Regional Municipality of Waterloo

PROJECT FILE REPORT

CONESTOGO PLAINS WATER SUPPLY CLASS ENVIRONMENTAL ASSESSMENT STUDY

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Executive Summary

Introduction and Background

The Region of Waterloo (Region) is responsible for the supply of drinking water to the Cities of Cambridge, Kitchener and Waterloo and the townships of North Dumfries, Wellesley, Wilmot and Woolwich. Conestogo and West Montrose are two small rural communities situated in the north-east area of the Region, in the Township of Woolwich (Township). Water services in these communities are provided through a coordinated effort between the Region, responsible for the supply, and the Township, responsible for the distribution. Water supply to the residents of Conestogo and West Montrose is provided through either privately owned wells or through one of the Region's groundwater supply systems in the area (e.g., Conestogo Plains, Conestogo Golf Course or West Montrose Water Supply Systems).

A Class Environmental Assessment (Class EA) study for the existing West Montrose Water System, completed in January 2013, concluded that a permanent connection from the existing Conestogo Plains Water Supply System to West Montrose would provide a permanent water supply solution to the community of West Montrose. It was also anticipated that a separate Class EA study would be completed to confirm the feasibility of using the Conestogo Plains water supply system to also supply West Montrose.

The Region initiated a separate Class EA study to identify the preferred long-term sustainable and reliable water supply solution to meet the existing and future water servicing requirements of the West Montrose and Conestogo service areas. CIMA was retained to complete the Class EA study.

Municipal Class Environmental Assessment

All municipal infrastructure projects in Ontario must follow the Municipal Class Environmental Assessment (Class EA) process (Municipal Engineers Association, October 2000 as amended in 2007 and 2011) in order to meet the requirements of the *Environmental Assessment Act* (*EA Act*).

This project was completed in accordance with the requirements of a Schedule B undertaking and as such, Phases 1 and 2 of the Municipal Class EA process were carried out. Consistent with the planning process for Schedule B undertakings, members of the public and interest groups were given opportunities to provide input and comments from the early stages of this study. Notification of study commencement and public notices for two public meetings were advertised in local newspapers and distributed to all in the project contact list. Information in regards

to the progress of the Class EA study process for the Conestogo Plains Water Supply System was provided at each public meeting and public feedback was requested.

This document summarizes Phases 1 and 2 of this Class EA process. This report will be placed on the public record for at least 30 calendar days for review by the general public. Notification to the public, stakeholders and government agencies will take place through the issuance of a Notice of Study Completion. Any concerns that cannot be resolved with the Region during the review period must be directed to the Minister of the Environment and Climate Change (MOECC) as a part II Order request. Provided that no significant issues arise during the review period which cannot be resolved in consultation with Region and that no Part II Order requests are received, the project is then approved and may proceed directly to implementation.

Identification of the Problem or Opportunity

The Region identified the opportunity to undertake a holistic approach to assessing the overall servicing requirements for both the Conestogo and the West Montrose service areas and complete a comprehensive examination of the water supply alternative solutions in a socially, environmentally and financially responsible manner. The study also provided the opportunity to explore the feasibility of connecting West Montrose to the Conestogo Plains water supply system and other alternatives including a potential connection to the Region's Integrated Urban System.

Development and Evaluation of Water Supply Alternative Solutions

Nine different water supply alternative solutions were identified and developed at a high level, at the early stages of the project, to represent specific hydraulic conditions and possible connection scenarios. All alternative solutions and their respective permutations were evaluated based on a set of preliminary screening criteria that included considerations related to level of service, system security and reliability, and system flexibility and redundancy. Following the preliminary screening of the 9 high-level alternative solutions, 3 feasible options were short-listed and considered for a more detailed evaluation:

Option 1 –Supply West Montrose with Surplus Capacity from Conestogo Plains

Scenario 1 – Continue with sequestration for iron control

Scenario 2 – Install new filtration system for iron and manganese removal

Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs

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Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System at City of Waterloo with Provision for Looping

Each option was further developed in terms of infrastructure / process requirements, hydraulic conditions, and capital, operating and life cycle costs. All four options were then subjected to a detailed comparative evaluation based on evaluation criteria that included potential impacts to the technical / natural environment, community / social environment and financial considerations.

Table ES.1 summarizes the ranking of the short-listed water supply options:

Table ES.1 Ranking of Short-Listed Water Supply Options

Short-Listed Water Supply Options	Ranking (1 to 4)
Option 2 Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs	1
Option 3 Supply West Montrose and Conestogo Plains from the Integrated Urban System at City of Waterloo with Provision for Looping	2
Option 1 – Scenario 1 Supply West Montrose with Surplus Capacity from Conestogo Plains, Continue with sequestration for iron control	3
Option 1 – Scenario 2 Supply West Montrose with Surplus Capacity from Conestogo Plains, Install new filtration system for iron and manganese removal	4

Recommended Water Supply Alternative Solution

The recommended water supply alternative solution was selected with consideration to the results of the evaluation process and public / agency feedback received during Phase 1 and Phase 2 of this Class EA study. The best overall recommended water supply solution for the West Montrose and Conestogo service areas is to:

+ Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs

The major components of the recommended water supply solution are planned to be implemented in sequential stages as follows:

Phase 1:

+ Watermain connection from IUS at St. Jacobs to Conestogo Plains

Phase 2:

+ Watermain connection from Conestogo Plains to West Montrose
+ Decommission of supply and major treatment systems in West Montrose
+ Installation of booster pumps dedicated to transfer water from Conestogo Plains to West Montrose

Phase 3:

+ Watermain connection from Conestogo Plains to Conestogo Golf Course
+ Replacement of two existing high lift pumps in Conestogo Plains with new pumps
+ Decommission of supply and treatment systems in Conestogo Golf Course

Project Implementation

Table ES.2 shows the anticipated implementation schedule for this project.

Table ES.2 Project Implementation Schedule

Next Steps	Proposed Implementation Timeline
Project File Report – 30 Day Review	Winter 2015
Confirm preferred alternative solution based on comments received during 30-day review period	Winter 2015
Design of Preferred Solution	2015 - 2016
Construction	
- St. Jacobs Connection[1]	2017 - 2018
- West Montrose Connection[1]	2018 - 2019
- Conestogo Golf Course Connection[1]	2019 - 2020
Notes: 1. Portions of the watermains will be constructed as part of the roadworks planned for Sawmill Road in 2017	

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1. Introduction

1.1 Background

The Region of Waterloo (Region) is responsible for the supply of drinking water to the Cities of Cambridge, Kitchener and Waterloo and the townships of North Dumfries, Wellesley, Wilmot and Woolwich. The Region's water supply system is a complex and integrated system that relies on groundwater, surface water and aquifer storage and recovery from the Region's Manheim (surface) Water Treatment Plant.

Conestogo and West Montrose are two small rural communities situated in the north-east area of the Region, in the Township of Woolwich (Township). Water services in these communities are provided through a coordinated effort between the Region, responsible for the supply, and the Township, responsible for the distribution. Water supply to the residents of Conestogo and West Montrose is provided through either privately owned wells or through one of the Region's groundwater supply systems in the area (e.g., Conestogo Plains, Conestogo Golf Course or West Montrose Water Supply Systems).

In January 2013, the Region completed a Class Environmental Assessment (Class EA) study for the West Montrose Water Supply System to address water supply issues and operational challenges experienced in the system associated with historical water quality and quantity concerns. The 2013 West Montrose Class EA study identified a permanent connection from the existing Conestogo Plains Water Supply System to West Montrose, as the preferred long-term and sustainable water supply option for the West Montrose community. Implementation of this recommendation was subject to verification of the existing and future surplus capacity of the Conestogo Plains water supply system, expected to be completed under the scope of a separate Class EA study.

Consistent with the recommendations of the 2013 West Montrose Class EA study, the Region identified the opportunity to undertake a holistic approach to assessing the overall servicing requirements for both the Conestogo and the West Montrose service areas and complete a comprehensive examination of the water supply alternative solutions in a socially, environmentally and financially responsible manner.

CIMA was retained by the Region to complete a Schedule B Class EA study to identify the preferred long-term sustainable and reliable water supply solution to adequately meet the existing and future water servicing requirements of the West Montrose and Conestogo service areas. This report outlines and summarizes the

planning and decision-making process undertaken to arrive at the final preferred water supply solution for the Conestogo and West Montrose service areas.

1.2 Context – West Montrose Class EA Study

Water services in the community of West Montrose are provided through coordination between the Region and the Township. The Region is responsible for the water supply, treatment and storage, while the Township is responsible for water distribution and water service connections.

For over the last decade, the Region has implemented a number of upgrades to the West Montrose groundwater supply system in an attempt to address challenges associated with both water quantity and quality that have historically impacted the optimum use of the existing sources. As the water demands in the system have been higher than the quantity of water produced by the production wells in the West Montrose system, the Region has had to supplement the existing supply with trucked water from other Regional supplies during periods of high demand. In addition, the existing wells require a high level of treatment and the water treatment plant requires a large operational effort and frequent maintenance.

In light of the above, the Region initiated a Schedule B Class EA study for the West Montrose Water System in 2011, to investigate water supply alternatives and determine a preferred solution which will provide a reliable and permanent water supply to the community of West Montrose. The West Montrose Class EA study, completed in January 2013, identified a permanent connection from the existing Conestogo Plains Water Supply System to West Montrose, as the preferred water supply option for the West Montrose community. The 2013 Class EA study also recognized that in anticipation of implementation of its recommendations, a separate Class EA study on the Conestogo Plains Water Supply System would need to be completed to confirm the existing and future surplus capacity of the Conestogo Plains system, assess the impact on other nearby groundwater wells, and ensure that the recommended water supply solution was the best solution.

1.3 Objectives of the Class EA Study

The main objective of the Conestogo Plains Water Supply System Class EA study is:

+ To identify the preferred long-term sustainable and reliable water supply solution that adequately meets the existing and future water servicing requirements of the West Montrose and Conestogo service areas.

Other Class EA objectives include:

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+ To evaluate the overall servicing requirements for the Conestogo and West Montrose service areas in a socially, environmentally and financially responsible manner;
+ To complete a comprehensive examination of the water supply alternative solutions for the West Montrose and Conestogo service areas, including potential connections to the Integrated Urban System;
+ To provide extensive consultation with all affected and interested parties; and,
+ To document the study process in compliance with the applicable phases of the Municipal Class EA planning process.

1.4 Objectives of the Project File Report

This Project File Report describes the planning and decision making process followed during the Class EA Study for the Conestogo Plains Water Supply System. The Project File Report describes the following:

+ Problem or opportunity being addressed,
+ Current conditions of existing groundwater systems,
+ Water supply alternative solutions considered in the study,
+ Evaluation methodology and evaluation criteria used to assess the different alternative solutions,
+ Anticipated potential impacts,
+ Proposed mitigation measures associated with the alternatives, and
+ Rationale for the selection of the preferred water supply solution and implementation plans.

The Class EA process also gives members of the public, interest groups and review agencies a chance to review the Project File Report during a 30-day calendar review period. The 30-day review period gives individuals an opportunity to raise outstanding concerns regarding the project with the Region. If issues cannot be resolved by the Region during this period, an individual may request that the Minister of the Environment takes action. The Minister will make an order for the project to comply with Part II of the *Environmental Assessment Act* by requiring the project to follow the requirements of an individual environmental assessment. The request must be submitted in writing to the Minister. If no Part II Order requests are

received within the 30-day review period, the project will proceed through the detailed design and construction phases as outlined in this Project File Report.

1.5 Report Outline

The report is divided into 12 subsections plus appendices and references, structured as follows:

+ **Section 1: Introduction** – Provides background information, an overview of the previously completed West Montrose Class EA study, objectives of the Conestogo Plains Water Supply Class EA study and objectives of this Project File Report.
+ **Section 2: Class Environmental Assessment Process** – Provides a summary description of the framework and activities to be completed to meet the Municipal Class EA process requirements and the phases related specifically to the Conestogo Plains Water Supply System Class EA study.
+ **Section 3: Public and Agency Consultation Process** – Outlines the Public Consultation and Communication programs set in place as well as the format of the Public Engagement Meetings. This section also provides a summary of public issues, comments and concerns received throughout the Class EA study, how they have been addressed, and any agency consultation that was sought out.
+ **Section 4: Study Area Overview** – This section outlines the study area location and major existing natural heritage features. The socio-cultural environment of the area is also discussed including the site settings and land uses, cultural and heritage resources, and geotechnical and hydrogeological conditions.
+ **Section 5: Existing Water Supply Systems** –Describes the current conditions of the existing groundwater systems in the area including water quality, water production and existing water demands of each.
+ **Section 6: Design Criteria** – Provides a detailed description of the design criteria developed for this Class EA study, in terms of population projections, unit consumption rates and projected water demands for each system.
+ **Section 7: Evaluation Process** – Details the evaluation framework applied to the water supply alternative solutions considered in the Class EA study.
+ **Section 8: Identification and Assessment of Water Supply Alternative Solutions** – Provides a general description of the high level water supply

alternative solutions considered in the study and the results of the preliminary assessment of such alternatives.

+ **Section 9: Development of Short-Listed Water Supply Alternatives** – Describes the water supply alternatives that were short-listed and carried forward in the process for a more detailed evaluation. Detailed descriptions include the infrastructure / process requirements for each alternative, associated hydraulic conditions and cost estimates.

+ **Section 10: Detailed Evaluation of Short-Listed Water Supply Alternatives** – Summarizes the results of the detailed comparative evaluation carried out for the short-listed water supply alternatives described in Section 9 as well as the results of the sensitivity and value analyses.

+ **Section 11: Preferred Water Supply Solution** – Describes the preferred water supply solution as chosen by the detailed evaluation, and outlines the major components and advantages of the proposed solution. Also, details the anticipated implementation schedule for the proposed works, required permits and approvals and preliminary cost estimate of the preferred solution.

+ **Section 12: Proposed Mitigation of Potential Impacts and Monitoring** – Summarizes the proposed mitigation measures recommended to be undertaken to minimize potential anticipated impacts.

2. Class Environmental Assessment Process

This section outlines the Municipal Class EA process and the steps that are involved in bringing a municipal infrastructure project such as this one to the design and construction phases.

2.1 Municipal Class Environmental Assessment

The development, expansion and/or update of any municipal water supply system in the province of Ontario are normally carried out as a Municipal Class Environmental Assessment (Class EA) under the provincial *Environmental Assessment Act.* The Class EA process is applied to certain classes of public sector projects that have possible impacts to the environment.

The Municipal Class EA process was created to ensure that all aspects of the environment are considered during the planning and construction phases of a project. The Class EA process outlines the steps that must be followed to satisfy the EA requirements for water, wastewater and road projects. The various phases of the Municipal Class EA process are described in Figure 1, located at the end of Section 2. In summary, the five phases are:

+ **Phase 1** Identification of the problem or opportunity
+ **Phase 2** Identification of alternative solutions to the problem or opportunity and their respective impacts to the environment. Evaluation of alternative solutions and selection of a preferred solution considering public and review agency input
+ **Phase 3** Identification and evaluation of alternative design approaches for the preferred solution. Selection of the preferred design concept based upon public and review agency input
+ **Phase 4** Documentation of the planning, rationale, design and consultation process in a Class EA Report. The report must be made available to the public and review agencies for review.
+ **Phase 5** Implementation of the preferred alternative solution / design concept and monitoring for environmental provisions and mitigation measures.

Public and agency consultation is an important part of the Class EA planning process. Gaining input from individuals and groups can help identify project concerns early, and to find ways to address concerns wherever possible. Public consultation is carried out at key stages of the Class EA process to allow time to review and provide input related to the project.

Projects subject to the Class EA process are classified into three possible "schedules" (or categories), depending on the degree of expected impacts:

+ Schedule A or A+ projects; are minor, operational and maintenance activities and are approved without the need for further assessment.
+ Schedule B projects require a screening of alternatives for their environmental impacts and Phases 1 and 2 of the planning process must be completed. A Class EA report, also referred to as a Project File Report, consistent with Phase 4 of the Class EA process must be completed subsequent to completion of Phase 2 and filed for public review.
+ Schedule C projects must satisfy all five phases of the Class EA planning process. These projects have the potential for greater environmental impacts. Phase 3 involves the assessment of alternative methods of carrying out the project, as well as public consultation on the preferred design concept. Phase 4 includes the preparation of an Environmental Study Report (ESR) that is filed for public review.

2.2 Conestogo Plains Class Environmental Assessment Process

The majority of the potential expansion works are generally consider Schedule B activities under the Municipal Class EA process, consisting of the following:

+ Upgrades and increase in capacity to an existing distribution system
+ Expand existing water treatment plant up to existing capacity
+ Increase pumping station capacity where new equipment is in a new building or structure
+ Expand / replace water storage facilities
+ New wells or increase of pumping capacity at an existing well site
+ Water crossings (except if by trenchless methods)

The Conestogo Plains Water Supply Class EA study was carried out as a Schedule B undertaking. As part of the study, a comprehensive review of background information, data and planning projections and an assessment of the existing municipal groundwater supply systems in the area was conducted to confirm and formulate the need for the project and the opportunity being addressed (Phase 1), and to develop the basis for the identification and evaluation of potential water supply alternative solutions (Phase 2).

This document summarizes Phases 1 and 2 of the Class EA process and fulfills the requirements of Phase 4. This Project File Report will be placed on the public record and will be available for review by the general public for at least 30 calendar days. Agencies and the public will be notified through the issuance of a "Notice of Study Completion". Provided that no significant issues arise during the review period which cannot be resolved in consultation with the Region, and also that no Part II Order requests are received, the project will be approved and may proceed directly to implementation. Part II Order requests must be directed to the Minister of the Environment.

2.3 Information on Part II Order Requests

Under the Class EA process, it is possible for the Minister or delegate to review the status of a project. The public, community stakeholders and review agencies may ask the Minister or delegate to ask a proponent to comply with Part II of the Environmental Assessment Act before proceeding with construction of the proposed project. This is known as a Part II Order.

The procedure for dealing with concerns which may result in the Minister ordering the proponent to comply with this part of the EA Act is as follows:

+ Concerns regarding the project should be brought to the attention of the proponent during Phase 2 through to Phase 4 if applicable
+ If the concerns are not resolved through discussion with the proponent, those raising the objection must then contact the Minister of the Environment and request a Part II Order. A written request shall be copied by the requester to the proponent at the same time as submission to the Minister

Any request sent to the Minister must be in writing and must address the following issues as they are related to the concern:

+ The environmental impacts of the project and their significance
+ The adequacy of the planning process followed by the proponent
+ The availability of other solutions to the project
+ The adequacy of the public communication and consultation program and the opportunities given to the public to make comments and raise concerns
+ The nature of the specific concern that remains unresolved
+ Details of any discussions between the requester and the proponent about the concern being raised

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+ The benefits of requesting the proponent to complete an individual environmental assessment
+ Any other relevant information

If a concern of a Part II Order request is resolved by the proponent, it is the responsibility of the requester to withdraw the request to the Minister. Withdrawals are to be done in writing to the Minster and copied to the proponent.

The Minister considers the request and both sides of the argument and makes one of the following decisions:

+ Deny the request
+ Refer the request for mediation
+ Order the proponent to comply with Part II Order

2.4 Class EA Phase 1 – Problem / Opportunity Statement

Phase 1 of the Class EA planning process requires the proponent to first document factors leading to the conclusion that the improvement or change being sought out is needed, and ultimately to develop a clear statement of the problems, deficiencies or opportunities to be investigated during the duration of the project.

For the development of a problem / opportunity statement for the Conestogo Plains Class EA study, the following was taken into consideration:

+ The West Montrose Water Supply System is continuously experiencing water quantity issues with its supply wells, operational challenges with treatment during periods of high water levels in the Grand River and the constant need to truck water into the community during these periods and in the summer
+ The West Montrose Water Supply System Class EA study, completed in January 2013, recommended a permanent connection from the West Montrose to the Conestogo Plains Water Supply System to provide a long-term water supply solution to the community of West Montrose and eliminate on-going concerns and limitations in the West Montrose supply system
+ The Conestogo Plains Water Supply System currently operates well below its existing rated capacity and the water quality is considered generally good, providing an opportunity to also supply water to West Montrose and some properties in the Conestogo Plains service area currently on private wells

+ Implementation of the recommendations of the 2013 West Montrose Class EA study are subject to verification through completion of a separate Class EA study for the Conestogo Plains Water Supply System

Based on the above, the problem / opportunity statement for the Conestogo Plains Water Supply System Class EA study has been defined as follows:

> *A preferred long-term water supply solution that adequately meets, in a sustainable, reliable and financially responsible manner, the existing and future servicing requirements of the West Montrose and Conestogo service areas is required to address concerns and limitations previously identified with the West Montrose Water Supply System. This Class EA study also provides the Region with the following opportunities:*
>
> - *To assess the overall present and future water servicing requirements of the Conestogo and West Montrose service areas with consideration to updated planning projections*
> - *To explore in detail and confirm the feasibility of connecting West Montrose to the Conestogo Plains Water Supply System*
> - *To complete a comprehensive examination of available water supply alternative solutions, including potential connections to the Region's Integrated Urban System.*

2.5 Class EA Phase 2 – Alternative Solutions

Phase 2 of the Class EA planning process requires the identification and evaluation of potential alternative solutions to the problem / opportunity defined during Phase 1. A long-list of potential alternative solutions were initially developed and their feasibility assessed based on their ability to meet the project objectives as well as other key screening criteria, previously established by the project team. The alternative solutions that were considered feasible were short-listed and carried forward in the process for a more detailed development, comparative evaluation and finally selection of the preferred water supply solution. A detailed description of these activities and the results is provided in the following sections of this report.

2.6 Project File Report

A Schedule B Class EA process requires completion of a Project File Report that documents the planning and decision making process followed during the Class EA study. This report constitutes the Project File Report and provides all supporting information used throughout the different phases of the Class EA study to support

the recommendations and selection of the preferred water supply solution for the Conestogo and West Montrose service areas, as described herein.

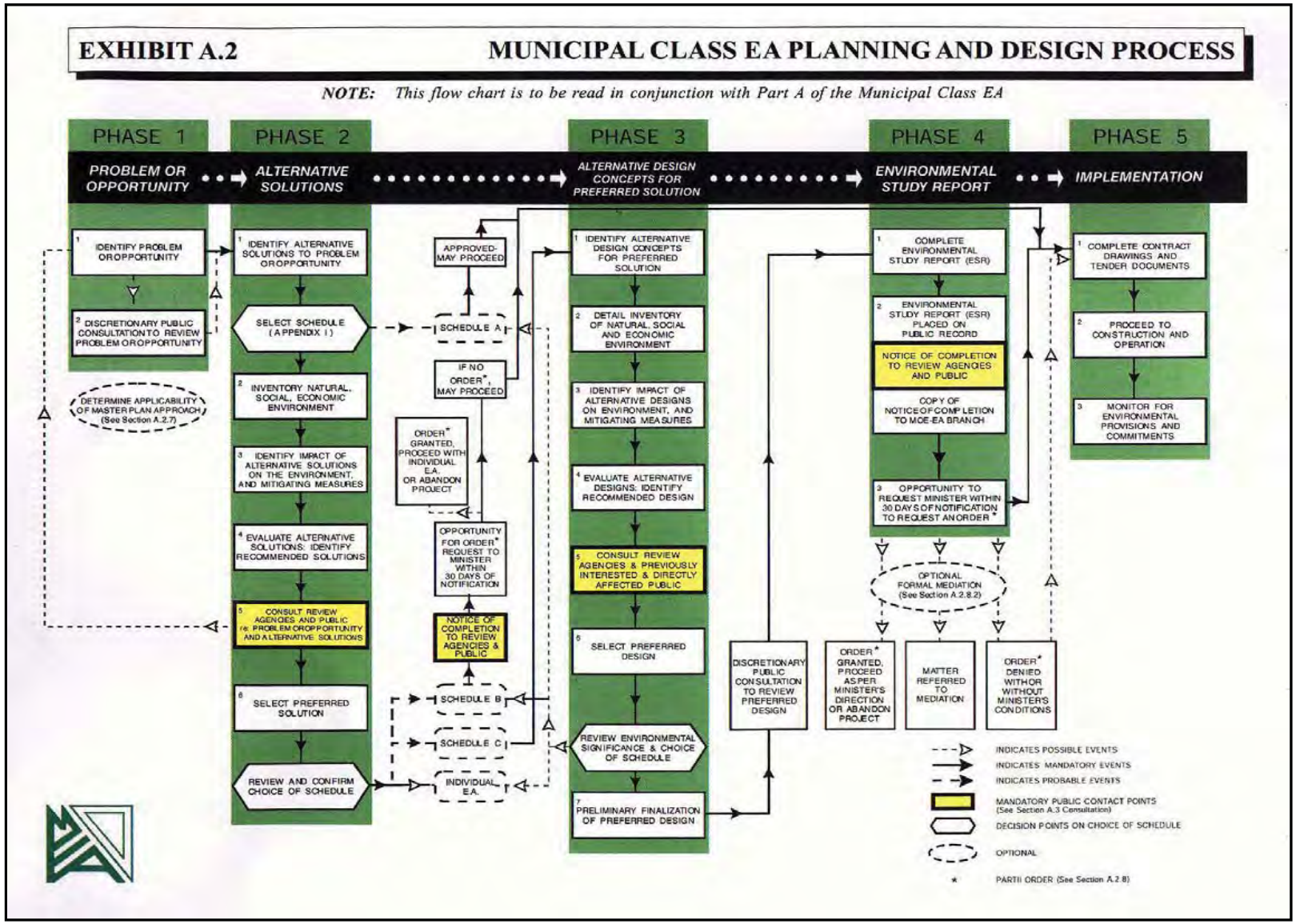

Figure 1 Municipal Class Environmental Assessment (EA) Planning and Design Process

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3. Public and Agency Consultation Process

Public consultation is an important part of the Class EA study process. Successful public consultation programs play an important part of building and maintaining community trust, improving project decision-making and identifying the community early. The public and agency consultation activities undertaken at key stages of this Class EA study are described in the following sections.

3.1 Objectives of Public Consultation and Communication Program

CIMA and the rest of the project team believe that the quality of decisions would be improved by seeking out and acting on input from the public and stakeholders. The public consultation and communication program was designed to achieve the following:

+ Inform the public and stakeholders about the project and provide accurate information in a timely fashion
+ Facilitate and communicate the opportunity for public input
+ Promote a public consultation strategy that includes the participation of stakeholders
+ Tailor the consultation and communication program to the specific needs of the interested members of the public and stakeholders
+ Involve stakeholders by identifying appropriate mitigation measures and to provide assurance that the measures will be implemented

3.2 Public Consultation, Communication Strategies and Tactics

A major component of the Municipal Class EA process is to inform governmental agencies, affected landowners, the local community and the general public of key project activities and to solicit comments and feedback from these groups on the results of major activities, before any final decisions are made.

The Municipal Engineers Association Class EA document outlines mandatory and discretionary consultation contact points with the public and agencies. In order to communicate the project progress and goals and to solicit proper feedback and insight throughout the process, CIMA undertook the following communication and consultation activities:

+ **Project Contact List:** A master project contact list was created at the onset of the project to include representatives from government and regulatory agencies, First Nation groups, utilities, landowners, developers, and a number of technical

review agencies and organizations that may have an interest in this project. Interested members of the public were added to the mailing list upon request and all individuals on the list were kept informed about project updates and upcoming meetings through direct mail.

+ **Notice of Study Commencement:** A "Notice of Study Commencement" was published on two separate publications in the following local newspapers.

  - The Woolwich Observer on Saturday August 10 and Saturday August 17, 2013
  - The Record on Friday August 9 and Tuesday August 13, 2013
  - The Waterloo Chronicle on Wednesday August 14 and Wednesday August 21, 2013

  Copies of the notice were also mailed out to all individuals and groups on the Project Contact List. A copy of the Notice of Study Commencement is provided in Appendix A.

+ **Public Consultation Centre (PCC) No. 1:** The first public meeting for this Class EA study was held on March 18, 2014 from 5:30 to 7:30 pm at the Conestogo Golf and Country Club. The meeting allowed all members of the public and stakeholders that may have an interest in the project to learn more about the need for the project, the Class EA process, the alternative solutions under consideration, the criteria proposed to evaluate the alternative solutions and to provide feedback on the information presented. The meeting was held within the study area in anticipation that residents within the study area would attend. This meeting had 16 attendees in total. The majority of comments received during the meeting were split between a preference from residents to remain on local groundwater supply systems and a preference to connect to the Integrated Urban System (IUS). In general, the questions asked were related to potential impacts to private wells in the area from increased pumping rates in the Conestogo Plains system and the potential cost and implications of residential service connections to the IUS.

  The PCC No.1 Notice informing the public of the meeting was issued in the following local newspapers:

  - The Woolwich Observer on Saturday March 8 and Saturday March 15, 2014
  - The Record on Friday March 7 and Friday March 14, 2014

A copy of the PCC No. 1 Notice was sent to all individuals and groups on the Project Contact List in advance of the public meeting. A copy of the "Notice of PCC No. 1" is provided in Appendix A.

+ **Public Consultation Centre (PCC) No. 2:** The second public meeting for this Class EA study was held on November 20, 2014 from 5:30 to 7:30 pm at the Conestogo Golf and Country Club. The purpose of the second PCC was to present the results of the detailed evaluation process and introduce the preliminary preferred water supply solution to the general public for feedback. The PCC also identified the rationale used to evaluate and select the preliminary preferred solution as well the timeline for construction and implementation of the recommended preferred solution. There were 12 attendees for PCC No.2. No major comments or concerns were received. The PCC No.2 Notice informing the public of the meeting was issued in the following local newspapers:

  - The Woolwich Observer on Saturday November 8 and Saturday November 15, 2014
  - The Elmira Independent on Thursday November 13 and Thursday November 20, 2014

  A copy of the PCC No. 2 Notice was sent to all individuals and groups on the Project Contact List in advance of the public meeting. A copy of the "Notice of PCC No. 2" is provided in Appendix A.

