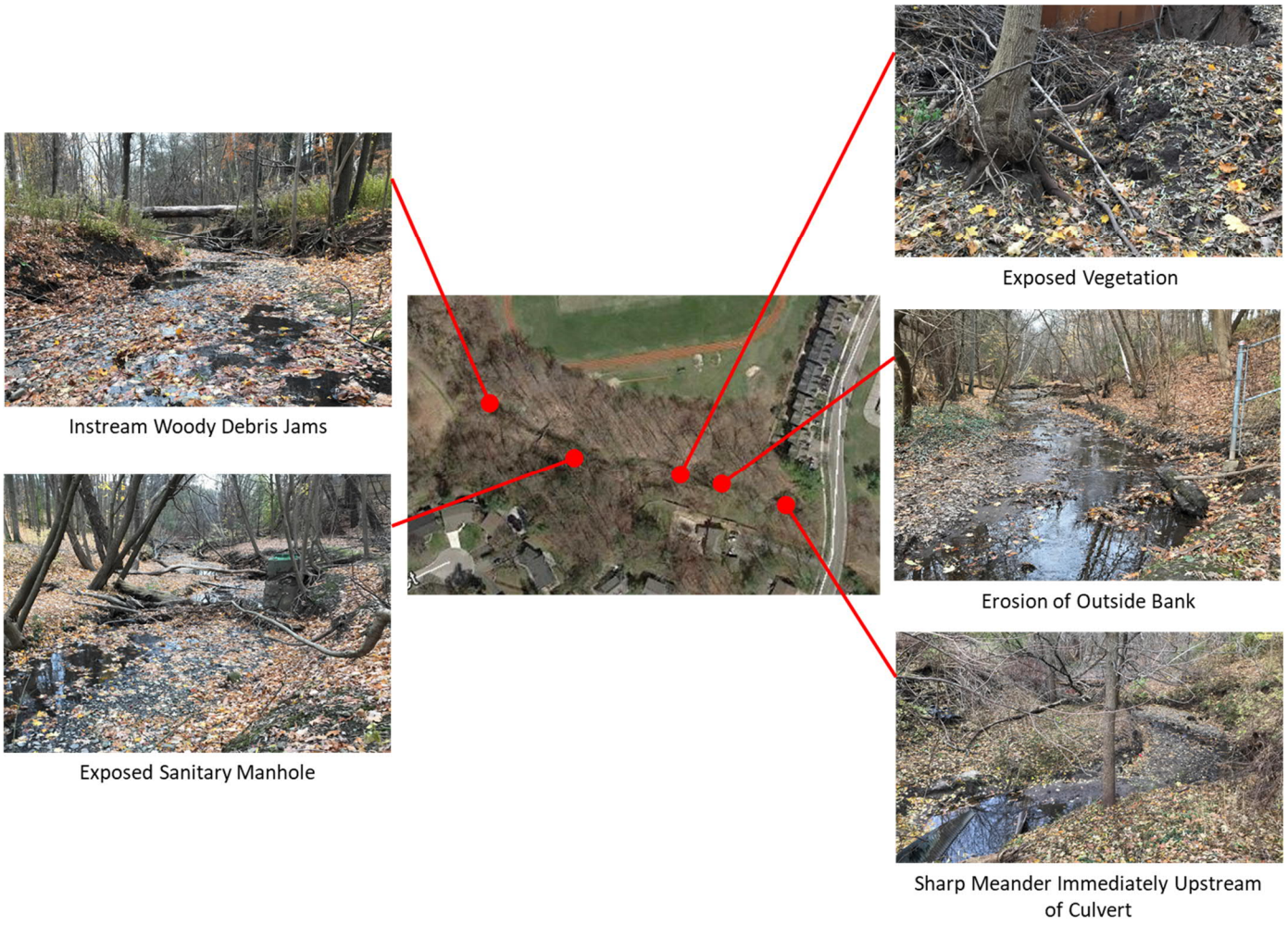


Figure 4-3: Key Issues along Reach 2

Reach 3

Reach 3 extends from North Shore Boulevard to the culvert outlet into Lake Ontario beneath Oaklands Park Court. The channel is entrenched within fill-mantled ground, which is readily eroded. A large, scallop-shaped hollow has formed along the east bank where flows have been deflected around a series of woody debris jams. **Figure 4-4** identifies key existing issues along Reach 3.



Figure 4-4: Key Issues along Reach 3

Further details regarding the existing conditions of the entire Study Area and individual reaches are documented in the following sections which summarize the discipline-specific reports that have been prepared for this Study and are appended to this report. Refer to the specific reports for more detailed inventories and descriptions of existing conditions along West Aldershot Creek.

4.1 NATURAL ENVIRONMENT

The description of existing conditions follows a summary of the physical setting and historical changes that have occurred in the area encompassing West Aldershot Creek. Land use surrounding West Aldershot Creek has changed from agricultural and rural residential to commercial and urban residential development over the historic record (1934 to 2018). Tableland along the western and eastern edge of the West Aldershot Creek ravine was cleared and graded before 1960. Aldershot High School was constructed immediately east of the valley between 1960 and 1962. A construction access road was present in 1960 along the edge of the channel in Reach 2 (refer to **Figure 4-5**) for installation of linear infrastructure (presumably the Region-owned sanitary sewer). West Aldershot Creek flowed within a ravine beneath and immediately upstream of what is now Fairwood Place West until it was backfilled after the 1960s to accommodate road construction and residential development. A small tributary flowing from the northeast into Aldershot Creek near North Shore Boulevard was modified in preparation for residential development between the high school field and North Shore Boulevard between 1962 and 1995. Planform instability immediately upstream of North Shore Boulevard reflects the installation of an undersized culvert beneath the road (refer to **Figure 4-5**). Riparian vegetation has consisted of moderately dense forest cover alongside Reaches 1 and 2 throughout the historic record, with Reach 3 being cleared after 1934 and slowly re-establishing sparse tree cover along the channel edge. The outlet into Lake Ontario has been unnatural since 1960.

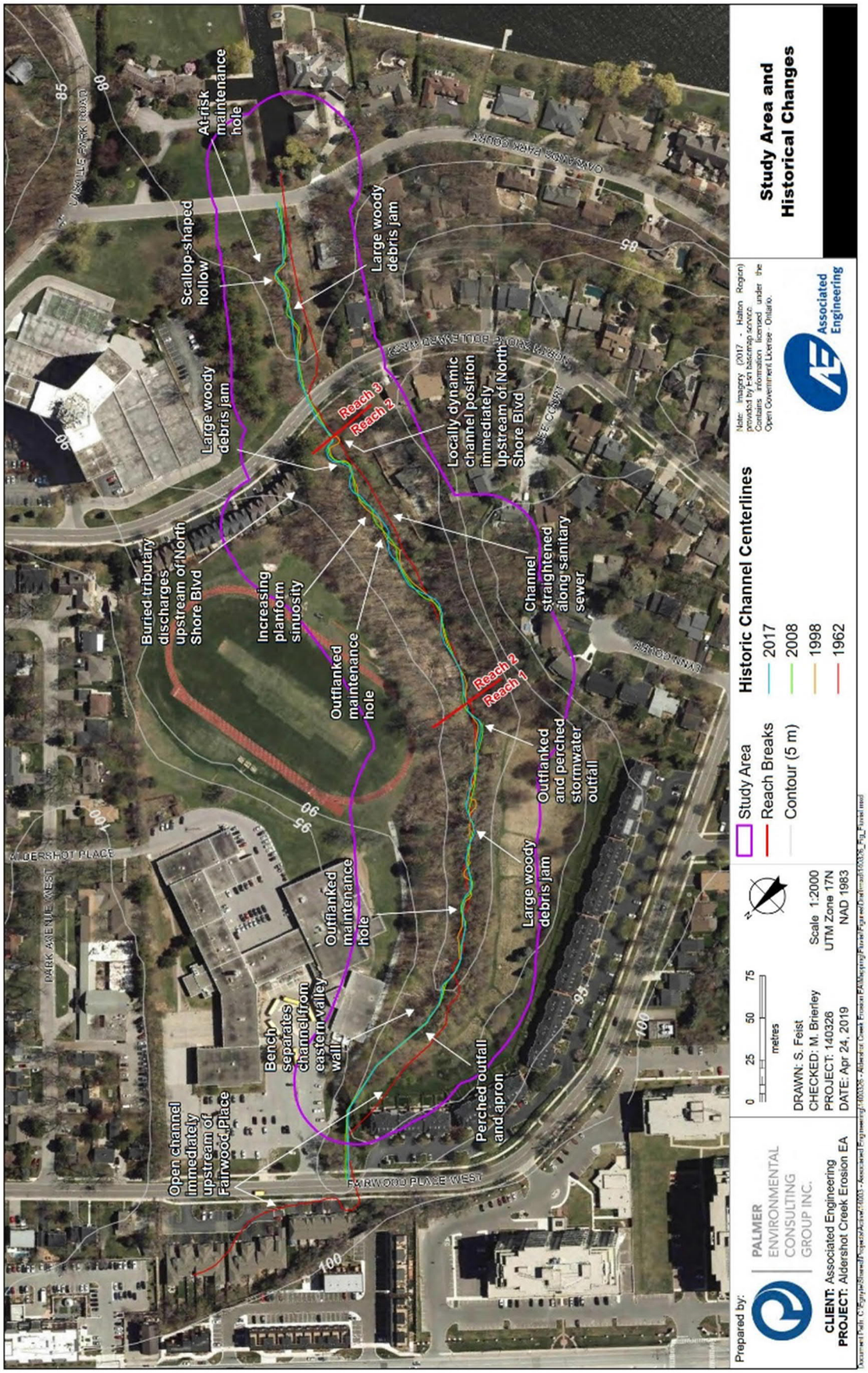


Figure 4-5: Study Area and Historical Changes

4.1.1 Geology, Hydrogeology and Slope Stability

Geology

The Study Area is situated within the Iroquois Plain physiographic region of Southern Ontario. The topography in this region is typically undulating till plains locally overlain by glaciolacustrine deposits. A review of available online surficial geology mapping indicated that the overburden materials of the site generally comprise sand, gravel, and minor silt and clay deposits. Bedrock geology mapping indicated that the site is underlain by materials comprised of shale, limestone, dolostone and siltstone of Queenston Formation. A natural concentration of surface runoff during the Holocene incised the glacial and deglacial deposits through gullying and fluvial erosion, forming the valley through which West Aldershot Creek now flows.

Soil Conditions

Soil conditions in the Study Area were assessed through advancement of four (4) boreholes (BH18-1 to BH18-4) to depths of 9.8m to 14.3m below the existing ground surface at strategic locations alongside the valley (**Figure 4-6**). The soil stratigraphy was recorded, groundwater conditions were observed in the boreholes, and the soil samples were tested for moisture content and grain size analysis. A summary of the subsurface conditions in the boreholes is provided below.

Topsoil: A 100 to 130mm thick layer of surficial topsoil was encountered in all boreholes. It should be noted that the thickness of the topsoil explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil at the site.

Fill Materials: Fill materials consisting of clayey silt, sandy silt, and sand were encountered below the topsoil in all boreholes and extended to depths ranging from about 1.0 to 2.6m below the existing ground surface. For the cohesive clayey silt fill materials, SPT 'N' value of 3 blows per 300mm penetration indicated a soft consistency. For the cohesionless sandy silt and sand fill materials, SPT 'N' values ranging from 5 to 26 blows per 300mm penetration indicated a loose to compact compactness condition. The in-situ moisture contents measured in the fill samples ranged from approximately 2% to 30%.

Silt, Sandy Silt, Silty Sand, and Sand: Silt, sandy silt, silty sand, and sand deposits were encountered below the fill materials in Boreholes BH18-1 to BH18-3, and extended to depths ranging from about 8.0 to 9.5m below the existing ground surface. SPT 'N' values ranged from 6 to 43 blows per 300mm penetration indicating a loose to dense compactness condition. The natural moisture contents measured in the soil samples ranged from approximately 3% to 23%.

Upper Clayey Silt: An upper clayey silt deposit was encountered between layers of silt, sandy silt, silty sand, and sand deposits in Boreholes BH18-1 and BH18-3. In Borehole BH18-1, this deposit extended from 7.7 to 7.9m below the existing ground surface. In Borehole BH18-3, this deposit extended from 3.0 to 6.3m below the existing ground surface. SPT 'N' values ranging from 16 to 43 blows per 300 mm penetration indicated a very stiff to hard consistency. The natural moisture contents measured in the soil samples ranged from approximately 13% to 21%.

Clayey Silt to Silty Clay: Clayey silt to silty clay deposits were encountered below the fill materials or silt, sandy silt, silty sand, and sand deposits in all boreholes, and extended to depths ranging from 9.8 to 14.3m below the existing ground surface. SPT 'N' values ranging from 7 to 43 blows per 300 mm penetration indicated a firm to hard consistency. All boreholes were terminated in these deposits. The natural moisture contents measured in the soil samples ranged from approximately 18% to 26%.

Groundwater

Groundwater condition observations were made in the boreholes during drilling and upon completion of drilling. Monitoring wells were installed in three (3) boreholes to allow determination of stabilized groundwater levels. The stabilized groundwater levels were measured on September 18, 2018. The monitoring well installation and groundwater data are summarized in the individual borehole logs (refer to *Integrated Geotechnical and Hydrogeological Assessment Report* located in **Appendix A**) and in **Table 4-1**.

Table 4-1: Monitoring Well Details and Water Levels (September 18, 2018)

Monitoring Well ID	Screen Interval (mBGS)	Water Level Depth (mBGS)	Water Level Elevation (m)
BH18-1	3.0 ~ 6.1	3.8	85.0
BH18-2	6.1 ~ 7.6	1.9	89.8
BH18-2	7.6 ~ 10.7	1.1	87.4

Note: mBGS = meter below ground surface

Measured groundwater levels were supplemented by site reconnaissance data of localized seepage directly adjacent to the creek (i.e. toe of the slope) to estimate the approximate water table and groundwater flow direction. Note that while seepage was observed further up the slope (i.e. mid slope), this is not necessarily representative of the groundwater table and may be a result of a perched water table in the fill material, surface runoff or a combination of the two.

Slope Stability

A detailed slope stability analysis was completed on four (4) cross-sections across Reach 1, where erosion is most severe and confining banks and valley walls are steepest and highest, based on borehole drilling and measured water levels in groundwater monitoring wells. The slope stability analysis focused on the potential for long-term deep-seated failure. General comments are provided on slope stability along Reach 2 and downstream, Reach 3, portions of the valley, where valley walls are generally not at risk from fluvial activity.

Reach 1: Results indicate that the slopes within Reach 1 are not subject to deep-seated failure. Detailed slope stability analysis indicates instability is limited to the over-steepened toe region of the slopes, which are expected to continuously slough until attaining a relatively stable 2H:1V slope. This is supported by visual investigation of the mid-crest region of the slope, in cross-section, which is at approximately 2H:1V. Without intervention, the toe will likely naturally flatten out to 2H:1V over time. The long-term stable slope crest (LTSSC) is delineated on **Figure 4-6**.

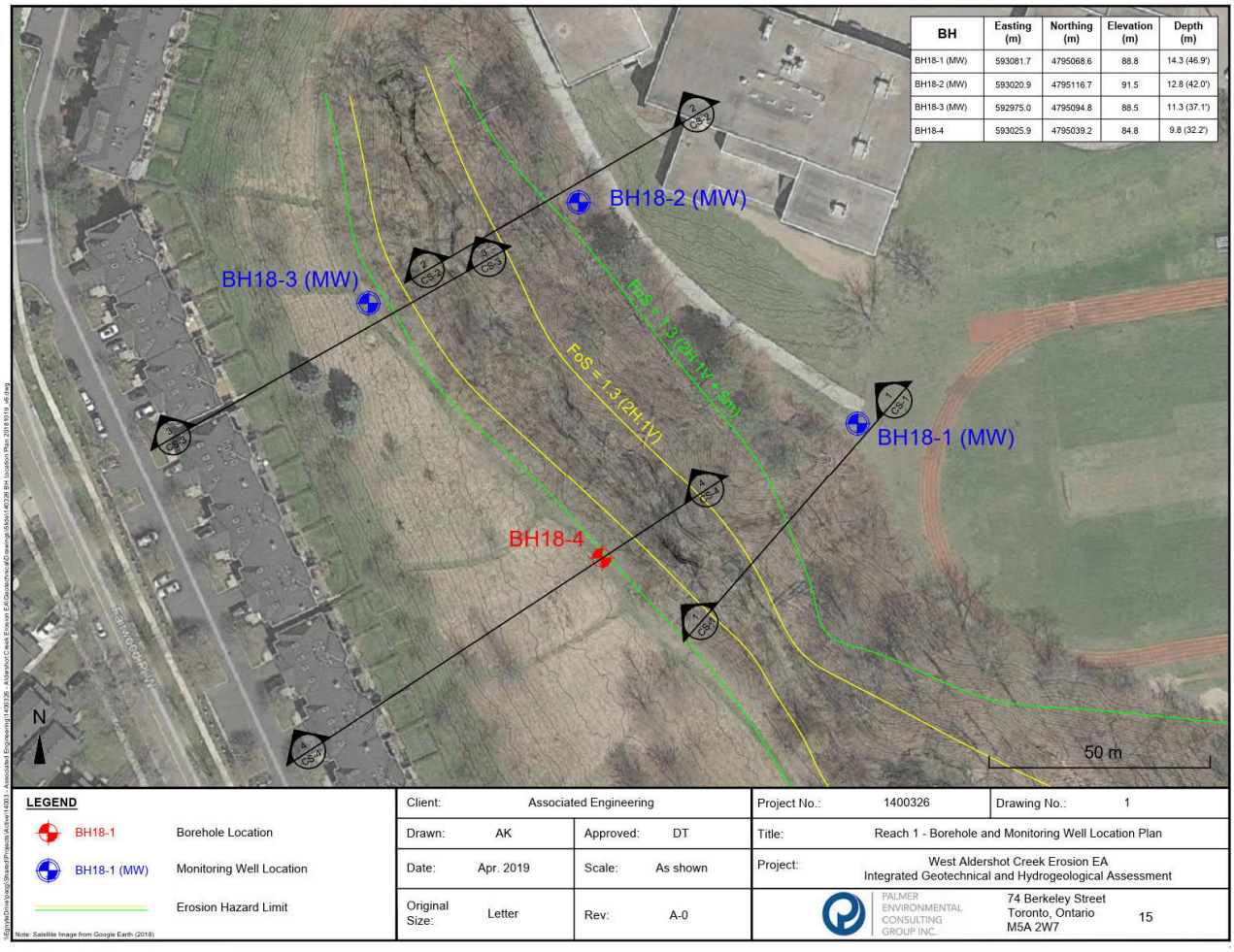


Figure 4-6: Borehole and Monitoring Well Location Plan for Reach 1

Reaches 2 and 3: Several cross-sections were cut across Reaches 2 and 3 and visually compared to cross-sections from Reach 1. Generally, the slopes within the downstream reaches (Reaches 2 and 3) flatten out significantly when compared to Reach 1, indicating comparatively stable conditions. Analysis also indicates the creek channel widens significantly in the downstream reaches when compared to Reach 1, indicating a lower risk of erosive potential and reduced need for mitigative measures. Given that no boreholes were drilled within Reaches 2 and 3, as per MNRF guidelines, in the absence of site-specific geotechnical information, a 3H:1V stable slope inclination has been assumed. The LTSSC is delineated on **Figure 4-7**.

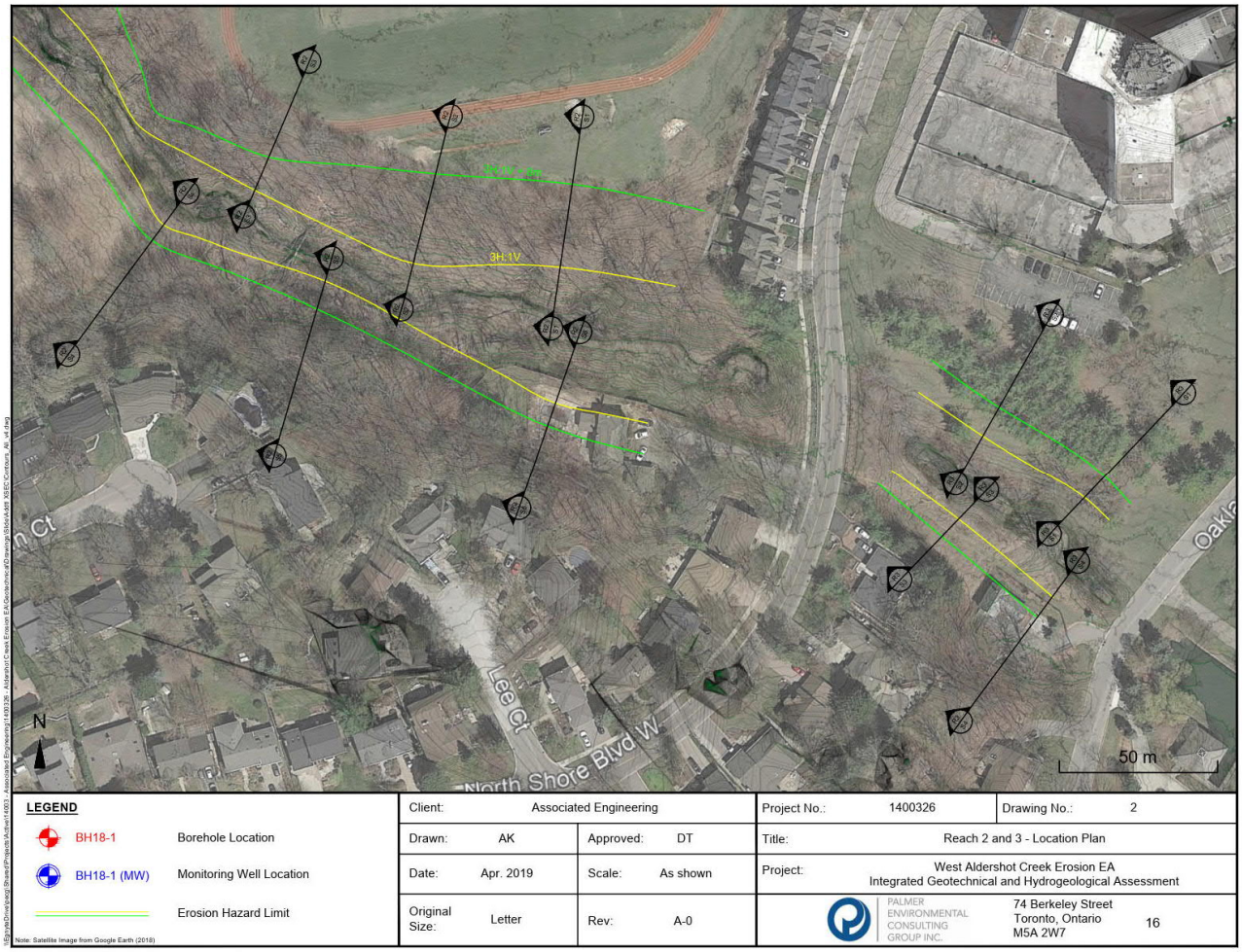


Figure 4-7: Borehole and Monitoring Well Location Plan for Reaches 2 and 3

Toe Erosion Allowance: The LTSSC is supplemented by a toe erosion allowance as delineated on **Figure 4-6** and **Figure 4-7**. The required toe erosion allowance has been determined based on consideration of MNRF guidelines, reach-specific rates of bank erosion estimated over the historical record, and an understanding of site-specific fluvial processes. A toe erosion allowance of 5 m has been applied along Reach 1 based on documentation of a time-averaged erosion rate of approximately 0.05 m/year since 1962, which is consistent with MNR's toe erosion allowance range of 5 to 8 m for cohesive clay/silt soils. Application of the lower limit of the range is also appropriate because most of the erosive energy along this ravine-like reach is attenuated through down-cutting as opposed to lateral erosion, more typical of the meandering watercourses on which MNRF's empirical ranges are based.

A toe erosion allowance of 8 m has been applied to Reaches 2 and 3, where meanders are better developed and locally separated from the cohesive valley walls by alluvial terraces and sand/silt fill (range of 8 to 15 m, MNR).

Detailed information regarding the Geotechnical Investigation, including slope stability analysis, is provided in the *Integrated Geotechnical and Hydrogeological Assessment Report* located in **Appendix A**.

4.1.2 Hydrology and Hydraulics

A hydraulic and hydrologic assessment of the West Aldershot Creek watershed and stormwater outfall contributions to the creek was completed, as well as hydraulic assessment of all culvert crossings along the creek. The assessment included: catchment delineation using GIS tools, characterization of design runoff/flows, climate change sensitivity analysis using the MTO IDF forecast tool, and hydraulic evaluation of existing structures and hydraulic grade line during the various design storm scenarios for the culvert crossings.

Hydrological Analysis

Hydrology was estimated using a combination of GIS and modeling tools. Catchment parameters were used in a PCSWMM model to estimate runoff and routed inflows into each of the Study reaches. A summary of the resultant flows into each creek reach is presented in **Table 4-2**.

Table 4-2: Estimated Flows into the three (3) Study Reaches

Reach	Estimated Flows (m^3/s)						
	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	Hazel
1	5.6	6.5	7.1	7.6	8.0	8.3	6.7
2	8.4	10.1	10.9	11.6	12.0	12.4	10.6
3	10.4	12.9	14.5	16.2	17.2	18.0	12.8

Climate Change: Understanding risks of climate changes on projects and potential adaptation and mitigation strategies helps our clients make informed decisions and plan long-term climate change strategies. Therefore, as part of the base scope of work for the hydraulic and hydrology assessments, a Climate Change Sensitivity analysis using the MTO IDF forecast tool was conducted to look at the potential implications that climate change may have on precipitation in the Study Area. Design rainfall intensities and rainfall depths for the 100-Year (6-hr) event was projected to 50 years. A comparison between the current and future projected rainfall statistics is presented in **Table 4-3**. Based on the results from hydrologic modeling, future rainfall intensities and depths are estimated to be approximately 5% higher than current (2010) design values. Climate change analysis was not considered in the prospective hydraulic analysis; however this can be changed if the City wishes to further consider the potential impacts of climate change in the Study Area.

Table 4-3: Current and Future Climate Change Influenced Design Flows

Current (2010)		Estimated Future Projected (2070)		Difference	
Rainfall Intensity, mm/hr (100-Yr, 6hr)	Rainfall Depth mm (100-Yr, 6hr)	Rainfall Intensity mm/hr (100-Yr, 6hr)	Rainfall Depth mm (100-Yr, 6hr)	Rainfall Intensity mm/hr (100-Yr, 6hr)	Rainfall Depth mm (100-Yr, 6hr)
13.3	80.1	14.0	84.0	~5%	~5%

Hydraulic Analysis

The hydraulics of the existing structures was analyzed in two stages:

1. Capacity of the existing culverts, and
2. Level of the hydraulic grade line during the various design storm scenarios for the culverts.