+ **Notice of Study Completion:** A "Notice of Study Completion" notifying the public and agencies that the Project File Report has been placed on the public record for review will be issued. The Notice advises the general public about where to find the Project File Report, as well as their ability to place a Part II Order request with the Minister of the environment if they have outstanding concerns about the project that cannot be resolved by the Region during the given review period. The Notice of Study Completion will be advertised in the Woolwich Observer on Saturday September 19 and Saturday September 26, 2015

  The notice will also be posted on the Region's website **www.region.waterloo.on.ca/water** and sent to all individuals and groups on the project contact list. A copy of the Notice of Study Completion is included in Appendix A.

3.3 Public Consultation Centre Format

The PCCs for this project were held as an open forum where attendees were encouraged to walk around the room, review the information displayed on poster boards around the room and have one-on-one conversations with staff from the Region and its consultant team, CIMA. Before leaving the PCC, attendees were encouraged to fill out a Comment Sheet answering questions pertaining to their possible concerns or content of the presentation as well as providing the opportunity to submit their own comments or questions.

The public meeting materials available included:

+ Display panels: Including information about the project using both text and visuals
+ Comments Sheets: Attendees were encouraged to fill out these sheets as an opportunity to provide comments, make suggestions or ask questions about the project and/or the Class EA Study process
+ "Installation of Regional Watermain from Integrated Urban System to Conestogo": This handout provided information at PCC No. 2 about the change in water disinfection from chlorination to chloramination which answered five frequently asked questions (FAQs) to provide information.

All meeting and presentation materials were posted on the Region's website at http://www.regionofwaterloo.ca/en/aboutTheEnvironment/MasterPlansandProjects.asp. Copies of the display panels and other material available at the meetings are included in Appendix B.

3.4 Summary of Public Issues, Comments and Concerns

Six (6) comments sheets were received during PCC No.1. No comments sheets were completed and submitted during or after PCC No. 2. The main issues, comments and suggestions gathered from the public consultation process are as follows:

+ Concerns about residents on private wells being forced to connect to the municipal supply, and associated costs and responsibilities
+ Concerns over potential impacts on existing private wells in the area, in terms of both quality and quantity, as a result of increasing pumping rates from the existing Conestogo Plains production wells
+ Some attendees were in support of continuing to rely on existing groundwater supply systems while others were in support of connecting to the Region's Integrated Urban System

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All public comments and potential impacts to the social / community environment were taken into consideration during the detailed comparative evaluation of the short-listed water supply options.

3.5 Agency Consultation

An important component of the Class EA process is proper consultation with government review agencies and the public. The Region ensured that the public and necessary review agencies were informed about this study and encouraged to contribute during the study. This section outlines the agency consultation component of the study.

A list of agencies was prepared at the start of the project that included all relevant Provincial Ministries, local municipalities and agencies, as well as local associations and utilities. Each party on the list of stakeholders was contacted to provide information or comments. The opportunity for these agencies to participate in the project was provided through the distribution of all study notices, direct letter mailings, and through direct invitations to participate in the two formal PCCs. The complete list of all agencies contacted and correspondence is included in Appendix C of this report.

3.5.1 Grand River and Conservation Authority

Consultation with the Grand River Conservation Authority (GRCA) was carried out from the early stages of the project, which included direct mailings of the project notices and invitations to the public meetings, as well as a pre-consultation meeting to review the scope and obtain their feedback on the natural heritage investigation to be completed as part of the Class EA study.

Considering the relevancy of aquatic and terrestrial resources within the study area, a number of comments were received from GRCA, which included:

+ To contact MNRF to obtain fish data and confirm the thermal regime / timing windows for waterbodies classified as warm water fish habitat
+ To assess impacts associated with watercourse crossings by both trenchless and open cut methodologies
+ To obtain details on species at risk from MNRF and Fisheries and Oceans Canada.

The natural heritage investigation completed in support of this Class EA and the respective report incorporated and addressed the above noted comments. All correspondence exchanged with GRCA throughout the course of the Class EA is included in Appendix C for further reference.

3.5.2 Aboriginal Affairs and Northern Development Canada

A letter from Aboriginal Affairs and Northern Development Canada, dated January 10, 2014, was received in response to an information request made by the project team in regards to potential Aboriginal and treaty rights within and in the vicinity of the study area.

It is noted in the letter that the project study area falls within:

+ close proximity to the Six Nations of the Grand River
+ close proximity to the Mississaugas of the Credit
+ the Upper Canada Treaties Region

In addition, the letter provides contact information for various councils and organizations for the Mississaugas of the Credit, Six Nations of the Grand River and the Métis Nation of Ontario. These councils and organizations were part of the Project Contact List; thus, copies of all project notices and invitations to participate in the public meetings were distributed to them as part of the communication and consultation program. A copy of the letter is included in Appendix C.

4. Study Area Overview

This section provides an overview of the main features, characteristics and existing conditions of the study area defined for this Class EA study.

4.1 Study Area Location

Delineation of the study area comprised the existing West Montrose and Conestogo service areas and existing water supply sites, where the majority of construction activities are most likely to occur, as well as those areas where the water supply alternative solutions considered in this Class EA study could potentially have some degree of impact. The boundaries of the study area are shown in Figure 2 below.

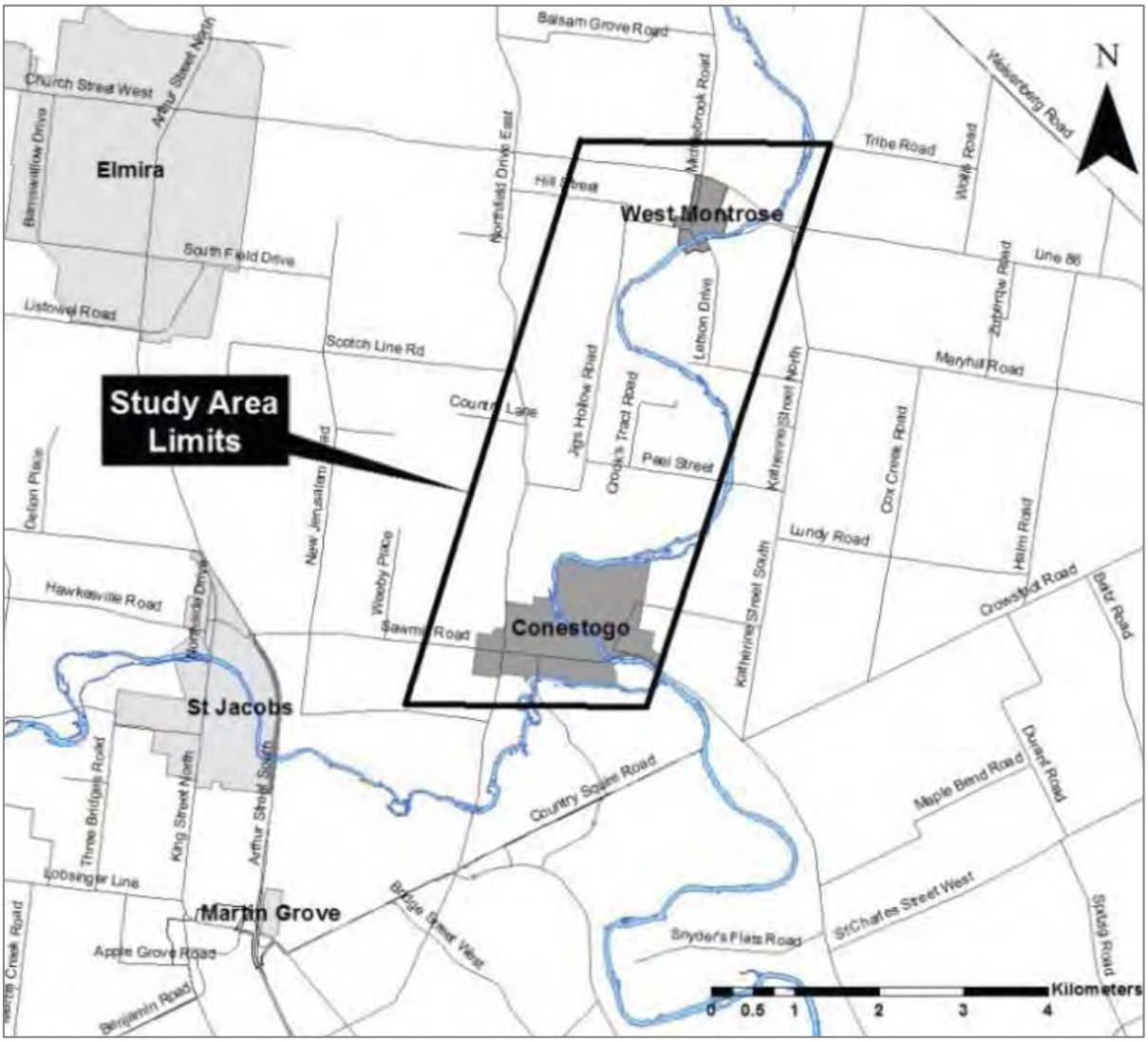

Figure 2 Conestogo Plains Water Supply System Class EA – Study Area

4.2 Site Setting and Surrounding Land Use

Within the study area, the landscape is predominantly agriculture, residential and natural features mostly related to watercourse and associated valleylands and wetlands. Row crops of corn, hayfield and cattle farms are dominant.

4.2.1 Conestogo

Conestogo is a rural community that lies approximately 4 Km north of the City of Waterloo and approximately 5 Km east of St. Jacobs at the confluence of the Conestogo and Grand Rivers. The community is located at the intersection of Northfield Drive East and Sawmill Road. The community of Conestogo was built on predominantly flat, elevated upland areas that are located west and north of the Grand and Conestogo River valleys, respectively. Ground surface elevations range from a high of approximately 345 m above sea level (masl) to a low of 309 masl at the confluence of the Grand and Conestogo River valleys.

The Conestogo service area is comprised of 485 lots. The majority of the area (437 lots) is comprised of residential development. The next major attribute of the area is land. 27 of the 485 lots is undeveloped land. There is a small percentage of commercial land development within the study area, with the Conestogo Golf Course being responsible for most of the commercial land use.

There are three serviced subdivisions within Conestogo, all serviced by the Conestogo well field located north of the City of Waterloo and divided into 2 sub-fields; the Conestogo Plains well field, located west of the Grand River within a residential subdivision and the Conestogo Golf Course well field, located east of the Grand River near the Conestoga Country Club. Both sub-fields were originally constructed by developers in the late 1980s; however, the Region currently owns and operates both well sub-fields.

4.2.2 West Montrose

West Montrose is a rural village that straddles the Grand River approximately 20 Km from the Kitchener-Waterloo city centre and approximately 6 Km north of Conestogo Golf Course well field. West Montrose lies on the Grand River floodplain, and to a much lesser extent, on the flat elevated upland area east of the Grand River.

The community of West Montrose is mostly comprised of residential units but lies outside of any significant urban areas. The community itself is bordered by agricultural land to the north and west, and the Grand River to the east and south. West Montrose is identified as a “Service Settlement” which, according to the Township of Woolwich is defined as:

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"*An area containing a small concentration of predominantly rural non-farm related single family dwellings on large lots at low density but which also provides limited commercial, industrial and service facilities to a surrounding rural area as well as to the immediate residents, subject to the controls and regulations imposed through the Settlement Plan and the Zoning By-law"* (Township of Woolwich, 2010).

The area of West Montrose is divided into a total of 91 lots. 79 of these lots are considered residential. The second most feature of the land use in this area is undeveloped land. The rest of the existing land use is evenly divided amongst commercial, agricultural, industrial and special uses.

Within West Montrose, there is an abundance of mineral aggregate resources and bedrock deposits which results in a number of licensed pits and quarries in the area. Agricultural fields surround West Montrose and the nearby aggregate extraction operation.

The community of West Montrose is serviced by the West Montrose well field, originally constructed in 1988 as a communal water supply system to service the adjacent residential subdivision. The Region currently owns and operates the West Montrose well field. Ground surface topography of this well field reaches a maximum of 350 masl on the till plain west of the Grand River and declines to a low of 310 masl along the river channel south of the well field.

4.3 Natural Environment

A natural heritage investigation was completed by LGL Limited in support of this Class EA study. The investigation included a review of the existing conditions within and adjacent to the limits of the study area, as shown in Figure 2, in order to provide an inventory of existing natural heritage features and to identify any potential constraints for consideration in the development and evaluation of water supply alternatives for this project. Documentation of existing conditions consisted of a desktop assessment of orthoimagery and a review of background data from secondary sources to establish natural heritage conditions within the area, followed by field surveys. The Natural Science Report completed by LGL Limited is included in Appendix E in this report.

4.3.1 Physiography and Soils

The Grand River travels north-south through the study area. The area west of the river is largely comprised of the rolling terrain of the Waterloo Hills (Chapman and Putnam, 1984). This area is comprised of sandy hills, gravel terraces and swampy valleys. East of the river, is a portion of land a part of the Guelph Drumlin Field. This field is made up of oval shaped hills with low slopes. The Conestogo and

Grand River valleys presently occupy valleys which were formed by meltwaters of receding glaciers forming terraces of high quality sand and gravel through successively lower water levels experienced over time. As a whole, the soils in the area have been classified as fertile, easily worked and adaptable to many crops which is reflected by the extensive agricultural land use within the study area.

4.3.2 Significant Natural Features

The study area was screened for significant natural features in the form of wetlands, valleylands and woodlands and Core Environmental Features (CEF) as outlined in the Official Plan for the Region. In addition, the study area was also screened for Areas of Natural and Scientific Interest (ANSIs), and provincially significant wetlands (PSWs).

Three types of wetlands were identified throughout the study area: provincially significant wetlands (PSWs), unevaluated wetlands and other wetlands. The study area has several unevaluated wetlands. These features are largely associated with the Grand River and its tributaries.

Two locally significant wetlands are found within the study area as identified by the Ministry of Natural Resources and Forestry (MNRF), which are the Winterbourne Riverine Wetland Complex and the Upper Conestogo Creek Complex. The Winterbourne Riverine Wetland Complex is described as being comprised of 19 wetland units of swamp and marsh covering an area of 54.47 ha along the Grand River. This complex is connected via surface water to other wetlands in the area. In the Upper Conestogo Creek Complex, one PSW straddles the south east corner of the study area, namely the Waterloo East Wetland.

The study area is also home to significant valleys. The valleys associated with Canagagigue Creek and the Grand River are considered steep to overstep.

Significant woodlands are identified as features that meet the criteria of a woodland according to the Regional Woodland Conservation By-law. These are areas that consist of native tree species and are greater than 4 hectares in size. There are several significant woodlands located within the study area, most of which are small in size. Those associated with the riparian area of Canagagigue Creek and the area between the Conestogo River and the Grand River to the south comprise the largest significant woodland features within the study area.

The MNRF has indicated that the St. Jacob's Hill Regional Earth Science Area of Natural and Scientific Interest (ANSI) is found within the study area. The ANSI is located on the banks of the Conestogo River in the Village of St. Jacobs. St. Jacob's

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Hill ANSI is a 2.4 ha feature. The Guelph Esker Regional Earth Science ANSI occurs along the north eastern border of the study area.

4.3.3 Wildlife and Wildlife Habitat

Records of wildlife residing within the study area were primarily obtained from accessible databases and requests for data from local groups. There are 5 mammalian species present in the study area. All of the species are considered to be common and secure in Southern Ontario including the following: muskrat, beaver, raccoon and mink. The Winterbourne Riverine Wetland Complex was deemed locally significant for its provision of winter cover for wildlife, namely, deer. MNRF Land Information Ontario (LIO) data indicates that a Crown Game Preserve occurs within the study area to include the lands south of the Grand and Conestogo Rivers to the west side of the Grand River.

The wetland evaluation for the Winterbourne Riverine Wetland Complex indicates that the hunting of waterfowl occurs here; however, no significant features for water bird nesting or staging are documented in the feature. A total of 130 bird species occur within the study area.

The wetland evaluation for the Winterbourne Riverine Wetland Complex indicates that the wetland also provides a habitat for snapping turtles. No other records were found pertaining to other reptiles in the study area. No records were found for amphibians in the study area either.

4.3.4 Aquatic Habitat and Fish Communities

The study area includes several watercourses that flow through and adjacent to areas that may house infrastructure related to the project. These include the Grand River, Conestogo River and Canagagigue Creek all of which are a part of the Grand River Watershed. The Grand River watershed is the largest inland river system in southern Ontario. The watershed covers a total area of 6,800 km2 and is home to a population of 925,000 people. This watershed is responsible for approximately 10% of the drainage to Lake Erie. The major tributaries of the Grand River are the Nith and Conestogo Rivers that drain the western portion of the watershed and the Speed River responsible for draining the north-east section.

The study area lies within the Central Grand River sub-watershed and borders the Conestogo Sub-basin. Physiography and hydrology in this area is complex due to the extensive moraines and glacial spillways which result in a large amount of groundwater contributing to relatively high baseflows. Land use in this area is mostly agricultural which is responsible for sediment and nutrient loads to the tributaries and Grand River.

The Grand River has been designated as a Canadian Heritage River due to its significant cultural and natural heritage features. The river is 280 km long, extending from its headwaters north of Dundalk to Port Maitland on Lake Erie. There are 80 confirmed fish species and 18 probable species to include several aquatic species at risk (SAR) that the river is home to.

The Conestogo River Watershed is primarily a runoff system, comprised largely of Tavistock Till Plain which is responsible for generating high runoff. Stream flow that lies within the study area is controlled by discharges from the Conestogo Dam. While the Waterloo Moraine contributes some of the stream flow in the study area, most of the flow during the summer period can be attributed to reservoir augmentation. The tributaries of the Conestogo River receive large amounts of groundwater discharge allowing for the opportunity to restore water quality in the lower portions of the river.

The Canagagigue is a minor tributary of the Grand River and flows from its headwater in the Waterloo hills in Peel Township to the flatter Guelph drumlin fields of Woolwich Township southeasterly towards the Grand River. The portion found within the study area is the lower portion downstream of Elmira and the confluence of West Montrose Creek to its mouth at the Grand River.

This river has been negatively impacted by poor disposal of toxic waste resulting from the production of Agent Orange in Elmira during the 1960s. Now, the creek receives inputs from the wastewater treatment plant (WWTP) and private industry. The Region currently undertakes extensive water quality monitoring upstream and downstream of the WWTP to monitor potential impacts to the creek. Data collected from this monitoring suggests that nutrient levels that reach the creek are high (above the recommended levels for phosphate and nitrate) independent of operations at the WWTP.

The portion of the Canagagigue River that flows through the study area is classified by the Ministry of Natural Resources and Forestry (MNRF) as a warm water fish habitat. A total of 27 species were recorded in the reaches of the creek downstream of Elmira.

4.3.5 Rare Species

In order to determine the potential for rare species to reside in the study area, a review was completed of MNRF's Natural Heritage Information Centre (NHIC) Biodiversity Explorer database and an MNRF Species at Risk Biologist was consulted. Records returned three plant species: Braun's Holly Fern, S3; Scarlet Beebalm, S3; and White-tinged Sedge, S3. Three fish species were also returned: Black Redhorse, THR; Silver Shiner, THR; and Greater Redhorse, S3. One mussel

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species was found: Wavy-rayed Lampmussel, THR and three reptile species: Snapping Turtles, SC; Milksnake, SC; and Eastern Ribbonsnake, SC. Finally, one bird species was found: Bobolink, THR.

It was also found that the Rainbow Mussel is likely to occur in the Grand River which is considered a SAR by the MNRF.

4.3.6 Vegetation and Vegetation Communities

The natural vegetation within the study area has been cleared in the past for agricultural and residential development. As a result of this, the remaining vegetation features present in the study area have been subject to some disturbance and are the result of a secondary regeneration or they are too difficult to farm and have been left alone due to topography and/or soil moisture conditions. There are typical roadside features like ditches dominated by upland and wet meadow species.

Natural features within the study area are attributed to the valleyland of the Grand River and its tributaries and include forest and wetland communities. Anthropogenic vegetation communities in the area include cultural meadows, cultural plantations and cultural woodland.

The Winterbourne Riverine Wetland Complex is a locally significant wetland. This area is associated with the floodplain of the Grand River and contains both meadow marsh and coniferous swamp communities.

In total, 133 vascular plant species were recorded within the study area. 53% of the plant species identified are native to Ontario and the remaining 47% are considered non-native to Ontario.

A total of 30 bird, two amphibian and one mammal species were documented during an investigation of the study area. The species found in the study area are common within the vegetation present. None of the species found are area-sensitive species. There appeared to be no active nests, cavities, hibernacula or dens.

Due to much of the vegetation being cleared for regular maintenance along the right of way, the availability of a breeding habitat for birds is limited within the study area. Contrastingly, the areas along Jigs Hollow Road that border the Grand River and Canagagigue Creek present greater opportunities for breeding due to the naturally forested areas in these parts. It was in these areas that the greatest diversity of species was observed.

The naturalized areas found around the larger watercourse crossings provide a higher quality habitat, better suited for wildlife. The sandy, natural shorelines of the river and creeks could present opportunities for turtles, aquatic mammals or amphibians.

4.3.7 Wildlife and Wildlife Habitat

All wildlife found in the study area was screened for those listed as at risk provincially, federally or locally. There were several reptile species at risk that were listed with an increased potential to occur in the area, but none were observed. One species that is listed as Threatened on the Ontario Endangered Species Act, the Barn Swallow, was observed multiple times within the study area.

The Eastern Wood Pewee was also observed in the study area. This species of bird is not listed as at risk, but it has been identified by Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as a species of Special Concern.

4.4 Cultural Heritage Resources

The Region of Waterloo Official Plan has noted that West Montrose and the surrounding countryside are home to a large Mennonite community. The strength of the Region's agricultural sector has been attributed to the culture and farming practices of the Mennonites. The Region's Official Plan seeks to preserve and support the social, economic and cultural requirements of this population (Region of Waterloo, 2010).

West Montrose is also home to the Heritage Bridge known as the West Montrose Covered Bridge. It is recognized as a historic site by Ontario's Archaeological and Historic Sites Board. It is the province's last remaining covered bridge and has a 198 foot span across the Grand River. The bridge was originally constructed in 1881 and underwent major repairs most recently in 1999. The bridge still supports light traffic daily and horses and buggies on Sundays. The covered bridge is located approximately 310 m from the existing infiltration wells site.

The Conestogo Bridge, also known as the Glasgow Bridge, is located on Glasgow Street South, 0.3 km south of King Street in the village of Conestogo, at the base of a steep hill in a vast open floodplain. The Conestogo Bridge is a significant landmark in the area located within the historic Mennonite community of Conestogo on the border of the City of Waterloo, acting as a gateway between urban and rural settings. The bridge, constructed in 1886, is among the oldest steel truss bridges remaining in Canada and is the second oldest truss bridge in the Grand River watershed after the Nithvale Bridge (1873), located in the Township of North Dumfries. The cultural and heritage value of this bridge is mainly attributed to several unique construction details such as heavy use of pin connections in the bracing and the use of non-traditional eyebars (or eye rods). The bridge's two-span structure is also significant in that it required greater engineering skills and technical achievement to construct, as this bridge would have proven more difficult to build

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than a similar single-span structure. The bridge underwent rehabilitation in 1984 in response to its natural deterioration.

There are also three significant recreational resources within the village of West Montrose; the “Kissing Bridge Trailway”, the “West Montrose Family Camp” and the Grand River. The Province of Ontario purchased the land of the Kissing Bridge Trailway in 1990 for potential future use as a utility corridor, but in 1997, the trailway was formed. The trail is most often used for hiking, biking and has designated areas for snowmobile use. The Grand River crosses the southern boundary of West Montrose and provides opportunities for canoeing and fishing.

Cultural Services of Planning, Development & Legislative Services in Region of Waterloo has completed a Cultural Heritage Evaluation (current as of January 8, 2015) for the proposed project area. A number of significant cultural heritage resources were identified, notably in the villages of Conestogo and West Montrose. Cultural Heritage staff have determined that there will be no long-term negative impacts to any of the identified resources, and as such the completion of a Heritage Impact Assessment (HIA) for the project is not required.

There are three designated properties, no municipally registered properties, 59 unofficially listed properties, and a total of 52 pre-1900 residential properties adjacent to the road corridor, along with two bridges. Many of the structures inventoried, notably those in Conestogo, as well as 52 Hill St. (Albright House) and 17 Covered Bridge Dr. in West Montrose, have very limited set backs from the road right of way. As such, care should be taken during construction to monitor and mitigate any potential impacts to these resources. A portion of road in this project area, Sawmill Rd., is considered scenic or of special character. There is one cemetery adjacent to the project area in West Montrose. The settlement of West Montrose is designated as a Cultural Heritage Landscape (CHL).

The Cultural Heritage Evaluation Memo is included in Appendix H.

4.5 Archeological Resources

A Stage 1 Archeological Assessment was completed by Archeoworks for Water Supply Alternative Solution No. 2 project area. This area encompasses the road allowances of Sawmill Road, Northfield Drive East, Jigs Hollow Road, Hill Street, Covered Bridge Drive, and Tallwood Drive, as well as the West Montrose and Conestogo water supply plants. The report can be found in Appendix G.

The Stage 1 background research identified archaeological potential for the recovery of Aboriginal and Euro-Canadian archaeological remains within undisturbed portions of the study corridor due to its close proximity (within 300 metres) to historic structures and historic villages, several historic transportation routes, designated and listed cultural heritage resources, the West Montrose Cultural Heritage Landscape, a commemorative plaque, previously registered archaeological sites, two historic pioneer cemeteries and primary water sources.

A property inspection has revealed that the study corridor is situated within a primarily rural setting, and traverses through the communities of West Montrose and Conestogo. Disturbances such as the existing Conestogo Plains and West Montrose water supply plants; paved/gravel roadways and driveways; paved sidewalks; gravel shoulders; roadside ditches and embankments; production wells, and underground utilities were identified. Areas of no or low archaeological potential include permanently wet areas consisting of the Canagagigue Creek, Grand River and steep slope. Undisturbed areas include (but are not limited to) ploughed agricultural fields, grassed margins, areas of overgrown grass, and manicured grass lawns.

4.6 Geotechnical and Hydrogeological Conditions

A geotechnical and hydrogeological investigation has been performed in May 2015 with a report completed to summarize the findings. The field work consisted of drilling and sampling twenty seven (27) boreholes (numbered BH-1 to BH-27) to depths ranging from approximate 3 m to 13 m below ground surface. The Draft Geotechnical and Preliminary Hydrogeological Investigation Report can be found in Appendix F in this report.

A previous geotechnical and pavement investigation was carried out on Sawmill Road and Northfield Drive during April 2012. Six boreholes (BH GA 11-1 to GA 11-5 and GA 11-8) from the previous investigation were used to supplement the current investigation. These boreholes were advanced to depths ranging from 3.4 m to 4.4 m below ground surface.

Two boreholes were drilled at the location of the Grand River Crossing. In general, the subsurface conditions consist of surficial deposits of organic silt, topsoil and/or fill overlying silty sand with localized silty clay pockets which is in turn underlain by silty sand and gravel to gravelly silty sand to the borehole termination depths.

Two boreholes were drilled at the location of the Canagagigue Creek Crossing from within the road allowance. The subsurface conditions on the south side of the creek consist of sand and gravel over silt which is in turn underlain by silty sand till. The

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subsurface conditions on the north side of the creek consist of surficial sand and gravel deposit containing interlayers of silty clay and sand, over gravel which is in turn underlain by silty clay till.

Boreholes along Sawmill Road, Northfield Drive, Jigs Hollow Road and Hill Street shows in general, the subsurface conditions consist of sand and gravel fill or asphalt overlying silty clay or silty clay till with local silty sand interlayers. The cohesive soils were underlain by silty sand to sandy silt extending to the borehole termination depths.

Boreholes drilled within the asphalt pavement on Covered Bridge Drive and Tallwood Drive show the subsurface condition encountered consist of asphalt overlying sand and gravel or silty sand and silty clay.

Groundwater levels in the area are subject to seasonal fluctuations, precipitation events and fluctuations in the creek/river. The unstabilized groundwater levels in the boreholes were measured during and upon completion of the drilling operations. Selected boreholes from the current and previous field investigations were also instrumented with a standpipe piezometer/well to permit long term monitoring of the ground water levels.

5. Existing Water Supply Systems

This section provides a description of the municipal water supply systems servicing the different communities within the study area.

5.1 Conestogo Plains Water System

5.1.1 System Description

The Conestogo Plains water supply system is owned and operated by the Region of Waterloo. The system obtains its raw water from groundwater wells C3 and C4, although, based on operating records for the last five years, well C4 has been used infrequently. The main components of the Conestogo Plains water system include:

+ Two groundwater wells, C3 and C4 (duty and standby), each equipped with a submersible well pump rated at 9.1 L/s at a TDH of 76.6 m. Both wells are considered groundwater supply (non-GUDI), as per existing Drinking Water Works Permit No. 012-212 Issue Number 1.

+ One above ground pump house including the following:

  - A sodium hypochlorite system for disinfection
  - A sodium silicate system for iron sequestration
  - A high lift pumping station containing four high lift pumps for delivery of treated water into the distribution system. Each pump is rated at 14.75 L/s at a TDH of 31.0 m
  - One three-celled 710 m^3 underground clearwell/reservoir
  - A portable generator capable of powering the complete water supply system

The Township of Woolwich owns and operates the Conestogo Plains water distribution system, including valves, pipes and residential meters. The distribution system serves for the most part residential properties and one commercial service property. The water distribution system comprises a combination of 150 mm and 200 mm diameter polyvinyl chloride (PVC) watermains distributing treated drinking water to the residential units via 25 mm diameter service connections.

A simplified process flow diagram of the Conestogo Plains drinking water system can be found in Figure 3.

A visual inspection and condition assessment of the facility was undertaken in December of 2013. Major findings and recommendations of the condition assessment to consider during the development and evaluation of water supply alternative solutions include:

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+ Reconfiguration of the existing chemical systems in conjunction with the other capital upgrade works to be done at the Conestogo Plains facility. Reconfiguration of the chemical systems could include replacement of dated components and equipment approaching the end of its useful life. Consideration should also be given to having a separate area dedicated exclusively to the chemical system(s) to be used, with proper labelling of all equipment. An extension of the existing building may be required to accommodate the new chemical systems area or to provide a separate space for new electrical equipment and ensure that sufficient clearance distances around the equipment are provided for proper operation and maintenance

+ Reconfiguration of the service entrance and provision of a new MCC and lighting panel. The Region may want to consider installing a new MCC panel in a dedicated space.

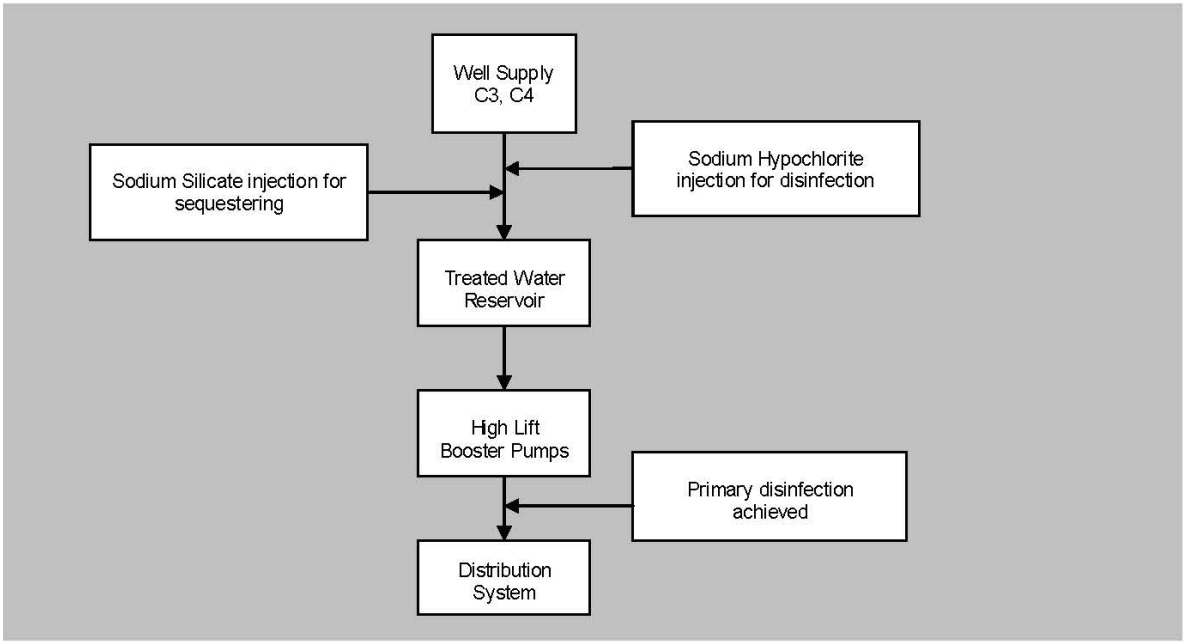

Figure 3 Conestogo Plains Water System - Process Flow Diagram

5.1.2 Water Quality

Water quality data analysis was completed on a number of selected physical and chemical parameters for raw and treated water in the Conestogo Plains system. The following summarizes the main findings:

+ The values for alkalinity of the raw water for both production wells were found to be within the high end of the prescribed aesthetic guideline range, at

approximately 240 mg/L. High alkalinity in water may produce scale incrustations on utensils, service pipes and water heaters; however, high alkalinity levels in the raw water for the Conestogo Plains water system is not considered relevant as the system does not employ coagulation as part of the treatment process.

+ Hardness levels in the raw water were found to exceed the aesthetic objective of 100 mg/L. Hardness hovered between the 340-380 mg/L range and may present problems to pipeline deposition or excessive laundry soap usage. Hardness is not substantially affected by conventional treatment and the use of domestic water softeners is common amongst residents in the Region.

+ Manganese levels in the raw water were found to be at or above the aesthetic objective of 0.5 mg/L. Manganese levels in water supplies above 0.5 mg/L are considered objectionable as it can stain whatever it comes into contact with, including plumbing fixtures and laundry.

+ Other parameters, such as aluminum, chloride, dissolved organic carbon, fluoride, iron, nitrate, nitrite and sodium are within the respective limits of the Ontario Drinking Water Quality Standards, Objectives and Guidelines. Also, both Conestogo Plains wells C3 and C4 have low nitrate levels and no organic parameters, indicating that the aquifer is a well protected supply.

+ Recorded turbidity levels for the Conestogo Plains groundwater wells indicate how well C4 experiences higher turbidity levels than well C3. Groundwater raw water supplies are inherently stable water sources; however, significant variations in turbidity are recommended to be investigated to ensure that turbidity is not being caused by the presence of organic particles, which could potentially affect the disinfection process.

+ In terms of treated water quality, alkalinity levels were within the high end of the prescribed aesthetic guideline range. In addition, the values for hardness exceed the aesthetic objective since this specific parameter is not affected by the current treatment provided by the Conestogo Plains treatment facility. None of the health related parameters outlined in the ODWQ Standards, Objectives and Guidelines were exceeded with the exception of turbidity levels measured in the reservoir, which reached maximum values of 2.0 NTU. Based on 2008 Conestoga Plains Treated Turbidity Data, there are a total of 49 times the daily maximum turbidity exceeded 1.0 NTU. The average daily turbidity is consistently below 1.0 NTU. According to the 2008-2013 Raw Well Water Quality Data Records (monthly samples), there are a total of 15 times the raw water turbidity exceeded 1.0 NTU. However, health-based turbidity guidelines do not apply to secure groundwater sources as the turbidity in these waters is expected to be of non-organic nature

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which does not pose a health threat and should not interfere with disinfection. It is good practice to ensure that water entering the distribution system has turbidity levels around 1.0 NTU for effective operation of the distribution system.

5.1.3 Water Production

Table 1 summarizes the water production in the Conestogo Plains water system from 2008 to 2012. Water volumes discharged into the distribution system are also provided.

Table 1 Conestogo Plains - Historical Water Production (2008-2012)

Year	Well C3 Production (m^3)	Well C4 Production (m^3)	System Well Production[1] (m^3)	Total Discharge to Distribution (m^3)
2008	25,658	3,470	29,128	28,524
2009	28,191	199	28,390	28,061
2010	29,743	168	29,911	29,896
2011	29,773	181	29,954	30,013
2012	28,436	5,597	34,033	33,705
Average	**28,360**	**1,923**	**30,283**	**30,040**

Notes:

1. System well production is the sum of water produced by wells C3 and C4.

The bulk of the water supply for Conestogo Plains is produced by well C3. C4 provides only a minor contribution to the system supply. Based on the data analysis from 2008 to 2012, in-plant usage is considered insignificant in the Conestogo Plains system.

The annual average combined well production from 2008 to 2012 for wells C3 and C4 was approximately 83 m^3/d. C3 operates as the lead well at an average flow rate of 78 m^3/d which is equivalent to 96 percent of the total system production. The average flow rate of well C4 over those same 5 years was 5 m^3/d; equivalent to 4 percent of the total system production.

A recent severe plugging of the well C3 screen resulted in a 25 percent decline in well performance prompting a rehabilitation of the screen by Lotowater in April 2013. This rehabilitation program recommended a future chemical treatment in order to prevent a further reduction in water production, as well as consideration for pump replacement as the current pump is slightly oversized for the normal operating flow rate presently experienced.

Historical records have indicated that well C4 has been rehabilitated four times with the most recent being in January 2013 to address turbidity and sand production issues. During the 2013 rehabilitation, Lotowater installed a liner on the upper portion of the well screen in an effort to eliminate sand issues. This approach was found to not successfully mitigate the sand issues.

5.1.4 Existing Water Demands

Annual water demands of the Conestogo Plains water system are summarized in Table 2.

Table 2 Conestogo Plains - Water Demands (2008-2012)

Year	Serviced Population[1]	System Average Day Demands[2] (m^3/day)	System Max. Day Demands[2] (m^3/day)	Max. Day Factor	Unit Consumption Rate[3] (L/cap/d)
2008	380	78	182	2.3	234
2009	388	77	179	2.3	224
2010	373	82	206	2.5	219
2011	373	82	262	3.2	218
2012	371	92	332	3.6	218
Average		82	232	2.8	223

Notes:

1. Serviced population numbers as provided on 2013 Region's Water and Wastewater Monitoring Report.
2. System average and max. day demands as per operating records provided by the Region between 2008 and 2012. Average and max. day demands shown in

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the table are consistent with demands shown in the 2013 Region's Water and Wastewater Monitoring Report.

3. Unit consumption rates in L/cap/d are calculated based on a five-year average of the average day flow divided by the service population, as established in the 2013 Region's Water and Wastewater Monitoring Report.

The average and maximum day demand for the Conestogo Plains system, based on the 5-year operating data, is 82 m^3/d (1.0 L/s) and 232 m^3/d (2.7 L/s), respectively. On average, the Conestogo Plains system operated at approximately 30 percent of its rated capacity of 786 m^3/d (9.1 L/s), and approximately at 42 percent of its existing rated capacity in the most recent year of 2012.

5.2 West Montrose Water System

5.2.1 System Description

Similar to the Conestogo Plains water supply system, the West Montrose system was originally installed by a private developer in 1988, to service an ultimate population of 221 persons or 79 residential units in West Montrose.

Originally, an induced infiltration system consisting of three shallow horizontal wells (WM1, WM2 and WM3) along the floodplain of the Grand River was constructed to supply water for the subdivision (Trow Ontario Ltd. 1988). Each of the three wells had a rated capacity of 1 L/s.

The West Montrose water supply system was jointly operated by the developer and the Region between 1992 and 1994, with the Region assuming complete ownership in 1994. Significant modifications and upgrades to the system were performed in 1999 to address system limitations identified by the Region in terms of capacity and treatment which included; construction of a new induced infiltration well WM4, rehabilitation of existing wells and upgrades to the treatment system and high lift pumping station.

Despite the extensive upgrades, the wells continued to exhibit poor performance, with wells reported to produce only half of the required demand in April 2011 and the remainder of the system demand being trucked in. Testing of the wells revealed that the pumps were being plugged by iron sludge on an annual basis and annual pump replacement was recommended as well as other possible upgrades.

The main treatment processes at the West Montrose facility include:

+ Four infiltration wells, WM1, WM2, WM3 and WM4, each equipped with a submersible well pump rated at 1.0 L/s (86.4 m^3/d) at a TDH of 45.0 m. All wells

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are considered GUDI groundwater supply, as per the existing Drinking Water Works Permit Number 012-209 Issue Number 1.

+ One treatment plant building including the following:
    - A sodium hypochlorite system for primary disinfection
    - An ammonium sulfate system for secondary disinfection
    - A package filtration system consisting of four pressure filters and four reaction vessels for iron and manganese removal
    - A cartridge filtration system for particulate removal
    - A high lift pumping station containing two high lift pumps equipped with variable frequency drive for delivery of treated water into the distribution system. Each pump is rated at 6.05 L/s (562 m^3/d) at a TDH of 30.0 m.
    - One two-celled concrete clearwell/reservoir with a minimum usable volume of 42.8 m^3.
    - A portable generator capable of powering the complete water supply system.

The Township of Woolwich owns and operates the West Montrose water distribution system, including valves, pipes and residential meters. The distribution system serves only residential properties with no service to industrial properties. The water distribution system comprises a combination of 150 mm diameter polyvinyl chloride (PVC) and ductile iron (DI) watermains distributing treated drinking water to the residential units via 25 mm diameter service connections.

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A simplified process flow diagram of the West Montrose water system can be seen in Figure 4.

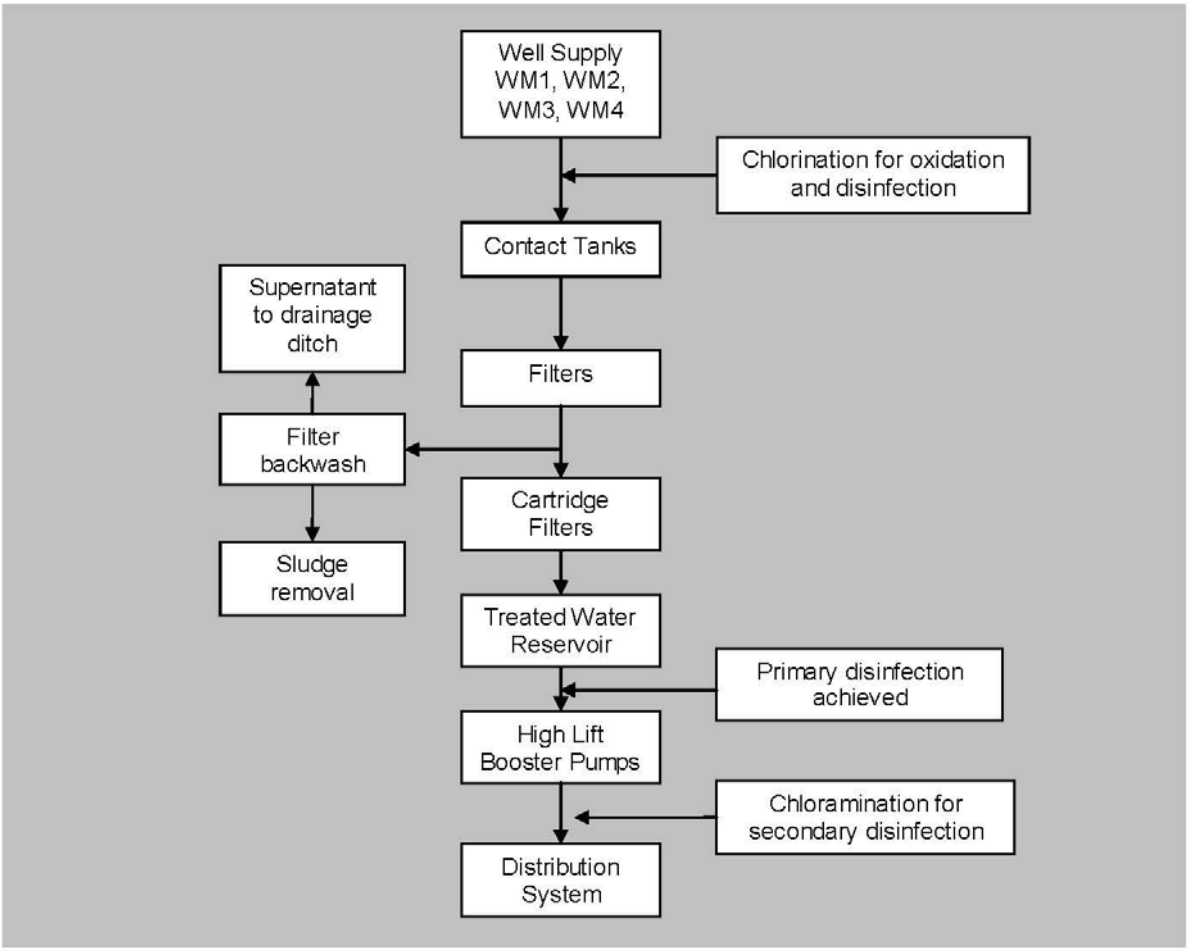

Figure 4 West Montrose Water System - Process Flow Diagram

A visual inspection and condition assessment of the facility was undertaken in December of 2013. The previous West Montrose Class EA study, completed in 2013, recommended a connection from the Conestogo Plains water system to West Montrose to address on-going operational and performance concerns mainly associated with the supply wells and their inability to produce sufficient water quantity to meet the West Montrose system demands. Consistent with the recommendations of the 2013 West Montrose Class EA study and the high-level water supply options considered in the Conestogo Plains Class EA study, the major supply and treatment components of the West Montrose water supply system are expected to be decommissioned. As such, the condition assessment completed for this water supply system was specifically focused on the treatment equipment and infrastructure expected to be functional in the future.

Major findings and recommendations of the condition assessment to consider during the development and evaluation of water supply alternative solutions include:

+ The major treatment system responsible for iron / manganese and particulate removal will be decommissioned as per the recommendations of this and the 2013 West Montrose Class EA studies.

+ A UV system, recently installed at the facility, will be redundant once the infiltration wells are decommissioned. The UV system has the potential to be used at another treatment facility in the Region as it would be relatively new and in good condition.

+ The existing West Montrose clearwell will continue to provide storage in the future for the West Montrose service area. The existing effective usable volume in the clearwell of 160 m^3 is larger than the require storage volume for the West Montrose system, under future conditions, as per MOECC Design Guidelines. The PVC baffles should be removed once the clearwell is converted from a treatment process to storage volume.

+ Based on the water supply preferred solution and the good working conditions of the existing high lift pumps in West Montrose, these pumps will continue to be used to meet the peak hour demands for West Montrose until future ultimate demands of 7.0 L/s are realized. The need for pump replacement with larger capacity will be dictated once the existing pumps show signs of deterioration beyond practical maintenance

+ The deep sump that houses the vertical section of the 75 mm common discharge header before connecting to the West Montrose distribution system has a vertical opening that extends from the floor level up into the wall. The opening is secured by two chains hanging from each side and also acts as a floor drain, as it receives the water that accumulates on the floor of the pumping station. A revised configuration of this area is recommended as part of the future modifications required at the West Montrose facility.

+ Upgrades to the motor starters for the high lift pumps and provide a VFD motor on each so that either pump can be used for high lift pumping should be considered. This will ensure the pumps are used equally, preventing one pump from wearing out before the other.

+ Reconfiguration of the existing chemical systems in conjunction with the other capital upgrade works to be done at the West Montrose facility should be considered. Reconfiguration of the chemical systems could include replacement of dated components and equipment approaching the end of its useful life.

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Consideration should also be given to having a separate area within the existing pumphouse and dedicated exclusively to the chemical system(s) to be used, with proper labelling of all equipment.

+ Consideration should be given to installing a permanent standby power at the West Montrose site as trailer mounted standby power units are no longer going to be approved by the Technical Standards and Safety Authority (TSSA).

+ The pump control panel and the PLC panel appear in good condition. These panels may need to be removed or reconfigured if the filtration, iron / manganese removal and backwash systems are removed as part of the pumphouse modifications. The Region may want to consider installing new motors starters and a new PLC panel. This will be more cost effective and easier to install and commission.

5.2.2 Water Quality

Water quality data analysis was completed on a number of selected physical and chemical parameters for raw and treated water in the West Montrose system. The following summarizes the main findings:

+ The Dissolved Oxygen Content (DOC) levels in the raw water averaged 4.6 mg/L with a maximum of 6.7 mg/L. DOC levels above the aesthetic objective of 5 mg/L may be conducive to water quality deterioration during storage and distribution and may also suggests a potential for the formation of disinfection by-products (DBPs) such as Trihalomethanes (THMs).

+ Raw water also exhibited levels of hardness way above the operational guideline of 100 mg/L, with concentration levels reaching 1,000 mg/L, which is generally considered unacceptable for domestic purposes. As hardness is not substantially affected by conventional treatment, the same levels of hardness would normally be expected in the treated water. However, the reported hardness concentrations are typical Regional Waterloo hardness levels and the use of a domestic water softener is a common practice within the Region.

+ Average and maximum levels for iron and manganese in the raw water were found to exceed their aesthetic objectives of 0.3 and 0.05 mg/L, respectively. Iron and manganese are similar metals that cause offensive taste, appearance and staining. Severe concentrations of iron and manganese precipitates may result in plugging of water pipes and generally become an economic problem due to the need to replace water supply equipment and the need to pump more water through constricted pipes.

+ Sulphate water levels in the raw water were also found to exceed the aesthetic objective of 500 mg/L. Generally, sulphate concentrations in drinking water above 150 mg/L may affect the taste; however, regular users adapt rapidly to high levels of sulphate in drinking water.

+ Average total dissolved solids (TDS) levels of 604 mg/L in the raw water were reported between 2010 and 2011. It has also been reported, that during periods of elevated water levels in the Grand River, the infiltration wells for the West Montrose system are required to shut down to avoid higher impacts of surface water and elevated turbidity.

+ The treated water values for DOC and hardness exceeded their aesthetic objectives. Hardness values around 460 – 540 mg/L (as $CaCO_3$) may present some problems with respect to pipeline deposition or excessive laundry soap usage. However, the use of a domestic water softener is a common practice within the Region.

+ Iron and manganese levels in the treated water were found to fall below the aesthetic objective and at none detectable levels respectively which indicates that the existing treatment system at the West Montrose treatment facility removes iron and manganese efficiently.

5.2.3 Water Production

The original operation of the West Montrose water system consisted of meeting the system demand with three pumps in operation while a fourth pump would remain as standby. Due to current operational challenges with the well pumps, the wells have not been able to meet the average system demands, leaving the Region to supplement the supply with trucked-in water during high-demand periods.

Table 3 summarizes the water production in the West Montrose water system from 2008 to 2012. Water volumes discharged into the distribution system, trucked water volumes and treated water volumes are also provided for comparative purposes.

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Table 3 West Montrose - Historical Water Production (2008-2012)

Year	System Well Production[1] (m^3)	Total Discharge to Distribution[2] (m^3)	Trucked Water[3] (m^3)	Treated Water[4] (m^3)	In-Plant Water Usage[5] (m^3)
2008	25,344	27,834	3,632	24,202	1,142
2009	28,023	28,800	3,453	25,347	2,676
2010	22,964	30,133	8,727	21,406	1,558
2011	23,238	28,453	10,605	17,848	5,390
2012	19,733	25,502	10,000	15,502	4,231
Average	**23,860**	**28,144**	**7,283**	**20,861**	**2,999**

Notes:

1. System well production is the total water produced by infiltration wells WM1, WM2, WM3 and WM4.
2. Total discharge to the distribution system is measured by the flowmeter downstream of the clearwell/reservoir, which accounts for the trucked-in water volume also discharged into the clearwell/reservoir prior to being pumped for distribution.
3. Trucked-in water volumes between 2008 and 2010 obtained from the West Montrose Class EA study. Trucked-in water for 2011 and 2012 as provided by the Region.
4. Treated water is calculated as the difference between total discharge to distribution and trucked water volumes.
5. In-plant water usage is calculated as the difference between system well production and treated water volumes.

Table 3 highlights the deficit of water supply compared to the West Montrose system demands. The average trucked-in water volumes for 2008 to 2012 represent approximately 26 percent of the total system demands, with higher trucked volumes reported in the years between 2010 and 2012. Similarly, the average in-plant usage represents approximately 13 percent of raw water flow, which is higher than the

recommended MOECC guideline to account for in-plant usage (5 percent of rated capacity for small plants).

The annual average combined well production between all four wells was approximately 65 m^3/d, based on operating records between 2008 and 2012, which is significantly lower than the permitted combined taking of 238 m^3/d. Based on individual pump run time data, it was observed that Well #3 was run for a total of 16 hours between January 2012 and April 2013. This clearly outlines operational and/or performance issues with well #3 or its well pump. Rehabilitation of this well, completed in August 2010, showed an improvement in well performance for a short period of time before breaking suction and being taken off-line. The well pumps for the remaining three wells were replaced in 2011 due to underperformance of the pumps caused by internal water passages being plugged with iron.

5.2.4 Existing Water Demands

Annual water demands for the West Montrose water system are summarized in Table 4.

Table 4 West Montrose - Water Demands (2008-2012)

Year	Serviced Population [1]	System Average Day Demands [2] (m^3/day)	System Max. Day Demands [2] (m^3/day)	Max. Day Factor	Unit Consumption Rate [3] (L/cap/day)
2008	193	76	138	1.8	396
2009	184	79	163	2.1	406
2010	177	83	166	2.0	419
2011	177	78	180	2.3	435
2012	204	70	240	3.4	415
Average		77	177	2.3	414

Notes:

1. Serviced population numbers as provided on 2013 Region's Water and Wastewater Monitoring Report.
2. System average and max. day demands as per operating records provided by the Region between 2008 and 2012. System average and max. day demands account for trucked water flows discharged into the reservoir prior to entering the distribution system. Average and max. day demands shown in the table are consistent with demands shown in the 2013 Region's Water and Wastewater Monitoring Report.
3. Unit consumption rates in L/cap/d are calculated based on a five-year average of the average day flow divided by the service population, as established in the 2013 Region's Water and Wastewater Monitoring Report.

As shown in Table 4, the average and maximum day demand for the West Montrose water system based on 5 years of operating data is 77 m^3/d and 177 m^3/d, respectively. On average, the West Montrose system operates at 74 percent of its rated capacity of 238 m^3/d. A maximum day demand of 240 m^3/d, slightly above the rated capacity, was reported in May 2012.

A review of the water losses within the West Montrose distribution system was completed in 2013 by the Township and confirmed by the Region. A significant improvement was observed in the West Montrose distribution system for the past couple of years due to some work carried out by the Township, which reflects an estimate water loss reduction of approximate 20%. In addition, a leak repair was made in July 2012.

5.3 Conestogo Golf Course Water System

5.3.1 System Description

The existing Conestogo Golf Course Water Supply System is located in the eastern part of the village of Conestogo, on the north side of Sawmill Road, in the Township of Woolwich. The Conestogo Golf Course system was originally constructed by a private developer to service the Conestogo Golf Course Subdivision. The Region assumed ownership of the system around 1995. The system is currently provided by two groundwater wells, identified as C5 and C6, with well C6 operating as the lead. The main components of the Conestogo Golf Course system include:

+ Two groundwater wells, C6 and C5 (duty, standby), equipped with submersible well pumps. Both wells are groundwater supply. The pump in well C5 has recently been replaced by a unit capable of pumping at rates of 4.5-5.5 L/s. C6 is equipped with a pump rated at 10.8 L/s.

+ One above ground pumphouse including:

  - A sodium hypochlorite system for disinfection
  - A high lift pumping station containing four high lift pumps for delivery of treated water into the distribution system. Two pumps are variable speed centrifugal pumps rated at 15 L/s at a TDH of 54.9 m and two other pumps are fixed speed vertical turbine pumps rated at 30 L/s at a TDH of 54.9 m
  - One two-celled 450 m^3 in ground clearwell / reservoir
  - A portable generator capable of powering the complete water supply system

A simplified process flow diagram of the Conestogo Golf Course drinking water system is shown in Figure 5.

The Township of Woolwich owns and operates the Conestogo Plains water distribution system, including valves, pipes and residential meters. The distribution system serves residential properties and the Wastewater Treatment Plant.

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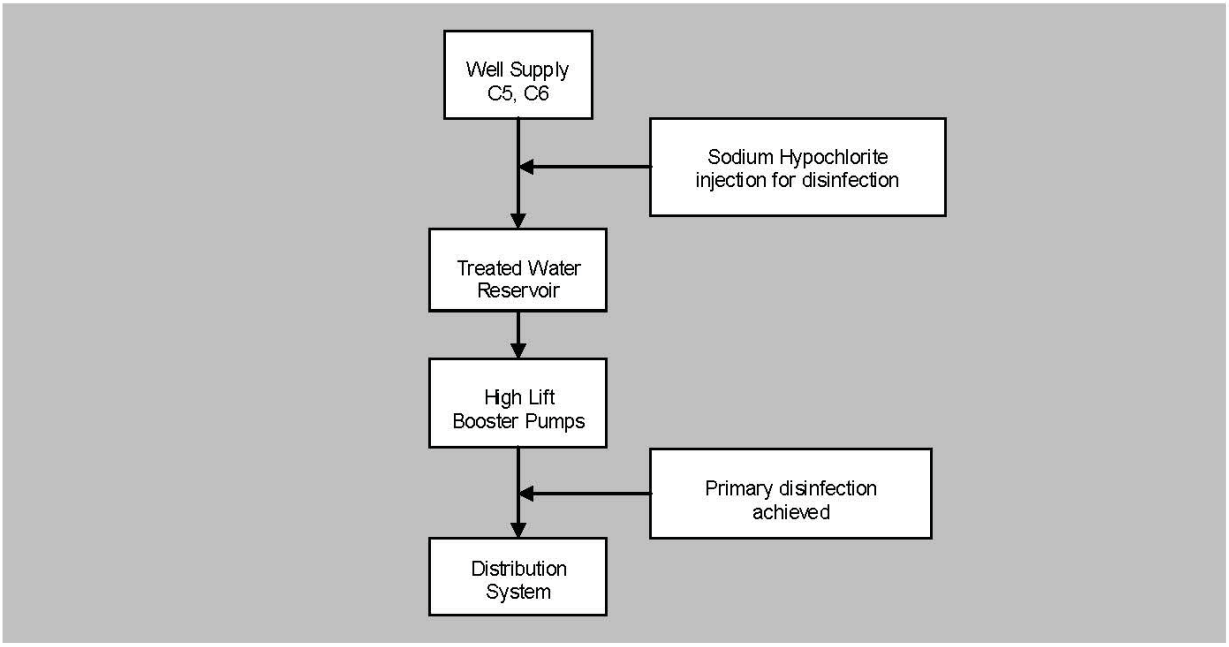

Figure 5 Conestogo Golf Course Water System - Process Flow Diagram

A visual inspection and condition assessment of the facility was undertaken in December of 2013. Major findings and recommendations of the condition assessment to consider during the development and evaluation of water supply alternative solutions include:

+ Wells C5 and C6 operate in a duty/standby configuration. The pump in C5 was recently replaced with one capable of pumping at rates of 4.5 to 5.5 L/s. Signs on the raw water lines indicate that well pump C6 should not exceed 10.8 L/s and well pump C5 should not exceed 7.0 L/s.

+ The existing well pumps, piping and associated valves and equipment appear to be in adequate condition to continue to provide the required level of service. The existing clearwell in Conestogo Golf Course is in adequate condition to be used to provide the required contact time for disinfection and water storage.

+ The existing high lift pumps could potentially be decommissioned if a future connection to the IUS is provided. In the meantime, the existing high lift pumping system is in adequate condition and should continue to be used to meet the maximum day demands plus fire flows for the Conestogo Golf Course service area.

+ The existing chemical system could continue to be used in its existing condition; however, it is recommended to install the fibreglass cover with separate

ventilation, if the Conestogo Golf Course system is to remain operational. This will mitigate corrosion by chlorine gas.

+ There is evidence of corrosion throughout the station, which suggests inadequate ventilation. Improving the ventilation for the building space, or mitigating the presence of chlorine gas should be reviewed.

+ There is some corrosion on the service entrance and MCC panels. The VFD motor starters and PLC panel are located on the opposite side of the room as the MCC requiring conduit runs between the panels. The room is crowded and there is no more wall space for other equipment. If the facility remains, it can function as is; however, the Region may want to consider updating the electrical power supply and ATS to be within one MCC line-up.