Streamflows and water levels were simulated using a topographic surface from a UAV-based LiDAR survey in HEC-RAS 5.0.5 with flow contributions as provided in **Table 4-2**. Manning's n values were assumed for a naturalized channel and floodplains with heavy brush. A figure of the model in plan is presented in **Figure 4-8**.

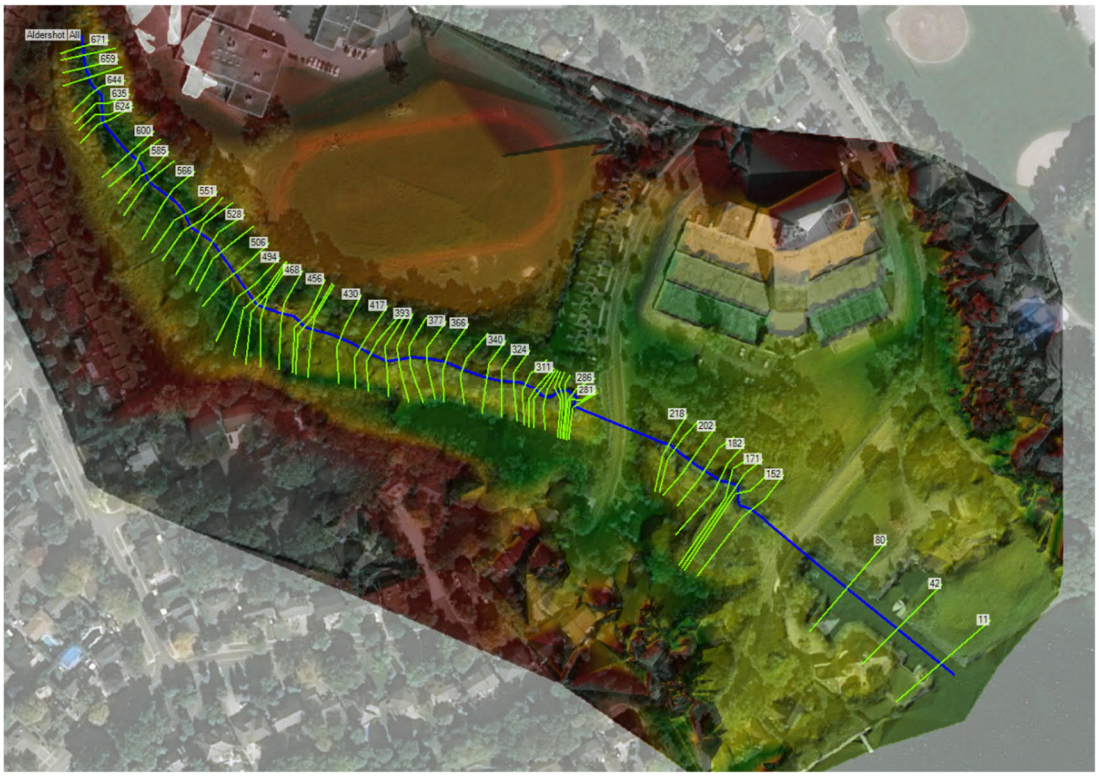


Figure 4-8: Plan View of Hydraulic Model

The culvert crossing Oaklands Park Court enters Hamilton Harbour, so the hydraulic model accounts for the downstream lake-level boundary conditions. The culvert crossing Oaklands Park Court is backwatered from Lake Ontario, and under high lake levels, its hydraulic capacity is reduced. Therefore, lake elevations formed the downstream boundary conditions in the hydraulic model and backwater effects were explored.

The model was run under two (2) different downstream boundary conditions as follows:

1. High lake levels: this scenario represents the critical boundary condition for determining flooding depths, extents, and backwater effects
2. Low lake levels: this scenario represents the critical boundary condition when determining velocities and associated erosion and scour (within the limit of backwater effect).

Upstream boundary conditions assumed a Normal Depth, due to the supercritical flow conditions in the upper reach. Flows for the 2-, 5-, 10-, 25-, 50-, 100-Year and Hazel (regional) storm were run in the hydraulic model to estimate flooding extent, water depth, and velocities for both downstream scenarios mentioned above.

A summary of the resultant velocities at selected cross sections for all modelled return periods under Scenario 2 (low lake levels) was prepared and indicates velocities ranges for each of the three (3) reaches, as illustrated in **Table 4-4**.

Table 4-4: Existing Conditions Summary Range of Resultant Velocities

Existing Conditions Hydraulic Modeling Scenario 2: Low Lake Levels							
Reach	**Range of In-Channel Flow Velocities (m/s)**						
	2-Year	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**	**Hazel**
1	0.6 – 4.0	0.7 – 4.1	0.7 – 4.2	0.7 – 4.3	0.6 – 4.4	0.6 – 4.5	0.5 – 4.4
2	0.3 – 2.1	0.2 – 1.9	0.2 – 1.3	0.2 – 0.8	0.2 – 0.6	0.2 – 0.6	0.2 – 0.7
3	0.5 – 2.3	0.5 – 2.5	0.6 – 2.6	0.6 – 2.7	0.6 – 2.8	0.6 – 2.8	0.6 – 2.8

It is important to note that the most conservative (highest) velocities in Reach 2 are achieved under the 2-Year scenario. This is explained by the undersized culvert beneath North Shore Boulevard West, at the downstream end of Reach 2. This culvert does not have the capacity to convey the 2-Year flow without backwater impacts, so upstream depths increase and velocities decrease slows upstream velocities.

Floodlines were calculated using HEC-RAS to estimate the extent and depth of flooding within each of the three (3) reaches. These floodlines were produced by combining the resultant water surface profiles generated by HEC-RAS with surveyed topography. HEC-RAS's built-in GIS platform, RAS Mapper, was

used to display the floodplains over aerial imagery to provide a visual representation of potential impacts to nearby properties and infrastructure. ***It is important to note that these floodplain lines were generated under a set of assumptions appropriate to the erosion study and are not suitable for regulatory purposes.*** **Figure 4-9** to **Figure 4-15** show the approximate existing floodplain extents and depth under each of the modelled return periods (2-, 5-, 10-, 25-, 50-, 100-Year and Hazel) under downstream boundary conditions of Scenario 1 (high lake levels), since this is the scenario most significant to establishing floodplain extents and depths near the outlet to Lake Ontario. Localized downstream increases in water surface elevation indicate hydraulic jumps.

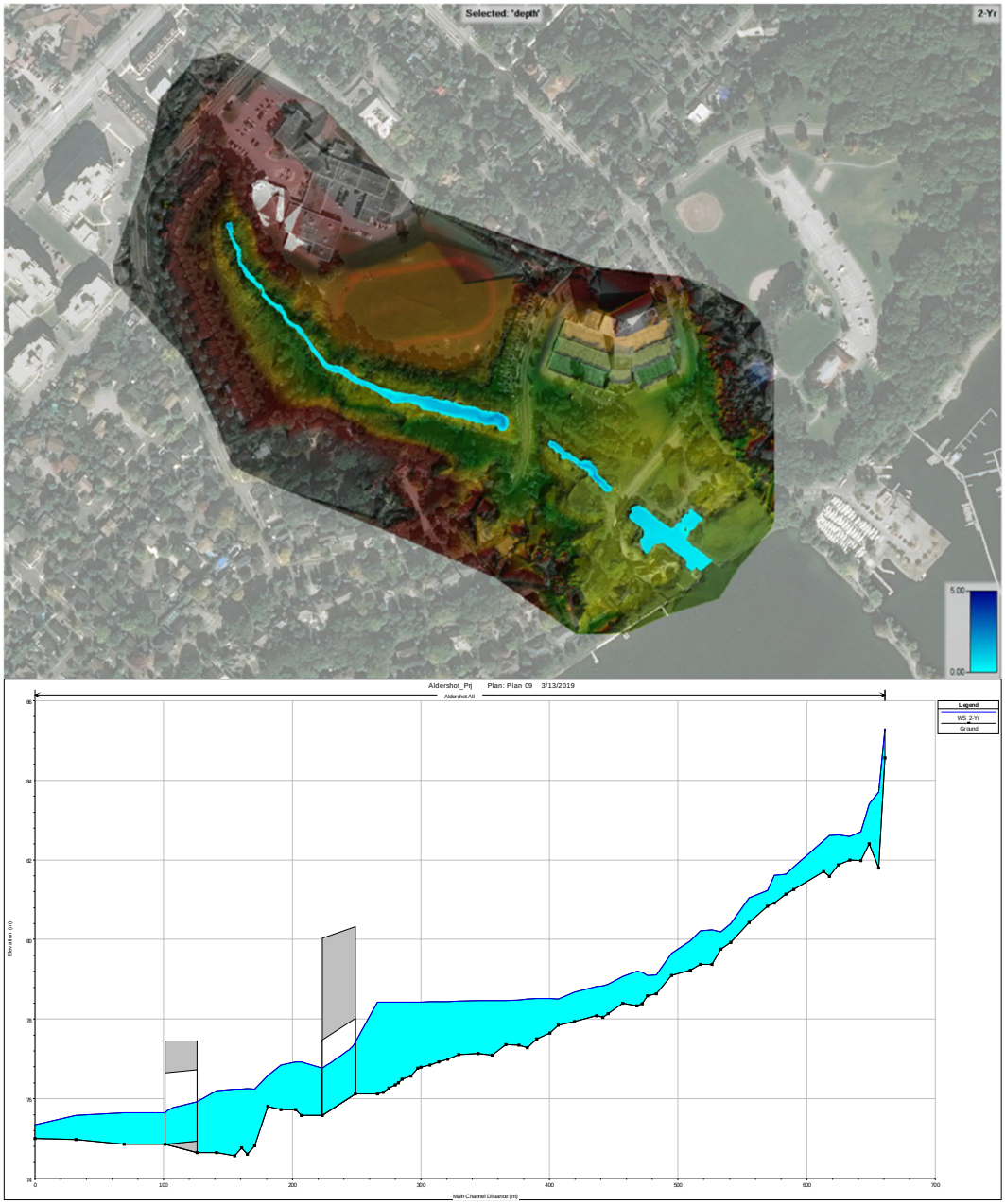


Figure 4-9: 2-Year Hydraulic Results for Existing Conditions

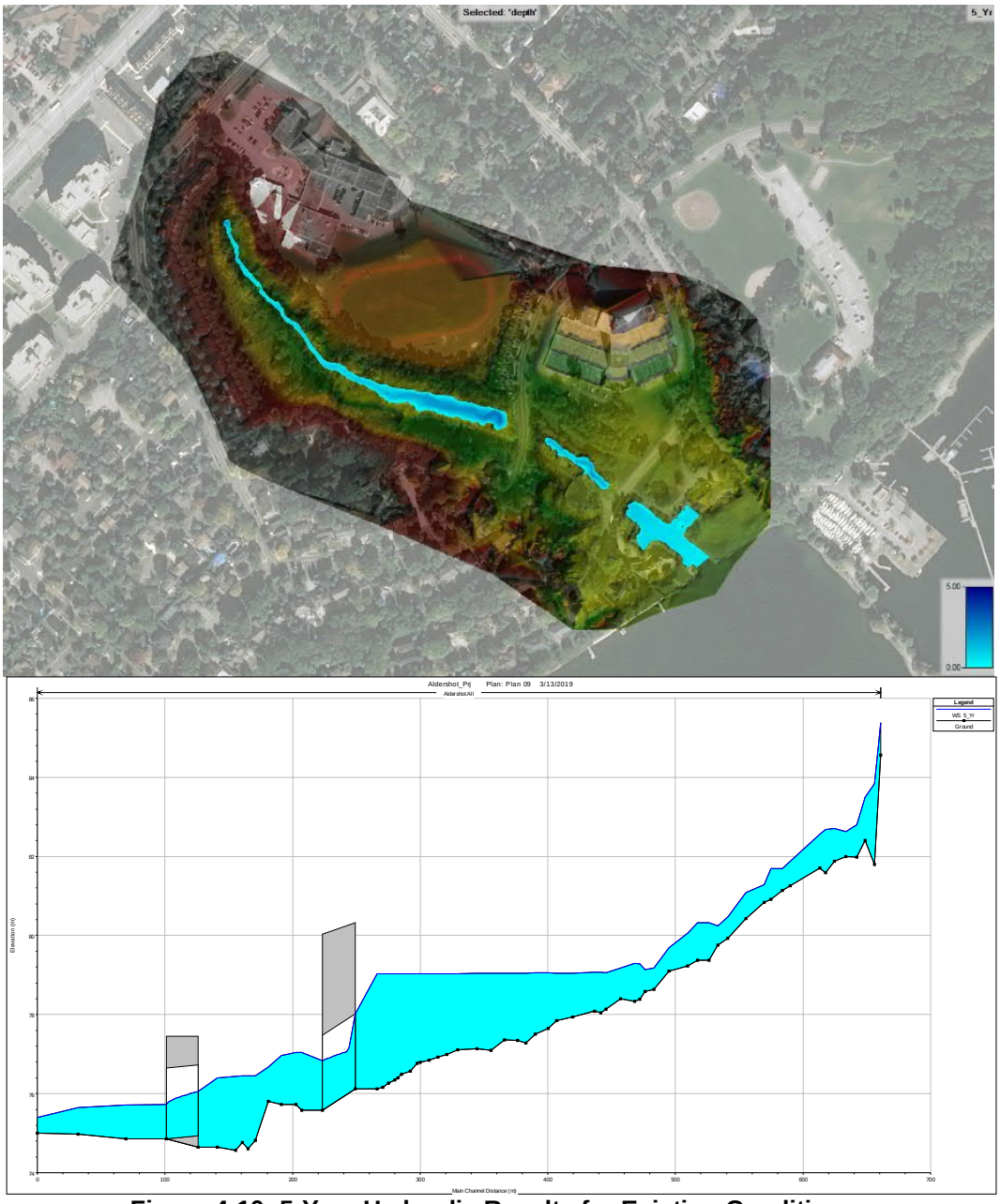


Figure 4-10: 5-Year Hydraulic Results for Existing Conditions

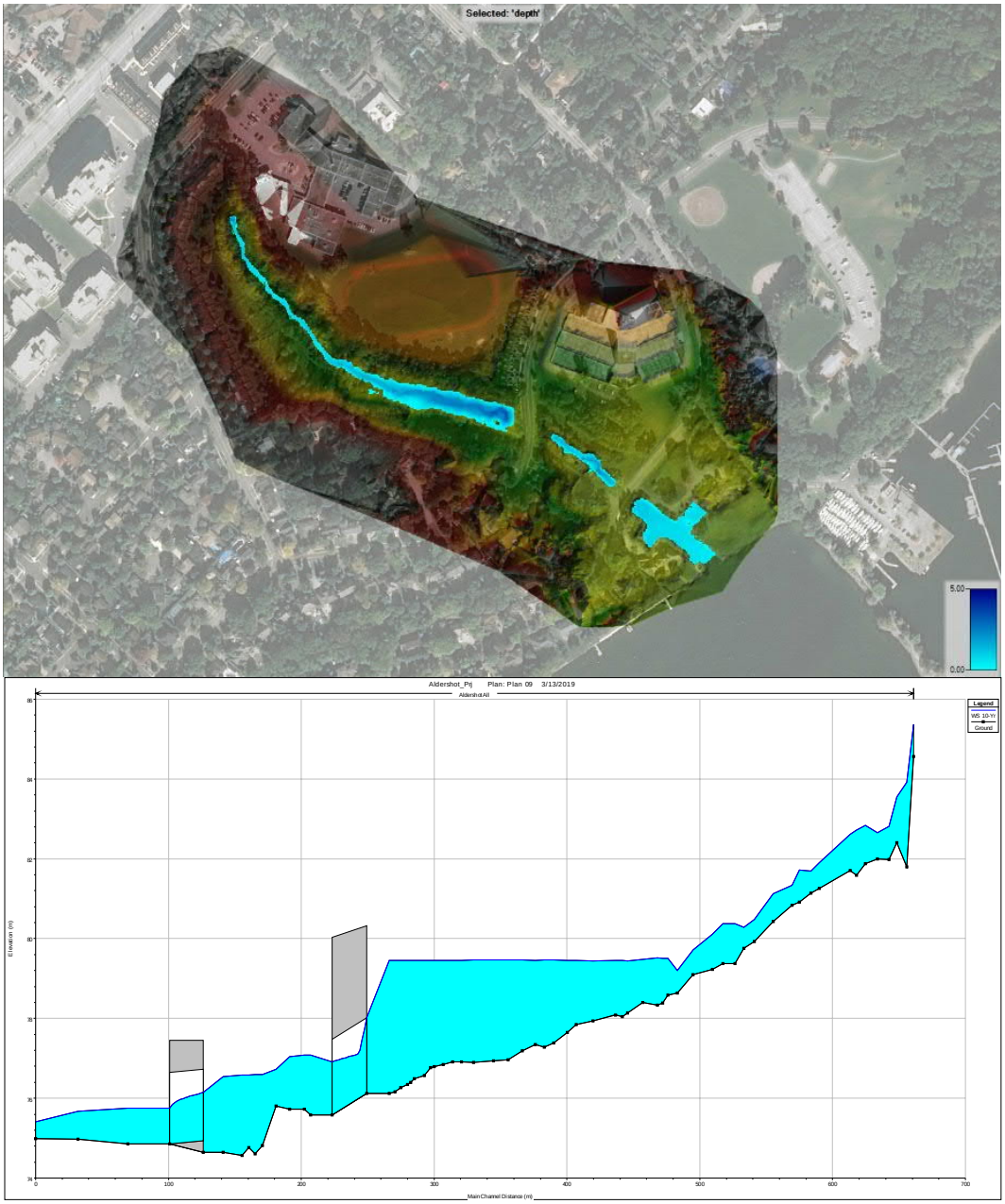


Figure 4-11: 10-Year Hydraulic Results for Existing Conditions

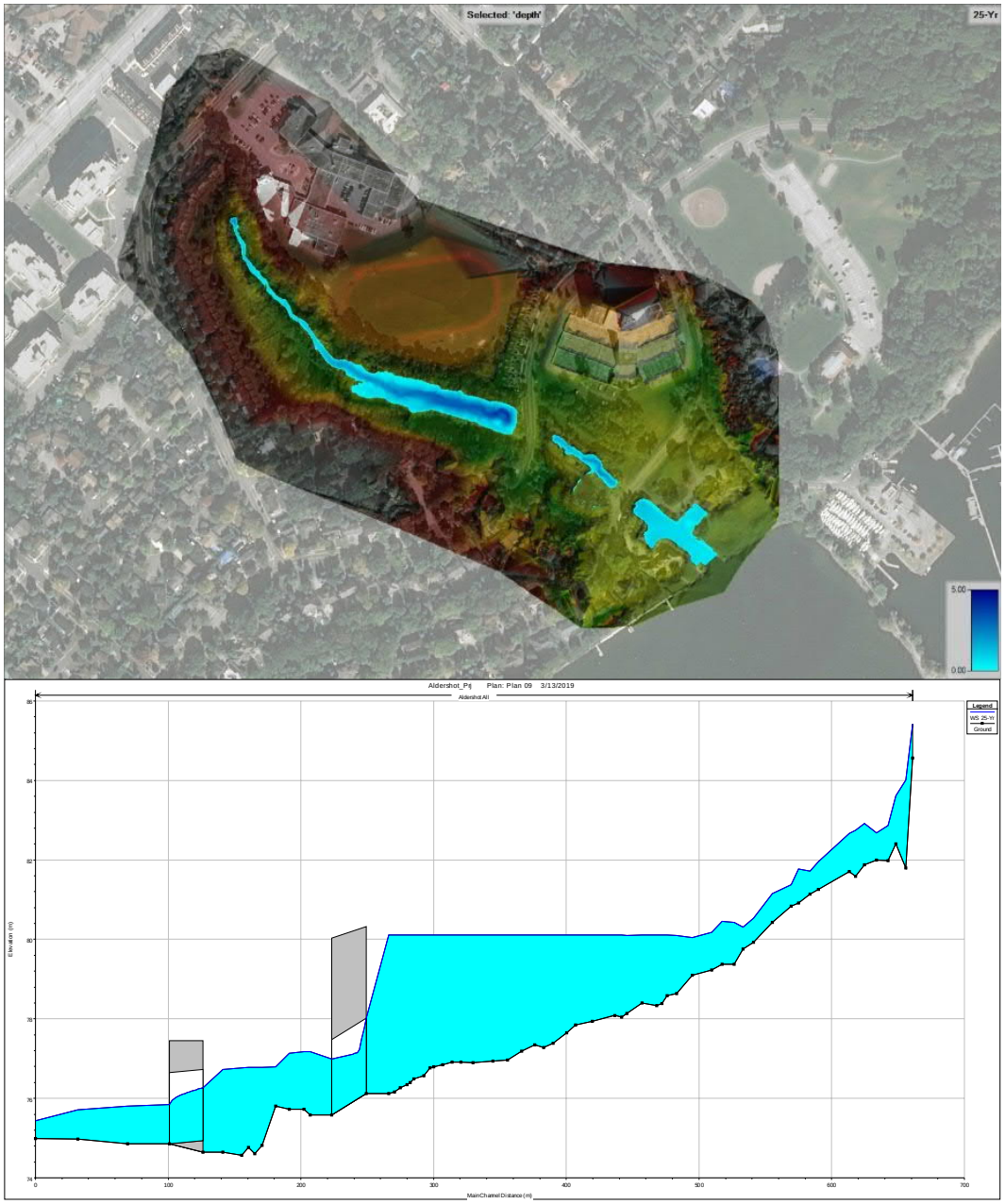


Figure 4-12: 25-Year Hydraulic Results for Existing Conditions

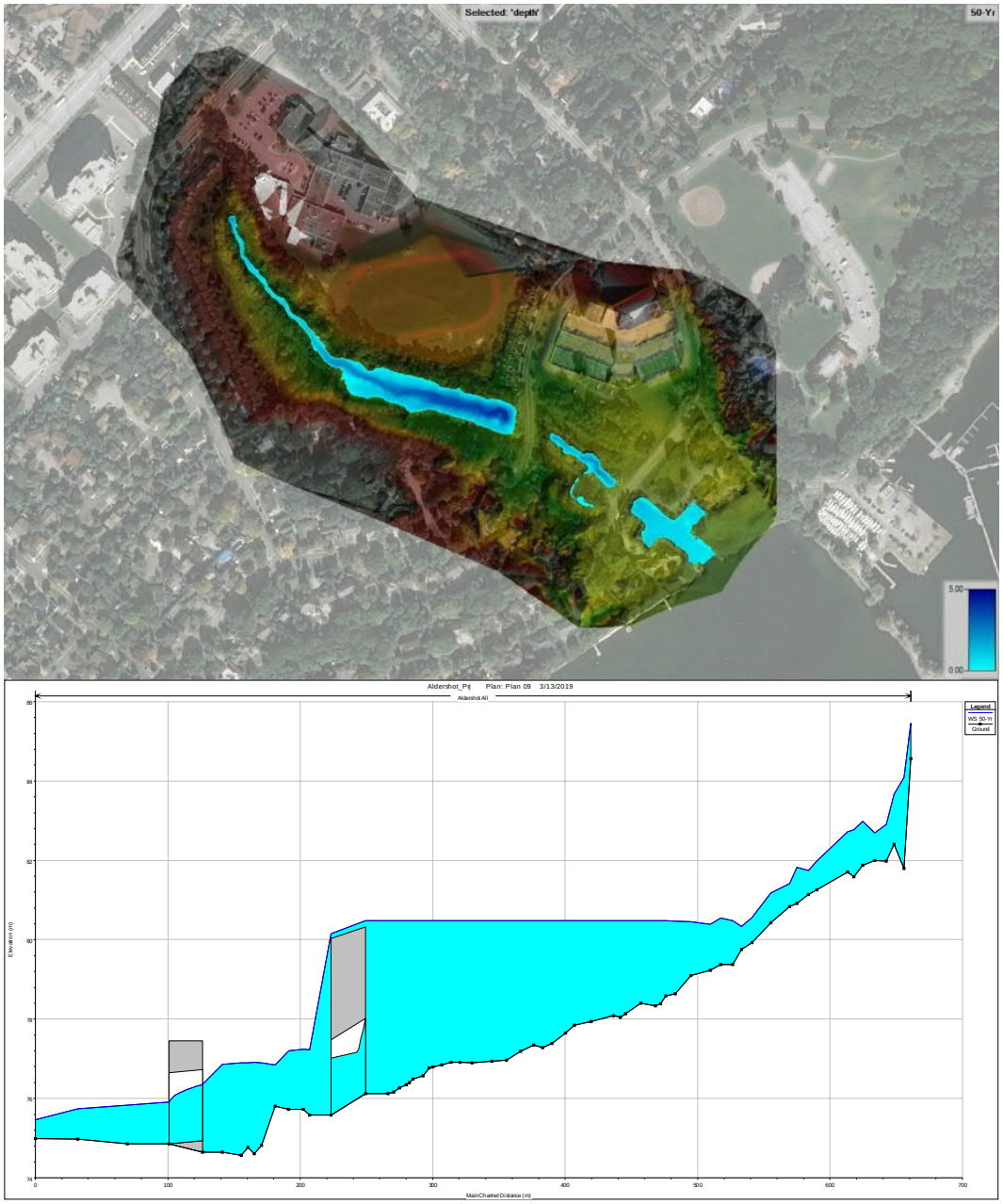


Figure 4-13: 50-Year Hydraulic Results for Existing Conditions



Figure 4-14: 100-Year Hydraulic Results for Existing Conditions

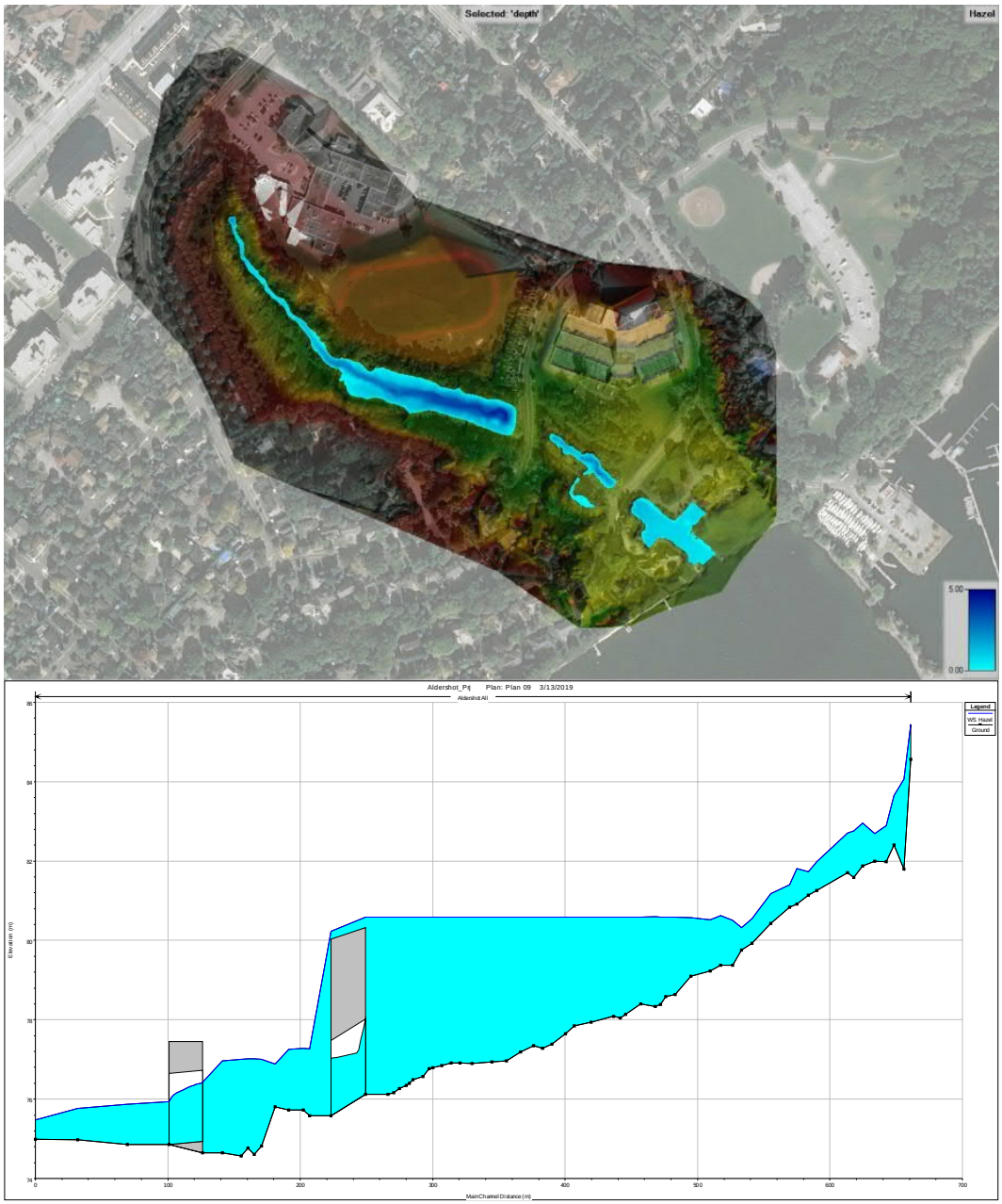


Figure 4-15: Hazel Hydraulic Results for Existing Conditions

Additional details pertaining to the hydraulic model and its development are provided in the *Hydrologic and Hydraulics Technical Memorandum* located in **Appendix B**.