5.3.2 Water Quality

Water quality data analysis was completed on a number of selected physical and chemical parameters for raw and treated water in the Conestogo Golf Course system. The following summarizes the main findings:

+ Alkalinity levels in both production wells were found within the high end of the prescribed aesthetic objective / operational guideline range between 280 and 300 mg/L. These levels are not considered relevant as the system does not employ coagulation as part of the treatment process; however, high alkalinity levels may produce scale incrustations on utensils, service pipes and water heaters.

+ The levels of hardness in the raw water exceed the operational guideline of 100 mg/L, with concentrations reaching as high as 600 mg/L, which is generally considered unacceptable for domestic purposes. As hardness is not substantially affected by conventional treatment, the same levels hardness would normally be expected in the treated water. However, it is noted that the reported hardness concentrations are typical Regional Waterloo hardness levels and the use of a domestic water softener is a common practice within the Region.

+ There were a few occurrences where the iron and manganese concentrations in the raw water for well C5 were found to slightly exceed their respective aesthetic objectives; however, the average measured concentrations for both parameters in both wells (C5 and C6) were within the aesthetic objectives of 0.3 and 0.05 mg/L, respectively.

+ Other analyzed parameters such as aluminium, chloride, DOC, fluoride, nitrate, nitrite and sodium were within their respective ODWQ Standards, Objectives and Guidelines. In addition, both production wells have low nitrate levels and a low

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concentration in organic parameters, indicating that the aquifer is a well-protected supply.

+ The plant treats raw water that varies in turbidity throughout the year. The average raw water turbidity from 2008 to 2012 was 0.64 NTU and 0.42 NTU for wells C5 and C6 respectively, reaching even higher levels of 1.8 NTU and 1.62 NTU, respectively.

+ As with the raw water data, the values for alkalinity in the treated water are within the high end of the prescribed aesthetic objective/operational guideline range. High alkalinity levels may produce scale incrustations on utensils, service pipes and water heaters.

+ Iron and manganese concentrations in the treated water were found to be well below their respective aesthetic objective. None of the health related parameters in the ODWQ Standards, Objectives and Guidelines had been exceeded for the period that the data was collected.

5.3.3 Water Production

Table 5 summarizes the water production in the Conestogo Golf Course water system along with the water volumes discharged to the distribution system for a 5-year period. Water volumes discharged into the distribution system are also shown in the table to provide an indication of the system demands as well as in-plant usage.

Table 5 Conestogo Golf Course - Historical Water Production (2008-2012)

Year	Well C5 Production (m^3)	Well C6 Production (m^3)	System Well Production[1] (m^3)	Total Discharge to Distribution (m^3)
2008	242	95,342	95,584	97,375
2009	9,917	71,321	81,238	81,440
2010	204	64,887	65,091	65,757
2011	2,354	53,607	55,961	55,419
2012	345	64,221	64,566	65,058
Average	**2,612**	**69,876**	**72,488**	**73,010**

Notes:

1. System well production is the sum of water produced by wells C5 and C6.

The annual average combined well production for C5 and C6 was found to be 199 m^3/d. C6 is currently operating as the duty well with an average flow rate of 191 m^3/d which is equivalent to approximately 96 percent of the total system well production. Well C5 is currently acting as the standby well with an average flow rate of approximately 7.2 m^3/d, which is equivalent to 4% of the total system well production.

A cursory review of the most recent rehabilitation completed in January 2013 on well C5 indicates that a new pump and motor with a capacity of 4.5 to 5.5 L/s were installed on well C5.

5.3.4 Existing Water Demands

Annual water demands for the Conestogo Golf Course water system are summarized in Table 6.

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Table 6 Conestogo Golf Course - Water Demands (2008-2012)

Year	Serviced Population[1]	System Average Day Demands[2] (m^3/day)	System Max. Day Demands[2] (m^3/day)	Max. Day Factor	Unit Consumption Rate[3] (L/cap/d)
2008	484	266	585	2.2	420
2009	491	223	469	2.1	420
2010	517	180	488	2.7	413
2011	517	152	470	3.1	404
2012	524	178	528	3.0	397
Average		200	508	2.6	411

Notes:

1. Serviced population numbers as provided on 2013 Region's Water and Wastewater Monitoring Report with the exception of 2012 calculated from 166 existing serviced dwellings, provided by Region's Planning Services and PPU of 3.16
2. System average and max. day demands as per operating records provided by the Region between 2008 and 2012. Average and max. day demands shown in the table are consistent with demands shown in the 2013 Region's Water and Wastewater Monitoring Report.
3. Unit consumption rates in L/cap/d are calculated based on a five-year average of the average day flow divided by the service population, as established in the 2013 Region's Water and Wastewater Monitoring Report.

Review of the data indicates that the average and maximum day demand for the Conestogo Golf Course system is 200 m^3/d and 508 m^3/d, respectively. On average, the system is operated at approximately 55 percent of its rated capacity of 932 m^3/d, and approximately 57 percent of its existing rated capacity in the most recent year of available data, 2012.

6. Design Criteria

This section summarizes the key design criteria for each system in terms of projected population growth and water demands in each service area. It also provides an overview of the water servicing areas within the scope of work of this EA.

6.1 Overview of Water Servicing Areas

This section presents a description of the servicing areas included in this EA, including their physical boundaries, and describes how existing planning information has been used to confirm existing conditions and develop future scenarios for these areas. Planning information related to the existing services and potential future connections provide the baseline for the development of key design criteria in terms of projections for each system. The water supply alternatives under consideration in this Class EA Study will be able to produce sufficient water to supply existing customers, as well as the ability to supply all potential future customers. Potential future customers include the entire settlement boundaries of the Conestogo Plains servide area, the Conestogo Golf Course service area, and the West Montrose service area.

6.1.1 Conestogo Service Area

The Conestogo service area, located within the Township of Woolwich, on the north-east side of the Region of Waterloo, is physically divided by the Grand River into two separate communities. Each community is supplied by a separate groundwater system; the Conestogo Plains water supply system, servicing the area to the west of the Grand River, and the Conestogo Golf Course water supply system, servicing the area to the east of the Grand River.

A general map of the existing service area of Conestogo is shown in Figure 6.

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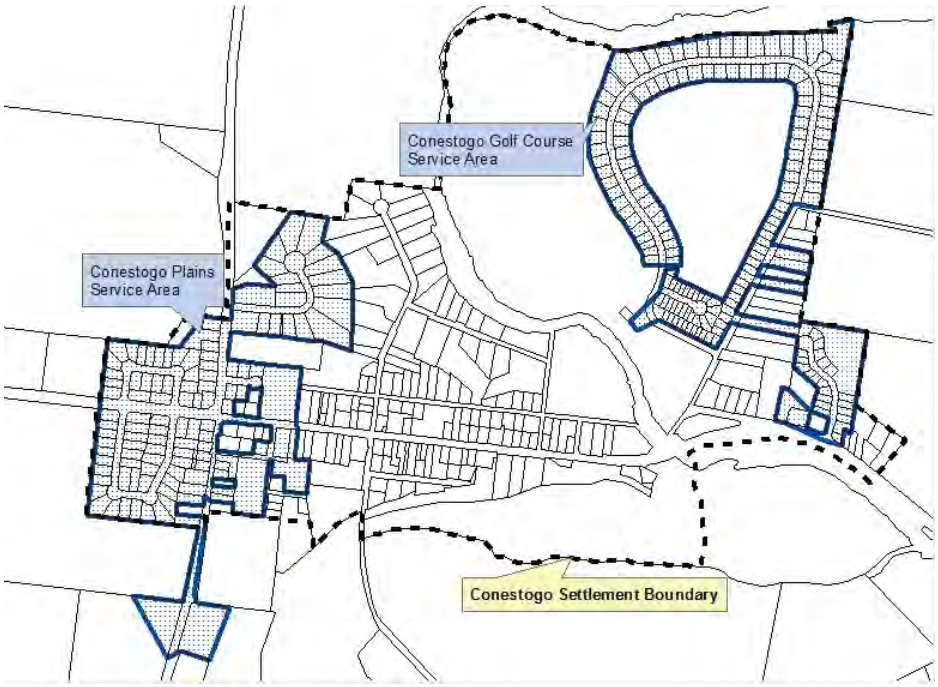

Figure 6 Conestogo Existing Service Area

A general map showing the extent of the overall Conestogo future service area, its settlement boundary and the characteristics in terms of land use is shown in Figure 7.

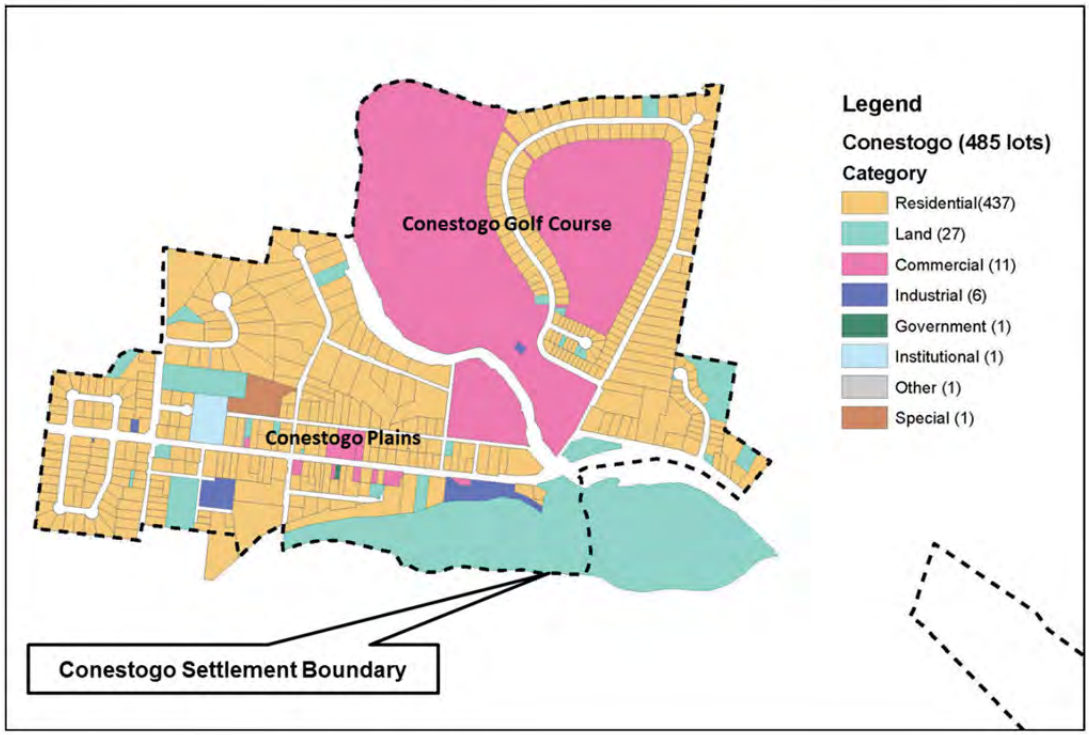

Figure 7 Proposed Conestogo Service Area

6.1.2 West Montrose Service Area

The existing West Montrose service area is located in the north east corner of the Region, approximately 7 km to the north east of the Conestogo community, within the Township of Woolwich. The community of West Montrose is mostly serviced by the existing West Montrose water supply system, with a number of dwellings relying on private groundwater wells for water supply.

The existing West Montrose water supply system was installed by a private developer in 1988, to service an ultimate population of 221 persons or 79 residential units within West Montrose.

A general map of the existing service area of West Montrose is shown in Figure 8.

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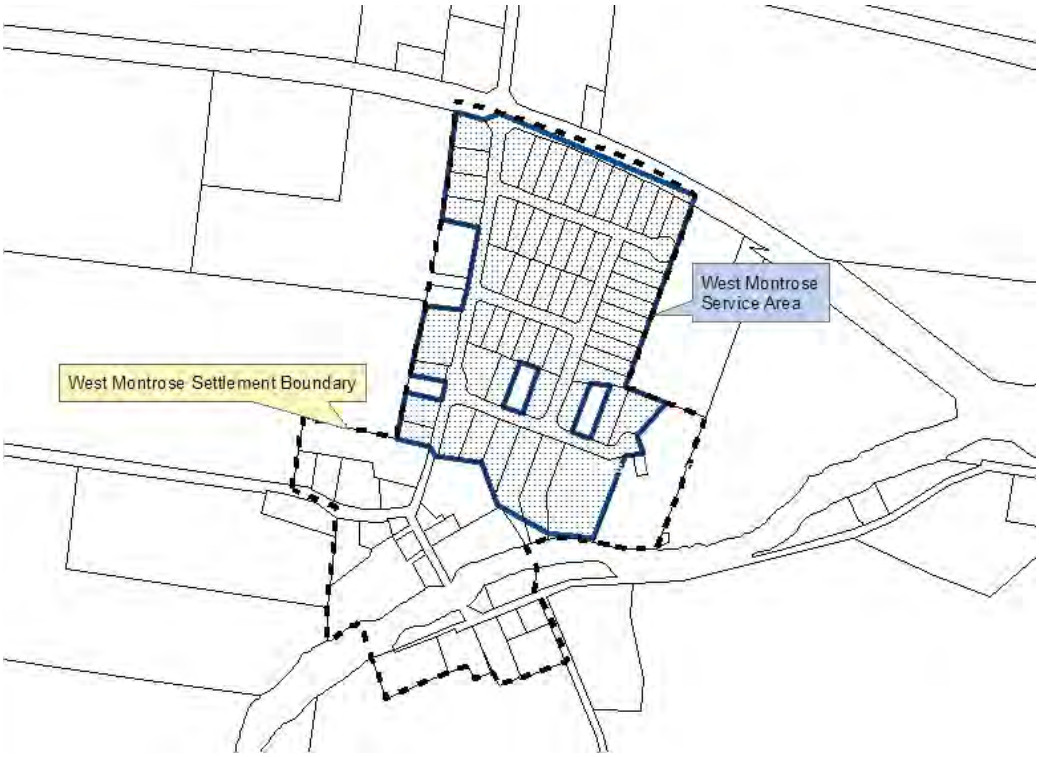

Figure 8 West Montrose Existing Service Area

A general map showing the extent of the overall West Montrose future service area, its settlement boundary and the characteristics of the area in terms of land uses is shown in Figure 9.

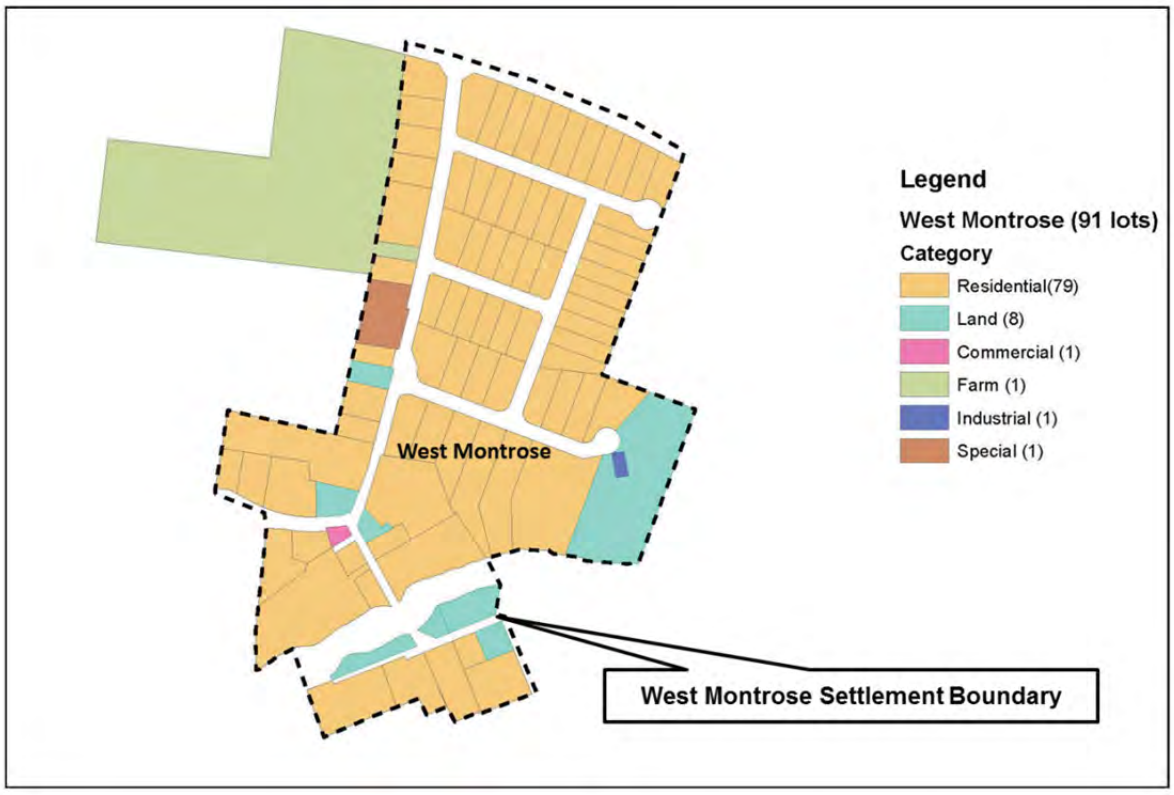

Figure 9 Proposed West Montrose Service Area

6.2 Consumption Rates, Population Projections and Water Demands

This section summarizes the key design criteria for each system in terms of projected population growth and water demands in each service area, and provides a baseline for the development of the high-level water supply options, presented in Section 8 of this report.

6.2.1 Consumption Rates

The existing unit consumption rates for each of the three service areas are summarized in Table 7. The rates have been calculated by using the five-year average method utilized by the Region, which accounts for average flows and serviced population records for each system for the last five years.

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Table 7 Unit Consumption Rates

Description	Unit	West Montrose	Conestogo Plains	Conestogo Golf Course
Calculated Unit Consumption Rate[1]	L/cap/d	414	223	411
Assumed Unit Consumption Rate[2]		345	240	420

Notes:

1. Calculated unit consumption based on the 5-year average flows and serviced population, as per 2013 Water and Wastewater Monitoring Report
2. Assumed unit consumption rates for Conestogo Plains and Conestogo Golf Course are slightly higher than the calculated rates to allow for some contingency

As shown in Table 7, the assumed unit consumption rate for the Conestogo Plains and Conestogo Golf Course systems are slightly higher than the respective calculated unit consumption rates, which account for some conservatism built into the demands. In the case of the West Montrose system, the calculated average unit consumption rate for the period between 2008 and 2012 was 414 L/cap/d. The 2013 West Montrose Class EA study estimated an average unit consumption rate of 431 L/cap/d for the period between 2006 and 2011; however, from a further review of the flows, it was observed that a percentage of the water demands was due to losses within the distribution system at the time of the study. Based on discussions with the Township of Woolwich about future plans to reduce the leaks in the distribution system, it was judged appropriately to assume a 20% water loss reduction in the system demands. As a result, the 2013 West Montrose Class EA adopted a unit consumption rate of 345 L/cap/d in their study.

A recent review (2013) of the water losses within the West Montrose distribution system was completed by the Township of Woolwich and confirmed by the Region. A significant improvement was observed in the West Montrose distribution system for the past couple of years due to some work carried out by the Township, which reflects approximately a 20% reduction in water losses. This is consistent with the previous assumptions made during the West Montrose Class EA study.

In addition, it was noted that a recent leak repair was completed in July 2012. A review of operating data between August 2012 and July 2013 shows a decrease in water demands which correspond to a consumption rate of 220 L/cap/d for the 11-

month period data. This number is significantly lower than the calculated 5-year-average of 414 L/cap/d, shown Table 7, and the West Montrose assumption of 345 L/cap/d.

Although the most available recent data seem to indicate that water demands from the West Montrose system have reduced after the leak repair, it was considered that using the last 11 months of data will not be representative enough for the purpose of this project as the summer months when peak demands are normally exerted (August and September) were not included in the data, and extreme and more frequent than usual wet weather events occurred during the reported year (2013), which would result in lower demands than usual. As such, it was concluded that a unit consumption rate of 345 L/cap/d, for the West Montrose water system, was a conservative number for the purpose of this exercise and was adopted.

6.2.2 Population Projections

Population projections for each potential service area have been updated based on most recent population figures, as provided by Planning Services and number of lots within the settlement boundaries of each service area. For the purpose of calculating the ultimate population projections, it has been assumed that all lots within the settlement boundaries could have the ability to ultimately connect to the municipal water system. The total number of lots includes all existing serviced and unserviced lots. No future growth is expected within the settlement areas under consideration.

The population projections for each study area can be found summarized in Table 8.

Table 8 Population Projections

Description	Unit	West Montrose	Conestogo Plains	Conestogo Golf Course
Ultimate population projection	person	339	820	618

6.2.3 Projected Water Demands

Projected water demands for each service area were established based on existing water consumption rates, historical water data and projected serviced population. A summary of the projected water demands is shown in Table 9.

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Table 9 Projected Water Demands

Description	Unit	West Montrose	Conestogo Plains	Conestogo Golf Course
Unit consumption rate	L/cap/d	345	240	420
Ultimate serviced population	person	339	820	618
Average day demands	m^3/d	117.1	196.7	259.4
Max. day factor[1]	-	2.3	2.8	2.6
Maximum day demands	m^3/d	272.7	549.7	678.3
Peak hour factor[2]	-	5.2	4.1	4.1
Peak hour demand	m^3/d	605.4	812.5	1071.3

Notes:

1. Max. day factors obtained from historical water data for each system between 2008 and 2012, as provided by the Region
2. Peak hour factor for each system based on MOECC design guidelines Tables 3-1 and 3-3

7. Evaluation Process

This section provides a description of the evaluation framework during the development and evaluation of water supply alternatives, which will further provide the basis for the selection of the preferred water supply solution for the West Montrose and Conestogo service areas.

7.1 Project Goals / Objectives

Specific project goals and objectives have been established to represent the driving factors behind this project as well as those elements that are expected to have an important influence in the decision making process. The success of the evaluation methodology can be measured by the extent to which the outcome of the evaluation process is able to achieve these goals/objectives at the end of the process. Consequently with this philosophy, the following project goals were developed:

+ The preferred water supply solution for the West Montrose and Conestogo service areas will be able to provide a secure water supply that meets or exceeds the Ontario Drinking Water Quality Standards in a fiscally and technically responsible manner
+ The preferred water supply solution will be capable of providing the required water servicing capacity within the settlement boundaries of each service area under consideration, consistent with the planning projections for each area provided by the Region Planning Services group
+ The preferred water supply solution will, to the greatest extent possible, minimize any potential impacts to or interference with existing private groundwater wells in the area
+ The preferred water supply solution will be, to the greatest extent possible, compatible with existing operational practices in the Region. The preferred water supply solution will allow the Region to continue to operate its facilities in a manner that is consistent with the availability of staff resources and in a way that is simple and fiscally responsible by balancing capital and operating costs
+ The preferred water supply solution will allow the Region to continue meeting water production and projected water demands during construction and implementation, while interfering to a minimum with the uninterrupted supply of water within the area and the IUS
+ The preferred water supply solution will address in a responsible and practical manner all issues and concerns identified by the different stakeholder groups throughout the Class EA study process

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7.2 Evaluation Methodology

Experience in other projects of similar nature has shown that development of a systematic, step-wise method for making decision at the start of the project helps to focus and clarify decision-making. An evaluation approach has been developed comprising preliminary screening criteria to identify feasible alternatives and a decision-making model that allows the team to compare and evaluate feasible alternatives and identify the preferred alternative solution for this project.

A general schematic of the proposed evaluation methodology that will be used to identify the preferred water supply solution for the West Montrose and Conestogo Service areas is outlined in Figure 10 and described in the following sections.

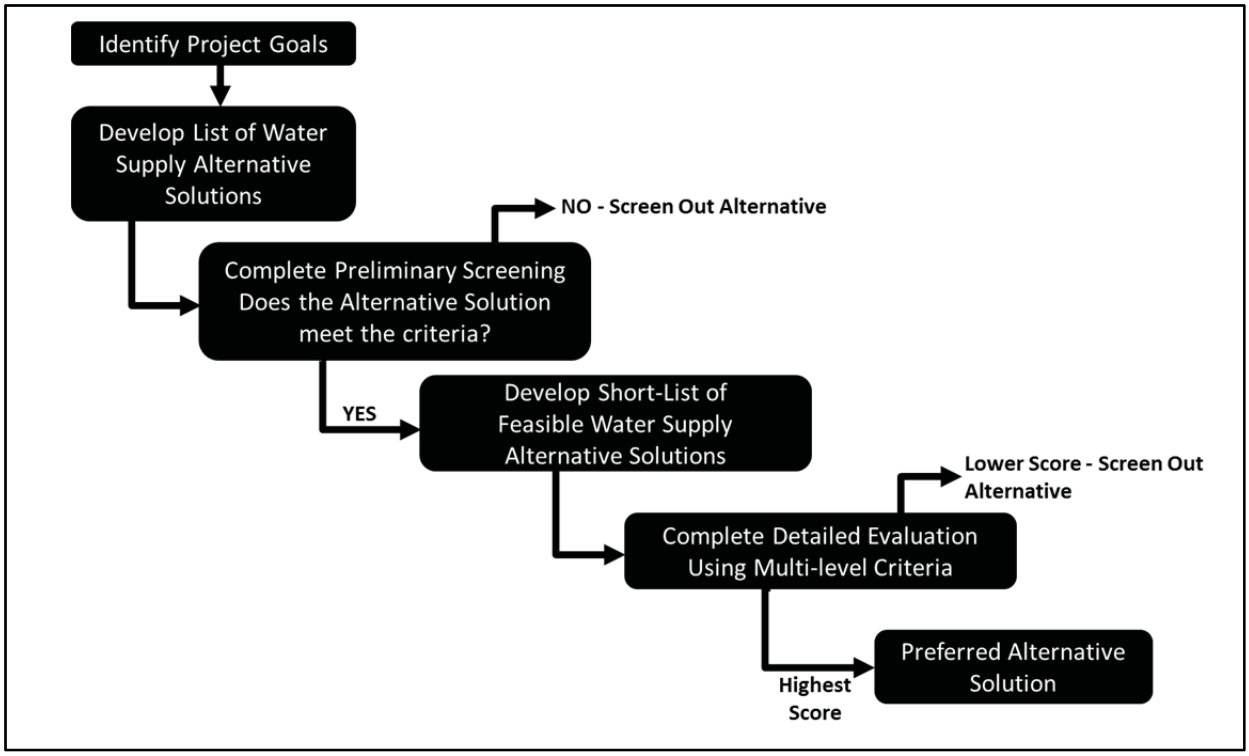

Figure 10 Overview of Evaluation Approach

7.2.1 Preliminary Screening

A long list of possible water supply alternative solutions was developed and screened, at the beginning of the project, to identify only those that are considered "feasible". This step in the evaluation process helps to avoid the need to carry unrealistic alternative solutions through the detailed evaluation step.

Preliminary screening was accomplished by applying the following criteria to each alternative:

+ Level of Service: The alternative solution will be able to maintain, as a minimum, the existing level of service, in terms of treated water quality and available system pressures

+ System Security and Reliability: The alternative solution has the capability to prevent accidental actions outside of the designed usage of the system and its components and other vulnerabilities (e.g. source water contamination) that may compromise the system's ability to remain operational over time

+ System Flexibility and Redundancy: The alternative solution has the ability to make possible the delivery of drinking water via the existing water system during emergency situations, without relying on an alternate water source(s). This would include provision for redundant pipe connections and strategic location of valves to allow for isolation of damaged pipe(s) and equipment to minimize the area(s) of lost service, provision for water storage to maintain service while repairs are being made and provision of emergency equipment (e.g. standby generators, spare pipes, valves, pumps etc.)

Water supply alternative solutions that satisfied all of these preliminary criteria were short-listed and carried forward to the next step in the evaluation process.

7.2.2 Detailed Evaluation of Alternatives

The next step in the process was to subject those "feasible" alternative solutions to a detailed comparative evaluation. This process involves a relative assessment of the short-listed alternative solutions using a weighting and ranking system that enables a systematic and rational comparison of the alternatives and identification of those that are preferred. The evaluation methodology is used as a basis to compare the features of each short-listed alternative, relative to each other, and their ability to perform under each evaluation criteria.

7.2.3 Evaluation Criteria, Objectives and Performance Scales

For the evaluation of the alternative solutions, a Triple Bottom Line (TBL) evaluation methodology was proposed. This methodology focuses on a set of criteria for three main categories; environmental protection and technical considerations (environmental/technical), social impacts and benefits (socio-cultural) and minimizing cost or financial impacts (financial).

Main categories were further broken down into evaluation criteria. For each criterion, the project team compiled sufficient information and assigned a score

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unique to each short-listed alternative. Scores from 0 to 5 were available to score each short-listed alternative under evaluation, with the higher scores given to the better performing options. The score represents how well the specific short-listed alternative meets the criterion under consideration or in other words, the potential residual impact (i.e., the net impact after mitigation). Therefore, the short-listed alternatives were rated such that the higher the ability to perform or meet the criterion, the higher the score (5) assigned. The final score for each alternative was calculated as the sum of: the score of each criterion across all categories multiplied by the value weight assigned to that criterion.

A comprehensive list of evaluation criteria within each main category was developed, each intended to reflect specific issues and considerations most relevant to this project. The proposed evaluation criteria grouped by main categories, as well as the relative performance scale to be used when assigning scores to each alternative, are shown in Table 10.

Table 10 Evaluation Criteria, Objectives and Performance Scales

Category	Criteria	Performance Scales
Technical / Natural Environment	**Water Quality / Quantity Protection–** Minimize the potential for surface water or groundwater contamination, includes potential effects to existing private groundwater wells	• Potential for surface water or groundwater contamination or well interference is minor or negligible, no mitigation is required – 5 • Potential for surface water or groundwater contamination or well interference is moderate, with some potential for mitigation – 3 • Potential for surface water or groundwater contamination or well interference is significant, with limited mitigation available – 0
	Level of Service – Maximize the opportunity to maintain or improve the existing level of service in terms of available service pressures	• Potential opportunity to maintain / improve available service pressures is significant, no mitigation is required – 5 • Potential opportunity to maintain / improve available service pressures is moderate, with some potential for mitigation – 3 • Potential opportunity to maintain / improve available service pressures is minor or negligible, with limited mitigation available – 0
	Ease of Implementation – Maximize the ability to facilitate construction without interfering with the uninterrupted supply of water and within the most reasonable timeframe.	• Potential impact on existing operations is minor, no mitigation is required – 5 • Potential impact on existing operations is moderate, with some potential for mitigation – 3 • Potential impact on existing operations is major or significant, with limited mitigation available – 0

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Category	Criteria	Performance Scales
	Operational Complexity – Minimize the risk to existing operational procedures and monitoring requirements and maximize the ability to decrease current operational complexity	• Potential risk to increase operational complexity of existing site/facilities is minor or negligible with significant opportunity(ies) to decrease current operational complexity, no mitigation is required – 5 • Potential risk to increase operational complexity of existing site/facilities is moderate, with some potential for mitigation and some opportunity(ies) to decrease current operational complexity,– 3 • Potential risk to increase operational complexity of existing site/facilities is significant, with limited mitigation available and no opportunity(ies) to decrease current operational complexity – 0
	System Reliability – Maximize the ability for the system to prevent accidental actions outside the designed usage of the system and other vulnerabilities that may compromise the system's ability to remain operational over time.	• Potential for system reliability is significant, no mitigation is required – 5 • Potential for system reliability is moderate, with some potential for mitigation – 3 • Potential for system reliability is minor or negligible, with limited mitigation available – 0

Category	Criteria	Performance Scales
	System Redundancy and Flexibility – Maximize the ability to continue to provide water supply during emergency situations based on provision for redundant equipment, connections, emergency storage, etc.	• Potential for system redundancy and flexibility is significant, no mitigation is required – 5 • Potential for system redundancy and flexibility is moderate, with some potential for mitigation – 3 • Potential for system redundancy and flexibility is minor or negligible, with limited mitigation available – 0
	Need for New Infrastructure – Maximize the ability to use existing infrastructure	• Potential to use existing infrastructure is significant with minimum requirements for new infrastructure, no mitigation is required – 5 • Potential to use existing infrastructure is moderate with some requirements for new infrastructure, with some potential for mitigation – 3 • Potential to use existing infrastructure is minimal with significant requirements for new infrastructure, with limited mitigation available – 0
	Natural and Archaeological Heritage – Minimize the potential impact from construction to existing terrestrial habitats/features, vegetation communities, including watercourse crossings as well as archaeological heritage features	• Potential impact from construction to natural and archaeological heritage is minimal or negligible, no mitigation is required – 5 • Potential impact from construction to natural and archaeological heritage is moderate, with some potential for mitigation – 3 • Potential impact from construction to natural and archaeological heritage is significant, with limited mitigation available – 0

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Category	Criteria	Performance Scales
	Regulatory Approvals – Minimize the need and time spent to obtain permits and approvals	• Required infrastructure is compatible with existing land uses and permits and approvals can be easily obtained, no mitigation is required – 5 • Required infrastructure can be compatible with existing land uses and some effort is expected to obtain permits and approvals, with some potential for mitigation – 3 • Required infrastructure is not compatible with existing land uses and significant effort is expected to obtain permits and approvals, with limited mitigation available – 0
	Coordination with Planned Infrastructure – Maximize the opportunity to coordinate with other planned infrastructure projects in the area during project implementation	• Potential opportunity for project implementation in coordination with other infrastructure projects is significant. Multiple projects can be implemented simultaneously reducing overall costs. No mitigation is required – 5 • Potential opportunity for project implementation in coordination with other infrastructure projects is moderate. Project can be implemented without affecting implementation of other planned infrastructure projects. Some potential for mitigation – 3 • Potential opportunity for project implementation in coordination with other infrastructure projects is minimal or negligible. Project may have a conflict with implementation of other planned infrastructure projects. Limited mitigation available – 0

Category	Criteria	Performance Scales
	Benefits for Area outside of Study Area – Maximize the opportunity to provide broader improvements to the Region's water system as a whole	• Proposed infrastructure has the potential for significant benefits to other areas outside of the study area, resulting in an overall greater contribution to the overall system. No mitigation is required – 5 • Proposed infrastructure has the potential for moderate benefits to other areas outside of the study area, resulting in moderate improvements to the overall system. Some potential for mitigation – 3 • Proposed infrastructure has minor or no potential benefits to other areas outside of the study area, resulting in small or negligible improvements to the overall system. No potential for mitigation – 0
Community / Social	**Public Health and Safety –** Minimize the potential risk to community health and safety from a source, treatment and distribution perspective	• Potential ability to provide a multi-barrier approach is significant so there is an extremely small potential risk to public health and safety, no mitigation is required – 5 • Potential ability to provide a multi-barrier approach is moderate so there is minor potential risk to public health and safety, with some potential for mitigation – 3 • Potential ability to provide a multi-barrier approach is minimal so there is moderate potential risk to public health and safety, with limited mitigation available – 0

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Category	Criteria	Performance Scales
	Public Perception – Maximize the potential for alternative to receive public support and acceptance	• Potential to receive a high level of support and endorsement from the public, no mitigation is required – 5 • Potential to receive a moderate level of support and endorsement from the public, with some potential for mitigation – 3 • Potential to receive a low level of support and endorsement from the public, with limited mitigation available – 0
	Noise (during construction) – Minimize the potential for noise during construction	• Potential for noise during construction is minor or negligible, no mitigation is required – 5 • Potential for noise during construction is moderate, with some potential for mitigation – 3 • Potential for noise during construction is significant, with limited mitigation available – 0
	Traffic (during construction) – Minimize traffic impacts during construction	• Potential for traffic impacts is negligible, no mitigation is required – 5 • Potential for traffic impacts is moderate, with some potential for mitigation – 3 • Potential for traffic impacts is significant, with limited mitigation available – 0
	Aesthetics – Minimize potential visual impacts from water supply infrastructure on private properties	• Potential for visual impacts from water supply infrastructure is minor or negligible, no mitigation is required – 5 • Potential for visual impacts from water supply infrastructure is moderate, with some potential for mitigation – 3 • Potential for visual impacts from water supply infrastructure is significant, with limited mitigation available – 0

Category	Criteria	Performance Scales
Financial	**Life Cycle Cost –** Minimize life cycle cost (includes major capital expenditures every 10 years)	A natural scale between 5 and 0 based on the relative difference in 40-year life cycle cost of each alternative, relative to the others

7.2.4 Weighting Factors

Weighting factors were assigned to each of the main categories evaluated during the detailed assessment of the short-listed water supply alternative solutions. Individual weighting factors reflect the degree of importance of each category within the overall evaluation scheme. Weights were assigned to the three main categories as follows:

+ Technical/Natural Environment – 50%
+ Community/Social – 25%
+ Financial – 25%

7.2.5 Initial Selection of Preliminary Preferred Water Supply Solution

The short-listed water supply alternative solutions were assessed relative to each other and evaluated against all criteria shown in Table 10. A score between 0 and 5 was assigned to each criterion based on the ability of the alternative to meet such criterion and with consideration to the performance scales described in Table 10. The scores were totaled for each water supply alternative. The water supply alternative that scored the highest was considered the option that provides the most overall benefits to this project and thus, was initially selected as the preliminary preferred water supply solution.

7.2.6 Sensitivity Analysis

Upon preliminary selection of the preferred water supply solution, the evaluation approach was subjected to a sensitivity analysis in order to examine how changing the criteria weights affected the scoring results. Sensitivity analyses help to assess the impacts of significant changes to the weighting of the evaluation criteria and establish whether the alternative with the original highest score remains the preferred option once criteria weighting factors are changed.

A sensitivity analysis was also completed on the life cycle costs to examine how changes into the life span of the project affect the overall net present value for each alternative.

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8. Identification and Assessment of Water Supply Alternative Solutions

This section provides a description of the water supply alternatives that were initially identified as potential solutions for this project, as well as the results of the preliminary assessment completed on these options.

8.1 General Description

Three high-level options representing potential water supply alternative solutions and connection scenarios for the West Montrose and the Conestogo service areas were developed in consultation with Region staff and the Township of Woolwich. Permutations of the high-level options were also developed to represent specific conditions and possible connection scenarios, including opportunities and strategies to optimize the efficiency and sustainability of the overall Region of Waterloo water supply approach.

High-level options and pertinent permutations were categorized into the following three main groups:

+ Option 1 – Supply West Montrose with Surplus Capacity from Conestogo Plains. It involves a group of options comprising a connection of West Montrose to the existing Conestogo Plains Water Supply System. These options were developed under the premise that water would be provided from the existing Conestogo Plains productions wells C3 and C4 to both the West Montrose and Conestogo Plains service areas, consistent with the original recommendations of the West Montrose Class EA Study (2013).

+ Option 2 involves a group of options comprising a connection to the Integrated Urban System (IUS) at St. Jacobs. The IUS will be the supply source for all options developed under Option 2. Some of these options (Options 2A & 2B) assume provision of water to the West Montrose and Conestogo Plains service areas only, while the other two options (Options 2C & 2D) assume provision of water to the West Montrose, Conestogo Plains and Conestogo Golf Course.

+ Option 3 involves a looping connection to the IUS through two separate locations namely, the City of Waterloo (intersection of Country Squire Road and Glasgow Street) and St. Jacobs. The IUS will be the supply source for all options developed under Option 3.

8.2 High-level Water Supply Options

This section describes the different permutations developed under each of the three high-level options described above.

8.2.1 Option 1 – Supply West Montrose with Surplus Capacity from Conestogo Plains

This option involves a group of options comprising a connection of West Montrose to the existing Conestogo Plains Water Supply System. These options were developed under the premise that water would be provided from the existing Conestogo Plains production wells C3 and C4 to both the West Montrose and Conestogo Plains service areas, consistent with the original recommendations of the West Montrose Class EA study completed in 2013.

Four different permutations were developed under Option 1, each representing a different strategy to supply water to the West Montrose service area and to continue to supply the Conestogo Plains service area.

+ Option 1A: Involved the use of a new set of transfer pumps that will be dedicated exclusively to transfer water from the Conestogo Plains reservoir to the West Montrose reservoir. From here, the treated water would be conveyed into the West Montrose distribution system by the existing high lift pumps in West Montrose. Existing high lift pumps in Conestogo Plains would continue to convey treated water into the Conestogo Plains distribution system.

+ Option 1B: This option involves the use of the existing high lift pumps at Conestogo Plains to convey treated water from the Conestogo Plains reservoir to both the West Montrose reservoir and Conestogo Plains distribution system. A new flow control valve in West Montrose will be used to control filling of the West Montrose reservoir based on the water levels.

+ Option 1C: This option involves the use of a new set of high lift pumps exclusively dedicated to convey water from the Conestogo Plains reservoir directly into the West Montrose distribution system. This option eliminates the use of the existing West Montrose reservoir. The new high lift pumps would be designed to deliver the required system pressures in West Montrose. The existing high lift pumps in Conestogo Plains would continue to convey treated water into the Conestogo Plains distribution system.

+ Option 1D: This option involves the use of the existing high lift pumps in Conestogo Plains to convey treated water from the Conestogo Plains reservoir directly into the West Montrose and the Conestogo Plains distribution systems. This option would eliminate the use of the existing West Montrose Reservoir.

General schematics of the sub-options developed under Option 1 are shown in Figure 11. In the figure, BPs and HLPs stand for booster pumps and high lift pumps respectively. These acronyms apply to all the following schematics.

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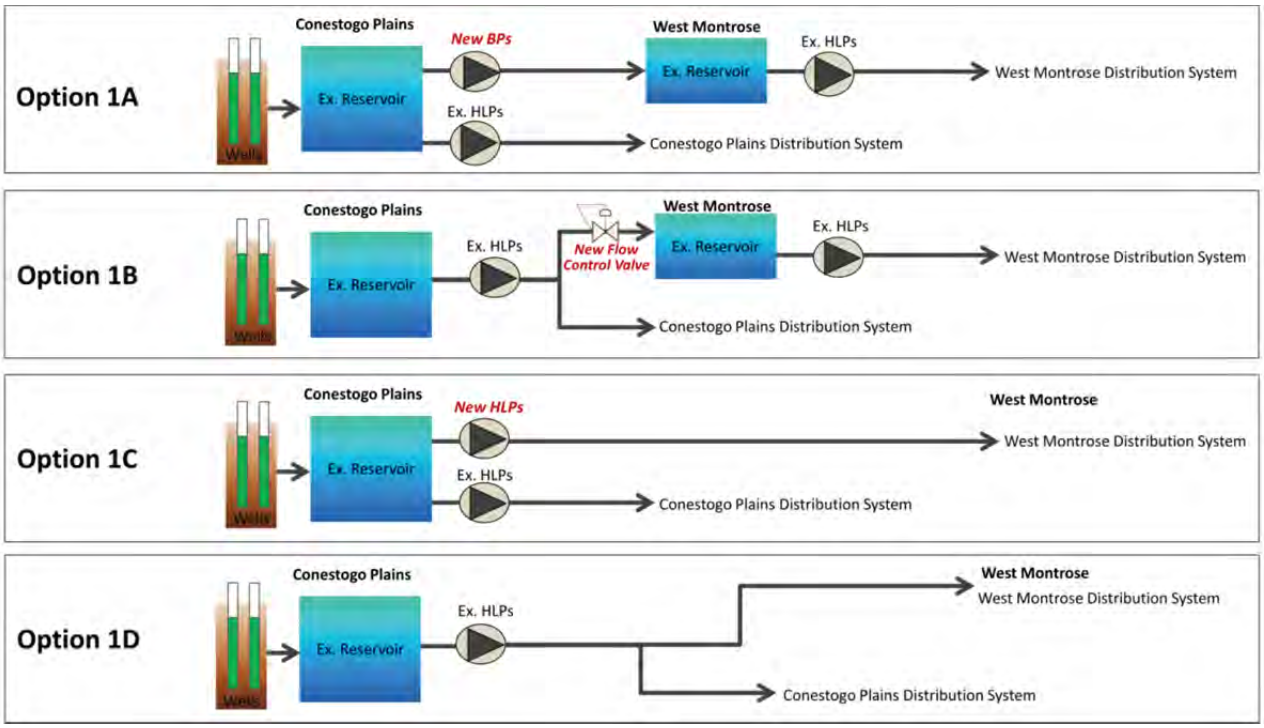

Figure 11 Option 1 Schematics – Supply West Montrose with Surplus Capacity from Conestogo Plains

8.2.2 Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs

Option 2 is made up of a group of sub-options comprising a connection to the IUS at St. Jacobs. The IUS would be the supply source for all options developed under Option 2. Two of the options (2A and 2B) assume provision of water to the West Montrose and Conestogo Plains service areas only, while the other two options (2C and 2D) assume provision of water to the West Montrose, Conestogo Plains and Conestogo Golf Course.

Four different permutations were developed under Option 2, each representing different strategies to supply water to the West Montrose and Conestogo Plains systems through a single connection to the IUS. In addition, two sub-options were developed to explore the possibility of a future connection of the Conestogo Golf Course service area to the IUS.

+ Option 2A: This option involves the same concept developed in Option 1A above with the only difference being the IUS at St. Jacobs as the supply source. Similar to 1A, a new set of transfer pumps will be dedicated exclusively to transfer water from the Conestogo Plains reservoir to the West Montrose reservoir. The

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existing high lift pumps in Conestogo Plains would continue to convey treated water into the Conestogo Plains distribution system

+ Option 2B: This option involves the same concept developed for 1B above, with the only difference being the IUS at St. Jacobs as the supply source. Similar to 1B, the existing high lift pumps in Conestogo Plains would convey treated water from the Conestogo Plains reservoir to both the West Montrose Reservoir and the Conestogo Plains distribution system. A new flow control valve in West Montrose would be used to control filling of the West Montrose reservoir based on the reservoir water levels

+ Option 2C: This option involves a direct connection from the Conestogo Plains distribution system and the West Montrose reservoir to the IUS at St. Jacobs. New flow control valves in West Montrose will be used to control filling of the West Montrose reservoir based on the reservoir water levels. This option provides an opportunity for a future connection of the Conestogo Golf Course distribution system to the IUS. As the existing high lift pumps at Conestogo Plains and Conestogo Golf Course would be eliminated, properly sized watermains would be required between the St. Jacobs connection point, Conestogo Plains and Conestogo Golf Course to ensure that system pressures are not significantly decreased under max day plus fire flow conditions. To this end, this option includes a 400 mm watermain between the St. Jacobs connection point and the Conestogo Plains, transitioning to a 300 mm watermain between Conestogo Plains and Conestogo Golf Course.

+ Option 2D: This option conceptually involves the same general idea developed for 2A. An additional element for Option 2D comprises the opportunity for a future connection of the Conestogo Golf Course distribution system to the IUS, through Conestogo Plains. The watermains between the St. Jacobs connection point and Conestogo Plains and between Conestogo Plains and Conestogo Golf Course have been sized to ensure that adequate system pressures in Conestogo Plains and Conestogo Golf Course are provided under max day plus fire flow conditions. To this end, this option includes two 300 mm watermain sections extending respectively from the St. Jacobs connection point to Conestogo Plains and from Conestogo Plains to Conestogo Golf Course. The existing high lift pumps in Conestogo Plains would continue to provide service pressures in this area until the connection to Conestogo Golf Course is made. At this point, two of the existing high lift pumps would be replaced with new ones that meet the demands under max day plus fire flow conditions for both communities.

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General schematics of the sub-options developed under Option 2 are shown in Figure 12.

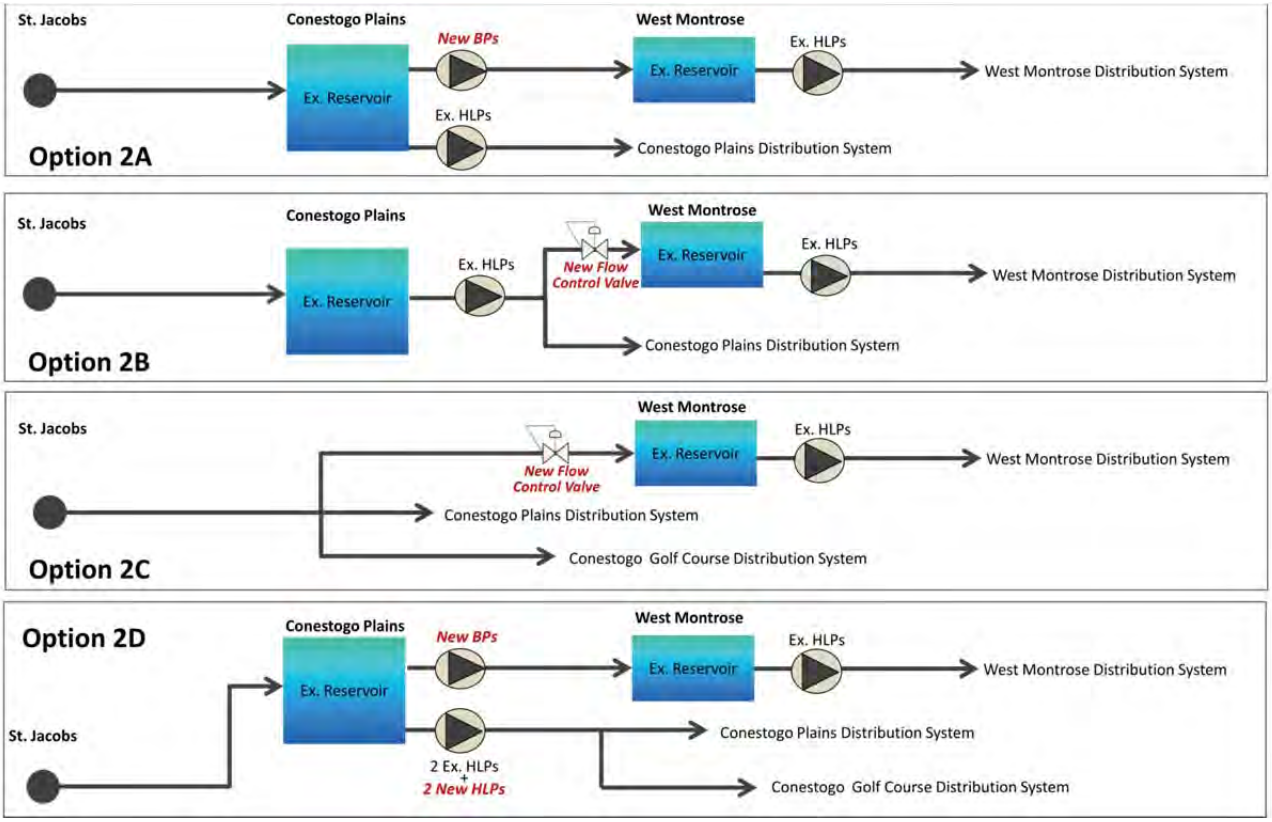

Figure 12 Option 2 Schematics – Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs

8.2.3 Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System at City of Waterloo with Provision for Looping

Option 3 is a single option that would include a direct connection from the Conestogo Plains distribution system and the West Montrose reservoir to the IUS at the City of Waterloo. The IUS is the supply source for Option 3. A new flow control valve in West Montrose would be used to control filling of the West Montrose reservoir based on the reservoir water levels. Looping in the IUS is provided through an additional connection to the IUS at St. Jacobs. Looping provides additional redundancy of supply to the communities of West Montrose and Conestogo as well as the Village of St. Jacobs. This option also comprises the opportunity for a future connection of the Conestogo Golf Course distribution system to the IUS.

A general schematic of Option 3 is shown in Figure 13.

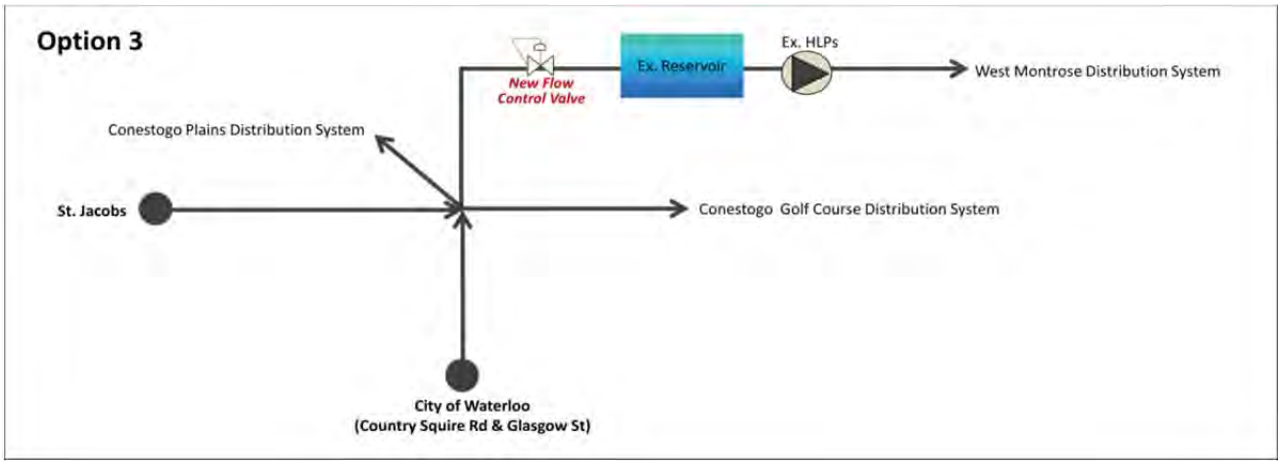

Figure 13 Option 3 Schematic – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with provision for looping

8.3 Summary of Projected Water Demands

Projected water demands have been calculated for the service areas to be connected under the different water supply options described above.

Table 11 summarizes the combined projected water demands associated with Option 1 and its sub-options, which involve provision of water to both the West Montrose and the Conestogo Plains service areas. Table 12 summarizes the combined projected water demands associated with Options 2 and 3 and their sub-options, which involve provision of water to the West Montrose, Conestogo Plains and Conestogo Golf Course service areas.

Anticipated water demands, shown in Tables 11 and 12, have been calculated based on key design criteria (i.e. population projections and existing water consumption rates) for each respective service area, previously described in Section 6 of this report.

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Table 11 Combined Projected Water Demands - West Montrose and Conestogo Plains

Description	Unit	Service Area	
		West Montrose	Conestogo Plains
Unit Consumption rates	L/cap/d	345	240
Ultimate serviced population/community	person	339	820
Combined ultimate serviced population	person	1,159	
Average day demands/community	m^3/d	117	197
Combined average day demands	m^3/d	314	
Max. day factor	-	2.3	2.8
Max. day demands/community	m^3/d	273	550
Combined max. day demands	m^3/d	822	
Peak hour factor	-	5.17	4.13
Peak hour demands/community	m^3/d	605	813

Table 12Combined Projected Water Demands - West Montrose, Conestogo Plains and Conestogo Golf Course

Description	Unit	Service Area		
		West Montrose	Conestogo Plains	Conestogo Golf Course
Unit Consumption rates	L/cap/d	345	240	420
Ultimate serviced population/community	person	339	820	618
Combined ultimate serviced population	person	1,777		
Average day demands/community	m^3/d	117	197	259
Combined average day demands	m^3/d	573		
Max. day factor	-	2.3	2.8	2.6
Max. day demands/community	m^3/d	273	550	678
Combined max. day demands	m^3/d	1,501		
Peak hour factor	-	5.17	4.13	4.13
Peak hour demands/community	m^3/d	605	813	1,071

8.4 Preliminary Screening Results

All option and sub-options were subjected to a preliminary screening exercise consistent with the methodology and screening criteria described in Section 7.2.1. The results and key considerations from the preliminary screening exercise are shown in Table 13. Table 13 also shows the options that were eliminated from further consideration and those that were considered for a more detailed evaluation.

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Table 13 Preliminary Screening Results

High-level Option / Description	Preliminary Screening Observations and Comments	Short-Listed	
		Yes	No
Option 1 – Supply West Montrose with Surplus Capacity from Conestogo Plains			
Option 1A	• Option provides control and active positive feed into the West Montrose reservoir due to the new set of transfer pumps that will be dedicated exclusively to feed the West Montrose reservoir. • Option provides security of supply through the Conestogo Plains and West Montrose reservoirs. • A preliminary desktop review of historical information on wells C3 and C4 indicate that iron and manganese levels are not expected to increase significantly; however, the Conestogo Plains wells have not been tested at higher pumping rates for extended periods of time. Based on experience on other well fields, concentration of metals tends to increase at higher pumping rates. Therefore, and for completeness purposes, Option 1A will be further developed to incorporate baseline costs for treatment reflecting the worst case scenario where enhanced treatment for iron and manganese removal would be necessary.	✓	
Option 1B	• Option provides security of supply through the Conestogo Plains and West Montrose reservoirs; however, option includes passive feed into the West Montrose reservoir as it uses the existing high lift pumps at Conestogo Plains to feed the West Montrose reservoir. • Changes in the service pressures in Conestogo Plains may occur as a result of the operation of the control valve required to fill the West		X

High-level Option / Description	Preliminary Screening Observations and Comments	Short-Listed	
		Yes	No
	Montrose reservoir.		
Option 1C	• Option does not provide adequate security of supply as it depends entirely on the integrity and performance of the Conestogo Plains system and the watermain connection between West Montrose and Conestogo Plains. • Option does not provide adequate flexibility and redundancy in West Montrose since the existing West Montrose reservoir is eliminated.		X
Option 1D	• Option does not provide adequate security of supply as it depends entirely on the integrity and performance of the Conestogo Plains system and the watermain connection between West Montrose and Conestogo Plains. • Option does not provide adequate flexibility and redundancy in West Montrose since the existing West Montrose reservoir is eliminated. • The resulting available service pressures in the West Montrose distribution system are unacceptable.		X
Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs			
Option 2A	• Option provides control and active positive feed into the West Montrose reservoir due to the new set of transfer pumps that will be dedicated exclusively to feed the West Montrose reservoir. • Option provides security of supply through the Conestogo Plains and West Montrose reservoirs.	✓	
Option 2B	• Option provides security of supply through the		X

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High-level Option / Description	Preliminary Screening Observations and Comments	Short-Listed	
		Yes	No
	Conestogo Plains and West Montrose reservoirs; however, option includes passive feed into the West Montrose reservoir as it uses the existing high lift pumps at Conestogo Plains to feed the West Montrose reservoir. • Changes in the service pressures in Conestogo Plains may occur as a result of the operation of the control valve required to fill the West Montrose reservoir.		
Option 2C	• Option does not provide adequate flexibility and redundancy since the existing Conestogo Plains reservoir is eliminated. • The resulting available service pressures in the Conestogo Plains distribution system are unacceptable.		X
Option 2D	• Option provides the same benefits as Option 2A, as well as an opportunity to connect the Conestogo Golf Course to the IUS in the future. • As conceptually, this option is the same as Option 2A – plus the potential connection of Conestogo Golf Course, this option will be integrated with Option 2A as a Phased-in Option.	✓ (Integrated with Option 2A)	
Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with provision for looping			
Option 3	• Looping provides system security and redundancy to other areas in the IUS. • Option provides the opportunity to optimize water circulation in areas in the City of Waterloo as well as the opportunity to connect the Conestogo Golf Course to the IUS in the future.	✓ (Staged Option)	

High-level Option / Description	Preliminary Screening Observations and Comments	Short-Listed	
		Yes	No
	• Option will be developed as a staged-option to reflect the potential connections / looping involved.		

Results of the preliminary assessment revealed that three out of the nine original high-level water supply options had the ability to meet the required level of service and provide adequate system security, flexibility and redundancy required for the service areas under consideration. Options 1A, 2A/2D and Option 3 were short-listed and carried forward for more detailed evaluation. Minor refinements were made to the three short-listed options to reflect potential staging and phasing-in scenarios.

9. Development of Short-listed Water Supply Alternatives

This section provides a description of the three high-level water supply options that have been short-listed following the preliminary assessment described in Section 8. Infrastructure / process requirements, general schematics and preliminary capital, operating and life cycle costs for each option are presented in the following sections.

9.1 Option 1 – Supply West Montrose with Surplus Capacity from Conestogo Plains

9.1.1 General Description

Option 1 involves a permanent connection from the existing Conestogo Plains water supply system to West Montrose. This option assumes the replacement of one of the existing Conestogo Plains supply wells (well C4). A new set of transfer pumps would be installed at Conestogo Plains and dedicated exclusively to the transfer of water from the Conestogo Plains reservoir to the West Montrose reservoir. From here, treated water would be conveyed into the West Montrose distribution system by the existing high lift pumps in West Montrose. Existing high lift pumps in Conestogo Plains will continue to convey treated water into the Conestogo Plains distribution system.