4.1.3 Fluvial Geomorphology

Channel Morphology

Erosion is extensive and locally severe along West Aldershot Creek, particularly where the channel is confined along the bottom of a nearly V-shaped ravine, with little to no floodplain to attenuate flow energy.

Significant degradation (down-cutting) along the bed paired with continuous scour along the banks has led to the development of severe undercuts (up to 2 m) along the base of the confining terraces and valley walls themselves as illustrated in **Figure 4-16**. Several mass movement failures have occurred recently along the lower valley walls in response to the fluvial erosion. Trees have fallen into the channel once their root masses are sufficiently undermined, which, in turn, has exacerbated erosion by forcing flows over, under and around the woody debris jams that form (**Figure 4-16**).



Figure 4-16: Upstream view of severe degradation, scour along the banks, and large woody debris jam (Reach 1)

Figure 4-17 presents a longitudinal profile, derived from the LiDAR survey data, along the channel centreline. Conspicuous slope-breaks along the profile, at reach breaks and large woody debris jams, are identified. Based on the available 0.25 m contour topographic mapping and longitudinal profile, reach breaks are located at distinct changes in bed profile. Reach 1 has a relatively steep gradient of 3.3% compared to Reach 2 (1.1%) and Reach 3 (0.4%). There are two notable and abrupt drops in energy gradient located at large woody debris jams in Reach 2 and 3.

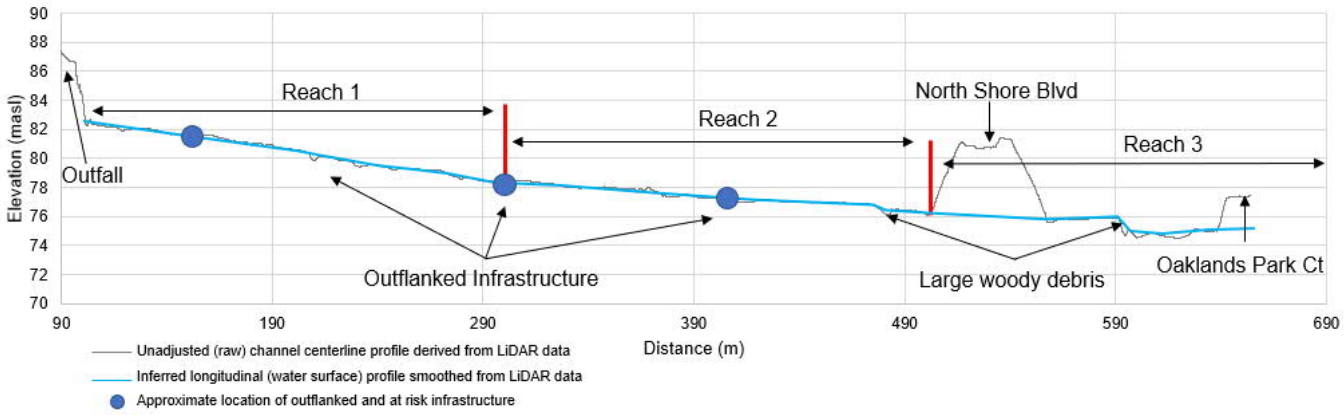


Figure 4-17: Longitudinal Profile Derived from UAV-based LiDAR Survey

Bed material consists of a discontinuous veneer of gravel and cobble (including some dispersed gabion stone) overlying glaciolacustrine deposits (clay to fine sand). The proportion of sand, which locally embeds the alluvial gravel-cobble material, increases downstream. Reach 3 exhibits near-continuous embedment of underlying gravels with sand from upstream erosion. The median grain (D50) size was estimated to be 30 mm from the Wolman pebble count and is representative of the distribution along Reaches 1 and 2, where most channel works are warranted.

Reach 1

Reach 1 originates at the outfall south of Fairwood Place and extends 200m downstream to the outflanked outfall that projects into the channel from the west bank (**Figure 4-5**). The reach is confined along both banks by high terraces or valley walls, punctuated by gullies and erosion scars where affected by fluvial erosion. The channel has become entrenched due to active degradation and is disconnected from what little floodplain once existed (**Figure 4-16**). This entrenchment concentrates shear stresses along the channel boundary during high flow events, which in turn leads to further degradation and instability. Bed degradation, undercut banks (up to 1 m), and localized channel widening have created an anomalously deep and narrow cross-sectional shape. The average channel depth is 1.5 m (measured from the bottom of the undercut to the bed) and width is 5.3 m (including undercut). These dimensions yield an anomalously low width:depth ratio of 3.5. The average bankfull discharge for Reach 1, estimated from the reliable Reach 2 value (5.8 m^3/s) and its proportion of the modelled 2-year flow for Reach 2 (5.8 m^3s/6.2 m^3/s = 94%), is 4.0 m^3/s (94% of the 4.3 m^3/s 2-year flow for Reach 1).

Bed material consists of a transient gravel-cobble veneer with near-continuous exposure of glaciolacustrine deposits (clay to fine sand) (**Figure 4-18a**). Winnowing of fines and sands has coarsened the bed material. Localized bank collapses triggered by undercutting of the high terrace scarps and valley walls is also introducing coarse sediment into the channel.

Pool-riffle morphology is poorly defined, as expected based on the relative steep channel gradient (3.3%). Widening and failure of the terraces and valley walls have resulted in extensive exposure of root mats and

an abundance of straight-trunked leaning and fallen trees that span or partly obstruct the channel (**Figure 4-18b**). The introduction of large wood into the channel has resulted in two jams along Reach 1. Erosion has been exacerbated by flows forced over, under and around the jams.



Figure 4-18: a) Gravels and cobbles with exposure of clayey to fine sandy glaciolacustrine deposits in Reach 1 (*left*); b) Leaning and fallen trees and extensive exposure of root mats (*right*)

A number of anthropogenic disturbances in addition to watershed urbanization influence channel morphology along Reach 1. Large concrete rubble has been historically placed along portions of the channel bed but has since been displaced and dispersed by high-velocity storm flows. Several small, corrugated steel pipe (CSP) culverts, mostly draining immediately adjacent land (if at all still functional), discharge into the channel.

Infrastructure owned by the City and the Region of Halton (the Region) is at risk at a number of locations along Reach 1. Stormwater discharged from the main outfall at the head of West Aldershot Creek (i.e. upstream limit of Reach 1) plunges over a concrete apron into a pool immediately below. The apron has been undermined and become perched 2m above the pool bottom (**Figure 4-19a**). A sanitary maintenance hole is nearly exposed along the outer (east) bank approximately 100 m downstream of the main outfall; immediately opposite, another maintenance hole is at risk of impact due to severe (~2 m) bank undercutting (**Figure 4-19b**). Depending on its depth, the sanitary sewer crossing may also be at risk of exposure due to degradation. Near the downstream end of the reach (180 m from the main outfall), an outfall has been outflanked along the west (right) bank and now projects well into the channel, with a slight perch above the bed (**Figure 4-19c**).



Figure 4-19: a) Severely perched outfall and apron at the head of West Aldershot Creek (*top left)*; b) Sanitary sewer manhole nearly exposed along outer bank (*top right)*; c) Outflanked and slightly perched stormwater outfall at downstream extent of Reach 1 (*bottom*)

Reach 2

Reach 2 extends from an outflanked and perched outfall to the crossing of North Shore Boulevard (**Figure 4-5, Figure 4-19c**). The upstream limit of Reach 2 is marked by an abrupt transition from the ravine-like channel of Reach 1 to a more typical, sinuous channel along the bottom of a broad valley (Reach 2). The valley walls are commonly set back from the channel. The reach exhibits evidence of anthropogenic modification (i.e. straightening) with a low embankment along the west bank creating a discontinuous and moderately accessible floodplain. Channel sinuosity increases downstream, with bank erosion commonly following the criss-crossing thalweg pattern. Lateral migration is the dominant erosional process along Reach 2. Erosive energy is more effectively distributed across the wider channel cross-section and floodplain, such that erosion is less extensive and severe than along Reach 1. The average bankfull width and depth are approximately 6 m and 0.4 m, respectively. Average bankfull discharge along Reach 2 was estimated at 5.8 m^3/s, based on back-calculation from field measurements and topographic survey data.

The channel exhibits a natural, roughly rectangular cross-section along its riffles and an asymmetric cross-section deepest along its outer bank within pools. Pool-riffle morphology is generally well developed along the reach, which has an average gradient of 1.1%, with shallow pools separated by small riffles. Bed materials are dominated by gravels and cobbles with a transient veneer of sands in pools. The gravel-cobble bed is susceptible to transport during moderate to high flows. Banks are generally composed of sand, gravels and fill material.

Riparian vegetation was historically cleared along the western bank in association with installation of linear infrastructure (i.e. sanitary sewer). Riparian vegetation is now nearly continuous along the banks and valley walls. It is dominated by mixed forest with shrubby and herbaceous species dominating the understorey. There are numerous instances of straight-trunked and 'pistol-butt' fallen or leaning trees along the channel (**Figure 4-20a**). A large woody debris jam was noted upstream of North Shore Boulevard resulting in a temporary, but significant grade control (**Figure 4-17**). The 1 m-high jam has resulted in the deposition of sand along the bed for approximately 60 m upstream, and severe erosion downstream (**Figure 4-20b**).

Anthropogenic influences on channel morphology include several small, corrugated steel pipe (CSP) culverts, mostly draining immediately adjacent land (if at all still functional), discharge into the channel. A maintenance hole is outflanked along the outer (west) bank, now located within the channel approximately 115 m upstream of North Shore Boulevard (**Figure 4-20a**). Severe erosion along the outer bank of a meander immediately upstream of North Shore Boulevard risks outflanking the inlet of the CSP culvert beneath the road. Flow is now deflected across the culvert inlet, eroding the opposite bank (**Figure 4-20c**). The culvert is undersized from a fluvial geomorphological perspective, impeding the conveyance of water and sediment downstream. The concrete foundation of a chain-link fence post has been exposed by fluvial scour along the east bank of a slight meander approximately 40 m upstream of North Shore Boulevard.



Figure 4-20: a) Fallen and leaning trees across channel with outflanked maintenance hole along outer bank (*top left)*; b) Large woody debris jam and resulting deposition upstream and severe erosion downstream (*top right)*; c) Outflanked culvert with flow deflected across inlet (*bottom)*

Reach 3

Reach 3 extends from North Shore Boulevard to the culvert outlet into Lake Ontario beneath Oaklands Park Court (**Figure 4-5**). The channel was historically straightened and entrenched within the fill-mantled ground, which is readily eroded (**Figure 4-21a**). The entrenched channel prevents flow from overtopping the physical top of bank, concentrating erosive energy within the channel. The floodplain is not readily accessible to flood flows. The channel cross-section is distinctly trapezoidal and uniform along its entire length, except for a large, scallop-shaped erosional hollow (**Figure 4-21b**). The hollow has formed along the east bank where flows have been deflected around a large woody debris jam complex.

Pool-riffle morphology is poorly defined along the entire length of the low-gradient (average 0.4%) reach. Bed materials consist of gravels overlain by a thick layer (0.2 m) of deposited sand. The large woody debris jam has created a temporary, but influential, grade control, altering the longitudinal profile of the reach

(**Figure 4-17**, **Figure 4-21c**). The ~1 m-high step formed by the debris jam impedes sediment transport and upstream fish passage. The average bankfull width and depth are approximately 5.5 m and 0.4 m, respectively. Average bankfull discharge was estimated at 6.7 m^3/s (94% of 7.1 m^3/s, 2-year flow).

Riparian vegetation was historically cleared along the eastern bank. Riparian vegetation is dense and nearly continuous along a narrow strip along both banks. It is dominated by deciduous stands along the tops of bank with the slopes dominated by shrubby and herbaceous meadow species.

The channel was historically straightened and entrenched between North Shore Boulevard and Oaklands Park Court. Both road culverts are undersized from a fluvial geomorphological perspective, impeding the conveyance of water and sediment downstream. Concrete rubble is scattered along the reach. Several small outfalls discharge into the channel. A maintenance hole 15 m downstream from the anomalous scour of the left (east) bank approximately matches the setback (4.5 m) of the sanitary/water main from the top of bank. The sanitary/water main is potentially at risk if erosion were to continue along its current trajectory.



Figure 4-21: a) Readily eroded fill-mantled ground immediately downstream of culvert at North Shore Boulevard (*top left)*; b) Large, scallop-shaped erosional hollow downstream of large woody debris jam (*top right)*; c) Large woody debris and plunge pool (*bottom)*

Erosion Inventory

As described above, erosion is widespread along West Aldershot Creek, although its severity generally decreases downstream from the head of the channel (Reach 1) to its mouth (Reach 3). A map-based inventory of the type and relative severity of bed and bank erosion was completed (**Figure 4-22**) to help identify drivers of channel instability and ultimately guide the development of erosion control solutions.

Reach 1 exhibits vertical to undercut banks and extensive scour along the bed. Instability has initiated slope failures, toppling riparian trees and has left stormwater and sanitary infrastructure at risk from near-continuous, severe erosion. Reach 1 is the primary erosion zone and the principal source of fine-grained sediment transported along West Aldershot Creek.

Along Reach 2, erosive energy is more effectively distributed across the wider channel cross-section and floodplain. As a result, erosion is discontinuous and less severe. Severe erosion is isolated to the outer (east) bank of a meander, downstream of a large woody debris jam, and immediately upstream of North Shore Boulevard. Reach 2 is a transport zone along which sediment eroded from the high, unstable banks of Reach 1 and, to a lesser extent, the low, locally scoured banks of Reach 2 is transported.

As in Reach 1, flow and erosive energy along Reach 3 are confined within a deep channel. However, oversizing of its cross-section and bank grading when the channel was historically straightened and excavated (post-1962) has moderated bed and bank erosion. The only severe erosion has occurred along the left (east) bank, where flows deflected over and around a large complex of woody debris jams have scoured a scallop-shaped hollow. Significant accumulation has occurred along portions of Reach 3, in the backwater area upstream of the woody debris jam complex and more broadly in association with backwater from high levels of Lake Ontario. Reach 3 is transitional between a transport and depositional zone, along which sediment eroded and transported along reaches 1 and 2 begins to deposit. The only significant source of (eroded) sediment along Reach 3 is the anomalous bank hollow formed in association with the woody debris jam.

Virtually all sediment eroded from the bed and banks of West Aldershot Creek is deposited abruptly at its mouth once it exits the culvert beneath Oakland Parks Court, at the shore of Lake Ontario. The recessed, anthropogenic shoreline punctuated by boat slips inhibits wave erosion and longshore drift, such that fluvial sediments locally accumulate at rates above those typical of a natural shoreline. Such accumulation of sediment, which required dredging, provided an initial impetus for the City to conduct this study and advance erosion control solutions.

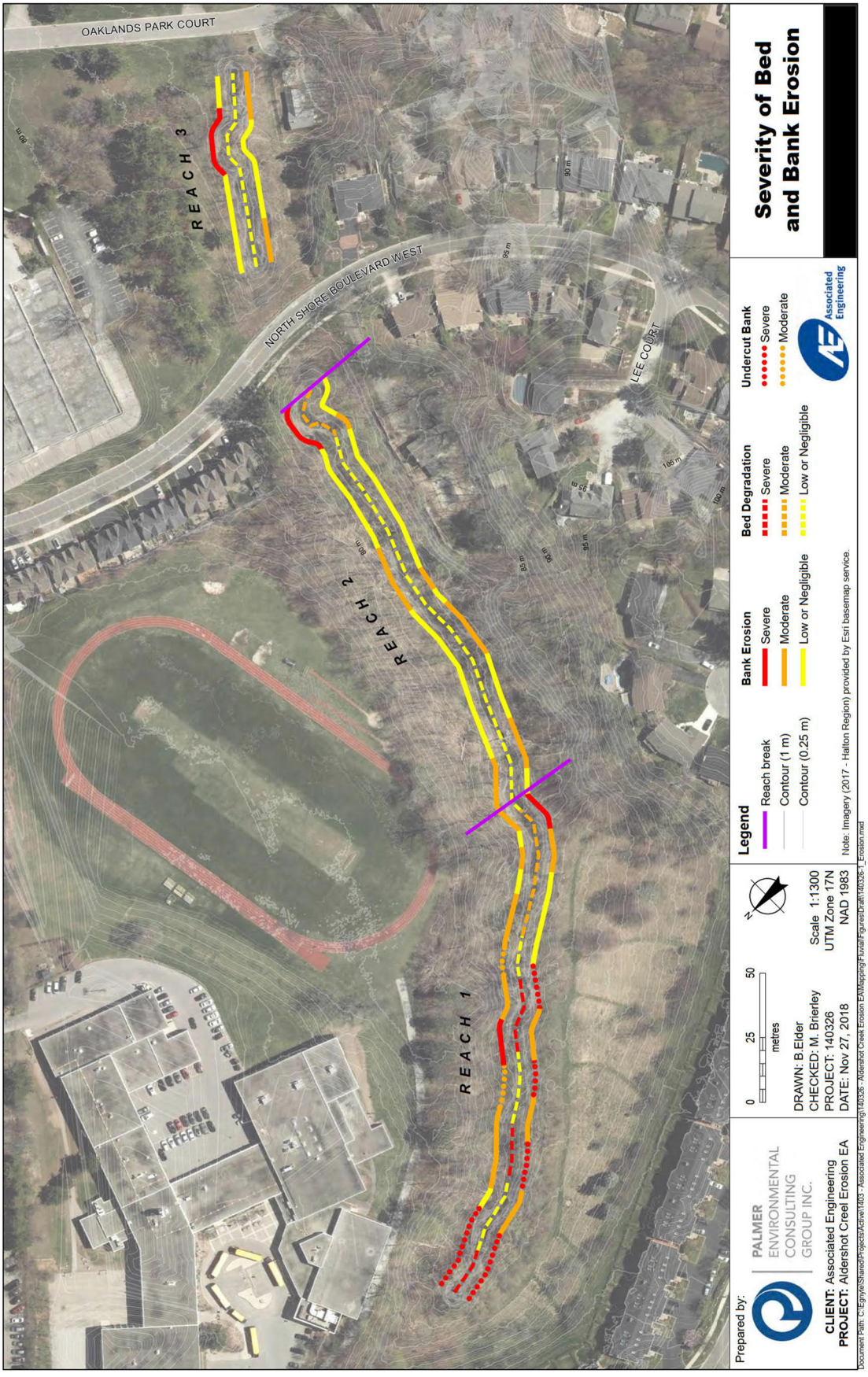


Figure 4-22: Severity of Bed and Bank Erosion

Considerations for Erosion Control

Ravine-like Reach 1 is the principal source of sediment that ultimately gets deposited at the creek mouth, so erosion control measures should focus on naturalized stabilization of this section of channel. The City should also intervene along Reaches 2 and 3, where natural channel adjustments cannot be accommodated without placing private property or infrastructure at risk.

One challenge facing the City is the management of in-stream (and riparian) woody debris. In natural watercourses, woody debris can help stabilize channels through its role in providing structure to the bed (e.g. steps) and protection of banks. In urbanized West Aldershot Creek, however, woody debris is being introduced into the channel at rates that exceed the recurrence of flows capable of dispersing and rafting it downstream. As a result, jams form that partly or wholly obstruct flows along the channel, forcing anomalous bed and/or bank scours. Regular inspections and strategic removal of in-stream woody debris by City crews will likely help mitigate anomalous bed and bank erosion now and in the future.

Establishment of appropriate design flows for proposed channel works requires consideration of field-based estimates of bankfull (~channel-forming) discharge and modelled flows, as well as reach-specific characteristics. Natural channel designs are typically sized according to estimates of bankfull or 2-year flow, which is appropriate for any channel works proposed along Reach 2, where flows greater than the bankfull or 2-year flow spill onto a floodplain and attenuate energy. Along the entrenched Reaches 1 and 3, however, little to no floodplain is available to attenuate energy. As such, flows will remain confined to the channel and shear stresses may be disproportionately high. Consideration will need to be given to designing erosion control treatments along Reaches 1 and 3 to withstand at least the 5-year flow, in order to meet the City's expectations for stability. The 5-year flow was modelled as 5.3 m^3/s along Reach 1 and 8.8 m^3/s along Reach 3.

Key considerations for the development of erosion control solutions are highlighted below for each of the three reaches.

Reach 1

- ***Entrenchment*** – Erosion mitigation along Reach 1 should prioritize creation of a wider, shallower cross-section, to the extent possible within the constraints of the ravine-like valley bottom, to more broadly distribute erosive forces and, in turn, reduce the propensity for bed degradation and bank erosion.
- ***Bed gradient*** – The average gradient of this reach was notably steeper when the outfall at the head of the channel was constructed. Discharge from the outflow would have rapidly scoured bed material, especially immediately downstream where the channel is most confined, and led to the reach-scale degradation that now characterizes this reach.
- ***Grade control*** – Erosion control solutions should incorporate grade control, such as would occur along natural, steep ravine channels through the formation of self-stabilizing stony or woody steps, in order to mitigate further degradation and reduce the risk of bank protection measures being undermined and failing. A proposal for erosion control along the banks further underscores the need for grade control, given the increased energy that will be available to erode unprotected channel boundary materials.

- ***Undercut banks*** –Erosion control solutions should incorporate regrading (cutting) of banks to attain more stable angles, preferably at least 2H:1V. Such a reduction in bank steepness would decrease the potential for erosion through scour (fluvial) and mass movement (geotechnical) processes. The protection of regraded banks using hard albeit natural material (e.g. boulders, armourstone) cannot be avoided due to the relative inaccessibility of any appreciable floodplain and the concentration of flood water along the channel. In accordance with the City's expectations, erosion protection materials should be sized to at least remain stable up to 5-year flows.
- ***Slope failure*** – Erosion control strategies should account for the general distribution and relative rate of surface runoff and groundwater seepage, where applicable, to avoid impacts to erosion control structures (e.g. settlement or erosion in behind).
- ***Downstream energy transfer*** – Erosion control measures that focus solely on armouring the channel bed and banks risk transferring erosive potential downstream to unprotected channel boundaries. Downstream energy transfer is best managed and moderated through the incorporation of roughness elements to the maximum extent possible, especially in steeper sections of channel. Reach 1 erosion control efforts should incorporate large stone for stability and enhanced bed roughness and riparian plantings. Vegetated (brush layering and live stakes) boulder revetments, which exhibit surface irregularities, should be prioritized over armourstone. To reduce the potential for energy transfer from Reach 1 to Reach 2, enhancement efforts should attempt to accommodate an increase in channel width (cross-sectional area) and increase floodplain interaction (benching) to dissipate energy. In addition, increased vegetation planting (i.e. brush layering and live stakes) could make banks more resistant to erosion. The City is further advised to maintain some opportunities for erosion to reduce downstream energy transfer. The total prevention of bank erosion would otherwise create additional long-term problems and impact downstream infrastructure (i.e. sanitary sewer or road crossings). A key driver of excessive erosion along Reach 1 is the paucity of sediment entering it from the stormwater outfall.

Reach 2

- ***Lateral adjustments*** –The channel is gradually readopting a meandering pattern since its straightening several decades ago. The City should allow such adjustments and the corresponding increase in channel sinuosity, thereby (i) reducing channel gradient and, in turn, flow velocities and shear stresses; and (ii) naturalizing energy expenditure and balancing sediment sources (erosion) and storage (deposition) along the valley. Bed or bank stabilization measures should be avoided unless necessary to protect adjacent private property or infrastructure (e.g., sanitary sewer maintenance hole).
- ***Longitudinal profile*** – Consideration should be given to slightly increasing riffle size (height and length) to restore a more natural degree of floodplain connectivity, better attenuate flood flows and help dissipate any energy transferred from upstream (especially if extensive erosion protection is implemented) and enhance aquatic habitat through diversification of low-flow hydraulics and substrates.