Consistent with the findings and observations made during the preliminary assessment, two sub-scenarios have been assumed for Option 1 as follows:

+ Treatment processes at the Conestogo Plains water treatment facility will continue to comprise iron sequestration and disinfection. This scenario does not assume additional treatment (iron and manganese removal) at the Conestogo Plains facility.

+ Additional treatment for iron and manganese removal will be provided at the Conestogo Plains water treatment facility. This option represents the worst-case scenario and assumes that concentrations of iron and manganese in the raw water will increase as a result of increased water takings for the additional supply to West Montrose.

Option 1 – Supply West Montrose with surplus capacity from Conestogo Plains System comprises the following major components:

+ Decommissioning of existing West Montrose infiltration wells WM1, WM2, WM3 & WM4

+ Refurbishment of existing treatment facility at West Montrose to satisfy new treatment and pumping requirements and decommissioning of some of the existing treatment equipment
+ Replacement of existing Conestogo Plains groundwater well C4
+ Long-term well and aquifer testing to confirm capacities and water quality
+ Minor upgrades to existing treatment system in Conestogo Plains
+ Refurbishment of existing pumping facility at Conestogo Plains to accommodate new transfer pumps for West Montrose
+ Watermain connection between West Montrose and Conestogo Plains water supply system – this is a common component for all three high-level water supply options

The two scenarios are subject to field verification. A general schematic of the major components of Option 1 is shown in Figure 14.

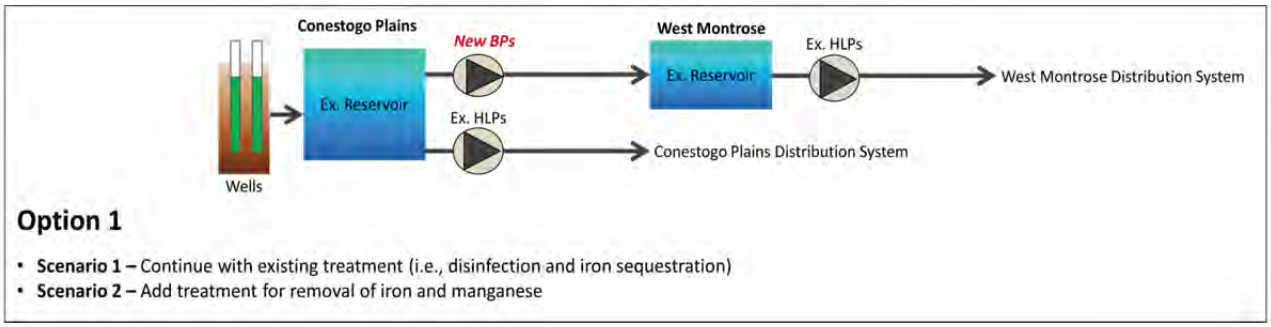

Figure 14 Option 1 – Supply West Montrose with Surplus Capacity from the Conestogo Plains System

Option 1 would provide control and active positive feed into the West Montrose reservoir due to the new set of transfer pumps that would be dedicated exclusively to feeding the West Montrose reservoir. This option provides security of supply through the Conestogo Plains and the West Montrose reservoirs. A preliminary desktop review of the historical information for wells C3 and C4 indicated that iron and manganese levels are not expected to increase significantly; however, the Conestogo Plains wells have not been tested at higher pumping rates for extended periods of time. Based on experience from other well fields, concentrations of metals tend to increase at higher pumping rates. Therefore, this option was further developed to incorporate baseline costs for iron and manganese removal treatment reflecting the worst case scenario where enhanced treatment for the removal of these two elements would be necessary.

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9.1.2 Infrastructure / Process Requirements

Table 14 summarizes the main infrastructure and process requirements for Option 1 – Supply West Montrose with surplus capacity from the Conestogo Plains system.

Table 14 Water Supply Option 1 – Infrastructure / Process Requirements

Area	Option Requirements
Supply	• Conestogo Plains Well C3 and existing pump rated at 9.1 L/s will continue to be used • Conestogo Plains Well C4 will be replaced and a new pump rated at 9.5 L/s will be installed • Infiltration wells WM1, WM2, WM3 & WM4 at West Montrose will be decommissioned and existing well pumps will be removed
Treatment	• Minor upgrades to existing disinfection system in Conestogo Plains • Existing sequestration system will continue to be used for iron control at Conestogo Plains (Scenario 1) or new filtration system will be installed for iron and manganese removal (Scenario 2) • New booster disinfection system will be installed within existing treatment facility at West Montrose • Decommissioning of existing filtration system at West Montrose
Pumping	• Two (1 duty/1 standby) new transfer pumps will be installed at Conestogo Plains to pump max. day flows to West Montrose, each with a rated capacity of 3.2 L/s • Continue to use existing high lift pumps in West Montrose to meet peak hour demands in West Montrose • Continue to use existing high lift pumps in Conestogo Plains to meet max. day and fire flows in Conestogo Plains
Storage	• Existing reservoir at Conestogo Plains will continue to provide necessary storage requirements for Conestogo Plains • Existing reservoir at West Montrose will continue to provide necessary storage requirements for West Montrose
Conveyance	• New 7.3 km of 100 mm diameter watermain will be constructed to connect West Montrose reservoir to the Conestogo Plains water supply system

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9.2 Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs

9.2.1 General Description

Option 2 involves a single connection to the IUS at St. Jacobs (east of Conestogo Plains). This option has been developed as a phased-in option, allowing for an initial connection of the West Montrose and Conestogo Plains service areas to the IUS and providing the opportunity for a future connection of the Conestogo Golf Course service area to the IUS, through Conestogo Plains. Treated municipal water to the West Montrose system will be supplied directly from the existing Conestogo Plains reservoir. In addition, the required fire flows for the service areas in Conestogo Plains and Conestogo Golf Course will continue to be provided through the municipal connection. Similarly, and consistent with current practices, the West Montrose water system will not provide fire flows for the community of West Montrose. Implementation of Option 2 would be completed in phases over time, as technically required or as permitted based on the Region's ability to finance the future connection of the Conestogo Golf Course.

Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs comprises the following major components:

+ Decommissioning of existing West Montrose infiltration wells WM1, WM2, WM3 & WM4
+ Refurbishment of existing treatment facility at West Montrose to satisfy new disinfection and pumping requirements and decommissioning of some of the existing treatment equipment
+ Decommissioning of existing Conestogo Plains wells C3 and C4 and treatment system
+ Refurbishment of existing pumping facility at Conestogo Plains to accommodate new transfer pumps for West Montrose
+ Watermain connection between Conestogo Plains and the IUS at St. Jacobs
+ Watermain connection between West Montrose and Conestogo Plains water supply system – this is a common component for all three high-level water supply options
+ Opportunity for future connection of the Conestogo Golf Course to the IUS through Conestogo Plains, including future decommissioning of supply, treatment and storage facilities in Conestogo Golf Course.

A general schematic of the major components of Option 2 is shown in Figure 15.

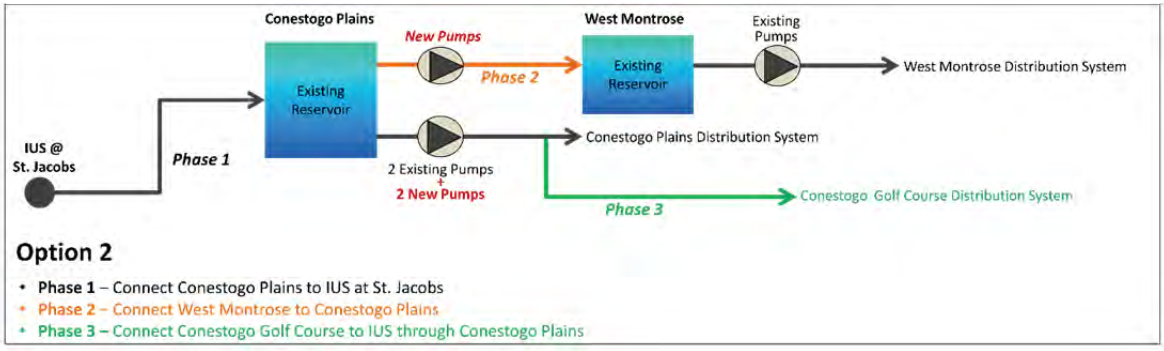

Figure 15 Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs

Option 2 provides control and active positive feed into the West Montrose reservoir due to the new set of transfer pumps that will be dedicated exclusively to feeding the West Montrose reservoir. This option would also allow for the opportunity to connect the Conestogo Golf Course to the IUS in the future.

9.2.2 Infrastructure / Process Requirements

Table 15 provides a description of the main infrastructure and process requirements for Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs.

Table 15 Water Supply Option 2 – Infrastructure / Process Requirements

Area	Option Requirements
Supply	• Conestogo Plains Wells C3 and C4 will be decommissioned and existing well pumps will be removed • Infiltration wells WM1, WM2, WM3 & WM4 at West Montrose will be decommissioned and existing well pumps will be removed • *Opportunity to decommission Conestogo Golf Course Wells C5 and C6, once Conestogo Golf Course is connected to the IUS through Conestogo Plains*
Treatment	• Decommission existing treatment system in Conestogo Plains • New booster disinfection system will be installed within existing treatment facility at West Montrose • Decommissioning of existing filtration system at West Montrose • *Opportunity to decommission existing treatment system in Conestogo Golf Course, once Conestogo Golf Course is connected to the IUS through Conestogo Plains*
Pumping	• Two (1 duty/1 standby) new transfer pumps will be installed at Conestogo Plains to pump max. day flows to West Montrose, each with a rated capacity of 3.2 L/s • Continue to use existing high lift pumps in West Montrose to meet peak hour demands in West Montrose • Continue to use existing high lift pumps in Conestogo Plains to meet max. day and fire flows in Conestogo Plains. Once, Conestogo Golf Course is connected, two of the existing high lift pumps in Conestogo Plains will be replaced with new pumps to meet max. day and fire flows for both communities. • *Opportunity to decommission existing high lift pumps in Conestogo Golf Course, once Conestogo Golf Course is connected to the IUS. Service pressures will be provided directly from the IUS.*
Storage	• Existing reservoir at Conestogo Plains will continue to provide necessary storage requirements for Conestogo Plains

Area	Option Requirements
	• Existing reservoir at West Montrose will continue to provide necessary storage requirements for West Montrose • *Opportunity to decommission existing Conestogo Golf Course reservoir, once Conestogo Golf Course is connected to the IUS*
Conveyance	• New 7.3 km of 100 mm diameter watermain will be constructed to connect West Montrose reservoir to the Conestogo Plains water supply system • New 3.0 km of 300 mm diameter watermain will be constructed to connect Conestogo Plains to the IUS at St. Jacobs • *New 1.53 km of 300 mm diameter watermain will be constructed to connect Conestogo Golf Course to the IUS, through Conestogo Plains, to allow for future connection of Conestogo Golf Course* • *Installation of Pressure Reducing Valves (PRV) may be required in Conestogo Golf Course*

9.3 Option 3 – Supply West Montrose and Conestogo Plains from the IUS at the City of Waterloo with Provision for Looping

9.3.1 General Description

Option 3 involves two separate connections to the IUS at the City of Waterloo and St. Jacobs. This option has been developed as a phased-in option to allow for an initial connection of the West Montrose and Conestogo Plains service areas to the IUS at the City of Waterloo, followed by an additional future connection to the IUS at St. Jacobs and the future opportunity for connection of the Conestogo Golf Course service area to the IUS.

This option has been developed to concurrently address the main objective of the Conestogo Plains Class EA study and to provide for an opportunity to optimize water retention times and increase redundancy in some areas of the City of Waterloo and the Village of St. Jacobs. Similar to Option 2, Option 3 would also be implemented in phases over time, as technically required or as permitted based on the Region's ability to finance the future connection of the Conestogo Golf Course. Full implementation of Option 3 will ultimately result in complete decommissioning of existing groundwater systems in Conestogo Plains and Conestogo Golf Course.

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This option eliminates the existing infrastructure (supply, treatment and storage) in Conestogo Plains and relies on the IUS for the supply of treated water to the Conestogo Plains distribution system and the West Montrose reservoir. The required fire flows for the service areas in Conestogo Plains will be provided through the municipal connection. Similarly, and consistent with current practices, the West Montrose water system will not provide fire flows for the community of West Montrose.

A potential future connection of the Conestogo Golf Course system will also eliminate the existing infrastructure (supply, treatment and storage) in Conestogo Golf Course and will rely on the IUS for the supply of treated water directly to the Conestogo Golf Course distribution system. The required fire flows for the service areas in Conestogo Golf Course will also be provided through the municipal connection.

Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with provision for looping comprises the following major components:

+ Decommissioning of existing West Montrose infiltration wells WM1, WM2, WM3 & WM4
+ Refurbishment of existing treatment facility at West Montrose to satisfy new disinfection and pumping requirements and decommissioning of some of the existing treatment equipment
+ Installation of new flow control valve to control filling of the West Montrose reservoir
+ Decommissioning of existing Conestogo Plains wells C3 and C4, treatment, storage and pumping system
+ Watermain connection between Conestogo Plains and the IUS at the City of Waterloo (intersection of Country Squire Road and Glasgow Street)
+ Watermain connection between West Montrose and Conestogo Plains water supply system – this is a common component for all three high-level water supply options
+ Future looping through an additional connection to the IUS between Conestogo Plains and the IUS at St. Jacobs.

+ Opportunity for future connection of the Conestogo Golf Course to the IUS, including future decommissioning of supply, treatment and storage facilities in Conestogo Golf Course.

A general schematic of the major components of Option 3 is shown in Figure 16.

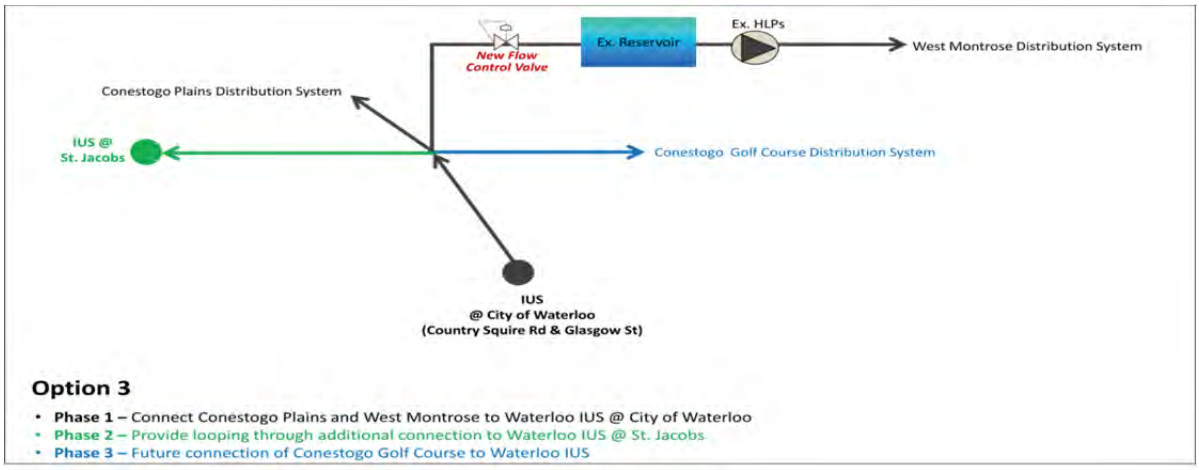

Figure 16 Option 3 Schematic - Supply West Montrose and Conestogo Plains from the IUS at the City of Waterloo with Provision for Looping

Looping would provide system security and redundancy to other areas in the IUS. Option 3 provides the opportunity to optimize water circulation in areas in the City of Waterloo as well as the opportunity to connect the Conestogo Golf Course to the IUS in the future. This option will be developed as a staged-option to reflect the potential connections/looping involved.

9.3.2 Infrastructure / Process Requirements

Table 16 presents a description of the main infrastructure and process requirements for Option 3 – Supply West Montrose and Conestogo Plains from the IUS at the City of Waterloo with provision for looping.

Table 16 Water Supply Option 3 – Infrastructure / Process Requirements

Area	Option Requirements
Supply	• Conestogo Plains Wells C3 and C4 will be decommissioned and existing well pumps will be removed • Infiltration wells WM1, WM2, WM3 & WM4 at West Montrose will be decommissioned and existing well pumps will be removed

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Area	Option Requirements
	• *Opportunity to decommission Conestogo Golf Course Wells C5 and C6, once Conestogo Golf Course is connected to the IUS*
Treatment	• Decommission existing treatment system in Conestogo Plains • New booster disinfection system will be installed within existing treatment facility at West Montrose • Decommissioning of existing filtration system at West Montrose • *Opportunity to decommission existing treatment system in Conestogo Golf Course, once Conestogo Golf Course is connected to the IUS*
Pumping	• Continue to use existing high lift pumps in West Montrose to meet peak hour demands in West Montrose • Decommission existing high lift pumps in Conestogo Plains • *Opportunity to decommission existing high lift pumps in Conestogo Golf Course, once Conestogo Golf Course is connected to the IUS. Service pressures will be provided directly from the IUS*
Storage	• Decommission existing reservoir in Conestogo Plains • Existing reservoir at West Montrose will continue to provide necessary storage requirements for West Montrose • *Opportunity to decommission existing Conestogo Golf Course reservoir, once Conestogo Golf Course is connected to the IUS*
Conveyance	• New 7.3 km of 100 mm diameter watermain will be constructed to connect West Montrose reservoir to the IUS • New 2.4 km of 300 mm diameter watermain will be constructed to connect Conestogo Plains to the IUS at the City of Waterloo (intersection of Country Squire Road and Glasgow Street) • New 3.0 km of 300 mm diameter watermain will be constructed to connect Conestogo Plains to the IUS at St. Jacobs • *New 1.53 km of 300 mm diameter watermain will be constructed to connect Conestogo Golf Course to the IUS, through Conestogo*

Area	Option Requirements
	Plains, to allow for future connection of Conestogo Golf Course • *Installation of Pressure Reducing Valves (PRV) may be required in Conestogo Golf Course*

9.4 Cost Estimates

Preliminary estimates of capital, operating costs and life cycle costs were developed for each high-level water supply option. Capital costs considered major upgrades to existing facilities, major equipment such as pumps, chemical systems, watermains and new infrastructure requirements. Net present value operating costs were based on 40-year life cycle which included operation, maintenance, power, chemical consumption, replacement and labour costs.

The following general assumptions were made when developing the costs for the three short-listed high-level options:

+ Implementation of the works will commence in 2015. All equipment and material to be purchased at the initiation of construction of the project.

+ Estimates of probable capital costs have been developed on a conceptual design level and based on prices and data in CIMA's possession, as well as previous experience from projects of similar nature and scope. For the purpose of a relative economic comparison between the three water supply options under construction, it should be highlighted that costs for all options were calculated under the same assumptions and rationale, thus, should prices change over time, the changes would apply proportionally for both options and the results of the comparative cost assessment would remain unaltered.

+ Cost estimates are based on 2013 construction costs. This project is not expected to be tendered for a number of years. Inflation and escalation to account for actual expected prices at the time of construction cannot be accounted for at this time.

+ There is a capital expenditure associated with the upkeep and maintenance of water facilities every ten years that include major maintenance and rehabilitation to existing infrastructure, supply wells, grounds and parking lots, for every water facility that remains operational.

+ There is a capital expenditure associated with the replacement of major pumping and treatment equipment every 30 years for every water facility that remains operational.

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+ All taxes (including the 13% HST) have been excluded.
+ Life cycle costs have been estimated based on:
+ A 40 year amortization period
+ An inflation rate of 2% and an interest rate of 6% to give a market/discount rate of 4%

Table 17 summarizes the units costs used for developing the operating costs for the three high-level options. The preliminary estimates for capital, operating and life cycle costs for the three high-level water supply options are shown in Table 18.

Table 17 Unit Costs Used for Cost Analysis

Parameter	Use	Unit Cost
Operating Costs[1]		
Sodium Hypochlorite	Primary disinfection and chloramination	$0.17/L
Sodium Silicate	Iron sequestration	$1.778/kg
Ammonium Sulphate	Secondary disinfection – chloramination	$1.598/kg
Other		
Labour	Operation and maintenance	$80/hr
Electricity[2]	Operation of equipment	$0.12/kwh

Notes:

1. As provided by the Region
2. Calculated based on Region invoices and water delivered for the years of 2011 and 2012

Table 18 High-Level Water Supply Options - Costs Estimates

Water Supply Option	Capital Cost ($ Million)	Annual Operating Cost	40-Year Life Cycle Costs ($ Million)
Option 1 Supply West Montrose with Surplus Capacity from Conestogo Plains System			
With No Treatment	$ 5.1	$ 99,000	$ 8.5
With New Filtration System	$ 5.8	$111,000	$ 9.5
Option 2 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs			
Connection to IUS at St. Jacobs plus additional connection of Conestogo Golf Course (Opportunity)[1]	$ 8.1	$ 86,000	$ 9.9
Option 3 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with provision for looping			
Connection to IUS at the City of Waterloo with looping at St. Jacobs plus additional connection of Conestogo Golf Course (Opportunity) [1]	$ 9.7	$ 62,000	$ 11.1
Notes: 1. Life cycle costs are calculated assuming that all works are implemented in 2015.			

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The capital, operating and life cycle costs presented in Table 18 were taken into consideration when all the high-level options were subjected to the detailed comparative evaluation.

9.4.1 Life Cycle Cost (LCC) Analysis

Life cycle costs (LCC) for each high-level option have been developed using various time periods including 20-year, 50-year and 60-year, in addition to the 40-year LCC scenario. The latter is assumed to be baseline LCC. The purpose of this exercise is to evaluate the impacts of the life cycle costs in the evaluation process. Since each of the options includes the construction of watermain(s) which are known to have a life expectancy of up to 75 years, the 50-year and 60-year LCC provide a good indication of the replacement cost of process equipment over the life of the watermains. The 20-year LCC represent the typical time period used for LCC calculations, so it was also evaluated.

The calculated LCC for the additional time periods of 20, 50 and 60 years are summarized in Table 19. LCC costs shown in this table were used during the sensitivity analysis.

Table 19 High-Level Water Supply Options - Life Cycle Costs Analysis

Water Supply Option	20-Year Life Cycle Costs ($ Million)	50-Year Life Cycle Costs ($ Million)	60-Year Life Cycle Costs ($ Million)
Option 1 Supply West Montrose with Surplus Capacity from Conestogo Plains System			
With No Treatment	$ 7.2	$ 8.7	$ 9.0
With New Filtration System	$ 8.2	$9.8	$ 10.1
Option 2 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs			
Connection to IUS at St. Jacobs plus additional connection of Conestogo Golf Course (Opportunity)[1]	$ 9.4	$ 10.3	$ 10.4

Water Supply Option	20-Year Life Cycle Costs ($ Million)	50-Year Life Cycle Costs ($ Million)	60-Year Life Cycle Costs ($ Million)
Option 3 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with provision for looping			
Connection to IUS at the City of Waterloo with looping at St. Jacobs plus additional connection of Conestogo Golf Course (Opportunity) [1]	$ 10.7	$ 11.2	$ 11.2
Notes: 1. Life cycle costs are calculated assuming that all works are implemented in 2015.			

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10. Detailed Evaluation Results of Short-listed Water Supply Alternatives

An important aspect of the Class EA process is the assessment of alternative solutions for a given project. This section presents the results of the detailed evaluation of the short-listed options described in Section 9 including the benefits evaluation, value analysis and cost benefit analysis.

10.1 Evaluation Criteria

The proposed evaluation criteria to be used during the comparative evaluation of the short-listed options, as well as the criterion's objective and the relative performance scales used when assigning scores, are shown in Table 10.

10.2 Summary Results

Table 20 summarizes the unweighted scoring results, on a scale from 0-5, assigned to each option during the evaluation process. Those options that meet the criteria best were given higher scores (e.g. closer to 5).

The complete evaluation matrix describing the rationale behind the scores assigned to each of the short-listed options for all evaluation criteria is included in Appendix D for further reference.

As shown in Table 20, Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs and Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping, are extremely comparable in terms of the overall benefits they provide to this project.

10.3 Value Analysis

A value analysis is an alternate means to determine the approximate value offered by different alternatives. In cases where the results of the detailed evaluation provide very close and comparable results, a value analysis can further provide an indication of the alternative that provides the greatest value to the project. Under normal circumstances, the option with the highest value indicator was selected as the preliminary preferred solution.

The value analysis was carried out as follows:

+ Scores in all criteria categories except costs (financial criteria) are tallied
+ Scores are divided by the life cycle costs resulting in a value indicator
+ The alternative with the highest indicator offers the greatest value

Table 21 summarizes the results of the value analysis for the two highest ranking options, Options 2 and 3.

Table 20 Evaluation Summary Results

Criteria	Scores (Unweighted)[1]			
	Option 1 – No Treatment	Option 1 – with Treatment	Option 2	Option 3
Technical / Natural Environmental Criteria				
Water Quality / Quantity Protection	2.5	3.0	5.0	5.0
Level of Service	3.0	3.0	5.0	4.0
Ease of Implementation	4.5	3.0	4.0	3.5
Operational Complexity	3.0	2.0	4.0	4.5
System Reliability	1.0	1.0	3.0	5.0
System Redundancy and Flexibility	3.0	2.0	4.5	5.0
Need for New Infrastructure	4.5	4.0	3.5	2.5
Natural and Archaeological Heritage	4.0	4.0	3.5	3.0
Regulatory Approvals	4.0	2.0	3.0	3.0
Coordination with Planned Infrastructure	3.0	3.0	5.0	5.0
Opportunities for Benefits Outside of Study Area	1.0	1.0	3.0	5.0
Sub-Total Weighted Technical-Natural Score (out of max. 50 points) =	**30.5**	**25.5**	**39.5**	**41.4**
Community / Social Criteria				

Criteria	Scores (Unweighted)[1]			
	Option 1 – No Treatment	**Option 1 – with Treatment**	**Option 2**	**Option 3**
Public Health & Safety	5.0	5.0	5.0	5.0
Public Perception	2.0	2.0	3.0	3.0
Noise (during construction)	4.5	4.0	3.5	3.5
Traffic (during construction)	4.5	4.0	3.0	2.0
Aesthetics	2.0	2.0	3.5	4.5
Sub-Total Weighted Score Socio-Cultural (out of max. 25 points) =	**18.0**	**17.0**	**18.0**	**18.0**
Financial Criteria				
40-year Life Cycle Cost	5.0	4.5	4.3	3.8
Sub-Total Financial (out of max. 25 points) =	**25.0**	**22.3**	**21.5**	**19.2**
TOTAL SCORE (out of max. 100 points) =	**73.5**	**64.7**	**79.0**	**78.6**
Ranking =	**3**	**4**	**1**	**2**

Notes:

1. Scores shown in the table are unweighted, unless indicated otherwise.

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Table 21 Value Analysis Results

Option	Score (points)[1]	40- Year Life Cycle Cost ($ Million, 2013)	Value Indicator (pts/$ million)
Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs	57.5	9.9	5.81
Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping	59.4	11.1	5.35

Note:

1. Score is the total score obtained in the Technical / Natural Environmental and Community / Social categories. Scores obtained in the financial category are excluded.

Based on the results of the value analysis, Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs, provides the greatest value to the project in terms of benefits achieved per dollar spent, when compared to the second highest ranking option, Option 3. Consistently, Option 2 is selected as the preliminary preferred solution, subject to public and agency review and input.

10.4 Sensitivity Analysis

The project team took steps to gain more confidence in the preliminary preferred water supply solution by using a sensitivity analysis. The sensitivity analysis helps to verify the robustness of the evaluation process and the consistency of the evaluation results when variables of the evaluation methodology are subjected to modifications. This test ensures that the preliminary preferred water supply option is appropriate before a final decision is reached.

The sensitivity analysis was completed for two additional scenarios, each with different weighting factors applied to the three main categories within the evaluation

criteria. The two new scenarios reflected different conditions from what was originally developed.

For example, under the original weighting, Technical and Natural Environment Criteria were assigned a combined total weighting score of 50%, whereas Community and Social Criteria were assigned a weighting score of 25%, with the remaining 25% being assigned to the Financial Criteria. Scenario 2 of the sensitivity analysis tipped the weighting factors between the technical and social criteria, such that the Technical and Natural Environmental criteria had a score of 25% and the Community and Social criteria had a score of 50%. The Financial criteria were left with the original weighting score of 25%, allowing the project team to observe whether these changes had an effect on the original results. Scenario 3 of the sensitivity analysis divided the weighting scores. Equally to 33% for the Technical and Natural Environmental, the Community and Social, and Financial criteria.

The original and additional scenarios under which the sensitivity analysis was performed are summarized in Tables 22 and 23.

Table 22 Benefit Criteria Weights for Sensitivity Analysis

Criteria Category	Original Weighting Scenario 1	Sensitivity Analysis Scenario 2	Sensitivity Analysis Scenario 3
Technical & Natural Environmental	50	25	33
Community / Social	25	50	33
Financial	25	25	33
TOTAL POINTS	**100**	**100**	**100**

The alternate weightings for scenario No. 2 and No. 3, as shown in Table 22, were applied to the benefit scores presented in Table 20. The resulting scores with the new weights applied during the sensitivity analysis are summarized in Table 23.

Table 23 Sensitivity Analysis Results

Short-listed Water Supply Option	Total Score Original Weighting Scenario 1	Overall Ranking	Total Score Sensitivity Analysis Scenario 2	Overall Ranking	Total Score Sensitivity Analysis Scenario 3	Overall Ranking
Option 1 Supply West Montrose with surplus capacity from Conestogo Plains System. **Scenario 1 -** Iron control through sequestration	73.5	3	76.2	3	77.6	2
Option 1 Supply West Montrose with surplus capacity from Conestogo Plains System. **Scenario 2 -** Iron and manganese removal through filtration	64.7	4	69.0	4	69.4	4

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Short-listed Water Supply Option	Total Score Original Weighting Scenario 1	Overall Ranking	Total Score Sensitivity Analysis Scenario 2	Overall Ranking	Total Score Sensitivity Analysis Scenario 3	Overall Ranking
Option 2 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs	79.0	1	77.3	1	79.0	1
Option 3 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping	78.6	2	75.9	2	77.2	3

Based on the results of the sensitivity analysis, it was concluded that Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs continues

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to provide the highest overall score amongst all the short listed options under any of the three scenarios.

Similarly, Option 3 – Supply West Montrose and Conestogo Plains from the IUS at the City of Waterloo for Provision for Looping continues to obtain the second highest score under Scenario 2. However, a slight change in rankings is seen under Scenario 3, where all criteria categories are weighted equally. An increase in weight to the financial category favours to some extent, the least expensive options, resulting in Option 1 – Supply West Montrose with Surplus Capacity from the Conestogo Plains System, with no provision for additional treatment as the second best option, after Option 2.

After completing the sensitivity analysis, the project team introduced a new variable to the evaluation process, which consisted of assuming various time periods for the life cycle costs (20-year, 50-year and 60-year LCC) for each of the short-listed options, under the Financial Criteria. The purpose of this exercise was to evaluate the impacts of the life cycle costs in the evaluation process. Since each of the options includes the construction of watermain(s) which are known to have a life expectancy of up to 75 years, the 50-year and 60-year life cycle costs provide a good indication of the replacement cost of process equipment over the life of the watermains. The 20-year life cycle cost represents the typical time period used for life cycle cost calculations.

Life cycle costs used in the evaluation process have been previously developed, at a conceptual design level and based on available information. The life cycle costs for each option are summarized in Table 24.

Table 24 Life Cycle Costs Summary

Short-listed Water Supply Option	20-year LCC $ Million	40-year LCC $ Million	50-year LCC $ Million	60-year LCC $ Million
Option 1 Supply West Montrose with surplus capacity from Conestogo Plains System. **Scenario 1 -** Iron control through sequestration	$7.2 M	$8.5 M	$8.7 M	$9.0 M
Option 1 Supply West Montrose with surplus capacity from Conestogo Plains System. **Scenario 2 -** Iron and manganese removal through filtration	$8.2 M	$9.5 M	$9.8 M	$10.1 M
Option 2 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs	$9.4 M	$9.9 M	$10.3 M	$10.4 M
Option 3 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping	$10.7 M	$11.1 M	$11.2 M	$11.2 M

With the additional life cycle costs, all criteria previously used and the scores assigned remained the same. The only difference between the use of the 20-, 50-

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and 60- year life cycle costs was under the financial criterion, and therefore, revisions to the corresponding weighted scores. The results of the evaluation process, assuming the different time periods for the life cycle costs instead of the original 40-year life cycle costs, are shown in Table 25.

Table 25 Additional Life Cycle Costs - Evaluation Summary Results

Short-listed Water Supply Option	Overall Score 20-year LCC	Overall Ranking	Overall Score 40-year LCC	Overall Ranking	Overall Score 50-year LCC	Overall Ranking	Overall Score 60-year LCC	Overall Ranking
Option 1 – Scenario 1	73.5	3	73.5	3	73.5	3	73.5	3
Option 1 – Scenario 2	64.5	4	64.7	4	64.8	4	64.8	4
Option 2	76.7	1	79.0	1	78.8	2	79.2	2
Option 3	76.2	2	78.6	2	79.0	1	79.5	1

Table 25 shows that Option 2 achieves the highest score when assuming a 20-year and 40-year life cycle cost. When the life cycle costs extend beyond 40 years, Option 3 achieved a slightly higher ranking than Option 2. The results are consistent with the current practices which reveal that options that rely on watermains only (i.e. Option 3), would incur minor operational and maintenance costs in the long-term, compared to other options that are comprised of more infrastructure such as reservoirs and pumping stations.

10.5 Detailed Evaluation Summary

From the results of the detailed comparative evaluation, value analysis and sensitivity analysis exercise, Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs has been chosen as the preliminary preferred water supply solution. Based on the comparative evaluation, it can be seen that

Option 2 obtained the highest scores through the evaluation process mainly for the following reasons:

+ Connection to the IUS provides security of supply and increases redundancy, flexibility and reliability in the delivery of water supply to Conestogo Plains, West Montrose and Conestogo Golf Course through multiple sources supplying water to the IUS.

+ Improves the capabilities of distributing water between the communities served by the IUS (e.g., St Jacobs).

+ Option maximizes the ability to use existing infrastructure in good operational condition (e.g., Conestogo Plains and West Montrose reservoir and pumping stations) and the need for new infrastructure (e.g., watermain connections). This in turn, results in a good balance between a reduction of operation and maintenance costs and the capital expenditure required for the new infrastructure.

+ The use of high lift pumps in both Conestogo Plains and West Montrose allows for better control of the service pressures within their respective distribution systems. High lift pumps provide system versatility if changes in pressures within the distribution system are required in the future, by changing the pumps.

+ Groundwater wells require frequent maintenance to ensure proper operation. By eliminating production wells from the Conestogo Plains (2 wells), West Montrose (4 wells) and Conestogo Golf Course (2 wells) water systems, option 2 allows the Region to reduce the overall operational complexity of its drinking water systems by eliminating all three groundwater supply and the major processes at the treatment facilities. This is turn, results in lower operation and maintenance costs.

+ It eliminates the potential interference and effects on existing private groundwater wells within the capture zone of the Conestogo Plains production wells, by eliminating the need to rely on the Conestogo Plains system, which would be required to pump at higher rates.

+ It provides the opportunity to connect Conestogo Golf Course in the future (similar to Option 3).

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11. Preferred Water Supply Solution

This section describes the preferred water supply solution, as identified and recommended in this Class EA study.

11.1 Overview

The results of the detailed evaluation, value analysis and sensitivity analysis support the selection of the **Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs** as the preferred water supply solution for the service areas of West Montrose and Conestogo. A simplified process schematic of the preferred water supply alternative solution is shown in Figure 17.

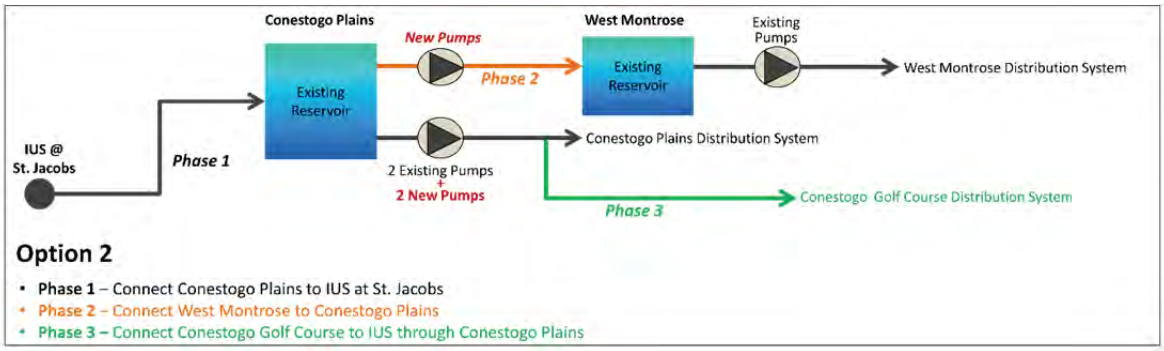

Figure 17 Simplified Process Schematic – Preferred Water Supply Solution

The concept behind the recommended water supply solution comprises the following:

+ To supply water to the West Montrose, Conestogo Plains and Conestogo Golf Course service areas from the Integrated Urban System (IUS) through a single connection to the IUS at St. Jacobs (east of Conestogo Plains). The preferred water supply solution will be implemented as a phased-in option, allowing for an initial connection of the West Montrose and Conestogo Plains service areas to the IUS and providing the opportunity for a future connection of the Conestogo Golf Course service area to the IUS, through Conestogo Plains.

+ Municipal water from the IUS will be transferred through a new municipal watermain to Conestogo Plains and stored at the existing Conestogo Plains reservoir. The existing high lift pumps in Conestogo Plains will continue to be used to convey treated water from the Conestogo Plains reservoir into the Conestogo Plains distribution system, maintaining existing service pressures. Similarly, treated water will also be pumped from the Conestogo Plains reservoir to the West Montrose reservoir, by a new independent set of transfer pumps, for

storage and further distribution to the West Montrose service area. The existing high lift pumps at West Montrose will continue to be used to supply treated water into the distribution system, maintaining existing system pressures. Once connection to the Conestogo Golf Course is provided, two of the existing high lift pumps in Conestogo Plains will be replaced by two new pumps, in order to provide the necessary pressures in the Conestogo Golf Course distribution system.

+ All other existing infrastructure related to supply wells and treatment at Conestogo Plains, West Montrose and Conestogo Golf Course, will be decommissioned as soon as each system is connected to and supplied by the IUS. Adequate disinfection system(s) will be provided, as required.

+ Consistent with current practices, the West Montrose water system will not provide fire flows for the community of West Montrose. The required fire flows for the service areas in Conestogo Plains and Conestogo Golf Course will continue to be provided through the municipal connection.

The preferred water supply solution will also include:

+ Decommissioning of existing West Montrose infiltration wells WM1, WM2, WM3 & WM4

+ Refurbishment of existing treatment facility at West Montrose to satisfy new disinfection requirements and decommissioning of some of the existing treatment equipment

+ Decommissioning of existing Conestogo Plains wells C3 and C4 and treatment system

+ Refurbishment of existing pumping facility at Conestogo Plains to accommodate new transfer pumps for West Montrose

+ 300 mm diameter transmission main between Conestogo Plains and the IUS at St. Jacobs

+ 100 mm diameter transmission main between the Conestogo Plains water supply system and the West Montrose system

+ Future 300 mm diameter transmission main between Conestogo Plains and Conestogo Golf Course

+ Future decommissioning of supply, treatment and storage facilities in Conestogo Golf Course (once Conestogo Golf Course is connected to the system).

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The above major components of the preferred water supply solution, including the routing for the associated distribution and transmission mains are shown in Figure 18.

The recommended water supply alternative solution and the rationale for its selection were presented for comments at the second PCC held on November 20, 2014. This option was considered and officially presented to the public at PCC No.2 as the preliminary preferred solution for the Conestogo and West Montrose service areas, subject to any comments or input received from the public and / or any regulatory agency. Since no objections or major comments were received in regards to the preliminary preferred water supply solution, subsequent to PCC No.2, the project team confirmed Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs as the preferred solution for this Class EA study.

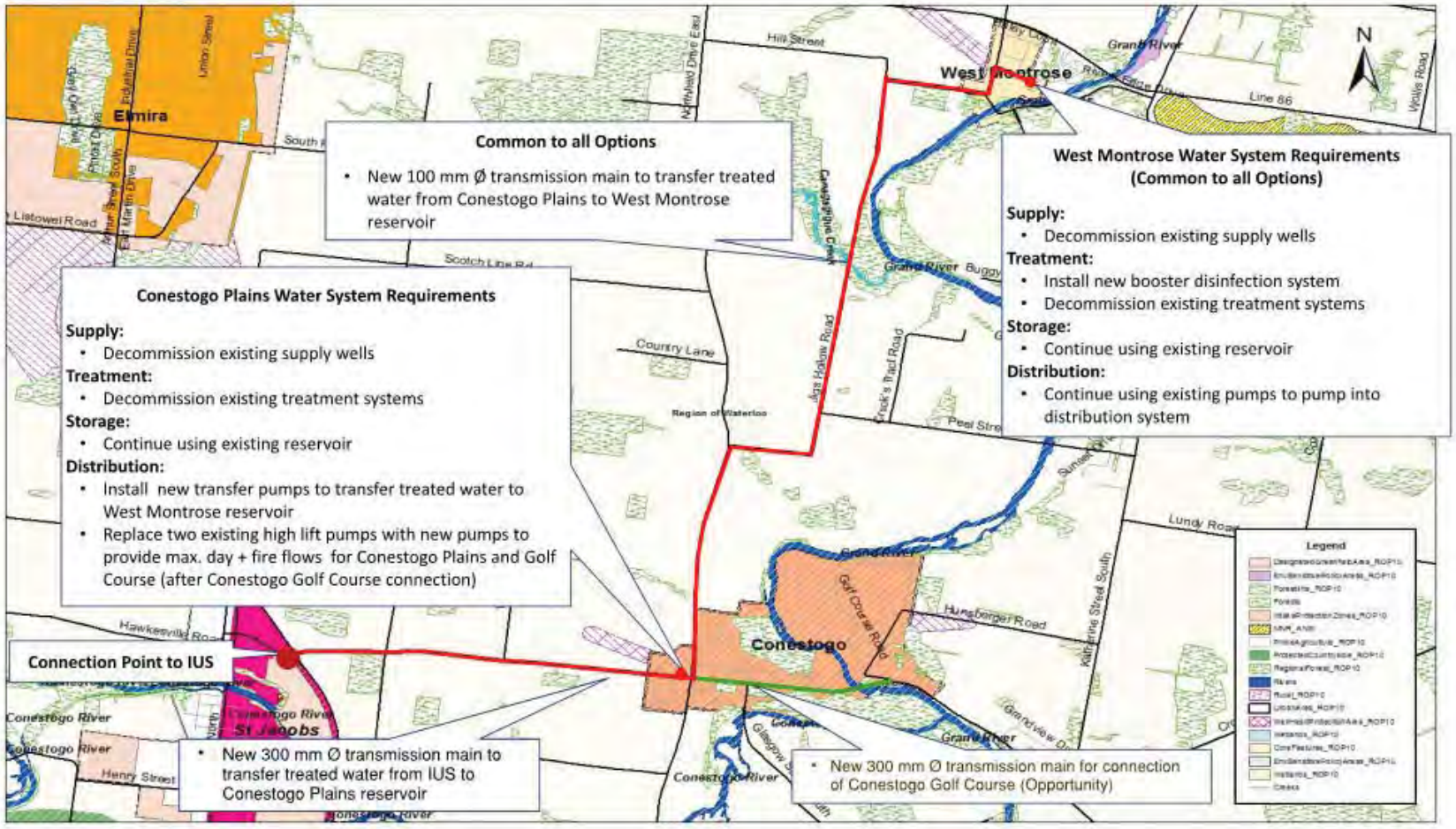

Figure 18 Graphic Representation – Preferred Water Supply Solution

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11.2 Implementation Schedule

The preferred water supply solution is expected to be implemented in three separate phases as follows:

+ Phase 1: Connection from the IUS at St. Jacobs to Conestogo Plains
+ Phase 2: Connection from Conestogo Plains to West Montrose. Once this connection is made, the supply and major treatment systems in West Montrose would be decommissioned.
+ Phase 3: Connection from Conestogo Plains to Conestogo Golf Course. This would also see the replacement of the two existing high lift pumps in Conestogo Plains with new pumps and the decommissioning of supply and treatment systems in Conestogo Golf Course.

The proposed timeline for the completion of the project is shown in Table 26.

Table 26 Project Implementation Schedule

Next Steps	**Proposed Implementation Timeline**
Project File Report – 30 Day Review	Fall 2015
Confirm preferred alternative solution based on comments received during 30-day review period	Fall 2015
Design of Preferred Water Supply Solution	2015 - 2016
Construction	
- St. Jacobs Connection[1]	2017 - 2018
- West Montrose Connection[1]	2018 - 2019
- Conestogo Golf Course Connection[1]	2019 - 2020
Notes: 1. Portions of the watermains will be constructed as part of the roadworks planned for Sawmill Road in 2017	

11.3 Required Permits and Approvals

Permits and approvals required with the proposed works associated with the preferred water supply solution are shown in Table 27.

Table 27 Required Permit and Approvals

Agency	Permit / Approval Description
Ministry of the Environment	• Amendment to Drinking Water Works Permit (IUS, Conestogo Plains, Conestogo Golf Course and West Montrose) • Amendment to Drinking Water License (IUS, Conestogo Plains, Conestogo Golf Course and West Montrose)
Ministry of Natural Resources	• Consultation with MNRF to confirm potential impacts to Species at Risk (SAR)
Grand River Conservation Authority	• For Jiggs Hollow / Canagagigue Creek watermain crossing
Local Utilities	• Utility clearance from local utilities, as required
Township of Woolwich	• Road work permits
Department of Fisheries and Oceans	• Screening for proposed construction within the regulated floodlines may be required.

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12. Proposed Mitigation of Potential Impacts and Monitoring

The following section provides a description of some of the potential impacts that are anticipated during the construction of the preferred water supply system.

As is often the case with construction projects, there is some potential for impacts to the public and environment such as noise, dust, vibration and visuals during the construction period. All construction work will be completed in accordance with the Occupational Health and Safety Act (OHSA) and other local regulations. Specific mitigation measures, as described below, are recommended for implementation to reduce anticipated potential impacts.

12.1 Socio-Cultural Environment

Impacts to the social-cultural environment as a result of construction of the proposed works were assessed in terms of dust, traffic, vibration, noise effects and loss of use at the existing sites and along the proposed watermain sections according to the proposed construction methods.

12.1.1 Noise, Dust , Truck Traffic

Considering that most of construction and decommissioning activities related to the Conestogo Plains, West Montrose and Conestogo Golf Course groundwater systems will be constrained to the property boundaries of the existing sites, the potential impacts to the surrounding social environment will be limited to the residents immediately adjacent to the sites and contiguous access roads, who will experience some construction related impacts (i.e., noise, dust, traffic, loss of use) due to regular construction activities. However, industry standard construction mitigation practices such as the use of fences, and best practices in dust suppression and control will be followed, as necessary.

Increased traffic is expected to last for the duration of construction from the delivery of equipment, materials and removal of any excavated or decommissioned materials from the sites. Although the potential for traffic impacts during the construction phase of this project are expected to be minor within the existing sites; some mitigation measures will be required to address traffic impacts during the construction of the associated distribution and transmission mains.

The potential for noise during construction is considered minor to moderate and is anticipated to be connected to construction traffic and equipment. Noise during operation of the modified groundwater systems in Conestogo Plains and West Montrose will not differ from existing noise conditions.

The proposed recommendation and mitigation measures to reduce or eliminate impacts to the socio-cultural environment include the following:

+ Existing trees and vegetation within the existing sites will buffer surrounding residents from construction related impacts. In terms of aesthetics, there is a moderate to minor potential for visual impacts of water supply infrastructure on private property during construction. An effort will be made to mitigate visual impacts on private property.
+ Due to the nature of this project, dust impacts are unavoidable. Contract documents should be prepared to obligate the contractor to control and minimize airborne dust through the use of measures such as spraying water over and adjacent to the construction areas.
+ Construction of the project will be carried out in accordance with the municipal noise requirements. Appropriate work hours will be specified in the contract. In order to mitigate noise, all vehicles and construction equipment are to be equipped with muffling devices and are to be operated in a noise-minimizing method.
+ Truck access to and from the sites will be limited and avoid residential streets, as much as practically possible. All standard best practices for vehicle and pedestrian safety will be employed throughout the construction areas
+ A traffic control plan will be prepared to mitigate any potential traffic disturbance during construction of the distribution and transmission mains
+ Any lane closures will be completed in accordance with best practices to protect safety to the workers and general public
+ Residents in the area will be informed in advance of any road closures and anticipated timing of the closures, as well as the overall schedule of construction
+ Installation of distribution and transmission mains will be completed with planned road upgrades, where applicable
+ The Region will ensure that the contractors take the necessary precautions to reduce noise disturbance as much as possible

12.2 Natural Heritage Environment

A natural science investigation was conducted by LGL Limited, as part of this Class EA study, to inventory the existing natural heritage conditions within the study area, identify potential environmental impacts associated with the construction of the proposed works, including the proposed distribution and transmission mains, and

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establish approaches to mitigate these possible impacts. A Terms of Reference was circulated to Grand River Conservation Authority (GRCA) and Ministry of Natural Resources and Forestry (MNRF) prior to initiation of the investigation in order to obtain feedback on the proposed effort, survey protocols and field work. The complete Natural Science Report is included in Appendix E for further reference. This section outlines the main issues considered during the assessment including anticipated impacts and proposed mitigating measures.

Construction activities related to watermains installation are anticipated to be restricted to road rights of way and no intrusion to existing natural heritage features is proposed or expected, with the exception of watercourse crossings. Nevertheless, direct and indirect impacts to the natural environment may occur as a result of implementation of this project. Potential identified impacts to the natural environment include:

+ Direct impacts may include removal of vegetation and direct and indirect disturbance to fish and wildlife and their habitats as a result of construction activities. Direct impacts to communities and aquatic habitats associated with the Grand River and Canagagigue Creek, and their corridors, can also result, particularly in the areas where installation of watermains is proposed to cross or lie in close proximity to the associated valleylands of these watercourses.

+ There is potential for sediment to enter the watercourses from adjacent construction activities, aquatic habitat disturbance from construction commotion and potential impacts associated with the removal of riparian vegetation including bank destabilization.

Site-specific mitigation measures need to be confirmed during detailed design of the project to protect both terrestrial and aquatic environments; however, the following recommended mitigation measures and timing windows should be employed as a minimum for works related to the construction of watermains:

+ An Erosion and Sediment Control Plan should be developed and implemented to monitor and mitigate impacts of construction to adjacent vegetation communities and watercourses.

+ Prior to commencement of construction, all appropriate erosion and sediment control measures (such as silt fencing) should be installed and maintained (with regular inspection) during construction and until the site has been stabilized.

+ Any vegetation removal (including dead standing trees) may be influenced by conditions set by the *Migratory Birds Convention Act* (MBCA) including, but not limited to, timing restrictions during breeding season for tree pruning or removal

during construction activities. Construction activities planned during the breeding bird season (typically from March 25 to August 31) should be avoided to the greatest extent. If unavoidable, construction should only be completed after a qualified avian biologist has completed a bird nesting survey to ensure no impacts to breeding birds to maintain compliance with the MBCA.

+ Adhere to construction timing windows to avoid impacts to fish where works are proposed within, or in proximity to, fish habitat. Avoid construction during sensitive periods for fish (spawning). Warmwater timing window typically extends from July 1 to March 31. A Department of Fisheries and Oceans (DFO) screening may be required for proposed construction within the regulated flood lines. In addition, consultation with DFO should be carried out to determine appropriate operational statements for watercourse crossings and anticipated contingency method.
+ Utilize trenchless technology for installation of piping across watercourses and sensitive wetland communities to avoid impacts to aquatic species, including fish and mussel SAR.
+ Refuelling of equipment and fuel storage will be conducted at a safe distance from the watercourses at a designated location, along with spill protection.
+ Complete hydrogeological and geotechnical assessments, to ensure no temporary or permanent impacts to adjacent surface water features through the construction methods proposed.
+ Minimize the construction footprint within proximity to the riparian area of watercourses.
+ Restore areas with native vegetation upon completion to the character similar to the surrounding vegetation communities.
+ Seed area with native seed mix for the appropriate conditions on all disturbed areas to stabilize area prior to re-vegetation
+ Plant areas with tree and shrubs to compensate for removal.
+ Apply appropriate setbacks to Grand River and Canagagigue Creek, and associated wetlands and wooded areas in order to maintain the character and quality of the natural areas providing habitat.
+ Clearly demarcate setbacks from natural features and edge of disturbance limits with the installation of silt fencing to protect remaining natural vegetation communities and associated wildlife habitat.

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+ Clearing and disturbance of floodplain vegetation should be kept to a minimum where possible, to avoid disturbance to the riparian areas, and prevent soil compaction; and

Other proposed infrastructure works such as decommissioning of and upgrades to existing water supply components, as outlined in this report, will be within existing cleared areas or within the site footprint. General mitigation measures for these infrastructure works consist of the following:

+ Fencing will help to isolate the construction area and help to deter wildlife from entering the work zone.

+ Nest search completed prior to removal of building components, to ensure that SAR birds are not using structures.

+ Refueling of equipment and fuel storage to be conducted at a safe distance from the watercourses at a designated location, along with the implementation of spill protection.

+ Tree removal and or pruning is recommended to be completed by a qualified arborist or tree professional, within the appropriate timing window, for protection of breeding birds as regulated by the Migratory Birds Convention Act, 1994.

12.3 Geotechnical and Hydrogeological Conditions

A preliminary geotechnical investigation has been carried out by Golder Associates to confirm the proposed watermain alignments and installation methodology. The Geotechnical and Preliminary Hydrogeological Investigation Report can be found in Appendix F in this report.

The initial proposed water supply line installation involved open-cut excavation and backfill along the watermain route where possible and trenchless watermain pipe installation methods at the water course crossings (i.e. Grand River and Canagagigue Creek).

12.3.1 Open Cut Excavation

An open cut excavation involves trench excavation and excavation sidewall support, bedding and pipe installation, trench backfilling and pavement restoration. The open cut method offers the best control of gradient and alignment, reduces the potential for delays resulting from encountering obstructions and provides the least risk of unanticipated damage to the active roadways.

The major disadvantages with an open cut installation include traffic disruption and potential for post construction settlement of the backfill materials. General mitigation measures for open cut excavation are:

+ Proper construction staging to minimize traffic disruption.
+ Placement of the pipe bedding must be carried out in the dry.
+ The bedding and cover material should be placed in 150 mm thick loose lifts and uniformly compacted to at least 95 per cent of the materials Standard Proctor Maximum Dry Density (SPMDD) using suitable vibratory compaction equipment.
+ The trench be backfilled with Granular B Type 1 compacted to 100 per cent of SPMDD below or crosses existing roadways. Elsewhere the backfill may consist of the excavated soil compacted to 95 per cent SPMDD.
+ Close supervision for placing and compacting of backfill materials due to space constraints in the narrow confines of trenches.
+ Place clay plugs in the trenches at 50 m intervals (or less) along the full length of the trench, where the invert of the trench is below the water table to minimize the extent of groundwater lowering.

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12.3.2 Trenchless Installation Methods

The water line crossings of the Grand River and Canagagigue Creek were initially proposed to be installed using trenchless installation methods. The predominant soils at these sites consist of saturated, granular soil deposits typically varying in composition from gravelly sand to sandy gravel. Based on grinding during drilling, and increased resistance to augering, these deposits are inferred to contain cobbles and potentially boulders. These soil deposits pose significant constraints to any trenchless installations due to the large water inflows that would occur into excavation/shaft areas, the potential for hole instability/loss of ground and the potential for encountering obstructions.

Trenchless methods that use open face excavation methods are not considered feasible. The use of closed-face, microtunneling methods would be the lowest risk option for installation through these materials but such methods are generally considered to be not economical for the diameter and size of crossings considered.

The use of Horizontal Directional Drilling (HDD) methods could be considered for the proposed water line installations. However, the coarse granular nature and, in particular the presence of cobbles and large proportions of gravel, will pose significant difficulties and risks with HDD methods.

12.3.3 Watermain Support from Bridges

The geotechnical investigation identified high risks and complexities anticipated with trenchless installation of watermains at river crossings. An alternate to trenchless methods is to support watermains from bridges. A technical memorandum investigating watermain suspension from bridge structures is included in Appendix I.

Supporting watermain from bridge is fairly common practice in Ontario and throughout the world where buried utility crossings are not reasonable due to complexity, environmentally sensitive areas, significant costs or property constraints. There are many examples of both existing structures and new bridge projects in Ontario where mains are being suspended from bridge infrastructure.

Based upon a review of the available bridge drawings and biennial inspection report for Sawmill Road Grand River Bridge at Grand River and Jigs Hollow Bridge at Canagagigue Creek, the additional watermain loads are considered negligible, and thus structural capacity is not anticipated to be an issue.

The recommended watermain support from bridges and associated mitigation measures include:

+ Grand River Bridge: there is an existing set of utilities suspended from the deck soffit between the exterior girder and first interior girder on the north side of the bridge. The remaining space between the girders is limited but the watermain could be accommodated in the same manner between the exterior girder and first interior girder on the south side of the bridge.
+ Jigs Hollow Bridge: the watermain can be suspended between the girders but sleeves through the concrete diaphragms would be required in addition to the sleeves through the abutment ballast walls.
+ Insulation and potentially heat tracing required to maintain the exposed pipes.
+ Protection and care required for future rehabilitation work on the bridge in vicinity of the watermain.
+ Preventive measures for bird nesting or public climbing onto the pipes.

12.4 Cultural Heritage Environment

For identification and evaluation of the cultural heritage resources located in the project area, a Preliminary Design Report was completed to inventory existing structures and landscapes. The report can be found in Appendix H.

A number of significant cultural heritage resources were identified adjacent to the project area, notably in the villages of Conestogo and West Montrose. The evaluation suggested no long-term negative impacts to any of the identified resources, and as such the completion of a Heritage Impact Assessment (HIA) for the project is not required.

Temporary impacts to identified cultural heritage resources during construction should be mitigated in an effort to mitigate impacts to the surrounding structures. The mitigation measures include:

+ Vibration monitoring during construction
+ Many of the buildings inventoried, notably those in Conestogo, as well as 52 Hill St. (Albright House) and 17 Covered Bridge Dr. in West Montrose, have very limited set backs from the road right of way. Care should be taken during construction to monitor and mitigate any potential impacts to these resources.
+ Further cultural heritage evaluation prior to construction if the proposed project plans change in nature or scope.

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12.5 Stage 1 Archeological Assessment

A stage 1 archeological assessment was completed by Archeoworks for Water Supply Alternative Solution No. 2 project area. The report can be found in Appendix G.

The Stage 1 background research identified archaeological potential for the recovery of Aboriginal and Euro-Canadian archaeological remains within undisturbed portions of the study corridor due to its close proximity (within 300 metres) to historic structures and historic villages, several historic transportation routes, designated and listed cultural heritage resources, the West Montrose Cultural Heritage Landscape, a commemorative plaque, previously registered archaeological sites, two historic pioneer cemeteries and primary water sources.

A property inspection has revealed that the study corridor is situated within a primarily rural setting, and traverses through the communities of West Montrose and Conestogo. Based on the results of the background research and property inspection, the following recommendations are presented:

+ Areas that exhibit disturbed conditions, as described within Section 3.1 of the Archeological Assessment Report, are recommended to be exempt from a Stage 2 AA.
+ Physiographic features of no or low archaeological potential as described within Section 3.2 of the Archeological Assessment Report are recommended to be exempt from a Stage 2 AA.
+ All identified undisturbed segments which contain archaeological potential as described within Section 3.3 must be subjected to a Stage 2 AA at five meter intervals.
    - Given the study corridor is a narrow linear corridor (10 meters or less) for the most part, as per Section 2.1.2, Standard 1.f of the 2011 S&G, in situations where there are planned impacts 10 meters or less beyond the previously impacted limits on both sides of the existing roadway, a test pit survey at five meter transects may be undertaken.
    - Where at the time of fieldwork the lands within the linear corridor meet the standards of pedestrian survey land preparation, as per Section 2.1.1, Standards 2 and 3 , a pedestrian survey at five meter transects must be carried out in accordance Section 2.1.1 of the 2011 S&G.