Reach 3

- ***Flood attenuation*** –The establishment of floodplain benching would promote the attenuation of flood flows, naturally dissipating erosive energy along the reach. Also, benching would positively

influence hydraulic capacity by creating a wider, shallow cross-section to more evenly distribute erosive forces, thereby reducing bed degradation and bank instability.

- ***Bed morphology*** – Establishing a defined pool and riffle bed morphology would improve longitudinal stability, restore natural fluvial form and function, and enhance aquatic habitat.
- ***Channel planform*** - The development of a natural, sinuous planform would increase the channel length, reducing channel gradient and, in turn, flow velocities and shear stresses. It would also optimize the balance of energy expenditure by creating natural areas of sediment storage (i.e. point bars and flood benches).

The fluvial geomorphological assessment details are provided in the *Fluvial Geomorphological Assessment Report* located in **Appendix C**.

4.1.4 Aquatic and Fish Habitat

Field reconnaissance and detailed data collection were completed by a PECG's fluvial processes specialist and aquatic biologist during low-flow conditions on August 23, 2018. The purpose of this work was to observe habitat features (riffles, runs, pools, undercut banks and instream features) and document channel conditions (creek slopes, bankfull and flow channel widths) in accordance with MTO's Protocol: Environmental Guide for Fish and Fish habitat. Particular attention was given to the presence, location and form of impediments and barriers to fish passage, and to opportunities for restoration and enhancement of aquatic habitat in association with planned erosion control works. Refer to **Figure 4-23** for Aquatic Habitat Mapping.

Three fish species have been captured in the Study Area and recorded by Conservation Halton: Creek Chub (*Semotilus atromaculatus*), Blacknose Dace (*Rhinichthys obtusus*), and Spottail Shiner (*Notropis hudsonius*). The fish were caught upstream of Northshore Boulevard (Reach 2). Two Creek Chub were caught in 2001 and Blacknose Dace and Spottail Shiner (total 5 fish) were caught in 2009. All three fish species are minnows and are considered common coolwater species, native to Ontario, and of intermediate tolerance to environmental perturbations and/or anthropogenic stresses. Creek Chub are tolerant of pollution and low dissolved oxygen and moderately intolerant of turbidity. Spottail Shiner are tolerant of turbidity and high water temperature.

Further details regarding fish habitat are provided in the *Terrestrial and Aquatics Ecology Report* located in **Appendix D**.

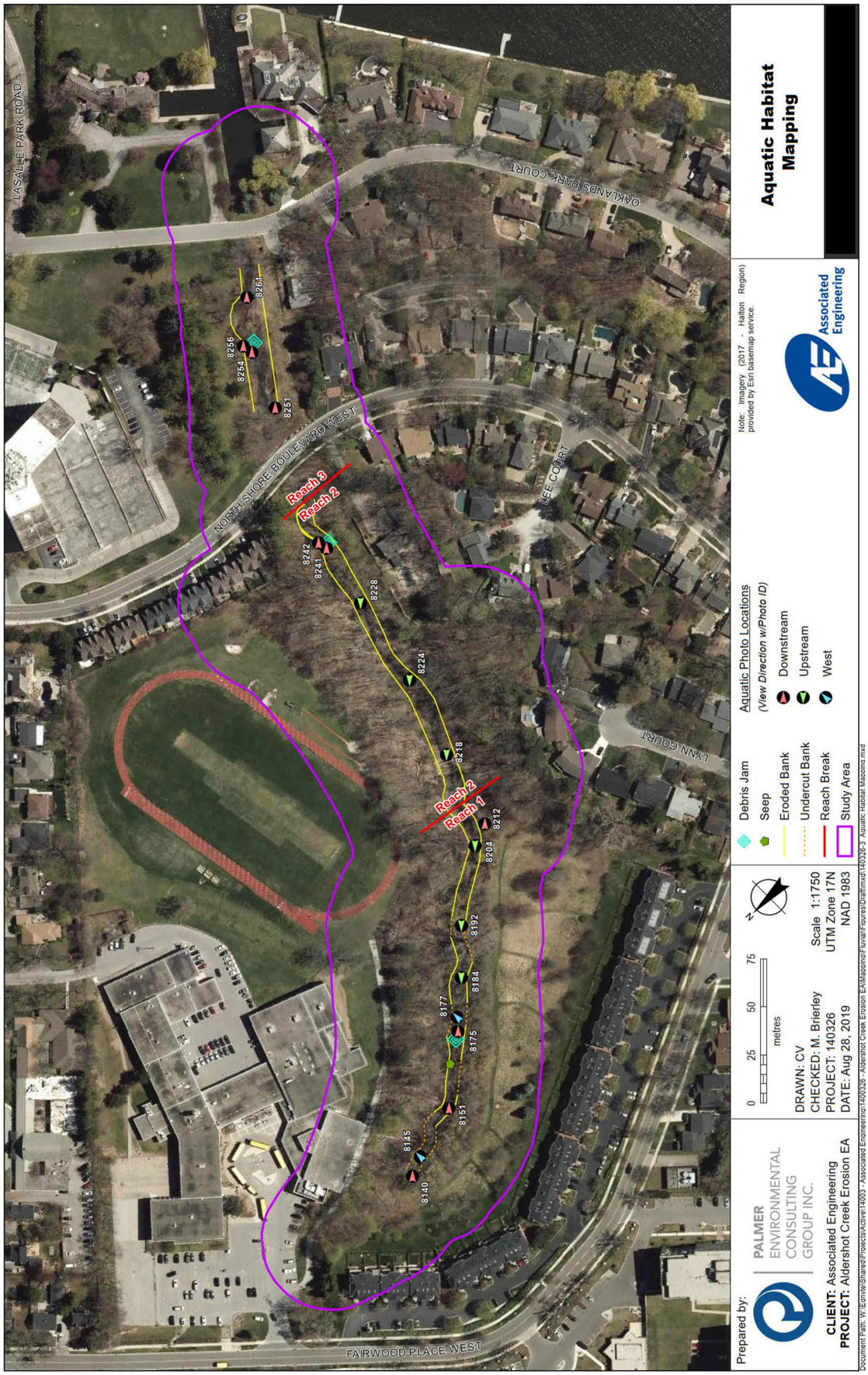


Figure 4-23: Aquatic Habitat Mapping

4.1.5 Terrestrial

Vegetation

Vegetation communities were mapped and described following the Ecological Land Classification (ELC) System for Southern Ontario and 2008 update tables; and the wetland characterization and limit was determined using the Ontario Wetland Evaluation System (OWES). Field investigations identified twelve (12) vegetation community types within the Study Area, including forests, meadow, open water and anthropogenic areas. The vegetation communities are identified in **Figure 4-24** and include:

- Fresh- Moist Sugar Maple – Hardwood Deciduous Forest
- Dry – Fresh Sugar Maple – Oak Deciduous Forest
- Dry – Fresh Red Oak Deciduous Forest
- Dry – Moist Old Field Meadow
- Mineral Cultural Thicket
- Anthropogenic ELC Types:
  - Parkland
  - Education
  - Low Density Residential
  - High Density Residential
  - Single Family Residential
  - Transportation
  - Open Water

Descriptions of the vegetation communities is provided in the *Terrestrial and Aquatic Ecology Report* located in **Appendix D**.

Botanical surveys were completed by traversing the Study Area and recording species observed in each vegetation community. Identified plants were compiled and their status at local (i.e. Halton) and provincial levels (i.e. S-Rank) were verified. Provincial rarity status was based on the SARO list.

A total of 99 species of vascular plants was recorded within the Study Area, 34 (or 34%) of which are known to be non-native to Ontario. While the ratio of non-native species to native species present within the Study Area is fairly low, it includes several highly invasive species such as Tartarian Honeysuckle (*Lonicera tatarica*), European Buckthorn, English Ivy, and Garlic Mustard. Their presence is indicative of high levels of disturbance and cultural influence typical of urban areas.

The majority of native species observed have a provincial “S5 - Secure” NHIC ranking, indicating that they are common within Ontario, and the remaining species are “S4 – Apparently Secure”. Honey Locust (*Gleditsia triacanthos*) is an exception with an “S2?” ranking, meaning imperiled due to very restricted range or very few populations, but this ranking remains to be verified. However, the Honey Locust within the Study Area are planted cultivars, as evidenced by the lack of thorns found on native varieties and would not be subject to this ranking.

One provincial Species at Risk (Endangered) was recorded – American Chestnut (*Castanea dentata*). A single individual of this tree was observed in Reach 3 (**Figure 4-24**). A complete list of plant species recorded is provided in the *Terrestrial and Aquatic Ecology Report* located in **Appendix D**.

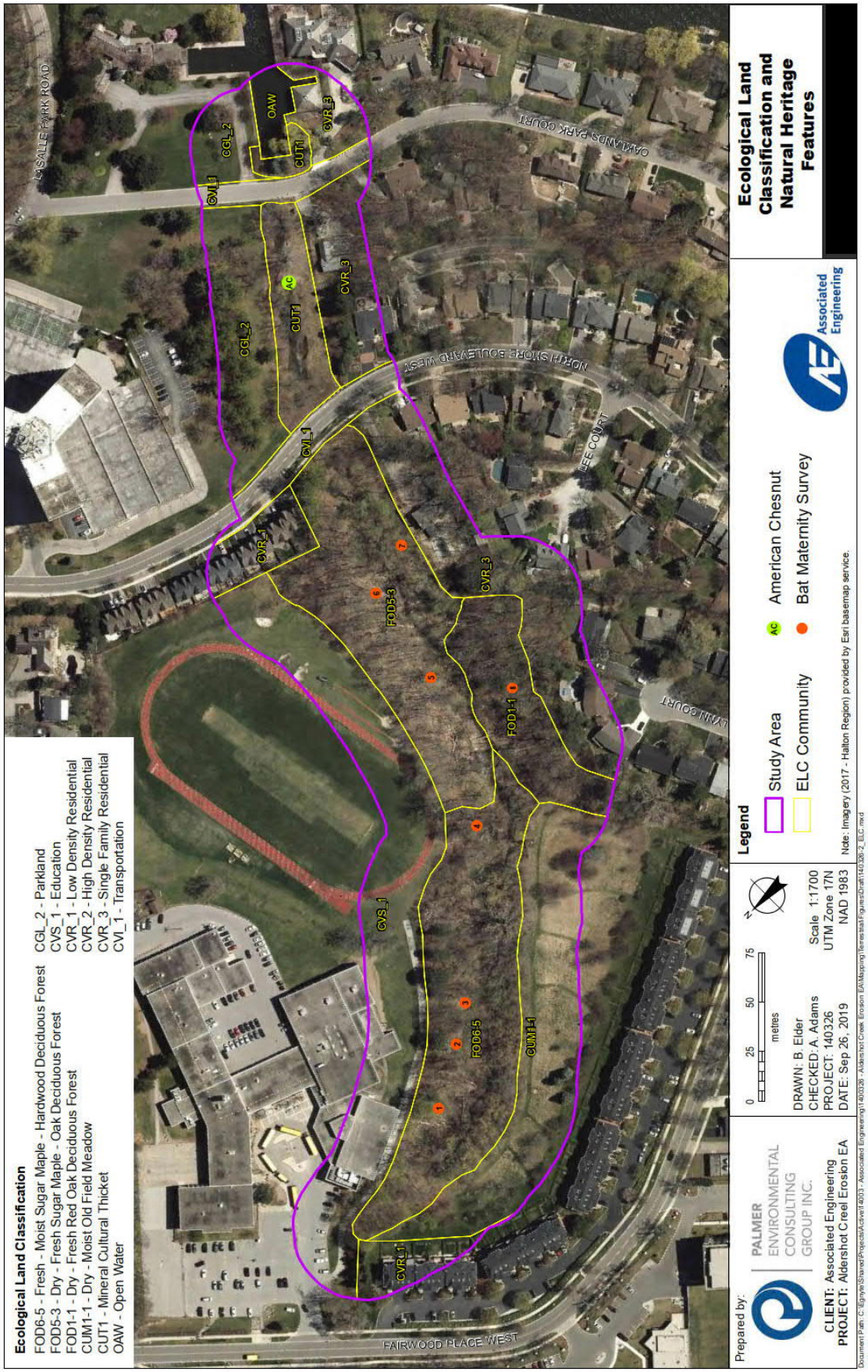


Figure 4-24: Ecological Land Classification and Natural Heritage Features

Breeding Birds

Breeding bird surveys were conducted following the principles of the *Ontario Breeding Bird Atlas Guide for Participants* (Bird Studies Canada, 2001). The survey documented the birds based on the following habitats and locations: forest and flyovers and adjacent areas. A total of 21 bird species was documented in the Study Area. Two of the species, Canada Goose (*Branta canadensis*) and American Robin (*Turdus migratorius*), are confirmed breeding as fledglings and were observed in suitable nesting habitat. The most frequently observed species found in the Study Area included birds characteristic of woodlands and open areas, such as Red-eyed Vireo (*Vireo olivaceus*), Northern Cardinal (*Cardinalis cardinalis*) and American Goldfinch (*Spinus tristis*). No SAR or area-sensitive species were observed in the Study Area. The full survey results are provided in the *Terrestrial and Aquatic Ecology Report* located in **Appendix D**.

Bat Habitat

A scoped bat maternity roost survey was undertaken based on assessing tree cavities in accordance with methods outlined the *Bats and Bat Habitats: Guidelines for Wind Power Projects* (Ontario Ministry of Natural Resources, 2011). According to the *Bats and Bat Habitats: Guidelines for Wind Power Projects,* the definition of a snag is *"any standing live or dead tree >10 cm DBH with cracks, crevices, hollows, cavities, and/or loose or naturally exfoliating bark."* Following the Significant Wildlife Criteria for Ecoregion 7E, maternity colonies can potentially be located in mature deciduous or mixed forest stands with >10 wildlife trees (snags) per hectare that are >25 cm DBH.

A survey for bat maternity roost potential was conducted on July 31, 2018. Within the eight plots established, five trees were observed with maternity roost potential, giving a density of potential roost trees of 12.5/ha; therefore, the Study Area has the potential to match the SWH criteria for bat maternity roost habitat. The results from the survey identified several trees as potential maternity roost habitat for SAR bat species, as standing snags were scattered within the forested community.

Incidental Wildlife

Incidental observations of wildlife were made during all field investigations. All direct observations or evidence of wildlife, such as nests, tracks, scat observed during the survey were recorded and added to all species lists. The presence of West Aldershot Creek itself and adjacent thicket and forest communities provide wildlife habitat opportunities. A Downy Woodpecker (*Picoides pubescens*) and at least 11 Monarch butterflies (*Danaus plexippus*) were observed during the July 31, 2018 field visit. A Green Frog (*Lithobates clamitans*) and Eastern Cottontail (*Sylvilagus floridanus*) were observed during the breeding bird surveys. Ruby-throated Hummingbird (*Archilochus colubris*) and an Eastern Chipmunk (*Tamias striatus*) were observed during the September 17, 2018 site visit.

Amphibian breeding surveys were not carried out due to timing constraints for the survey; however, with the observation of a Green Frog, it is assumed that the creek supports breeding amphibians. Given the small size of the potential habitat features within the creek, as well as the urban context, it is likely only very small numbers of more tolerant amphibians would be supported.

Full terrestrial survey results are provided in the *Terrestrial and Aquatic Ecology Report* located in **Appendix D.**

4.1.6 Species at Risk

A habitat suitability assessment for SAR was conducted as part of the pre-field information gathering efforts in order to determine whether SAR habitat is present, potentially present, or absent within the Study Area. The screening of SAR habitat suitability within the Study Area was compiled based on background information and existing conditions and observations recorded in the Study Area.

Based on the screening, one SAR (American Chestnut) was observed during field surveys and as many as eleven (11) additional species have suitable habitat or are potentially present within the deciduous forests of the Study Area.

Eastern Wood-pewee (*Contopus virens*) and Barn Swallow (*Hirundo rustica*) were the only Species at Risk recorded at the site. Eastern Wood-pewee is listed as Special Concern, provincially and federally. One individual was heard singing during the early breeding survey in 2019, which indicated possible breeding. Barn Swallow is listed as Threatened provincially and federally. Two individuals were observed flying overhead during the last survey in 2019. Suitable breeding is not present within the Study Area.

No area-sensitive bird species were recorded at the site.

4.1.7 Significant Wildlife Habitat

The Study Area was screened for Significant Wildlife Habitat (SWH) types as per MNRF criteria schedules for Ecoregion 7E. The screening summary considers all potential SWH types for Ecoregion 7E.

A more detailed discussion regarding the potential for SAR and the evaluation of the SWH types are provided in the *Terrestrial and Aquatics Ecology Report* located in **Appendix D**.

4.1.8 Source Water Protection

The *Clean Water Act* (2006) aims to protect existing and future sources of drinking water. To achieve this, several types of vulnerable areas have been delineated around surface water intakes and wellheads for every municipal residential drinking water system that is located in a source protection area. These vulnerable areas are known as a Wellhead Protection Areas (WHPAs) and surface water Intake Protection Zones (IPZs). Other vulnerable areas that have been delineated under the *Clean Water Act* include Highly Vulnerable Aquifers (HVAs), Significant Groundwater Recharge Areas (SGRAs), Event-based modelling areas (EBAs), and Issues Contributing Areas (ICAs). Source protection plans have been developed that include policies to address existing and future risks to sources of municipal drinking water within these vulnerable areas.

The Study Area is located within the Halton Region Source Protection Area. It was confirmed via email (**Appendix I**) from both the local source water protection authority (Conservation Halton) and the Region of Halton's Source Protection Office that the source protection plan for the Halton Region Source Protection

Area does not include any policies applicable to this Study. From a drinking water source protection perspective, the erosion controls resulting from this Study will benefit water quality.

4.2 INFRASTRUCTURE

The Study Area contains numerous storm sewer outfalls outletting to West Aldershot Creek. The major outfalls include an existing structure located at the upstream end of the Study Area, at the head of Reach 1, which contains a 750mm diameter and 1430mm diameter storm outfall, and a concrete outfall at the downstream end of Reach 1 that has been outflanked by bank erosion along the creek. Based on site assessment, the structural integrity of the existing storm outfall at the head of Reach 1 is deemed adequate and does not require replacement due to structural condition. Several of the storm outfalls are undermined or exposed due to erosion along the creek banks and bed as illustrated in **Figure 4-25**.



Figure 4-25: Existing Storm Outfalls within Study Area

Within the Study Area, the creek crosses North Shore Boulevard West and Oaklands Park Court through a 1900mm diameter CSP culvert and 3.3m wide elliptical culvert, respectively.

An existing sanitary sewer system owned and operated by the Region of Halton parallels and locally crosses West Aldershot Creek (**Figure 4-26**). The existing concrete sewer pipe ranges in size from 200mm to 300mm diameter. The sewer system conveys sewage to the La Salle Park Wastewater Pumping Station (WWPS) located on Oaklands Park Court, adjacent to the creek. Due to the extensive erosion along West Aldershot Creek several sanitary manhole structures are exposed along the creek banks as illustrated in **Figure 4-27**.

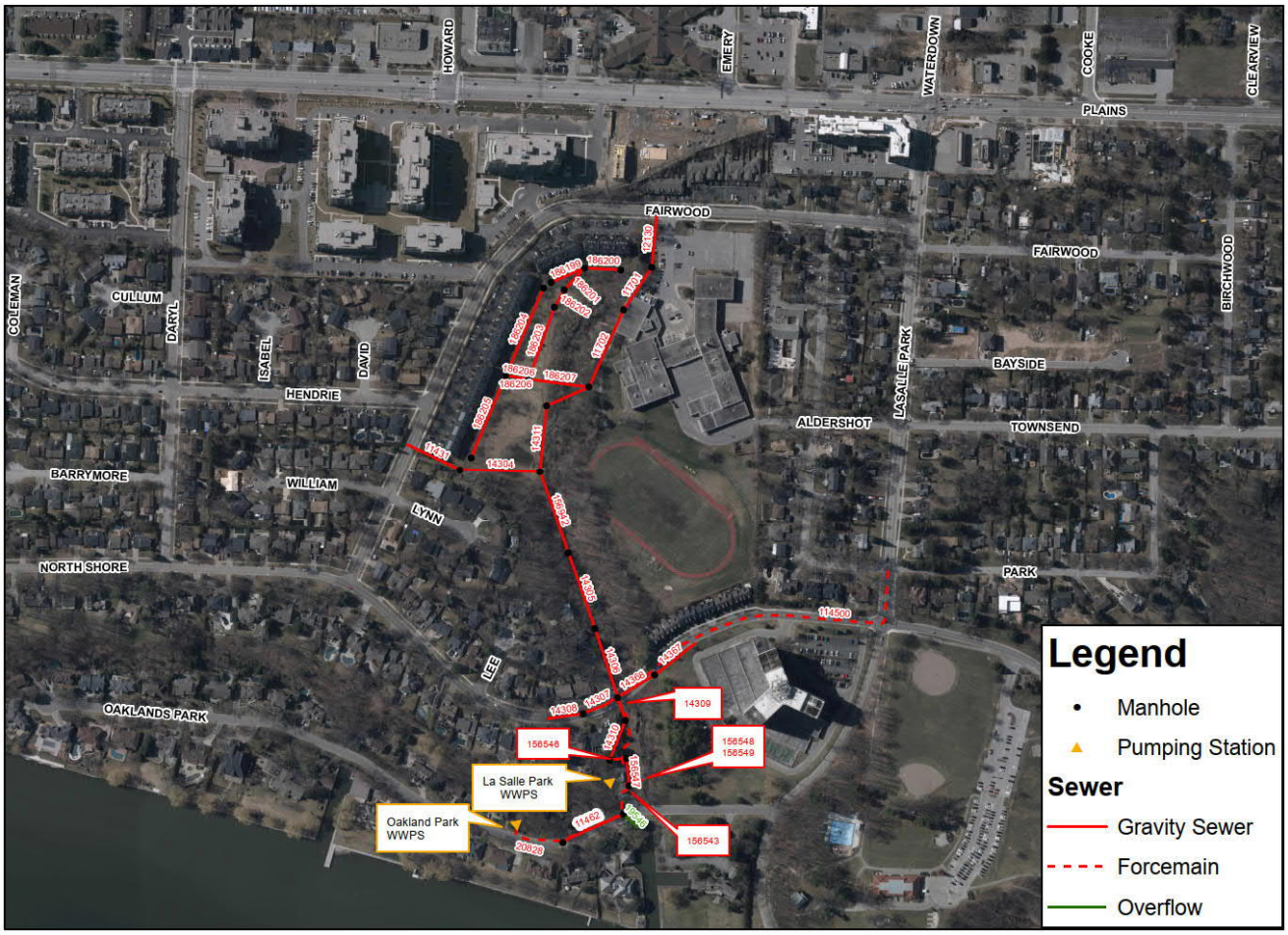


Figure 4-26: Existing Region of Halton Sanitary Sewer System within Study Area



Figure 4-27: Exposed Sanitary Sewer Infrastructure within Study Area

During the Study the Region of Halton provided information to the Study Team regarding a new 375mm diameter sanitary sewer that will be constructed on LaSalle Park Road from Fairwood Place to the La Salle Park WWPS. The proposed sewer will be constructed along West Aldershot Creek between North Shore Boulevard and Oaklands Park Court as illustrated in **Figure 4-28**.



Figure 4-28: Proposed Region of Halton Sanitary Sewer adjacent to Study Area

The Study Area also contains an existing watermain that is owned and operated by the Region of Halton. The existing watermain parallels West Aldershot Creek (**Figure 4-29**) but at such a distance that it is not at an immediate risk from erosion. Impact of proposed remedial works for the creek on the watermain will be considered during detailed design, although considered to be low or negligible.

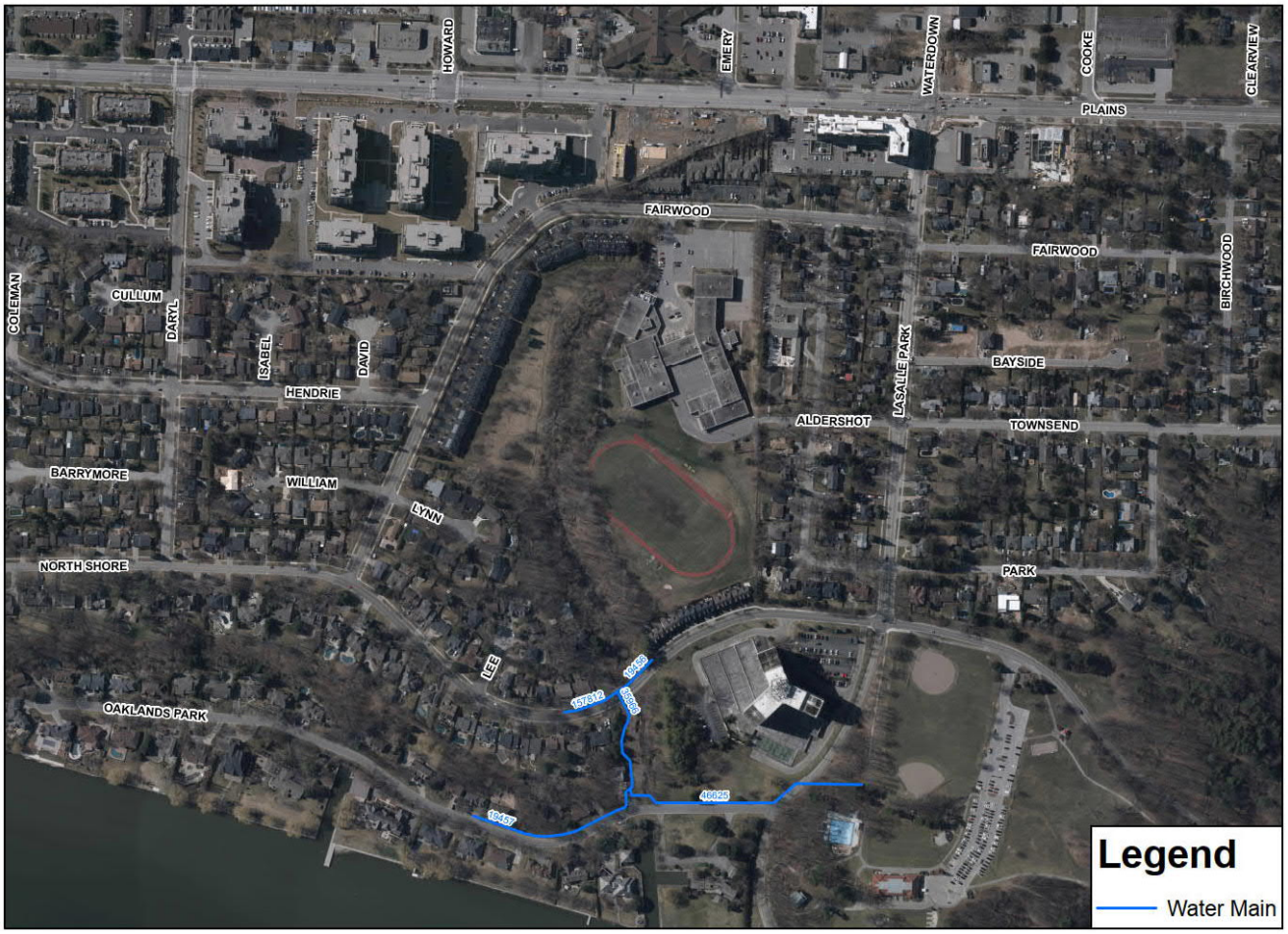


Figure 4-29: Existing Region of Halton Watermain within Study Area

4.3 SOCIO-ECONOMIC ENVIRONMENT

4.3.1 Land Use

The Study Area occurs within the City's urban boundary with high-density residential and low-density residential land uses (City of Burlington Official Plan, Schedule B). Adjacent to the Study Area is Aldershot High School as well as a sanitary pumping station owned and operated by the Region of Halton. The remaining land uses adjacent to West Aldershot Creek are a mix of single residential dwellings, townhomes and apartment/condominium properties.

4.3.2 Ownership

Within the Study Area, West Aldershot Creek is located on both public and private property. West Aldershot Creek traverses numerous privately-owned properties and Region of Halton owned property. **Figure 4-30** illustrates the property parcels within the Study Area.

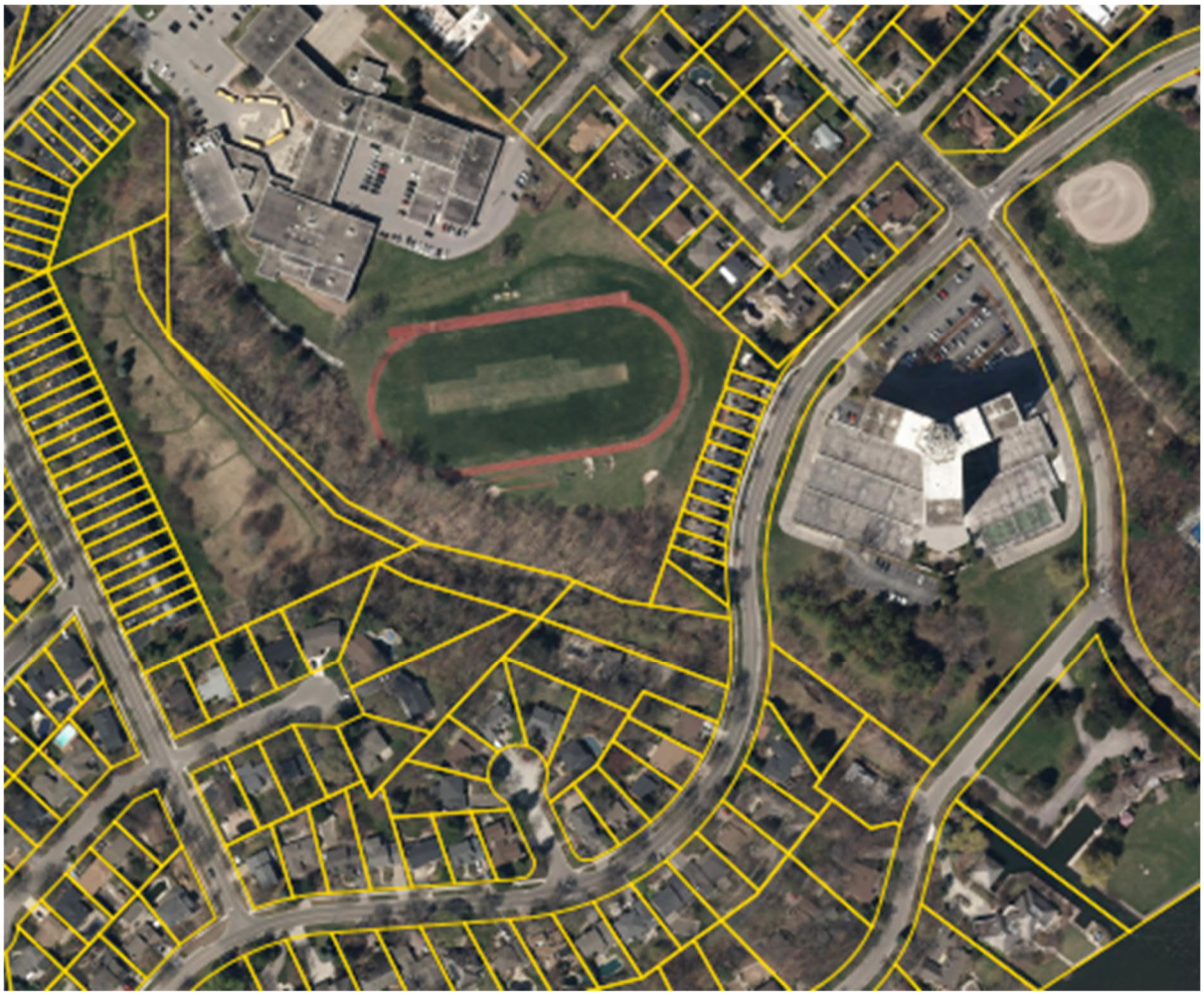


Figure 4-30: Property Parcels within the Study Area

To facilitate the remediation works recommended in this Study, the City will obtain temporary and/or permanent easements over the creek where it is contained within private property. However, the land will still be privately owned. As such, any work done on the watercourse within the privately-owned portion of the creek must be done in consultation with the land owners.

4.4 CULTURAL ENVIRONMENT

Archaeological Services Inc. (ASI) was contracted by Associated Engineering Ltd. to conduct a Stage 1 Archaeological Assessment (Background Research and Property Inspection) as part of the West Aldershot Creek Erosion Control Study.

4.4.1 Archaeological Assessment (Stage 1)

The Stage 1 Archaeological Assessment field work was completed on October 24, 2018 in order to gain first-hand knowledge of the geography, topography, and current conditions and to evaluate and map archaeological potential of the Study Area.

The Study Area meets the following criteria indicative of archaeological potential:

- Proximity to Euro-Canadian settlements (village of Aldershot, farmsteads, estates, Brown's Wharf);
- Proximity to historic transportation routes (Great Western Railway, Waterdown Road); and
- Proximity to water sources (Lake Ontario, West Aldershot Creek).

The property inspection determined that parts of the Study Area exhibit archaeological potential and these areas will require Stage 2 archaeological assessment, prior to any land disturbing activities, as identified in **Figure 4-31** (green shaded areas indicate archaeological potential).

Parts of the Study Area are located in low and wet conditions along the creek bed or sloped in excess of 20 degrees and do not retain potential. The remainder of the Study Area have been subjected to deep soil disturbance events associated with construction of the existing ROWs and twentieth and twenty-first century residential development and school construction. These areas do not retain archaeological potential and do not require further survey.

It was noted that should the proposed work extend beyond the current Study Area, further Stage 1 archaeological assessment should be conducted to determine the archaeological potential of the surrounding lands.

The Stage 1 Archaeological Assessment report prepared by ASI is provided in **Appendix E**.



Figure 4-31: Stage 1 Archaeological Assessment Summary

5 Alternative Solutions

Under Phase 2 of the Class EA planning and design process, all reasonable and feasible solutions to the problem are identified and examined. In order to address the Problem encompassing the deficiencies that were identified as part of the Class EA study, a range of reasonable and feasible "solutions" were identified as alternative ways to solve the problem.

At the onset of this Study, discussions with the City identified that source control and Low Impact Development (LID) applications for the contributing flows to the Study Area were outside of the scope of this Class EA. As the Study Area is within the Hamilton Harbour Area, the City is actively implementing initiatives to reduce urban runoff and improve water quality as recommended under the HHRAP (refer to Section 1.3.1) as part of infrastructure upgrades (sewer and road reconstruction), and all new development applications.

Additionally, although the culverts under North Shore Boulevard and Oaklands Park Court were identified as being undersized, according to MTO design criteria and referenced in the North Shore Watershed Study (2006), culvert replacement and upsizing was confirmed (by the City) to be outside of the scope of this Class EA. It is City policy to not replace culverts until they have reached the end of their service life. At that time, replacement and upsizing (if deemed necessary) is proposed, designed, permitted and implemented. Until the culverts under North Shore Boulevard and Oaklands Park Court reach the end of their service life they will remain as existing, which, due to their undersizing, is currently offering flood attenuation, flow control and velocity reduction in Reach 2 and 3 of West Aldershot Creek.

5.1 IDENTIFICATION OF ALTERNATIVE SOLUTIONS

For this Study, a range of erosion control concepts have been developed including 1) Do nothing, 2) Site-specific erosion control measures, 3) Sub-reach erosion control measures, and 4) Reach-scale erosion control measures. Each of these alternatives are described in further detail below.

Alternative 1: Do Nothing

In the "Do Nothing" alternative, no improvements or intervention would be made to solve the identified problem. This means that excessive erosion of the bed and bank would continue in the form of downcutting, widening and planform adjustment. Implementing this alternative poses a risk to aquatic and riparian habitats, public and private property, and boat slips at the creek mouth will increase. Although no capital costs are assigned to this alternative, ongoing maintenance and emergency works costs pertaining to erosion damages would occur.

Alternative 2: Site-specific Erosion Control Measures

In this alternative, targeted measures would be provided in localized areas for the protection of City and Region infrastructure and towards public and private properties. Under this alternative, excessive erosion would continue in non-targeted areas.

Alternative 3: Sub-reach Erosion Control Measures

For this alternative, extended measures would be implemented to mitigate excessive erosion, in addition to the targeted measures proposed in Alternative 2. Extended measures can include bank regrading or reconstruction in selected areas to provide slope stabilization. Under this alternative, protective measures would be provided for larger trees and public and private property. Other solutions to be investigated under Alternative 3 include riffle enhancement to increase floodplain accessibility and the removal of large woody debris to limit the potential for future obstructions to fish passage and sediments.

Alternative 4: Reach-scale Erosion Control Measures

This alternative involves complete reconstruction and restoration of the full reach. The proposed solution would incorporate the benefits described in Alternatives 2 and 3, in addition to establishing a new equilibrium within West Aldershot Creek. This alternative has the highest monetary cost associated with it; however, it provides the most long-term benefits.

Each of the alternatives described above will be applied to the three (3) Study reaches. The following sections further describe the application of the four (4) alternatives.

5.2 DESCRIPTION OF ALTERNATIVES FOR REACH 1

Alternative 1: Do Nothing

Without intervention, the condition of the reach would further deteriorate. Excessive erosion of the bed and banks would continue in the form of channel down-cutting, the undercutting of banks and toppling of trees. There would be no improvements or protection provided to at-risk infrastructure, including the sanitary sewer and storm outfalls. The channel would continue to erode and undermine structures under this option. Implementing a “Do Nothing” approach would continue to pose a risk to aquatic and riparian habitats.

Alternative 2: Site-specific Erosion Control Measures

The overall work involved in this alternative would be to undertake localized measures within three site specific areas of Reach 1 (Site A, B and C) as illustrated in **Figure 5-2**.

Targeted measures for Site A include re-grading and stabilizing the banks with vegetated boulder revetment or armourstone, where constrained. To alleviate undermining of the main stormwater outfall, armourstone steps would be installed to cascade outflow into a stabilized plunge pool for energy dissipation. Also, armourstone grade control “ribs” are proposed between pools to inhibit further down-cutting and undermining of bank protection measures. Armourstone “ribs” will have a V-shaped cross-section to draw energy away from banks and create a low flow path to maintain fish passage. Armourstone “ribs” will be embedded into the bed such that their surfaces match the upstream and downstream bed to avoid the formation of a step or any impediment to upstream fish passage. Pools will consist of natural riverstone to enhance bed morphology and aquatic habitat, as well as to avoid excessive scour. The channel width would be widened slightly to help dissipate erosive energy, with a defined low-flow channel to improve existing conditions along this section of Reach 1. Design elements for Site A will be incorporated as part of each concept alternative to stabilize this highly erosive section of Reach 1. **Figure 5-1** is an analogue for what the proposed works at Site A would resemble.

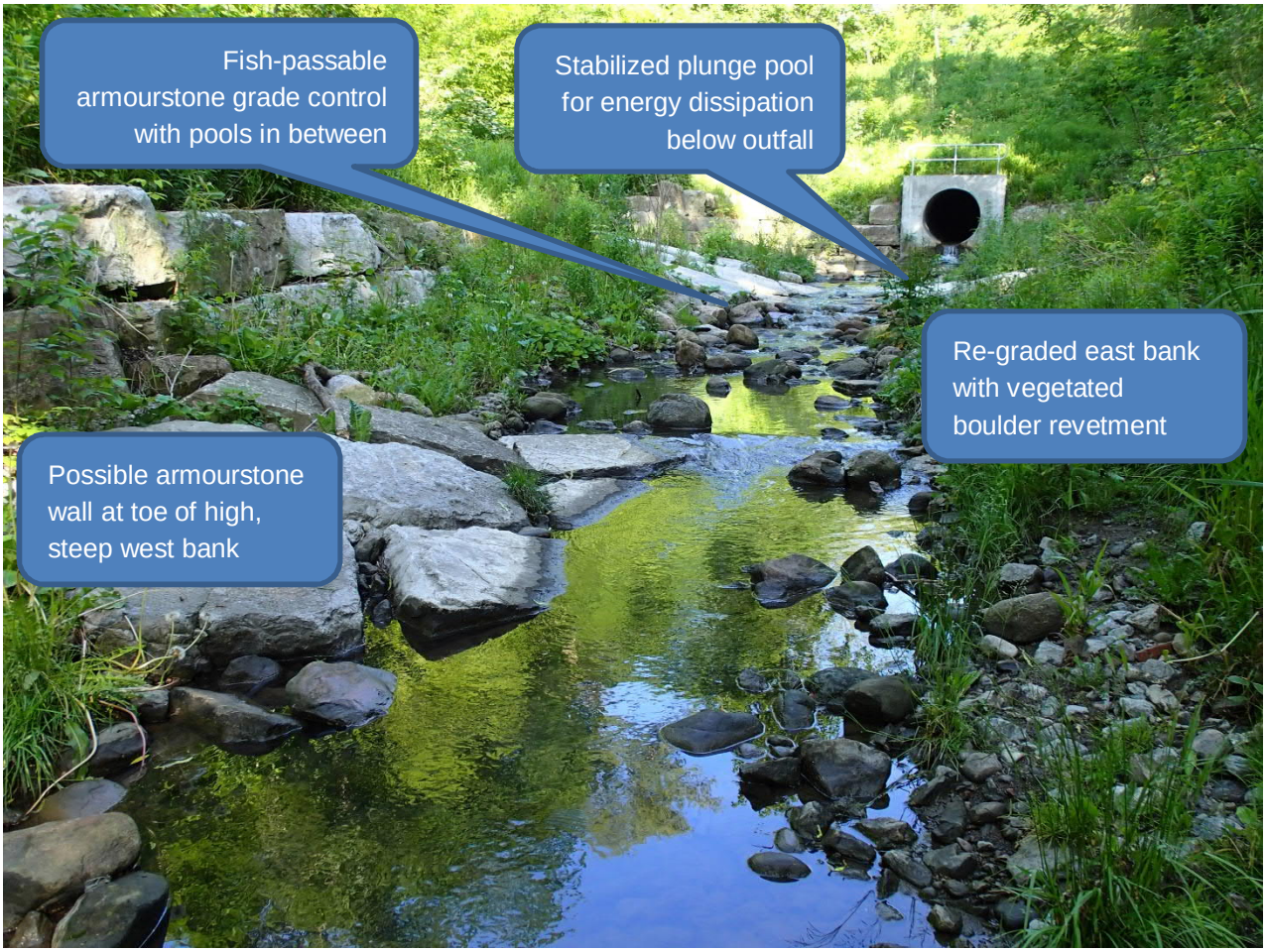


Figure 5-1: Analogue for Proposed Works at Site A in Reach 1

At Site B, the focus would be on protecting the exposed sanitary manhole structure with armourstone protection. Also, the existing unstable section of bank opposite the manhole would be re-graded and restored for improved stability and to mitigate future risk to the western manhole. Bed protection will be incorporated into works at this site if the sewer crossing itself is also at risk.

Measures for Site C include bank stabilization and cut-back of the outflanked stormwater outfall, as well as a compensatory cut of the opposite bank.

Alternative 3: Sub-reach Erosion Control Measures

Alternative 3 would involve extended measures in addition to those described in Alternative 2 to improve the condition of the creek within Reach 1 as illustrated in **Figure 5-3**. Site D would be included downstream of Site A to create the first sub-reach area while Site E would be included downstream of Site B to create the second sub-reach area.

The storm outfall from Aldershot High School is located at the top of bank at Site D. To improve conditions the existing concrete rubble debris would be removed along the bank and a 'slope drain' would be created down the valley wall to convey storm outfall discharge in a controlled manner. This would be implemented through localized recontouring and placement of cobbles intermixed with moisture-tolerant shrubs.

Targeted measures proposed at Site E include bank stabilization with the removal of unstable sections. To help combat future erosion, root wad with boulder ballast is proposed along the channel edge. These measures would also provide protection for a large cottonwood tree located at the top of bank.

Alternative 4: Reach-scale Erosion Control Measures

This alternative involves complete reconstruction and restoration of Reach 1 as illustrated in **Figure 5-4**. This work would occur along the channel and valley bottom (approximately 250m), from the undermined outfall to the outfall outflanked along the western bank.

The new channel would be better able to accommodate the urbanized hydrologic regime, although not without naturalized bed and bank protection where energy cannot be dissipated through spillage onto a floodplain. Along the full reach, the channel would be reconstructed to accommodate a wider, shallower cross-section with a narrow floodplain bench to the extent possible. Grade control will remain necessary at least along the uppermost portion of the reach, where the channel is deeply entrenched. Vegetated boulder treatments of the banks will also be required, at least along outer banks, given the erodibility of clayey to fine sandy substrates. The vegetated boulder revetment will ensure local shading along the edges of the newly constructed low flow channel. Bed morphology will also be diversified with pool and riffle sequences to restore natural function but also enhance aquatic habitat. The reconstruction of Reach 1 will incorporate substrate and hydraulic (flow) diversity, overhanging vegetation and the reduction of fine sediment accumulation. In addition, local topographical lows will be utilized to minimize grading along the valley. The targeted measures described in Alternatives 2 and 3 would also be implemented under this approach, although with possible refinements to accommodate broader changes upstream and downstream (e.g. Site B).

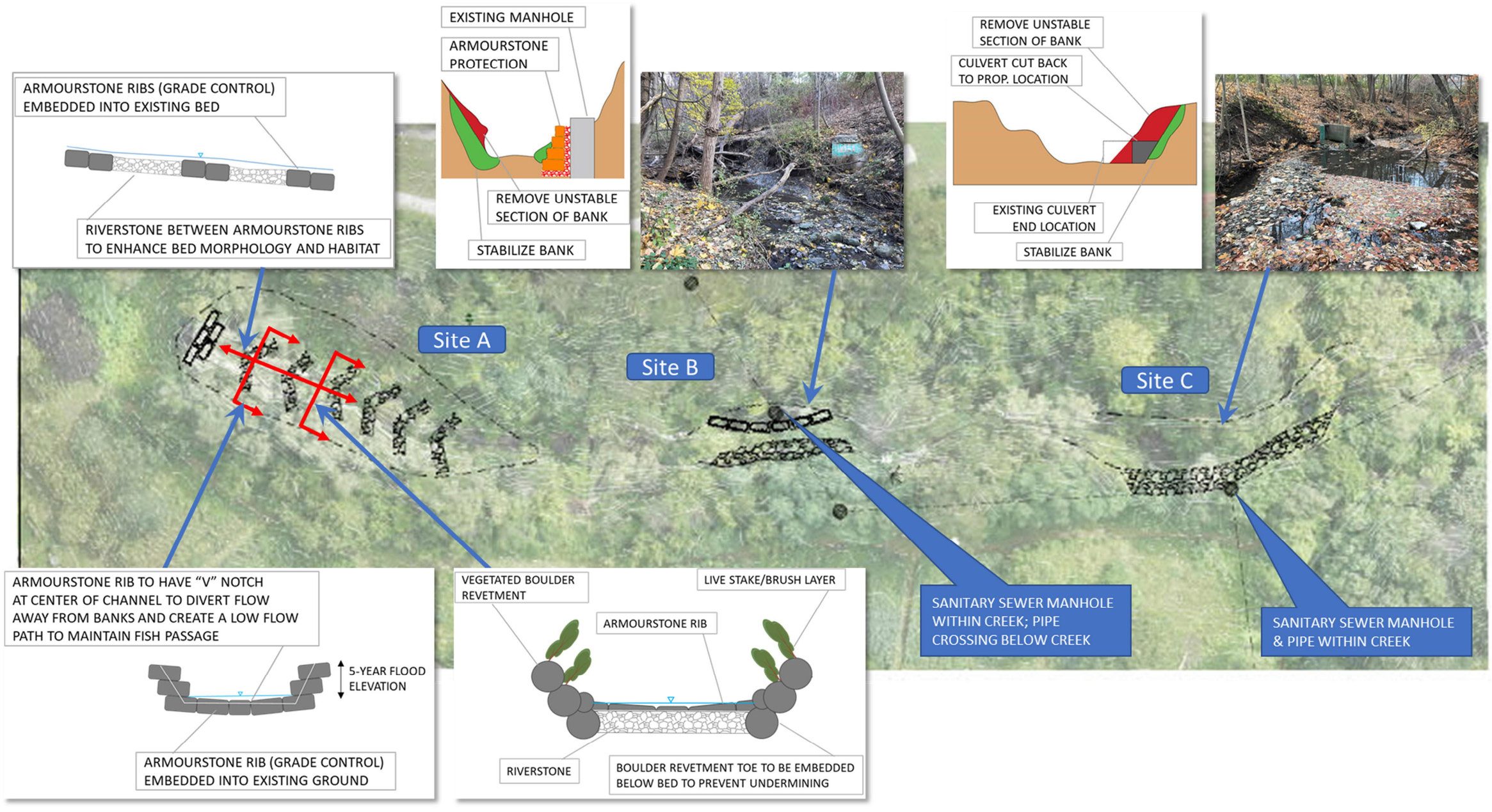


Figure 5-2: Alternative 2 along Reach 1

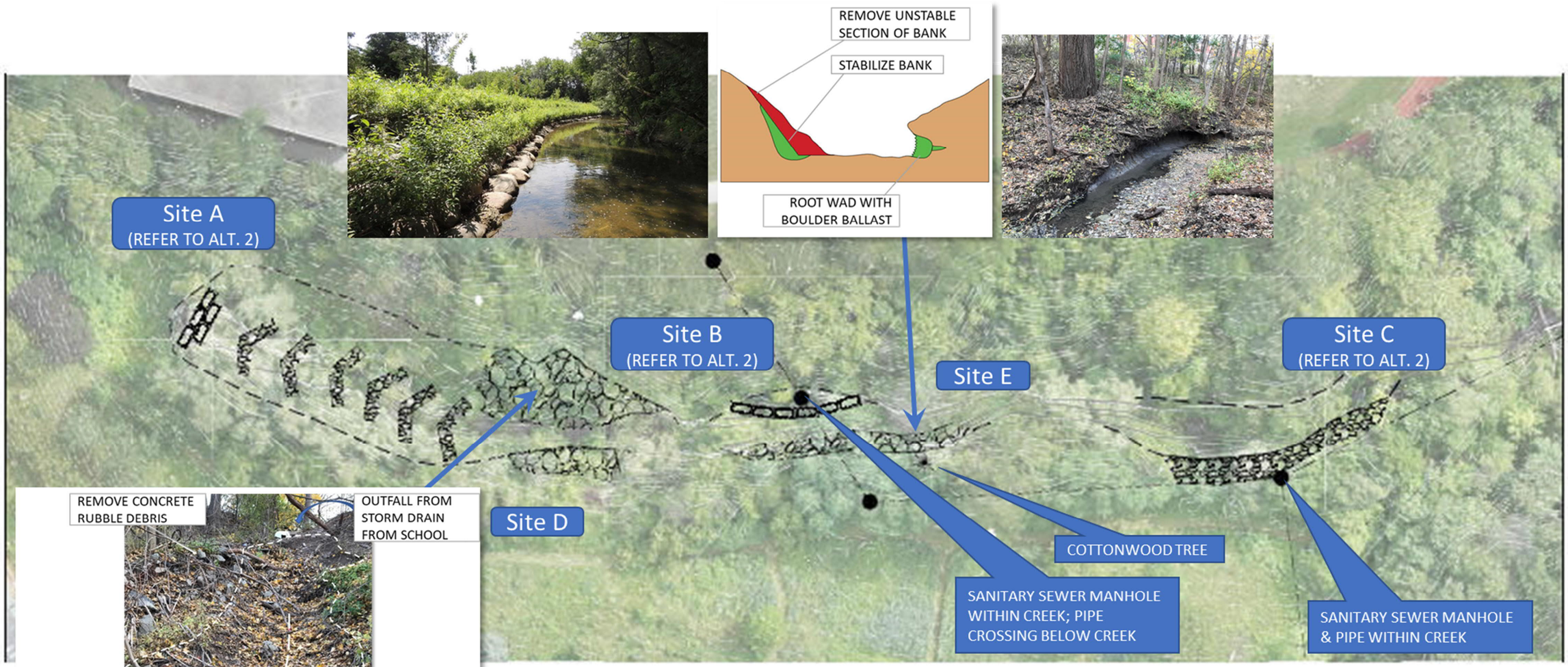


Figure 5-3: Alternative 3 along Reach 1

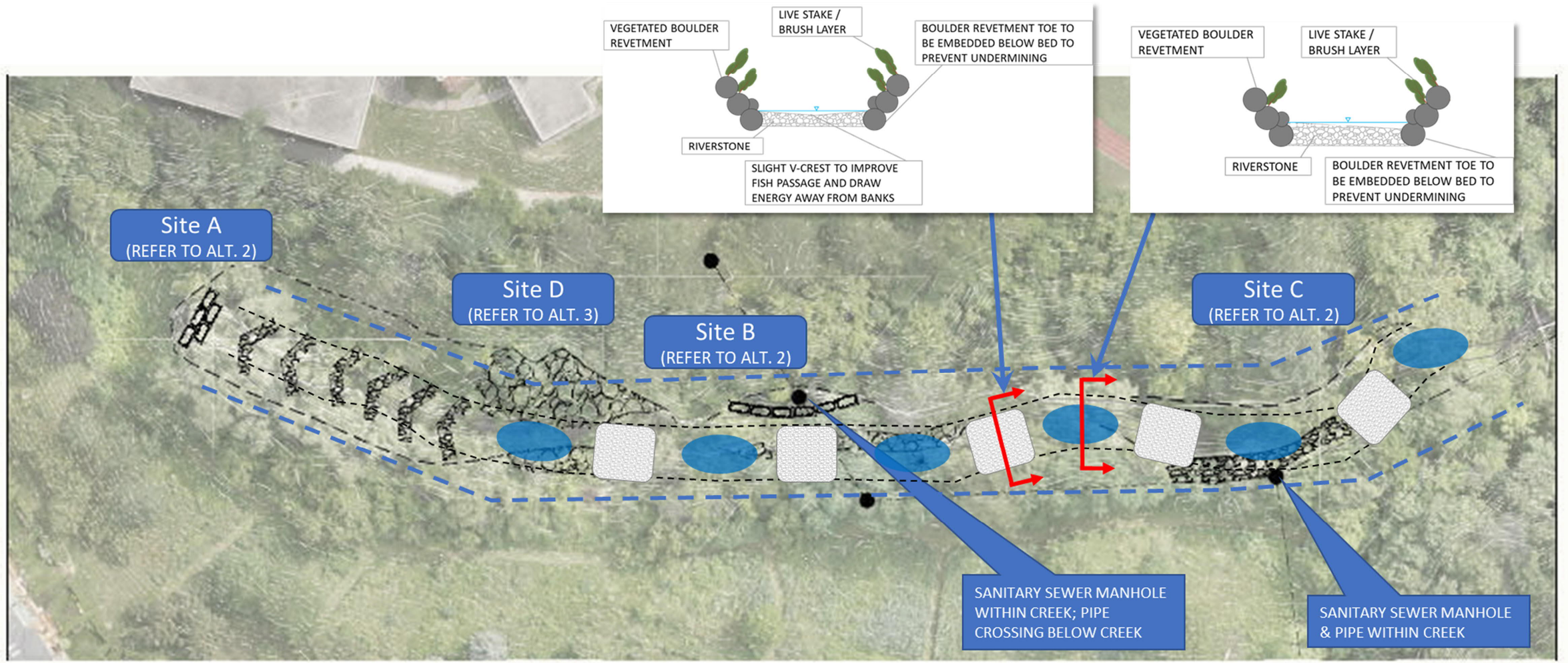


Figure 5-4: Alternative 4 along Reach 1

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5.3 DESCRIPTION OF ALTERNATIVES FOR REACH 2

Alternative 1: Do Nothing
Under this option, no improvements or changes would be made to address the identified erosion issues along Reach 2. Localized excessive bank erosion would continue. No changes would be made to manage the instream woody debris jams and erosion that is concentrated along the outer banks of the channel bends. Also, no provisions would be made to provide protection for exposed infrastructure located along Reach 2.

Alternative 2: Site-specific Erosion Control Measures
In this alternative, localized measures would be undertaken at two site specific locations within Reach 2 (Site F and G) as illustrated in **Figure 5-5**.

An existing sanitary manhole structure located at Site F is exposed. Under this alternative, protection of the structure would be provided with a vegetated boulder revetment. In addition, a compensatory cut would be made of the opposite bank to maintain or increase cross-sectional capacity.

Site G features a sharp meander immediately upstream of the culvert at North Shore Boulevard. To combat excessive erosion and culvert outflanking, bank stabilization using vegetated boulder revetments is proposed to smoothly guide flows into the culvert.

Alternative 3: Sub-reach Erosion Control Measures
For Reach 2, Alternative 3 involves the localized measures discussed in Alternative 2, in addition to a raised riffle technique throughout the channel (Site H) as illustrated in **Figure 5-6**.

The raised riffle technique involves incorporating raised and stabilized crest of riffles to restore channel-floodplain connectivity and better attenuate energy during high flows. In addition, localized bank reconstruction would be implemented to protect an existing fence. The removal of large woody debris and adjustment of the channel cross-section proposed under this alternative will limit the potential for future obstructions.

Alternative 4: Reach-scale Erosion Control Measures
Complete reconstruction and restoration of the channel and valley bottom (approximately 260m) along Reach 2 would be provided under this alternative as illustrated in **Figure 5-7**.

This work would help accommodate the anticipated downstream transfer of energy from Reach 1 and inhibit development of new erosion zones. The new channel would be better able to accommodate the urbanized hydrologic regime. Along the full reach, the channel would be reconstructed to accommodate a wider, shallower cross-section with improved floodplain accessibility. Vegetated boulder treatments of the banks may be required, locally, to mitigate risk to infrastructure or valley walls. Elements of Alternatives 2 and 3 necessary for infrastructure protection will be incorporated as appropriate.

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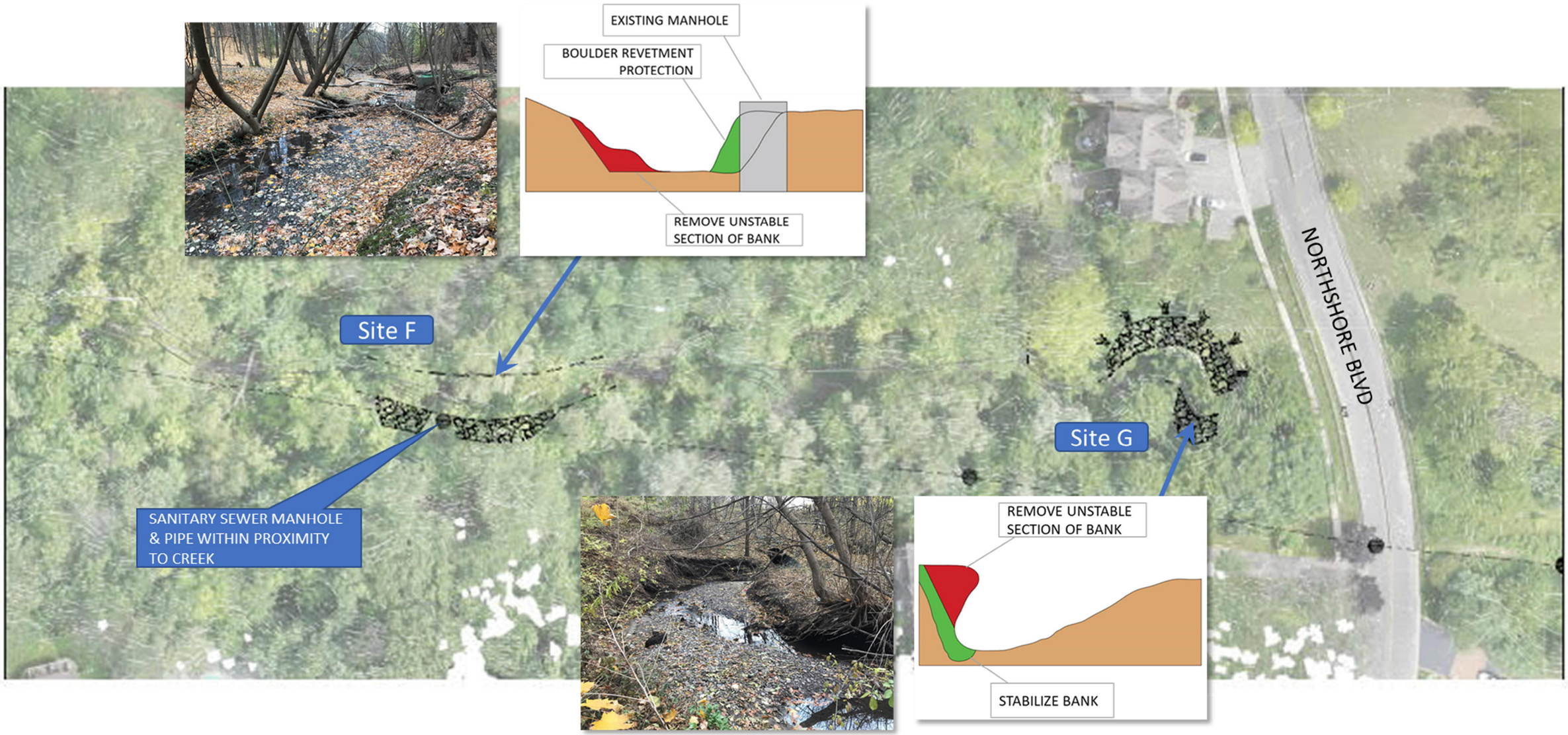


Figure 5-5: Alternative 2 along Reach 2



Figure 5-6: Alternative 3 along Reach 2

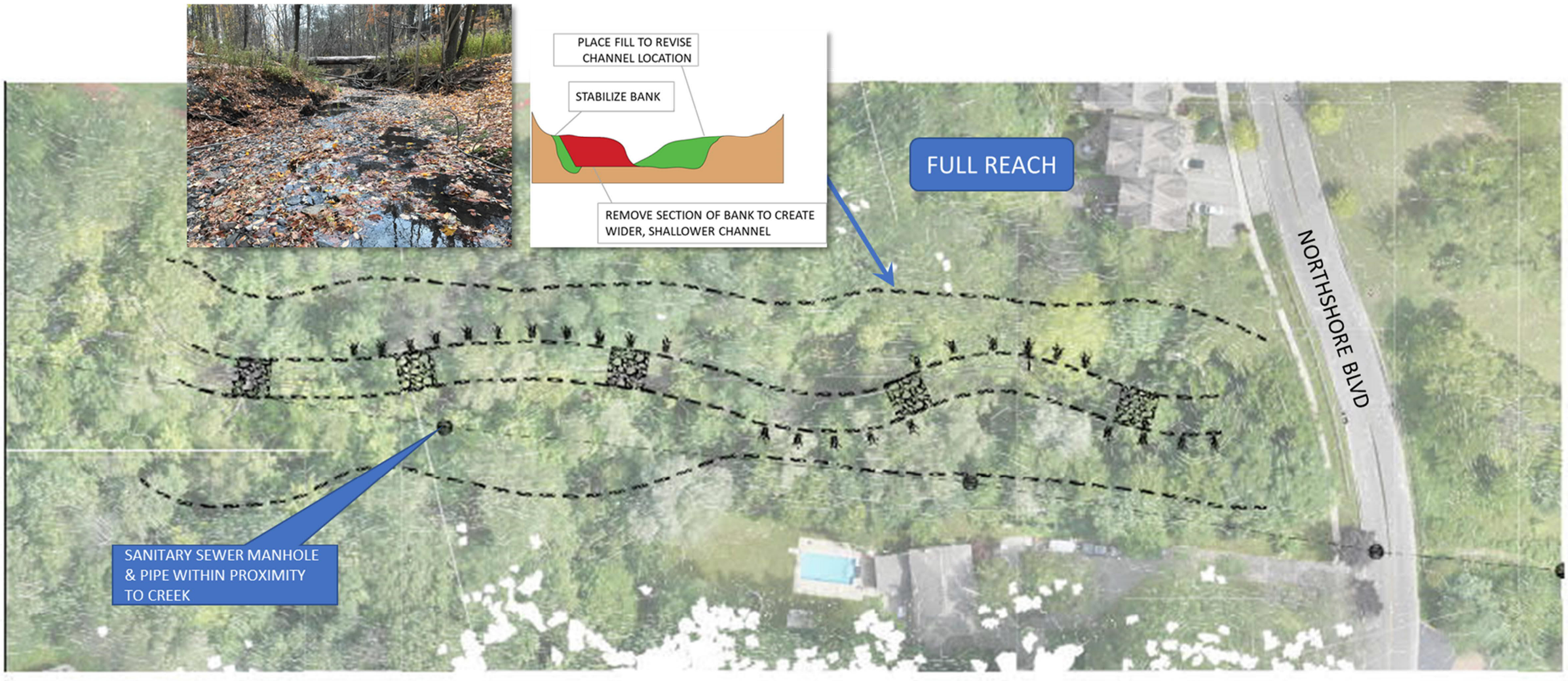


Figure 5-7: Alternative 4 along Reach 2

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5.4 DESCRIPTION OF ALTERNATIVES FOR REACH 3

Alternative 1: Do Nothing
Without intervention, no improvements would be made to address existing erosion-related issues within Reach 3. Currently, there is a large woody debris jam that impedes sediment transport and fish passage. No provision will be made under this alternative to address that issue. Additionally, no bank stabilization or restoration measures are proposed at the blow-out along the left bank, just upstream of a manhole. Excessive erosion at this erosional hollow will remain an outstanding issue and pose a risk to public and private property if the "Do Nothing" approach was selected.

Alternative 2: Site-specific Erosion Control Measures
The overall work associated with this alternative includes targeted measures to address channel erosion at the blow-out area within Reach 3 (Site I) as illustrated in **Figure 5-8**.

The single endangered tree set back from the west bank would be unaffected by proposed works and additionally protected with hoarding during implementation. Bank stabilization and restoration would be completed where scoured by flow deflected around a woody debris jam. Also, targeted measures will be implemented to protect private property, which includes maintaining the yard of an adjacent condominium building.

Alternative 3: Sub-reach Erosion Control Measures
Alternative 3 involves the localized measures discussed in Alternative 2, in addition to the implementation of riffles within the channel (Site J) as illustrated in **Figure 5-9**.

The creation or enhancement of riffles will improve long-term stability of the channel profile and diversify aquatic habitat. The mid-reach riffle is proposed in part as a replacement to the temporary grade control provided currently by the woody debris jam; it would inhibit head-cutting through accumulated fine sediments immediately upstream. The large woody debris jam would be disaggregated and removed, thereby restoring a more natural flow pattern. Upstream riffle stabilization is required to ensure the invert of the culvert beneath North Shore Boulevard West remains back-flooded and does not become perched and form a barrier to fish passage.

Alternative 4: Reach-scale Erosion Control Measures
Complete reconstruction and restoration of the channel (approximately 110m) within Reach 3 would be completed under this alternative as illustrated in **Figure 5-10.**

The proposed works would transform the channel from an entrenched, trapezoidal channel to a multi-stage channel with opportunities for flood attenuation and natural deposition. Channel planform would be refined to match observed trends toward increasing sinuosity. The new channel would be better able to accommodate the urbanized hydrologic regime, although not without naturalized bank protection where energy cannot be sufficiently dissipated through spillage onto a floodplain. Along the full reach, the channel would be reconstructed to accommodate a wider, shallower cross-section with floodplain benches to the extent possible. Riffles would serve as natural grade control. The targeted measures described in

Alternatives 2 and 3 would also be implemented under this approach. This alternative would address excessive erosion at the blow-out and reduce the potential for additional, uncontrolled erosion. The erosion-control measures described in Alternatives 2 and 3 would be included under this approach, as appropriate.

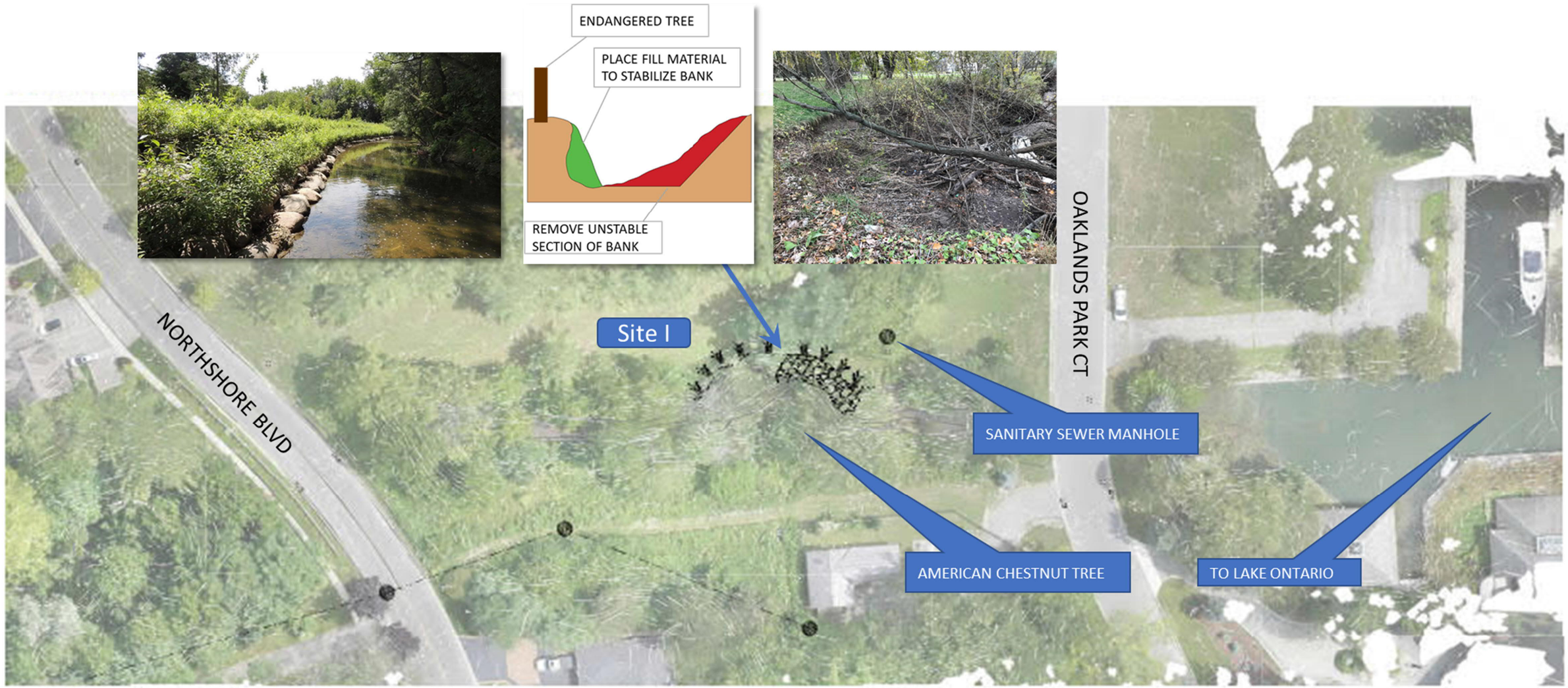


Figure 5-8: Alternative 2 along Reach 3

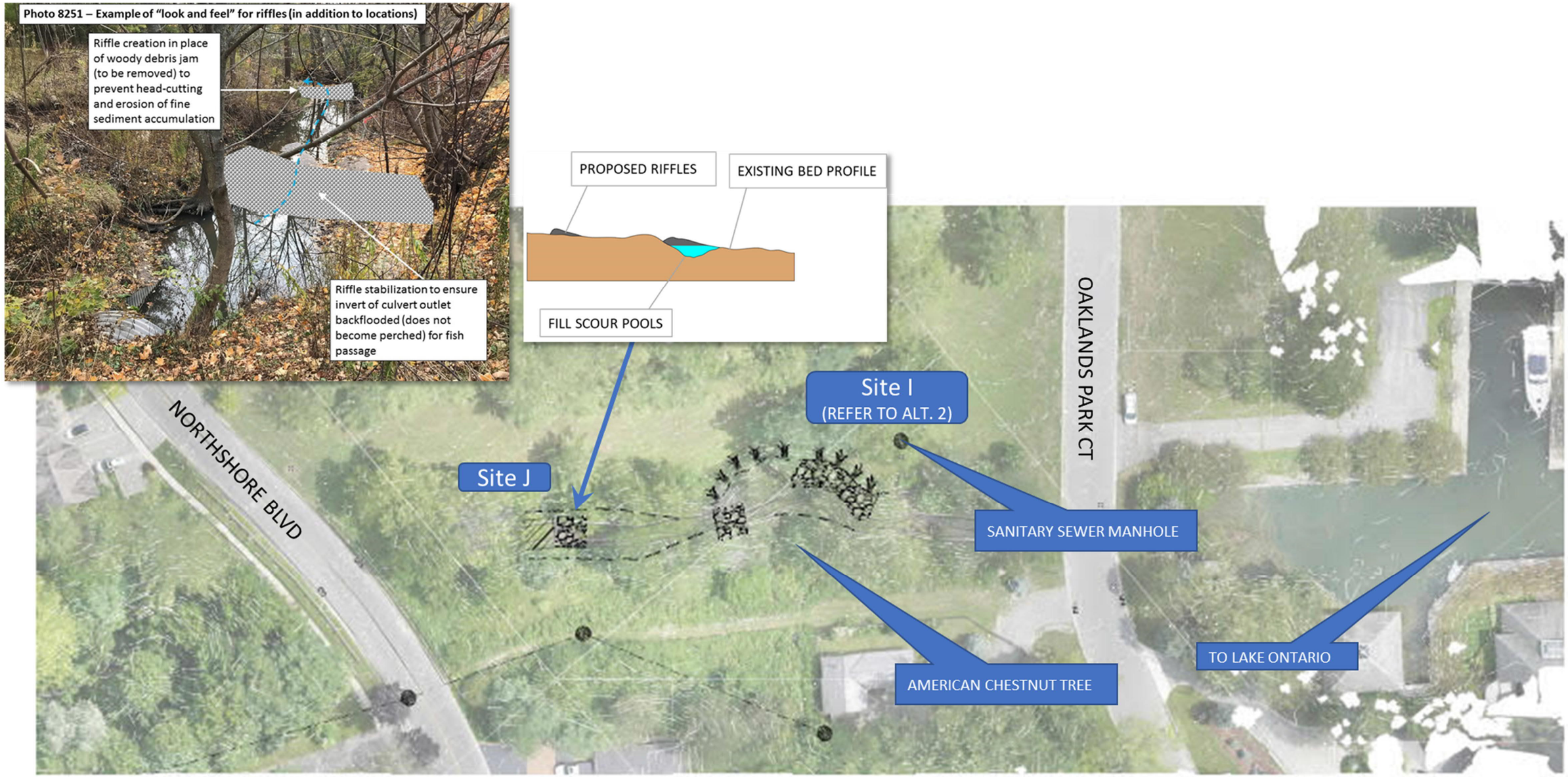


Figure 5-9: Alternative 3 along Reach 3

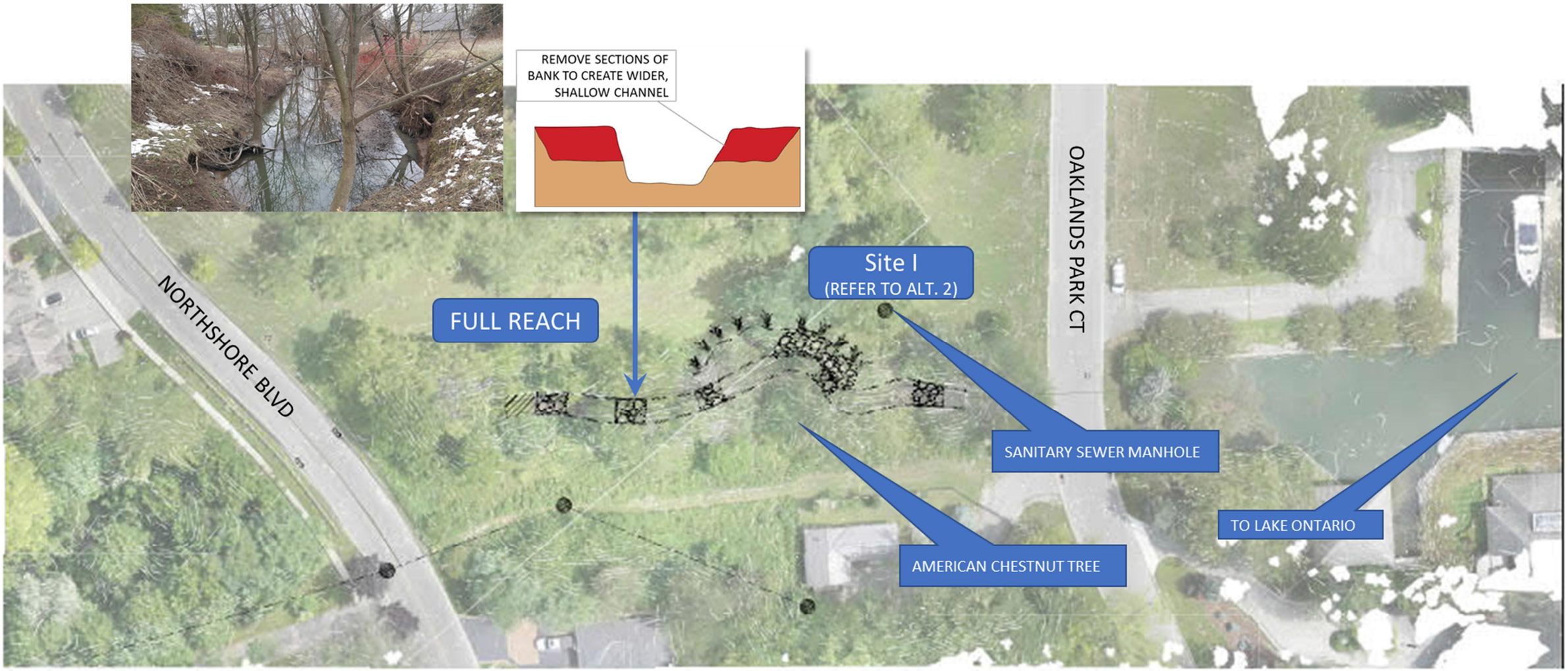


Figure 5-10: Alternative 4 along Reach 3

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5.5 EVALUATION CRITERIA

Each conceptual approach to address the problem statement and achieve the project objectives was compared and evaluated, by reach, using criteria within several categories. The evaluation categories and their respective criteria, finalized based on input received from affected agencies, stakeholders, the public and City staff, are summarized in **Table 5-1**. **Table 5-2** expands on the criteria considerations and weightings.

Table 5-1: Category and Evaluation Criteria

Category	Evaluation Criteria
Social	• Property Protection • Benefit to Community • Public Safety • Aesthetic Value • Archaeological Features
Environmental	• Terrestrial Habitat • Aquatic Habitat • Fluvial Geomorphology • Hydrology & Hydraulics • Geotechnical & Hydrogeological
Technical	• Existing Infrastructure • Regulatory Permitting and Approval and Acquisition Requirements • Constructability
Economic	• Capital Costs • Maintenance Requirements and Costs

Table 5-2: Criteria Definitions

Evaluation Criteria	Definition	Weight
Property Protection	• Mitigating risks and impacts to adjacent private property	10%
Benefit to Community	• Improved usage of areas surrounding creek for recreation or leisure	4%
Public Safety	• Mitigating risks and impacts to public safety	10%
Aesthetic Value	• Inclusion of aesthetically pleasing treatments and components to maintain or enhance natural environment of creek area	4%
Archaeological Features	• Impact on potential archaeological features	4%
Terrestrial Habitat	• Impact on connectivity, diversity and sustainability of existing terrestrial environment including SAR and potential for habitat improvement	8%
Aquatic Habitat	• Impact on connectivity, spawning and sustainability of existing aquatic environment including SAR and potential for habitat improvement	8%

Evaluation Criteria	Definition	Weight
Fluvial Geomorphology	• Impact on rates of erosion for bed and banks	8%
Hydrology & Hydraulics	• Impact on flow rates, flooding and surface drainage	7%
Geotechnical & Hydrogeological	• Impact on slope stability and suitability of soils and groundwater conditions	4%
Existing Infrastructure	• Mitigating risks and impacts to existing infrastructure (linear, road, utilities)	8%
Regulatory Permitting and Approval and Acquisition Requirements	• Securing permits and approvals from regulatory agencies (ie: CH, DFO, MECP and MNRF); property easement acquisition	5%
Constructability	• Feasibility and complexity associated with implementing proposed works	5%
Capital Costs	• Cost to City to complete detailed design, secure permits, gain approvals and property, and complete construction	8%
Maintenance Requirements and Costs	• Extent of regularly scheduled maintenance and cost to City to maintain proposed works	7%

5.6 SUMMARY OF EVALUATION PROCESS

The four alternative solutions proposed for each of the three reaches were evaluated against the sixteen (16) evaluation criteria using a five-point scale as summarized in **Table 5-3**, ranging from most desirable (5) to least desirable (1).

Table 5-3: Evaluation Five-Point Scale

Numerical Rating	Rating
1	Least Desirable
2	Worst Choice
3	Adequate Choice
4	Better Choice
5	Most Desirable

For each reach, the four alternatives were evaluated using the criteria identified in Section 5.5. The evaluation matrix for each of the reaches is provided in **Table 5-4** to **Table 5-6**. A weighted sum was determined for each alternative for each of the four (4) categories (social, environmental, technical and economic) and then totalled to determine an overall score for each alternative. The alternatives were then ranked, with the highest scoring alternative deemed to be the preferred. As evident in the tables, the preferred solution for each reach is:

- Reach 1: Alternative 4 – Reach-scale Erosion Control Measures;
- Reach 2: Alternative 3 – Sub-reach Erosion Control Measures; and
- Reach 3: Alternative 3 – Sub-reach Erosion Control Measures.

Table 5-4: Evaluation Matrix for Reach 1

Objective	Evaluation Criteria	Weight	Considerations	Score				Total Score				Notes	Comments
				Alternative 1 Do Nothing	Alternative 2 Site Specific EC	Alternative 3 Sub-reach EC	Alternative 4 Reach-scale EC	Alternative 1	Alternative 2	Alternative 3	Alternative 4		
Social	Property Protection	10%	Mitigating risks and impacts to adjacent private property	1	2	3	4	9.6	16.4	21.2	25.2	Properties of concern include Fairview Place Townhouse Complex, Aldershot School, Apartment building complex, private residential properties	Focusing on long-term protection against property loss
	Benefit to Community	4%	Improved usage of areas surrounding creek for recreation or leisure	1	2	3	3					Informal access to creek surrounding area will be considered (limiting where high risk/sensitive) for local residents (ie: nature walks)	Reduce high risk areas of erosion and unstable banks; consider vegetation that will deter access at high risk/sensitive areas
	Public Safety	10%	Mitigating risks and impacts to public safety	1	3	4	5					Inclusion of safety measures including safety grating (on outfall structures) and limiting access where necessary	
	Aesthetic Value	4%	Inclusion of aesthetically pleasing treatments and components to maintain or enhance natural environment of creek area	3	3	3	3					Inclusion of organic bank treatments, hardscape with integrated vegetation, maintaining and including native vegetation species	Consideration for ultimate build-out condition rather than post-construction condition; Existing condition of fallen trees, down-cutting, erosion scars, collapsing outlets is a negative; Improved sinuosity of creek considered positive
	Archaeological Features	4%	Impact on potential archaeological features	3	3	3	3					Stage 1 assessment identified various areas with archaeological potential and requirement of a Stage 2 assessment	Consideration given to impact of construction to existing archaeological features as well as impact of continuous erosion and slope stability on archaeological features
Environmental	Terrestrial Habitat	8%	Impact on connectivity, diversity and sustainability of existing terrestrial environment including SAR and potential for habitat improvement	5	3	3	2	13.4	21.6	24.6	28.6	Existing terrestrial habitat includes deciduous forest with seeps/swampy areas on steep slopes with benches; mixture of common wildlife. Potential bird breeding grounds for Canada Goose & Northern Cardinal.	Trees should be retained to the degree feasible for stability provided by root-systems - disturbance area increases from Alt 2 to 4. Design must consider re-establishment of seeps/groundwater outlets. Disturbance of canopy cover for construction should limit access to steep slopes; consider the interim and long term effect on terrestrial; opportunity to replace non-native with native species.
	Aquatic Habitat	8%	Impact on connectivity, spawning and sustainability of existing aquatic environment including SAR and potential for habitat improvement	1	2	2	4					Existing aquatic habitat lacks low-flow channel definition and aquatic vegetation, and is frequently impacted by high rates of erosion of silty soils. One debris jam impedes fish passage. Possible record of two SAR.	Alt 2 and 3 would reduce rates of erosion (high suspended sediment loads), but less so than Alt 4. Alt 4 would create stable, more diverse channel conditions with improvements to aquatic habitat
	Fluvial Geomorphology	8%	Impact on rates of erosion for bed and banks	1	3	4	5					Reach 1 currently experiencing severe, extensive bed & bank erosion with undercut banks and numerous downed trees. Little to no floodplain access.	Reach scale erosion not being addressed downstream of outlet for Alt 2 and 3; long-term reach scale erosion protection shall be considered using grade controls (ie: riffles)
	Hydrology & Hydraulics	7%	Impact on flow rates, flooding and surface drainage	1	4	5	5					Reach 1 currently experiencing deep and fast flows through reach with no sediments from incoming flows. Source of sediments for downstream.	Alternative 3 and 4 improve hydraulics similarly; Pools and riffles slow down low flow velocities. Armouring side slopes increases high flow velocities (lower flood limit)
	Geotechnical & Hydrogeological	4%	Impact on slope stability and suitability of soils and groundwater conditions	1	4	4	5					Existing slope stability concern alongside private properties (school) and at stormwater outfall. Overall low, existing global instability. Identified need for toe protection and accommodation of locally perched groundwater table.	Existing condition is poor in reach 1. Escalating improvements for each alternative; ranging from providing localized stability in targeted areas with the need for toe erosion protection in non-targeted areas to full reach erosion and stability protection
Technical	Existing Infrastructure	8%	Mitigating risks and impacts to existing infrastructure (linear, road, utilities)	1	5	5	5	11.6	13.0	14.0	11.0	Existing infrastructure including regional sanitary sewer system (piping and maintenance holes), drainage culverts, storm outfall structures and utilities require protection from exposure and repair due to erosion.	Each alternative focuses on protection of existing infrastructure impacted by erosion
	Regulatory Permitting and Approval and Acquisition Requirements	5%	Securing permits and approvals from regulatory agencies (ie: CH, DFO and MNRF); property easement acquisition	5	4	3	1					Based on scope of work various permits and approvals will be required from regulatory agencies; City will require property easements along creek alignment	Ease of obtaining permits will decrease with each alternative due to greater impact to existing natural conditions of each alternative
	Constructability	5%	Feasibility and complexity associated with implementing proposed works	5	1	3	2					Construction access & staging requirements, impact to residents during construction, creek flow passage, vegetation, construction timing windows, complexity of installation	Construction access and staging will be challenging for each alternative; although localized improvements for Alt 2 and 3 will still have significant impact to surrounding environment due to accessibility issues
Economic	Capital Costs	8%	Cost to City to complete detailed design, secure permits, gain approvals and property, and complete construction	5	3	2	1	9.4	7.6	7.4	7.2	Cost based on magnitude of works.	
	Maintenance Requirements and Costs	7%	Extent of regularly scheduled maintenance and cost to City to maintain proposed works	1	2	3	4					Regular, irregular or no maintenance (excluding rehabilitation works) required; structural or vegetation maintenance may include grate cleaning, stone adjustment, annual inspections, etc.; cost considers annual maintenance requirements	Maintenance requirements will reduce for each alternative as a greater extent of the existing issues are being addressed in each alternative
							TOTAL	44	59	67	72		
							RANK	4	3	2	1		

Table 5-5: Evaluation Matrix for Reach 2

Objective	Evaluation Criteria	Weight	Considerations	Score				Total Score				Notes	Comments
				Alternative 1 Do Nothing	Alternative 2 Site Specific EC	Alternative 3 Sub-reach EC	Alternative 4 Reach-scale EC	Alternative 1	Alternative 2	Alternative 3	Alternative 4		
Social	Property Protection	10%	Mitigating risks and impacts to adjacent private property	1	2	4	4	10.4	16.4	23.2	25.2	Properties of concern include Fairview Place Townhouse Complex, Aldershot School, Apartment building complex, private residential properties	Focusing on long-term protection against property loss
	Benefit to Community	4%	Improved usage of areas surrounding creek for recreation or leisure	1	2	3	3					Informal access to creek surrounding area will be considered (limiting where high risk/sensitive) for local residents (ie: nature walks); informal school amphitheater (rotten logs and earthen benches) maintained	Reduce high risk areas of erosion and unstable banks; consider vegetation that will deter access at high risk/sensitive areas; enhance amphitheater if possible
	Public Safety	10%	Mitigating risks and impacts to public safety	1	3	4	5					Inclusion of safety measures including safety grating (on outfall structures) and limiting access where necessary	
	Aesthetic Value	4%	Inclusion of aesthetically pleasing treatments and components to maintain or enhance natural environment of creek area	4	3	3	3					Inclusion of organic bank treatments, hardscape with integrated vegetation, maintaining and including native vegetation species	Consideration for ultimate build-out condition rather than post-construction condition; Existing condition of fallen trees, down-cutting, erosion scars, collapsing outlets is a negative; Improved sinuosity of creek considered positive
	Archaeological Features	4%	Impact on potential archaeological features	3	3	3	3					Stage 1 assessment identified various areas with archaeological potential and requirement of a Stage 2 assessment	Consideration given to impact of construction to existing archaeological features as well as impact of continuous erosion and slope stability on archaeological features
Environmental	Terrestrial Habitat	8%	Impact on connectivity, diversity and sustainability of existing terrestrial environment including SAR and potential for habitat improvement	5	4	4	3	16.6	18.8	27.8	27.8	Existing terrestrial habitat includes deciduous forest with larger trees and some swampy areas; mixture of common wildlife. Contains most viable potential bat habitats. Potential bird breeding grounds for Canada Goose & Northern Cardinal.	Disturbance of canopy cover for access of construction equipment; consider the interim and long term effect on terrestrial; opportunity for enhancement of riparian features. Contains route to watercourse with potentially fewest required tree removals. Presents opportunity to replant dying/dead Ash trees.
	Aquatic Habitat	8%	Impact on connectivity, spawning and sustainability of existing aquatic environment including SAR and potential for habitat improvement	2	2	4	4					Existing aquatic habitat includes a debris jam impeding fish passage and gravel-cobble bed embedded with sand. Aquatic vegetation inhibited by canopy and habitat compromised by erosion. Possible record of two SAR.	Alt 3 and 4 would provide the opportunity to remove impediment to fish passage and improve habitat diversity through riffle enhancement.
	Fluvial Geomorphology	8%	Impact on rates of erosion for bed and banks	1	2	3	4					Reach 2 currently experiencing low to moderate bed & bank erosion with woody debris jams. Discontinuous and moderately accessible floodplain.	Reach scale erosion not being addressed downstream for Alt 2 and 3; long-term reach scale erosion protection shall be considered using grade controls (ie: riffles)
	Hydrology & Hydraulics	7%	Impact on flow rates, flooding and surface drainage	1	2	5	5					Reach 2 currently provides ample energy to transport sediments from Reach 1 to Reach 3 with minor sinuosity along creek bed. Flow reduction occurs at woody debris jams.	Alternative 3 and 4 improve hydraulics similarly; Pools and riffles slow down low flow velocities. Armouring side slopes increases high flow velocities (lower flood limit)
	Geotechnical & Hydrogeological	4%	Impact on slope stability and suitability of soils and groundwater conditions	3	4	4	4					No specific slope stability concerns identified, apart from local creek bank erosion sites that can be addressed satisfactorily without detailed geotechnical information.	Valley walls are set back from channel; erosion mitigation alternatives would not have impact on slope stability or groundwater
Technical	Existing Infrastructure	8%	Mitigating risks and impacts to existing infrastructure (linear, road, utilities)	1	5	5	5	11.6	13.0	15.0	11.0	Existing infrastructure including regional sanitary sewer system (piping and maintenance holes), drainage culverts, storm outfall structures and utilities require protection from exposure and repair due to erosion.	Each alternative focuses on protection of existing infrastructure impacted by erosion
	Regulatory Permitting and Approval and Acquisition Requirements	5%	Securing permits and approvals from regulatory agencies (ie: CH, DFO and MNRF); property easement acquisition	5	4	3	1					Based on scope of work various permits and approvals will be required from regulatory agencies; City will require property easements along creek alignment	Ease of obtaining permits will decrease with each alternative due to greater impact to existing natural conditions of each alternative
	Constructability	5%	Feasibility and complexity associated with implementing proposed works	5	1	4	2					Construction access & staging requirements, impact to residents during construction, creek flow passage, vegetation, construction timing windows, complexity of installation	Construction access and staging will be challenging for each alternative; although localized improvements for Alt 2 and 3 will still have significant impact to surrounding environment due to accessibility issues
Economic	Capital Costs	8%	Cost to City to complete detailed design, secure permits, gain approvals and property, and complete construction	5	4	3	1	9.4	9.2	10.4	7.2	Cost based on magnitude of works.	
	Maintenance Requirements and Costs	7%	Extent of regularly scheduled maintenance and cost to City to maintain proposed works	1	2	4	4					Regular, irregular or no maintenance (excluding rehabilitation works) required; structural or vegetation maintenance may include grate cleaning, stone adjustment, annual inspections, etc.; cost considers annual maintenance requirements	Maintenance requirements will reduce for each alternative as a greater extent of the existing issues are being addressed in each alternative
							TOTAL	48	57	76	71		
							RANK	4	3	1	2		

Table 5-6: Evaluation Matrix for Reach 3

Objective	Evaluation Criteria	Weight	Considerations	Score				Total Score				Notes	Comments
				Alternative 1 Do Nothing	Alternative 2 Site Specific EC	Alternative 3 Sub-reach EC	Alternative 4 Reach-scale EC	Alternative 1	Alternative 2	Alternative 3	Alternative 4		
Social	Property Protection	10%	Mitigating risks and impacts to adjacent private property	1	2	3	4	8.8	15.6	21.2	26.0	Properties of concern include Fairview Place Townhouse Complex, Aldershot School, Apartment building complex, private residential properties	Focusing on long-term protection against property loss
	Benefit to Community	4%	Improved usage of areas surrounding creek for recreation or leisure	1	2	3	3					Informal access to creek surrounding area will be considered (limiting where high risk/sensitive) for local residents (ie: nature walks)	Reduce high risk areas of erosion and unstable banks; consider vegetation that will deter access at high risk/sensitive areas
	Public Safety	10%	Mitigating risks and impacts to public safety	1	3	4	5					Inclusion of safety measures including safety grating (on outfall structures) and limiting access where necessary	
	Aesthetic Value	4%	Inclusion of aesthetically pleasing treatments and components to maintain or enhance natural environment of creek area	2	2	3	4					Inclusion of organic bank treatments, hardscape with integrated vegetation, maintaining and including native vegetation species	Consideration for ultimate build-out condition rather than post-construction condition; Existing condition of fallen trees, down-cutting, erosion scars, collapsing outlets is a negative; Improved sinuosity of creek considered positive; negligible existing riparian aesthetics
	Archaeological Features	4%	Impact on potential archaeological features	3	3	3	3					Stage 1 assessment identified various areas with archaeological potential and requirement of a Stage 2 assessment	Consideration given to impact of construction to existing archaeological features as well as impact of continuous erosion and slope stability on archaeological features
Environmental	Terrestrial Habitat	8%	Impact on connectivity, diversity and sustainability of existing terrestrial environment including SAR and potential for habitat improvement	4	5	5	5					Existing terrestrial habitat includes culturally influenced riparian cover and open areas; mixture of common wildlife. One Endangered tree species identified. Opportunities to increase native species cover. Existing access route available.	Alt 2 to 4 will require protection fencing for Endangered tree. Use existing clearings for access of construction equipment; consider the interim and long term effect on terrestrial; opportunity for enhancement of riparian features. Avoid waterfowl nesting areas near lake outlet.
	Aquatic Habitat	8%	Impact on connectivity, spawning and sustainability of existing aquatic environment including SAR and potential for habitat improvement	2	2	4	4	15.0	22.8	31.8	31.8	Existing aquatic habitat includes high/large debris jam barring upstream fish passage, with extensive sand deposition upstream, and a large erosion scar introducing sand near the mouth. Possible record of two SAR.	Alt 3 and 4 would involve removal of barrier to upstream fish passage, in addition to mitigation of excessive bank erosion.
	Fluvial Geomorphology	8%	Impact on rates of erosion for bed and banks	1	3	4	4					Reach 3 currently experiencing low bed degradation with low to severe bank erosion and woody debris jams. Little access to floodplain.	All alternatives are addressing the major erosional area of the Reach
	Hydrology & Hydraulics	7%	Impact on flow rates, flooding and surface drainage	1	2	5	5					Reach 3 is currently a straight trapezoidal channel providing storage of sediments from upstream. Flow reduction occurs at woody debris jams.	Alternative 3 and 4 improve hydraulics similarly; Pools and riffles slow down low flow velocities. Armouring side slopes increases high flow velocities (lower flood limit)
	Geotechnical & Hydrogeological	4%	Impact on slope stability and suitability of soils and groundwater conditions	3	5	5	5					No specific slope stability concerns identified, apart from local creek bank erosion sites that can be addressed satisfactorily without detailed geotechnical information.	No valley walls in proximity to channel; erosion mitigation alternatives would not have impact on slope stability or groundwater
Technical	Existing Infrastructure	8%	Mitigating risks and impacts to existing infrastructure (linear, road, utilities)	1	5	5	5	11.6	14.0	14.0	11.0	Existing infrastructure including regional sanitary sewer system (piping and maintenance holes), drainage culverts, storm outfall structures and utilities require protection from exposure and repair due to erosion.	Each alternative focuses on protection of existing infrastructure impacted by erosion
	Regulatory Permitting and Approval and Acquisition Requirements	5%	Securing permits and approvals from regulatory agencies (ie: CH, DFO and MNRF); property easement acquisition	5	4	3	1					Based on scope of work various permits and approvals will be required from regulatory agencies; City will require property easements along creek alignment	Ease of obtaining permits will decrease with each alternative due to greater impact to existing natural conditions of each alternative
	Constructability	5%	Feasibility and complexity associated with implementing proposed works	5	2	3	2					Construction access & staging requirements, impact to residents during construction, creek flow passage, vegetation, construction timing windows, complexity of installation	Construction access and staging will be challenging for each alternative; although localized improvements for Alt 2 and 3 will still have significant impact to surrounding environment due to accessibility issues
Economic	Capital Costs	8%	Cost to City to complete detailed design, secure permits, gain approvals and property, and complete construction	5	4	3	1	9.4	10.6	10.4	7.2	Cost based on magnitude of works.	
	Maintenance Requirements and Costs	7%	Extent of regularly scheduled maintenance and cost to City to maintain proposed works	1	3	4	4					Regular, irregular or no maintenance (excluding rehabilitation works) required; structural or vegetation maintenance may include grate cleaning, stone adjustment, annual inspections, etc.; cost considers annual maintenance requirements	Maintenance requirements will reduce for each alternative as a greater extent of the existing issues are being addressed in each alternative
							TOTAL	45	63	77	76		
							RANK	4	3	1	2		

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5.7 SELECTION OF PREFERRED ALTERNATIVE SOLUTIONS

Within Reach 1, Alternative 4, reach-based erosion control, was selected as the preferred solution. This solution best addresses the severity of erosion and risks to infrastructure along the reach, and provides an opportunity for aquatic and terrestrial habitat improvements. A complete reconstruction and restoration of the channel, a length of approximately 250m, will occur from the undermined storm outfall structure downstream to the storm outfall outflanked along the western bank.

Within Reaches 2 and 3, Alternative 3, sub-reach based erosion control, was selected as the preferred solution. This solution will implement extended measures to mitigate excessive erosion and protect City and Region infrastructure at key areas. Alternative 3 yields a more positive net effect for both Reaches 2 and 3 as implementing bio-engineering and hardening solutions present a lower cost than Alternative 4, while still addressing the problem and opportunity statements.

A summary of the recommended measures to be implemented for each of the reaches is provided in **Table 5-7.** The conceptual design drawings illustrating the preferred solutions are presented in **Appendix F**.

Table 5-7: Summary of Preferred Solutions

Reach and Preferred Solution	Implementation Notes of Preferred Solution
Reach 1: Alternative 4 Reach-scale erosion control measures	• Reconstruct the channel, with an towards establishing a wider, shallower cross-section with narrow floodplain benches to the extent possible • Regrade east bank with vegetated boulder revetment at upstream outfall structure • Incorporate stepped, armourstone cascade into stabilized plunge pool at upstream outfall structure for energy dissipation • Install fish-passable armourstone grade control between pools from upstream outfall structure to approximately 40m downstream • Protect existing exposed manhole structure using armourstone protection • Cut back existing outflanked storm outfall at downstream end of reach in association with bank stabilization
Reach 2: Alternative 3 Sub-reach erosion control measures	• Stabilize and restore unstable sections of bank in key areas and plant native vegetation to promote slope stability • Protect existing exposed manhole structure using boulder revetment protection • Incorporate raised and stabilized crest of riffles to restore channel floodplain connectivity and attenuate energy during high flows • Reconstruct and stabilize bank at location where existing chain link fence footing is exposed

	• Remove large woody debris jams
Reach 3: Alternative 3 Sub-reach erosion control measures	• Stabilize and restore unstable sections of bank in key areas and plant native vegetation to promote slope stability • Incorporate riffles at key locations to maintain back-flooding of culvert invert and fish passage, and prevent head-cutting and erosion of fine sediment accumulation and • Remove woody debris jam complex

6 Implementation of the Preferred Solutions

6.1 PERMITS AND APPROVALS

In-stream works typically require approval from one or more regulatory agencies, depending on the nature of the work proposed. **Table 6-1** below summarizes anticipated approval requirements prior to implementation of the preferred solution as described in Section 5.7.

Table 6-1: Approval Requirements

Agency	Approval Mechanism	Details
Conservation Halton (CH)	Permit under O.Reg. 162/06	Pre-consultation with CH has been undertaken as discussed in Section 8.1.7. Permit application will be following completion of detailed design.
Department of Fisheries and Oceans	Authorization under the Fisheries Act	DFO review is required for this project. A Request for Review package will be prepared and submitted once preliminary designs are completed, to determine if an authorization is required. MECP/MNRF will also confirm construction timing windows and will need to issue a permit for fish rescue/salvage during work area isolation.
Ministry of Environment, Conservation and Parks (MECP)	Species at Risk	Consultation with MECP with respect to potential mitigation of risks to Species at Risk (e.g. American chestnut, bats) will be required. Details of MECP involvement will be confirmed at detailed design.
City of Burlington	Public Tree By-law 068-213	A permit to remove trees on public lands will be required for removals required to facilitate construction.

Pursuant to 4.2 (3) Subsection 34 (1) of O. Reg. 387/04, under the Ontario Water Resources Act, active in-stream flow diversions are exempt from requiring a permit to take water in association with temporary by-pass for work area isolation. A permit pursuant to the Navigation Protection Act (formerly the Navigable Waters Protection Act) is not required prior to implementation of proposed works due to the size (unnavigable) of the creek. All permits and approvals must be in hand prior to commencing construction of the proposed works.

6.2 PROPOSED CONSTRUCTION SCHEDULE

Assuming that there are no outstanding Part II Order requests at the end of the 30-day public review period, design and construction of the preferred solutions is tentatively scheduled as outlined in **Table 6-2**.

Table 6-2: Proposed Implementation Schedule

Schedule Item	Date
End of 30-Day Review Period	Month 0
Design, Permitting and Tender Period	Month 0 to Month 9
Construction	Month 9 to Month 15
Post-Construction Monitoring	Month 15 to Month 39
Additional Monitoring	Year 3, 4 and 5

Conservation Halton and MNRF will confirm acceptable construction timing windows with consideration for protection of the local fishery. Also, vegetation removal will not be permitted within the bird nesting season or bat maternity active season in compliance with the *Migratory Birds Convention Act* and the *Endangered Species Act.*

6.3 COST ESTIMATE

The estimate of probable cost (Class D +/- 30%) of implementing the preferred solutions is summarized in **Table 6-3** and is based on concepts presented in this report and typical values from previously completed works by Associated Engineering and Palmer Environmental Consulting Group.

Table 6-3: Estimated Implementation Cost

Reach	Implementation Cost
Reach 1: Reach-scale erosion control measures	$480,000
Reach 2: Sub-reach erosion control measures	$350,000
Reach 3: Sub-reach erosion control measures	$240,000
Contingency Allowance	$220,000
TOTAL	$1,290,000

6.4 DETAILED DESIGN COMMITMENTS AND ADDITIONAL WORK

At the detailed design stage, a number of follow-up investigations will be required to enhance understanding of site-specific conditions. Site-specific investigations will facilitate advancement of conceptual approaches to detailed design, and will inform implementation strategies that minimize environmental risks. Additional work anticipated to be required in association with detailed design includes:

- Additional correspondence with Conservation Halton (CH)
    - The Study Team will meet again with CH to confirm expectations related to the implications of proposed channel works (cut/fill and bed/bank treatments) for flood elevations, erosion hazard limits (including slope stability), and aquatic and terrestrial ecology. The meeting will also allow identification and discussion of potential in-stream and riparian restoration and enhancement opportunities;
    - Confirm all requirements that must be met to secure a permit pursuant to O.Reg. 162/06; and
    - Design restoration works which are completed to the greater of either CH's guidelines or City of Burlington's By-Law requirements.

- Additional consultation with Ministry of Environment, Conservation and Parks (MECP)
    - The Study Team will consult with the MECP with respect to mitigation for potential impacts to Species at Risk.

- Consultation with the Region of Halton
    - The Study Team will coordinate implementation details with the Region of Halton concerning the proposed works outlined in this report and the proposed sanitary sewer works planned by the Region that will occur within the Study Area.
    - If timing of the Region's works aligns with the City's works there is an opportunity to abandon and/or remove at-risk infrastructure thereby minimizing the amount of rehabilitation work required within the creek. However, if the timing of the projects do not align, the creek rehabilitation works will proceed with the proposed at-risk infrastructure protection.

- Consultation with Aldershot High School and Hamilton District School Board
    - The Study Team, with City representatives, will discuss the possibility of the school board installing fencing along the top of the valley slope on school property to limit access to the creek area by students.

- Utility locations
    - All existing utility locations will be confirmed and noted on design drawings to ensure proposed works protect the existing utilities and do not adversely impact them
    - If required, the Study Team will coordinate proposed works with affected utility owners.

- Additional site-specific topographic survey information (as needed)
    - Data from the UAV-based LiDAR survey conducted as part of this Study will support detailed design. Additional, ground-based topographic survey will be completed and tied into the original topographic data set, if necessary, to ensure satisfactory representation of the following:
        - Geometry of the channel bed and banks, including accurate representations of channel planforms, cross-sections, and longitudinal profiles;
        - The location and elevations of all municipal infrastructure, including but not limited to storm sewer outfalls, sanitary sewer infrastructure, crossings, and culverts;
        - Locations of significant vegetation along the channel and floodplain (including type and size) and throughout areas of potential access for construction; and
        - Property lines, fence lines, and private structures.

- Review of Existing Upstream Outfall Structure
    - As per Conservation Halton comments provided during their review of the draft study outcomes, the possibility of reconstructing the upstream outfall structure with a drop structure will be considered during detailed design. As noted during site visits however, the existing structure is structurally sound and does not require replacement due to structural deficiencies.
    - Regardless of outfall structure replacement, armourstone (hard surface) bank stabilization measures will still be required at the upstream end of the creek system at the outfall structure to avoid a wide cut for bank re-grading and associated loss of mature trees.

- Tractive force analysis
    - A tractive force analysis should be undertaken to quantify stresses exerted on the channel boundary (bed and banks). This analysis will help determine the gradation of stone size mixtures to be specified in the channel design and selection of bank materials.

- Arborist Report
    - An Arborist Report will be completed to support development of a Tree Preservation and Removal Plan. Recommendation will be included to avoid impacts to the American Chestnut individual (Reach 3). All trees with a diameter in excess of 10 cm (DBH) will be tagged with species and have their size recorded, and will be included on the detailed design drawings.

- Floodline hydraulic analysis
    - A floodline hydraulic analysis will be undertaken to confirm any changes between existing and proposed floodline elevations and to identify resultant velocities for the various return periods for the three (3) reaches.

- Stage 2 Archaeological Assessment
    - Once area of impact is confirmed for the proposed works, a Stage 2 Archaeological Assessment will be required for any areas identified in the Stage 1 Archaeological

Assessment Report as requiring Stage 2 assessment and anticipated to be impacted by construction.

- Easements and Permission to Enter Requirements
    - Under the preferred solutions, remediation works are proposed on private lands within the City of Burlington. It is required that property ownership be considered during the detailed design to verify construction feasibility and associated easement requirements for access, egress and construction staging.

7 Potential Environmental Impacts & Proposed Mitigation Measures

This section describes the potential effects of the proposed works on the environment (both positive and negative), at a high level, and the mitigation measures and commitments made to either minimize or offset these effects.

7.1 NATURAL ENVIRONMENT

7.1.1 Potential Effects on Terrestrial Ecology

The most adverse effects to terrestrial ecology come from the removal of vegetation. Vegetation provides habitat and helps maintain the ecological integrity of West Aldershot Creek. Vegetation adjacent to construction zones may be mechanically damaged. Removal of vegetation may also impact habitat for breeding and migratory birds and/or SAR bats. Exposed soils during construction may promote establishment of invasive species. The proposed works are expected to improve potential benthic invertebrate habitat by controlling erosion, maintaining or improving riparian buffers, and maintaining a shade canopy adjacent to the stream.

7.1.2 Potential Effects on Aquatic Habitat

Aquatic habitat along Aldershot Creek has been severely impacted and fragmented by excessive erosion and the presence of large woody jams that impede or prevent upstream fish passage. The eroded and unstable system has impaired natural process, inhibiting the development of pool and riffle sequences as a means of self-stabilization. The proposed works are not predicted to cause any adverse effects to aquatic habitat or communities. Habitat connectivity will be restored through the removal of large woody jams, allowing species movement up to the outfall structure. Also, works will incorporate substrate diversity, pool and riffle sequences and overhanging vegetation. Where modifications are proposed to the bed, riverstone will be upsized slightly to maintain stability in comparison to existing mobile gravels and cobbles, but without any adverse affect on habitat or the functions it provides. A key long-term benefit will be the reduction of fine sediment accumulation along Reaches 2 and 3.

7.1.3 Potential Effects on the Receiving Watercourse

The proposed works for West Aldershot Creek will not cause any adverse effects on the receiving watercourse in relation to an increase in water quantity or a decrease in water quality. The area of land contributing flows to the watercourse will remain unchanged.

Erosion protection measures will be implemented during construction. With the proposed bio-engineering techniques and reconstruction measures implemented, the existing erosion will decrease. This will reduce the amount of sediment entering the watercourse and therefore have a positive effect on the receiving watercourse.

7.1.4 Erosion and Sediment Control

During construction, there is risk of potential erosion and siltation impacts that could release sediment into the watercourse. This impact would degrade the water quality of the creek and affect the habitat of wildlife. Therefore, an erosion and sediment control plan will be developed to help mitigate this risk. Possible measures include, but not limited to, the use of biodegradable erosion control media, siltation fences or biodegradable 'logs', check and coffer dams, mud mats, etc. All in-stream work will be completed in isolation of flowing water through the use of streamflow by-pass methods such as a flume, dam-and-pump and/or diversion channel. These activities will be confirmed during the detailed design phase of the project before implementation and will be reviewed and approved by Conservation Halton as part of its permit process.

7.1.5 Air Quality, Dust and Noise

There is one sensitive receptor, Aldershot High School, located in close proximity to the Study Area. It is not anticipated that the school or any of the adjacent properties will be negatively impacted, including air quality, noise or dust, after the implementation of this project. There will be construction noise generated during the remediation works within the creek due to the required use of heavy machinery and other construction equipment. Measures will be taken to manage construction noise including maintaining equipment to prevent unnecessary noise. Any initial noise complaint will trigger verification that noise control measures are in effect. If persistent noise complaints occur, alternative noise control measures will be considered.

Impacts of air quality during project construction are not considered to be significant. Although dust impacts from heavy construction equipment may impact air quality, this is not a recurring activity as it will be limited to the construction period. Contract provisions will minimize impacts to adjacent properties during construction. Therefore, the impacts from construction on air quality are not considered significant.

Provisions to minimize air quality impacts during construction include removal of construction-caused debris and dust through regular cleaning and maintenance of construction sites and access roads; dust suppression using non-chloride dust suppressants on unpaved areas, subject to the area being free of sensitive plant, water, or other ecosystems that may be affected by dust suppression chemicals; and prompt cleaning of paved streets/roads where tracking of soil, mud or dust has occurred.

7.2 SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT

7.2.1 Utilities

During detailed design utility companies will be contacted to confirm the presence and location of existing infrastructure within the Study Area. It is not anticipated that the proposed works will impact any utility locations.

The existing storm sewers and outfalls and sanitary sewer system located within the Study Area will require protection during construction to ensure the infrastructure is not damaged by construction works.

7.2.2 Potential Effects on Adjacent Land Use

During construction there will be some nuisance effects, such as noise, odour and dust. As well, construction access will likely be required to West Aldershot Creek via property not owned by the City. During detailed design, property owners will be contacted to discuss potential construction impacts. The City will secure permanent and/or temporary easements along West Aldershot Creek to facilitate construction. Permanent easements will transfer land maintenance responsibility to the City. Impacts to adjacent properties will be minimized.

7.2.3 Archaeological Potential

The Stage 1 Archaeological Assessment determined that parts of the Study Area exhibited archaeological potential. If impacted, these areas will require a Stage 2 archaeological assessment by test pit prior to any proposed impacts to the property. During design, consideration will be given to avoid impacting these areas.

7.3 CLIMATE CHANGE CONSIDERATIONS

Climate change is an issue that has and continues to evolve on a global scale. Governments at all levels are acknowledging the need to take actions that reduce carbon emissions into the atmosphere to mitigate the effects of climate change. There is also a recognition that climate change is impacting community infrastructure systems. This requires a consideration of adaption measures to mitigate the impact of climate change on levels of service these systems were originally designed to deliver.

Upon review of this Study's undertaking it is determined that the project is relatively minor in scale and will not have significant climate change impact. Although it is likely that tree removal will be necessary to facilitate the remediation works for West Aldershot Creek, and recognizing that trees are a carbon sink, measures will be taken to compensate for the removals through planting of new trees and/or native vegetation within the Study Area.

In addition, as part of the base scope of work for the hydraulic and hydrology assessments, a Climate Change Sensitivity analysis using the MTO IDF forecast tool was conducted to look at the potential implications that climate change may have on precipitation in the Study Area. Based on the results from

hydrologic modeling, future flows are estimated to be approximately 8% higher than current design rainfall intensities. In fact, the forecasted 50-year climate change influenced intensity is close to the current 100-year value.

Considering the sustainability of the project, through proposed bio-engineering and natural remediation measures, while minimizing the inclusion of hard engineering solutions, the overall natural environment of the area will remain and be enhanced through the restoration of the creek and surrounding areas with native vegetation which will provide suitable riparian habitat while minimizing the current erosion and sedimentation issues plaguing the watercourse.

7.4 CONSTRUCTION CONSIDERATIONS

Potential environmental effects during and following construction were discussed in Sections 7.1 and 7.2. The following measures are proposed to mitigate adverse impacts.

Fish Protection

All in-water and near-water activities in West Aldershot Creek will be conducted within the applicable in-water construction timing windows, as identified by Conservation Halton and MNRF, to protect the resident fishery life functions as outlined below. Fish protection measures include:

- The warm water timing window of **July 1 to March 31** should be applied for all in-water and near-water works. All in-water and near-water activities will occur within this construction timing window.

If eels or mussels are observed during construction, work should be stopped, and the mussels should be identified immediately by a qualified aquatic biologist. Should SAR species be identified, mitigation measures should be discussed with the MECP and Conservation Halton for implementation into project design and schedule.

Amphibian Protection

As amphibian surveys have not been conducted for this project, it is appropriate to assume their presence (Green Frog was observed incidentally) and mitigate appropriately. Appropriate mitigation should include the avoidance of in-water work within the amphibian breeding window. For the Great Lakes Basin, this is generally **mid-March through July 31**.

SAR Bat Protection

Tree removal will be completed between **November 1 to March 31**, outside of the maternity roosting period. Should pre-construction tree screening identify that trees with maternity roost potential must be removed, the installation of artificial roosts (e.g. “bat boxes”) is recommended at a 1:1 ratio, as these structures can provide alternative habitat opportunities. Such structures should be erected during the November 1 to March 31 period after tree removal, so they are available to bats prior to the following maternity roost period.

Terrestrial Ecology Protection

Mitigation measures to alleviate any potential harmful effects on terrestrial ecology by completion of the proposed works include:

- A 3m tree protection zone (TPZ) should be established around the American Chestnut tree. Fencing should be erected, and no construction activities should be permitted within the TPZ.
- The proposed location of construction and access routes should be identified to disturbed areas comprising non-native vegetation, where possible.
- Vegetation should be installed above the banks.
- Invasive species management could be included in the construction works.
- Incidental wildlife observations will be made during construction.
- Restoration planting should comprise non-invasive species entirely and be adapted to the soil and moisture conditions of the site.
- All landscaping and rehabilitation works within CH's regulated area are to be completed to the greater of either CH's guidelines or City of Burlington's By-Law requirements.
- A tree protection plan and compliance with the *Migratory Bird Convention Act* should be included.
- Trees with a 15cm or greater DBH that are removed for construction will be replaced at a ratio of 3:1.
- City of Burlington Forestry criteria will be met through the proposed works.
- Post construction, any exposed soils should be re-vegetated as soon as possible with native seed mixes to reduce erosion. If stabilization in not possible by plantings, then other appropriate erosion controls should be applied in the interim.
- Removal of woodland vegetation should take place outside of the breeding bird window and bat spring roosting activity through fall swarming and migration (**April 1 to October 31**) in order to avoid disturbance of migratory breeding birds and bat species protected by the *Migratory Birds Convention Act* and/or *Endangered Species Act*.
- If vegetation removal is necessary during the period of April 1 to October 31, a pre-construction sweep of the area for bird and bat nesting activities should be undertaken.

Tree Removal

Tree root systems play a large role in the stabilization of soils and slopes. The large network of roots provided by trees and shrubs help hold soils and materials together. Tree root death degrades this function and compromises soil stability. As such, erosion control measures and construction access routes within the valley should minimize tree disturbance and injury, and incorporate new, native plantings to the extent possible. Should removals be required, routes that take advantage of the removal of Ash (*Fraxinus*) species should be considered, as these species are already heavily impacted by Emerald Ash Borer (EAB) in southern Ontario.

Erosion and Sediment Control

A comprehensive Erosion and Sediment Control (ESC) plan will be implemented to prevent migration of sediment laden runoff (or other contaminants) from the construction zone to the creek. The ESC measures

are recommended to include adequate control measures constructed to Ontario Provincial Standard Drawing (OPSD) standards in accordance with the *Erosion & Sediment Control Guidelines for Urban Construction* (Greater Golden Horseshoe Conservation Authorities, 2006). This plan will include inspection and maintenance of the measures until final cover is established. Specific aspects include:

- ESC measures are to be installed prior to beginning work and maintained in working order throughout all stages of construction activities;
- Perimeter silt fence will be installed between the work areas and the watercourses to isolate the work areas and ensure that deleterious substances do not enter the creek at any time;
- The fencing will be properly installed and inspected daily, including after every rainfall, and cleaned, maintained and/or adjusted accordingly. It will be left in place and maintained until all surfaces contributing drainage to the watercourse are fully stabilized;
- All exposed and newly constructed surfaces will be stabilized using appropriate means in accordance with the characteristics of the soil material;
- These surfaces will be fully stabilized and re-vegetated as quickly as possible following completion of the proposed works;
- No sediment, sediment-laden water or deleterious substances are to be discharged into West Aldershot Creek at any time;
- Contingency procedures, materials and notification procedures will be readily available in the event of a silt release and for general application in regular maintenance and repair.

Protection during Removal of the Existing Materials

Removal of the existing material in West Aldershot Creek will require adherence to appropriate debris containment and extraction techniques. Removal of debris will be undertaken by isolating the active work area from the flowing portion of the creek with the use of temporary isolation techniques such as coffer dams. Both large material and fine particulate entry into the watercourse will be monitored regularly. Any accidental deposition of debris into the existing isolated creek bed shall be carefully removed prior to re-instating flow to the isolated reach. All excavated material shall be removed and deposited in an area contained behind properly installed and maintained sediment barriers or devices.

Construction Access, Site Controls and Operational Constraints

The construction access and work areas will be confined to the extent required for the construction activities, and these areas are then defined in the field using appropriately installed protective fencing or other suitable barriers. Removal of riparian vegetation, particularly woody vegetation, will be kept to a minimum necessary for the proposed works. The woody vegetation that will likely require removal will be replaced with appropriate native species.

Any temporarily stock piled material, construction or related materials will be properly contained in areas separated a minimum of 30m from any watercourse. All construction materials and debris will be removed and appropriately disposed of following construction. Every effort will be made to retain as much of the natural vegetation as reasonably possible to help ensure bank stability, control erosion and expedite the re-colonization of vegetative cover. All vegetation clearing required for access will be conducted using proper

clearing techniques and appropriate construction timing windows as may be defined by other legislation (ie: *Migratory Birds Convention Act*).

All activity will be controlled to prevent entry of any petroleum products, debris or other potential contaminants or deleterious substances, in addition to sediment as outlined above, to any watercourse. Storage, maintenance and refueling of equipment will be conducted a minimum of 30m from the watercourse. A Spills Prevention and Response Plan will be developed and kept on site at all times. Appropriate machinery for construction use will be selected on the basis to minimize impact to the surrounding environment.

Waste Disposal

During construction, all waste removed from the site must be directed to the appropriate facility for disposal. If any hazardous/biological waste is discovered, the appropriate agencies should be notified, and the waste should be directed to the required facility. The waste management plan will be confirmed during the detailed design phase of the project.

Rehabilitation Following Construction

All of the areas disturbed during construction will be restored, stabilized and re-vegetated as soon as the works are complete to prevent migration of fine material to the watercourse during runoff events, as well as minimizing the opportunity for colonization of the area by invasive species. Only native plants, compatible with site conditions will be used. For the best chances of success, planting events should target spring or fall, when trees are focused on growth and establishment activities. Summer periods should be avoided as trees are often focused on maintenance during high-heat periods, which may over-stress newly planted stock. Winter periods should also be avoided as trees are largely dormant during this time and root growth would be delayed, potentially inhibiting establishment. All landscaping and rehabilitation works within CH's regulated area will be completed to the greater of either CH's guidelines or City of Burlington's By-Law requirements.

Site Inspection and Monitoring

Environmental monitoring will be conducted to inspect environmental protection measures (ESCs, containment measures, etc.) and to identify deficiencies. The inspector will ensure all environmental mitigation and design measures are properly installed, constructed and maintained, and appropriate contingency and response plans are in place and implemented, if required.

7.5 MONITORING AND MAINTENANCE

As part of implementing this project, monitoring and maintenance will be conducted during construction to ensure that:

- Individual mitigation measures are providing the expected control and/or protection continuously throughout the construction period;

- The mitigating measures are adequate to minimize or eliminate adverse effects;
- Additional mitigating measures are provided, if required, to address any unanticipated adverse environmental effects that arise during construction; and
- Adequate information is available for the assessment of the mitigation measures.

Site inspection and monitoring during construction will be completed by qualified members of the Study and Design team to ensure general compliance of the construction works with the final design and issued permits.

For creek restoration projects, Conservation Halton typically requires a commitment to post-construction monitoring for a period of 3 to 5 years following construction as a part of the permitting agreement. The specific details and length of monitoring required will be developed in consultation with the City, Conservation Halton, and/or DFO during the permitting process.

Immediately post-construction a site inspection should be undertaken which includes monitoring channel stability during stabilization period. Detailed as-built surveys and drawings should also be completed. Continued monitoring post-construction should occur for a minimum of three (3) years with two (2) monitoring site visits per year (spring and fall). These site visits should monitor the intended channel functions and restoration works.

8 Stakeholder Consultation

Stakeholder consultation is a key feature of the Class EA process. Through an effective consultation program, the proponent can generate meaningful dialogue between the project planners and the public, property owners, First Nations, authorities and agencies allowing an exchange of ideas and the broadening of the information base, leading to better decision-making.

8.1 SUMMARY OF CONSULTATION ACTIVITIES

Throughout the project, stakeholders, including the public, property owners, First Nations, authorities, agencies and utilities, were given a variety of opportunities to review and comment on the project process, key findings, proposed alternatives and recommended solution(s). The Municipal Class EA requires the proponent to undertake two (2) mandatory points of public contact for a Schedule 'B' project. The Project Team exceeded the mandatory number of public contacts, with the following opportunities for review and/or comment provided:

- Notice of Study Commencement;
- Notice of Public Information Centre;
- Public Information Centre; and
- Notice of Study Completion.

Public comments were received throughout the Class EA process and are provided in **Appendix I**.

8.1.1 Notice of Study Commencement

The Notice of Study Commencement was prepared and issued July 26, 2018. The Notice was published in the *Burlington Post* and posted on the City of Burlington website. Contact letters including the Notice was mailed directly to all adjacent property owners, First Nations, known interested agencies and stakeholders.

The purpose of the Notice was to introduce the project (purpose and objectives), outline the Municipal Class EA process, request public involvement and identify contact persons. Contact information for the City's Project Manager and Associated Engineering's Environmental Assessment Coordinator were made available to the public to elicit any initial feedback on the project. Several comments were received from interested parties following the distribution of the Notice.

A summary list of the stakeholder register, Notice of Commencement and a sample copy of the cover letter are provided in **Appendix G**. Received comments and project team responses are provided in **Appendix I.**

8.1.2 Notice of Public Information Centre

A Notice of Public Information Centre (PIC) was prepared and distributed to stakeholders and review agencies. The Notice was published in the *Burlington Post* on November 15, 2018 and November 22, 2018 and posted on the City of Burlington website. The Notice was also hand delivered to all adjacent landowners.

The Notice provided a description of the project, details of the PIC, and included a request for comments and input. Contact information for the City's Project Manager and Associated Engineering's Environmental Assessment Coordinator were made available to the public to encourage the submission of comments.

A copy of the Notice of Public Information Centre is provided in **Appendix G.**

8.1.3 Public Information Centre (PIC)

A PIC took place on December 3, 2018 at the Aldershot Pool, 50 Fairwood Place in the City of Burlington from 6:00pm to 8:00pm to present Study details. The Project Team including representatives from the City, Associated Engineering and Palmer Environmental were in attendance to answer any questions that attendees had.

The PIC presented the following elements:

- Background information on the Study;
- Background information on the Class EA process;
- Problem/opportunity being considered for the Study;
- Key considerations and issues associated with the Study;
- Description of the alternative design concepts; and
- Next steps in the Class EA process.

Comments were received at and proceeding the PIC from several residents supporting the overall Study approach and proposed alternatives.

A copy of the PIC display panels, sign-in sheet and comment form are provided in **Appendix H**. Received comments and project team responses are provided in **Appendix I.**

8.1.4 Notice of Study Completion

The Notice of Study Completion was prepared and distributed to stakeholders and review agencies. The Notice was published in the *Burlington Post* on October 17, 2019 and posted on the City of Burlington website.

The Notice of Study Completion informs the public and stakeholders of the completion of the Class EA and provides the locations where interested parties can review the completed Project File Report (PFR). The Notice also informs the public of the 30-day review period associated with the conclusion of the Class EA process and provides notification of the provision to request a Part II Order.

The Notice of Completion and a sample copy of the cover letter are provided in **Appendix G**.

8.1.5 Consultation with the Ministry of the Environment, Conservation and Parks

An acknowledgement letter was provided from the Ministry of the Environment, Conservation and Parks (MECP) in response to the Notice of Commencement provided to the MECP Central Region. Several areas of interest were provided for consideration and have been included in this Project File Report.

The draft Project File Report was circulated to the MECP for review and comment prior to finalizing the Class EA Study. The MECP identified the project as requiring further consultation with the MECP during detailed design with respect to mitigation for potential impacts to SAR.

MECP correspondence is provided in **Appendix I**.

8.1.6 First Nations Consultation

As required as part of the Class EA process, to satisfy the Crown's legal duty to consult Aboriginal communities, First Nations were contacted. The MECP identified in their acknowledgement letter (refer to Section 8.1.5) that First Nation groups with the potential to be affected by the proposed project include Six Nations of the Grand River, Haudenosaunee Confederacy Chiefs Council and Mississauga of the New Credit First Nation.

These First Nation groups were contacted at project initiation with the Notice of Commencement and to notify them of the Public Information Centre with the Notice of PIC. No response was received from either group.

First Nation correspondence is provided in **Appendix G**.

8.1.7 Consultation with Conservation Halton

West Aldershot Creek is within the jurisdiction of Conservation Halton (CH), which is a key stakeholder. Consultation with CH occurred at various points during the Class EA Study, including:

- At project initiation with the Notice of Commencement;
- At a site visit on July 3, 2018, to review existing conditions and discuss potential remediation solutions;
- At a Study review meeting on December 3, 2018, prior to the Public Information Centre, to discuss study background information and proposed alternatives developed; and
- Prior to finalizing the Study to review our draft Project File Report including our evaluation process and preferred solutions.

It is important that the Study alternatives and preferred solution receive approval from CH because as the project transitions to Phase 5 of the Class EA process (implementation), the City of Burlington will require approval and permitting from CH prior to construction.

Meeting minutes and review notes from CH consultation are provided in **Appendix I**.

8.1.8 Stakeholder Consultation

In addition to MECP, CH and First Nations, there were other stakeholders that were notified of the Study and provided the opportunity to give feedback and input on the existing issues in the Study Area, Study alternatives and the evaluation process. Stakeholders included the Region of Halton, various provincial regulatory agencies, utility companies, the local school boards, property owners adjacent to the Study Area and the community at large. The various points of contact made with stakeholders and the public are summarized in Section 2.5.

Stakeholder correspondence and comments received are provided in **Appendix I**.

9 Conclusions and Recommendations

This study was carried out as a Schedule B project under the Class Environmental Assessment (Class EA) for Municipal Water and Wastewater Projects and is subject to the requirements of the Environmental Assessment Act. This document provides relevant information with respect to Phases I and II of the Environmental Assessment Process. Subsequent phases of the process will involve completion of contract drawings and documents for all proposed works together with appropriate monitoring requirements.

9.1 CONCLUSIONS

Changes to the hydrologic regime resulting from watershed urbanization have led to extensive erosion along West Aldershot Creek between Fairwood Place and Lake Ontario. Due to the varying degree of erosion-related issues along the creek, the Study divided the creek into three distinct reaches. The Study investigated the existing conditions of the three creek reaches, developed a series of remedial alternatives specific to each reach, evaluated and ranked these alternatives, and identified and developed a preferred

alternative solution. The process included public consultation as well as individual consultation with key stakeholders including landowners and regulatory authorities.

The preferred alternative included reach-scale erosion control measures along Reach 1, sub-reach erosion control measures along Reach 2 and sub-reach scale erosion control measures along Reach 3. The preferred alternative achieves the Study goals of mitigating excessive erosion and associated risks to infrastructure, enhancing aquatic and riparian habitat, and reducing the risk to public and private property. Conceptual designs have been prepared for the preferred alternative along each reach. Following completion of the Class EA Study, detailed design, permitting and construction will be undertaken to implement the preferred alternative and remedy the identified problems.

9.2 RECOMMENDATIONS

During the Study, recommendation for site investigations and implementation measures were identified. These items should be taken into consideration during the detailed design and include the following items:

- Obtain easements where the creek crosses privately owned property;
- Undertake a detailed topographic survey, as required, to update preliminary survey completed during the Class EA Study;
- Undertake additional breeding bird studies;
- Update hydraulic model of creek;
- Complete a geomorphic analysis of channel hydraulics and tractive forces;
- Complete Stage 2 Archaeological Assessment;
- Prepare Arborist Report to develop a Tree Preservation and Removal Plan; and
- Determine appropriate construction staging and erosion and sediment controls.

During the detailed design stage, a second Public Information Centre (PIC) will be held to inform the public and adjacent landowners of the upcoming construction works. Additionally, approvals will be required from Conservation Halton, Ontario Ministry of Natural Resources and Forestry (MNRF), and Ontario Ministry of Environment, Conservation and Parks (MECP). Engagement of Fisheries and Oceans Canada for project review will also be required.

10 Closure

This report was prepared for the City of Burlington to satisfy the requirements of the Municipal Class EA process and *Environmental Assessment Act* and to set the stage for the detailed design and construction of the Preferred Alternative Solutions for the Study Area discussed herein.

The services provided by Associated Engineering (Ont.) Ltd. and Palmer Environmental Consulting Group in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering (Ont.) Ltd.



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