- Within areas of ploughed agricultural fields measuring wider than 10 meters, those fields must be ploughed and subjected to appropriate weathering requirements prior to field investigation, in accordance with Section 2.1.1 of the 2011 S&G. followed by pedestrian survey at five-metre transects.

+ Further archeological investigation will be required prior to construction activities extended beyond the assessed limits of the study corridor, in order to minimize impacts to archeological resources.

12.6 Public Consultation

Public consultation will continue to be an integral aspect throughout the design and construction of the preferred water supply solution. The Region's website will be regularly updated with project details, and neighbouring residents will be kept informed throughout the process.

APPENDIX A
Project Notices

NOTICE OF STUDY COMMENCEMENT

Class Environmental Assessment Study

Conestogo Plains Water Supply System

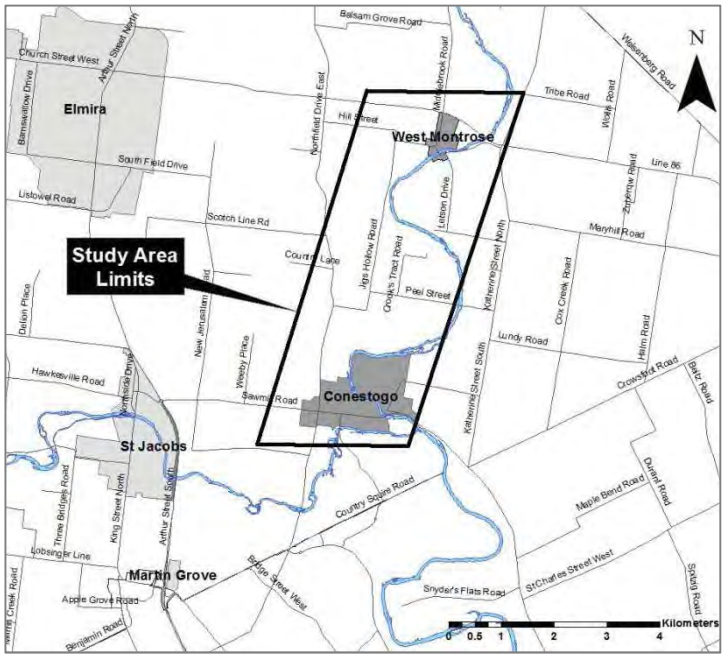
Background

Conestogo and West Montrose are two rural communities in the north-east area of the Region of Waterloo (Region), in the Township of Woolwich (Township). Water services to these communities are provided through a coordinated effort between the Region, responsible for the supply, and the Township, responsible for the distribution. The Conestogo Plains and the West Montrose Water Supply Systems are two separate groundwater systems servicing the western part of the community of Conestogo and the community of West Montrose, respectively.

In January 2013, the Region completed the West Montrose Class Environmental Assessment (Class EA) study to address water supply issues and operational challenges experienced in the West Montrose water system. The 2013 Class EA recommended a permanent connection from West Montrose to the Conestogo Plains water supply system to ensure a sustainable, long-term water supply solution to the community of West Montrose. The Conestogo Plains water supply system currently operates well below its existing rated capacity and the water quality is considered generally good, providing an opportunity to also supply the West Montrose system and some properties in the Conestogo community currently on private wells.

Class EA Study for the Conestogo Plains Water Supply System

In advance of implementation of the recommendations of the 2013 West Montrose Class EA study, the Region has identified the opportunity to undertake a holistic approach to assessing the overall servicing requirements for both the Conestogo Plains and the West Montrose service areas in a socially, environmentally and financially responsible manner.



As such, the Region is initiating a Class EA study to complete a comprehensive examination of the water supply alternative solutions for the Conestogo Plains and West Montrose areas. This Class EA study is being conducted in accordance with the requirements of a Schedule B project of the *Municipal Class Environmental Assessment document* (Municipal Engineers Association, October 2000 as amended in 2007 & 2011).

The feasibility of connecting West Montrose to the Conestogo Plains water supply system and other alternatives including a potential connection to the Integrated Urban System will be considered during the Conestogo Plains Water Supply System Class EA study.

Your Opinion Matters

The Region will consult with the public and review agencies throughout the Class EA study. Public Consultation Centres (PCCs) will be held to provide information on the study progress and to facilitate your input. We will publish invitation notices to the PCCs in local newspapers. More information about this project will be available on the Region's website (www.regionofwaterloo.ca/water).

Contact Us

We are interested in hearing any comments or concerns that you might have about this project. Please contact either of the project team members below if you have questions or comments, wish to obtain more information on the project, or would like to be included on the Project Contact List:

Dominika Celmer- Repin, Ph.D., P.Eng.
Project Manager, Water Services Division
Region of Waterloo
150 Frederick Street
Kitchener ON N2G 4J3
Telephone: 519-575-4757 ext. 4095

Eric Tuson, P.Eng.
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7
Telephone: 289-288-0287 Ext. 6839

NOTICE OF PUBLIC CONSULTATION CENTRE No.1

Class Environmental Assessment Study

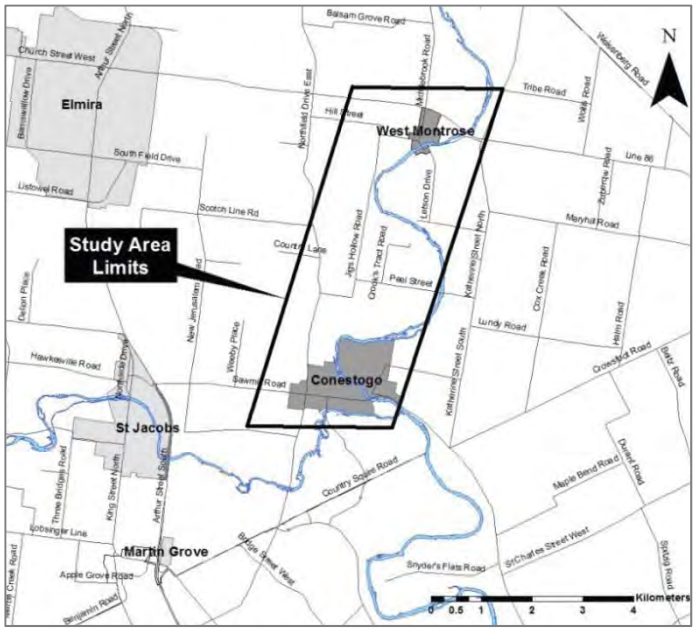
Conestogo Plains Water Supply System

Background

In January 2013, the Region of Waterloo (Region) completed the West Montrose Class Environmental Assessment (Class EA) study that recommended a permanent connection from West Montrose to the Conestogo Plains water supply system to ensure a sustainable and long-term water supply option to the community of West Montrose. The Conestogo Plains water supply system currently operates well below its existing rated capacity and the water quality is considered good, providing an opportunity to supply the West Montrose system in addition to the whole community of Conestogo.

Class EA Study for the Conestogo Plains Water Supply System

In August 2013, the Region initiated a Class EA study to confirm the feasibility of servicing West Montrose from the Conestogo Plains system.



This study is being conducted in accordance with the requirements of a Schedule B project of the *Municipal Class Environmental Assessment document* (Municipal Engineers Association, October 2000 as amended in 2007 & 2011).

Through the initial steps of the Class EA process, potential water supply options for servicing the West Montrose and Conestogo communities have been identified and assessed. The preliminary assessment explored the feasibility of supplying West Montrose from the existing Conestogo Plains water supply system, and also other options including a potential connection of these communities to the City of Waterloo.

In the next stages of this study, water supply options will be subjected to more detailed evaluation considering technical/natural environment impacts, social / community impacts and cost impacts. The preferred water supply option will be selected to minimize potential impacts to the environment and community and maximize the opportunity to provide sustainable and reliable water servicing to the West Montrose and Conestogo communities.

Your Opinion Matters

Public consultation is a key component of this Class EA study. A first Public Consultation Centre is planned to provide introductory information about the project and present results of preliminary activities completed to-date and to obtain your feedback. The first Public Consultation Centre will be held:

Date:	Tuesday, March 18, 2014
Time:	5:30 p.m. – 7:30 p.m.
Location:	Conestoga Golf & Country Club Club Room (1st floor, wheelchair accessible) 400 Golf Course Road Conestogo, ON, N0B 1N0

You are encouraged to attend the Public Consultation Centre to discuss and provide your comments to the project team. Comments received through the course of the study will be considered in finalizing the preferred solution.

Contact Us

If you are unable to attend, we would still like to hear from you. Please contact either of the project team members below if you have questions or comments, wish to obtain more information on the project, or would like to be included on the Project Contact List:

Dominika Celmer- Repin, Ph.D., P.Eng.
Project Manager, Water Services Division
Region of Waterloo
150 Frederick Street
Kitchener ON N2G 4J3

Eric Tuson, P.Eng.
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7

NOTICE OF PUBLIC CONSULTATION CENTRE No.2

Class Environmental Assessment Study

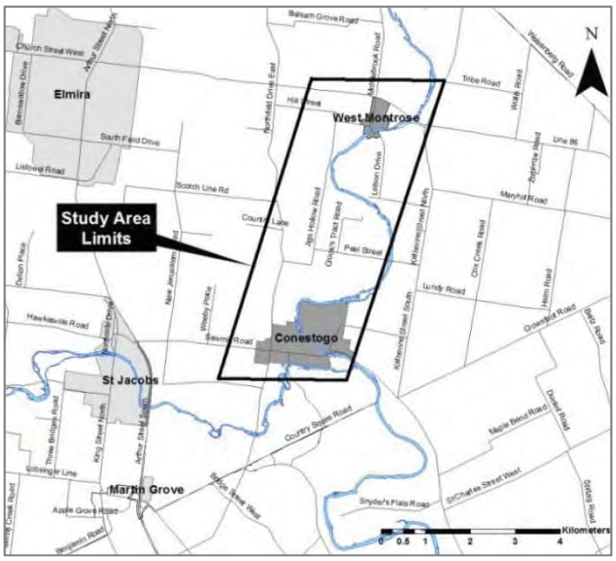
Conestogo Plains Water Supply System

Background

In January 2013, the Region of Waterloo (Region) completed the West Montrose Class Environmental Assessment (Class EA) study that recommended, subject to a detailed review of the Conestogo Plains system, a permanent connection from West Montrose to the Conestogo Plains water supply system to ensure a sustainable and long-term water supply option to the community of West Montrose.

Class EA Study for the Conestogo Plains Water Supply System

In August 2013, the Region initiated a Class EA study to confirm the feasibility of using the Conestogo Plains system to also supply West Montrose. As part of this study, several alternatives for servicing both communities were identified and evaluated based on social/community, technical/natural environment and economic impacts and available mitigation measures.



The Class EA study is being conducted in accordance with the requirements of a Schedule B project of the *Municipal Class Environmental Assessment* document (Municipal Engineers Association, October 2000 as amended in 2007 & 2011).

A preliminary preferred water supply solution that comprises supplying the West Montrose and Conestogo Plains service areas from the Region's Integrated Urban System (IUS) at St. Jacobs has been selected. This solution offers the opportunity to also connect the Conestogo Golf Course service area to the IUS in the future. The preliminary preferred water supply solution has been selected to minimize potential impacts and maximize the opportunity to provide sustainable and reliable water servicing to the West Montrose and Conestogo communities.

Your Opinion Matters

Public consultation is a key component of this Class EA study. A first Public Consultation Centre was held on March 18, 2014 to introduce the project, present results of preliminary activities completed to-date and obtain your feedback.

A second Public Consultation Centre will be held to present the results of the evaluation process, introduce the preliminary preferred water supply solution and gather your feedback before any final decision is made. The second Public Consultation Centre will be held:

Date:	Thursday, November 20, 2014
Time:	5:30 p.m. – 7:30 p.m.
Location:	Conestoga Golf & Country Club Club Room (1st floor, wheelchair accessible) 400 Golf Course Road Conestogo, ON, N0B 1N0

You are encouraged to attend the Public Consultation Centre to discuss and provide your comments to the project team. Comments received through the course of the study will be considered in finalizing the preferred solution.

Contact Us

If you are unable to attend, we would still like to hear from you. Please contact either of the project team members below if you have questions or comments, wish to obtain more information on the project, or would like to be included on the Project Contact List:

Pam Law
Project Manager, Water Services
Region of Waterloo
150 Frederick Street, 7th Floor
Kitchener, Ontario, N2G 4J3
Telephone: 519-575-4095

Eric Tuson, P.Eng.
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7
Telephone: 289-288-0287 Ext. 6839

Region of Waterloo

NOTICE OF COMPLETION
Class Environmental Assessment Study
Conestogo Plains Water Supply System

In August 2013, the Region initiated a Class Environmental Assessment (EA) study to confirm the feasibility of using the Conestogo Plains system to also supply West Montrose. As part of this study, several alternatives to ensure long term sustainable water supply to both communities were identified and evaluated.

The Class EA study has been conducted in accordance with the requirements of a Schedule B project of the Municipal Class Environmental Assessment document (Municipal Engineers Association, October 2000 as amended in 2007 & 2011).

The Class EA has identified that the preferred water supply solution, for the West Montrose and Conestogo Plains service areas is the connection to the Region's Integrated Urban System (IUS) at St. Jacobs. This solution offers the opportunity to also connect the Conestogo Golf Course service area to the IUS in the future. The preferred water supply solution has been selected to minimize potential impacts and maximize the opportunity to provide sustainable and reliable water servicing to the West Montrose and Conestogo communities.

Your Opinion Matters

A Project File Report (PFR) documenting the planning and decision making process followed during the Class EA study has been prepared. By this notice, the PFR is being placed on the public record for a 30-day review period. Subject to comments received as a result of this Notice and the receipt of all necessary approvals, the Region intends to proceed with the detailed design and construction of the Conestogo Plains Water Supply System project as documented in the PFR.

The report will be available for public review starting on September 16, 2015, until October 16, 2015. The Report will be available online at **www.region.waterloo.on.ca/water** and at the following locations during normal business hours:

Region of Waterloo Clerk's Office 150 Frederick Street, 2nd Floor Kitchener, ON N2G 4J3 Phone: 519-575-4420	Township of Woolwich Clerk's Office 24 Church Street West Elmira, ON N3B 2Z6 Phone: 519-669-1647

Materials are available in alternate formats upon request.

Contact Us

Interested persons should provide written comments regarding the project within the prescribed review period to either of the following individuals:

Pam Law, P. Eng.
Senior Project Engineer, Water Services
Region of Waterloo
150 Frederick Street, 7th Floor
Kitchener, Ontario, N2G 4J3
Telephone: 519-575-4095
Fax: 519-575-4452
Email: PLaw@regionofwaterloo.ca

Eric Tuson, P.Eng.
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7
Telephone: 289-288-0287 Ext. 6839
Fax: 289-288-0285
Email: Eric.Tuson@cima.ca

If concerns arise during the prescribed review period that cannot be resolved through discussions with the Region, a person or party may request that the Minister of Environment and Climate Change make an order for the project to comply with Part II of the Environmental Assessment Act. This request (commonly referred to as a Part II Order) must be received within the above prescribed review period by the Minister at the address listed below and copied to Ms. Pam Law at the Region of Waterloo. If no request is received on or before October 16, 2015, the Region intends to proceed with detailed design and construction of the project.

The Honourable Glen Murray
Minister of the Environment and Climate Change
11th Floor, Ferguson Block
77 Wellesley Street West
Toronto, ON, M7A 2T5

APPENDIX B
Public Consultation

APPENDIX B.1

Public Correspondence

Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday March 18th, 2014
Conestoga Golf & Country Club – Club Room

SING-IN SHEET

NAME	ADDRESS	EMAIL
DENTON GAISER	[redacted]	
Judi + David Keegin		
JOHN & TERESA LACKNER		
John Chinnick		
Rick Pedersen		
Lynn Hare		
SCOTT DAHMER		
NATHAN HALLMAN		
Ken & Sue Schwark		
Matt Muller		
Bernie Marshall		
DAVE KRAMP		

COLLECTION NOTICE

Personal information requested on this form is collected under the authority of the Municipal Act, and will be used to assist the Region of Waterloo in making a decision on this project. Any personal information such as name, address, telephone number, and property location included in a submission from the public may become part of the public record file for this matter.

Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday March 18th, 2014
Conestoga Golf & Country Club – Club Room

SING-IN SHEET

NAME	ADDRESS	EMAIL
[illegible] Phillips	[redacted]	
GORDON HAYWOOD		

COLLECTION NOTICE

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Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday, March 18, 2014
Conestoga Golf & Country Club – Club Room

COMMENT SHEET

The Region of Waterloo is interested in hearing any comments, questions or concerns that you may have regarding the Conestogo Plains Water Supply System project. This study is being conducted according to the requirements of a Schedule B project of the *Municipal Class Environmental Assessment* document (Municipal Engineers Association, October 2000 as amended in 2007 & 2011). Please take some time to complete this Comment Sheet. All comments will be carefully considered in the Class Environmental Assessment Study. Please drop your completed Comment Sheet today in the box provided, or send it to either of the following individuals (see below) by **April 2, 2014**:

Dominika Celmer-Repin
Project Manager, Water Services
Region of Waterloo
150 Frederick Street, 7th Floor
Kitchener, Ontario, N2G 4J3
Telephone: 519-575-4757 Ext.3864
Fax: 519-575-4452
Email: Dcelmer-Repin@regionofwaterloo.ca

Eric Tuson
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7
Telephone: 289-288-0287 Ext. 6839
Fax: 289-288-0285
Email: eric.tuson@cima.ca

1. Do you have any comments, concerns, questions or suggestions regarding the purpose and the need for this project?

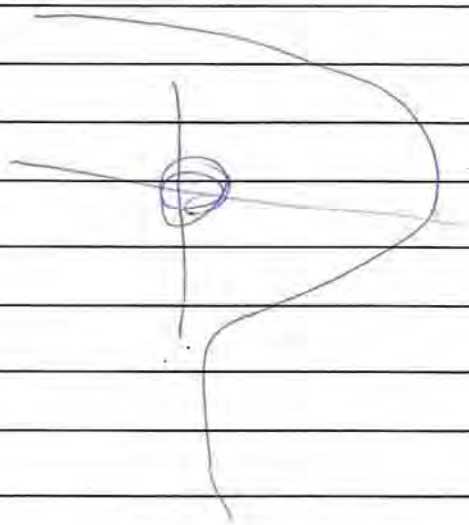
Chloramene - concentrates at dangerous levels

Nith River - Grand River Flooding.

COLLECTION NOTICE

Personal information requested on this form is collected under the authority of the Municipal Act, and will be used to assist the Region of Waterloo in making a decision on this project. Any personal information such as name, address, telephone number, and property location included in a submission from the public may become part of the public record file for this matter. Questions regarding this collection should be forwarded to the Region's staff member indicated above.

2. **Please describe any elements, aspects or features that you feel should be considered during the evaluation and selection of the preferred water supply solution**



Thank you for your participation. All comments will be considered in selecting and finalizing the preferred solution. Please provide your contact information below should you wish to be added to our Project Mailing List.

NAME: _____
(please print)

ADDRESS: _____

POSTAL CODE: _____

COLLECTION NOTICE

Personal information requested on this form is collected under the authority of the Municipal Act, and will be used to assist the Region of Waterloo in making a decision on this project. Any personal information such as name, address, telephone number, and property location included in a submission from the public may become part of the public record file for this matter. Questions regarding this collection should be forwarded to the Region's staff member indicated above.

Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday, March 18, 2014
Conestoga Golf & Country Club – Club Room

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Project Manager, Water Services
Region of Waterloo
150 Frederick Street, 7th Floor
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Telephone: 519-575-4757 Ext.3864
Fax: 519-575-4452
Email: Dcelmer-Repin@regionofwaterloo.ca

Eric Tuson
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7
Telephone: 289-288-0287 Ext. 6839
Fax: 289-288-0285
Email: eric.tuson@cima.ca

1. Do you have any comments, concerns, questions or suggestions regarding the purpose and the need for this project?

My Husband & I would like to stay on Water from Sawmill Rd. Thats in Conestogo Plains Water Supply System not from Kitchener as Safety is not from Kitchener =

COLLECTION NOTICE

Personal information requested on this form is collected under the authority of the Municipal Act, and will be used to assist the Region of Waterloo in making a decision on this project. Any personal information such as name, address, telephone number, and property location included in a submission from the public may become part of the public record file for this matter. Questions regarding this collection should be forwarded to the Region's staff member indicated above.

2. **Please describe any elements, aspects or features that you feel should be considered during the evaluation and selection of the preferred water supply solution**

Thank you for your participation. All comments will be considered in selecting and finalizing the preferred solution. Please provide your contact information below should you wish to be added to our Project Mailing List.

NAME: MONA PHILLIPI
(please print)

ADDRESS: [redacted]

POSTAL CODE: [redacted]

COLLECTION NOTICE

Personal information requested on this form is collected under the authority of the Municipal Act, and will be used to assist the Region of Waterloo in making a decision on this project. Any personal information such as name, address, telephone number, and property location included in a submission from the public may become part of the public record file for this matter. Questions regarding this collection should be forwarded to the Region's staff member indicated above.

Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday, March 18, 2014
Conestoga Golf & Country Club – Club Room

COMMENT SHEET

The Region of Waterloo is interested in hearing any comments, questions or concerns that you may have regarding the Conestogo Plains Water Supply System project. This study is being conducted according to the requirements of a Schedule B project of the *Municipal Class Environmental Assessment* document (Municipal Engineers Association, October 2000 as amended in 2007 & 2011). Please take some time to complete this Comment Sheet. All comments will be carefully considered in the Class Environmental Assessment Study. Please drop your completed Comment Sheet today in the box provided, or send it to either of the following individuals (see below) by **April 2, 2014**.

Dominika Celmer-Repin
Project Manager, Water Services
Region of Waterloo
150 Frederick Street, 7th Floor
Kitchener, Ontario, N2G 4J3
Telephone: 519-575-4757 Ext.3864
Fax: 519-575-4452
Email: Dcelmer-Repin@regionofwaterloo.ca

Eric Tuson
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7
Telephone: 289-288-0287 Ext. 6839
Fax: 289-288-0285
Email: eric.tuson@cima.ca

1. Do you have any comments, concerns, questions or suggestions regarding the purpose and the need for this project?

Option 1 - additional Risk that existing private wells may be impacted by additional pumping from wells in Conestogo.

was a private well owner in conestogo plates I do not want to be forced onto municipl supply, but

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would like to know opportunity costs benefits ~~details~~ for potential connection to municiple water supply.

2. **Please describe any elements, aspects or features that you feel should be considered during the evaluation and selection of the preferred water supply solution**

As long as there is no impact to local property owners Option 1 seems to make sense.

Option 2/3 provides risk mitigation for future supply issues.

Thank you for your participation. All comments will be considered in selecting and finalizing the preferred solution. Please provide your contact information below should you wish to be added to our Project Mailing List.

NAME: John Chinnick
(please print)

ADDRESS: [redacted]

POSTAL CODE: [redacted]

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Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday, March 18, 2014
Conestoga Golf & Country Club – Club Room

COMMENT SHEET

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1. Do you have any comments, concerns, questions or suggestions regarding the purpose and the need for this project?

I HAVE A SHALLOW WELL (APPROX. 20' DEEP) - I HAVE SEEN A DECREASE IN THE WELL WATER LEVEL AFTER THE CONESTOGO WELLS WENT INTO SERVICE. MY CONCERN IS THAT IF MORE WATER IS TAKEN FROM THESE WELLS - WILL MY WELL BE COMPROMISED?

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2. **Please describe any elements, aspects or features that you feel should be considered during the evaluation and selection of the preferred water supply solution**

I LIKE THE IDEA OF CONNECTING TO WATERLOO'S SUPPLY, WITH THE POSSIBILITY OF CONNECTING TO THE MUNICIPAL SUPPLY.

Thank you for your participation. All comments will be considered in selecting and finalizing the preferred solution. Please provide your contact information below should you wish to be added to our Project Mailing List.

NAME: SCOTT DAHMER
(please print)

ADDRESS: [redacted]

POSTAL CODE: [redacted]

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Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday, March 18, 2014
Conestoga Golf & Country Club – Club Room

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1. Do you have any comments, concerns, questions or suggestions regarding the purpose and the need for this project?

We like the water quality of the Plains wells and prefer not to be connected to the LHS and consume that quality of water.

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I realize connection to IUS would provide steady water supply, but power outs are infrequent and periods without water aren't much of a hardship.

2. **Please describe any elements, aspects or features that you feel should be considered during the evaluation and selection of the preferred water supply solution**

- would be interested to know the effects increased pumping rates would have on the quality of Plains water. (iron, manganese).

Thank you for your participation. All comments will be considered in selecting and finalizing the preferred solution. Please provide your contact information below should you wish to be added to our Project Mailing List.

NAME: DAVE KRAMP
(please print)

ADDRESS: [redacted]

POSTAL CODE: [redacted]

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Region of Waterloo

RECEIVED
MAR 2 4 2014
WATER SERVICES

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday, March 18, 2014
Conestoga Golf & Country Club – Club Room

COMMENT SHEET

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1. Do you have any comments, concerns, questions or suggestions regarding the purpose and the need for this project?

Concerns: 1) Water level in our wells will be affected.
2) Quality of water may be affected.
3) Who is responsible for the costs involved in remedying any of these effects?

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2. **Please describe any elements, aspects or features that you feel should be considered during the evaluation and selection of the preferred water supply solution**

Using the water system from Waterloo would not impact on Conestoga residents' wells.

Thank you for your participation. All comments will be considered in selecting and finalizing the preferred solution. Please provide your contact information below should you wish to be added to our Project Mailing List.

NAME: David and Judi Kergin
(please print)

ADDRESS: [redacted]

POSTAL CODE: [redacted]

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Cassie Sining Liu

From: Pam Law <PLaw@regionofwaterloo.ca>
Sent: Tuesday, March 25, 2014 12:14 PM
To: [redacted]
Cc: Dominika Celmer-Repin; Eric Tuson; Sandra Rodriguez; Richard Sigurdson
Subject: RE: Conestogo Plains Water Supply

Hi Robert,

I'd like to start by introducing myself, my name is Pam Law and I will be taking over management of this project for the Region.

The intent of this project is to look only at the water supply for the communities of Conestogo and West Montrose. Water supply is the responsibility of the Region. This study will be ensuring that there is sufficient water supplied from the preferred solution to allow residents who are not currently connected to the system to connect, if they desire in the future. This study is not looking at the cost or the timing of expanding the current distribution system. This will be looked at and decided on by the Township following completion of this project.

If you have any further questions regarding connection to the distribution system, you may connect Richard directly.

Thanks
Pam

Pam Law, P. Eng.
Senior Project Engineer
Region of Waterloo
Water Services
PLaw@regionofwaterloo.ca
519-575-4095

From: Robert Baxter[redacted]
Sent: Monday, March 24, 2014 10:04 AM
To: Dominika Celmer-Repin
Subject: Conestogo Plains Water Supply

Greetings Dr Celmer-Repin,

I am inquiring about obtaining water service to a vacant lot I own at[redacted], Conestogo.

I have received the Notice of Public Consultation for the Class EA for providing water to West Montrose.

I wondered if water service is available to properties in the Village of Conestogo? My lot is near Sawmill just one property off Sawmill on Misty River.

Pls advise if servicing could be available or direct me to the appropriate individual or department.

Regards, Bob

Robert Baxter, P. Eng., CCIM

Cassie Sining Liu

From: Pam Law <PLaw@regionofwaterloo.ca>
Sent: Wednesday, March 26, 2014 2:31 PM
To: [redacted]
Cc: Sandra Rodriguez; Eric Tuson; Dominika Celmer-Repin
Subject: RE: Conestogo Plains Water Supply

Murray,

Thank you for your email and for providing your input on the project. We actually completed a study in early 2013 which looked at the West Montrose water supply system. As part of this project we did a thorough investigation of the existing infiltration wells, other local groundwater sources, surface water sources and connections to existing water supplies. Here is a copy to the final report if you are interested:

http://www.regionofwaterloo.ca/en/aboutTheEnvironment/resources/FiinalReportWestMontroseWaterSupplyClassEAJanuary2013.pdf

There is a table on pages 4 – 6 which provides a summary of the advantages and disadvantages of all of the alternatives that were looked at as part of the study. The study found that there were no improvements that could be made to the existing infrastructure that would make it able to provide adequate water for the existing community.

I hope this responds to your comments. If you have any further questions, feel free to contact me.

Pam Law, P. Eng.
Senior Project Engineer
Region of Waterloo
Water Services
PLaw@regionofwaterloo.ca
519-575-4095

From: Murray Shantz <[redacted]
Date: March 26, 2014 at 12:05:07 PM EDT
To: <eric.tuson@cima.ca>
Subject: Conestogo Plains Water Supply

Dear Sirs
I have not been able to attend your public consultation session held on March 18.MY house is directly behind Conestogo water supply.I have some concerns of spending a large amount of money to do studies and engineer plans to build a pipeline to West Montrose.Having owned a large business and still involved with it I feel you should fix West Montrose water supply . Then you would have 2 supplies for growth for next 50 years.I am sure your minds are already made up to build the pipeline and I am just giving you my opinion.

Thanks

Murray Shantz-[redacted]

Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.2
Thursday, November 20, 2014
Conestoga Golf & Country Club – Club Room

SIGN-IN SHEET

NAME	ADDRESS	EMAIL
Lisa MacDonald	[redacted]	
Hardyn Stuart Martin		
[illegible]		
[illegible]		
Art Timmerman		
Wayne Fisher		
Mark Bauman		
LARRY SHANTZ		
PAM BOLGER		
James Etienne		
MURRAY MARTIN		
Brenda & Rusty Brissette		

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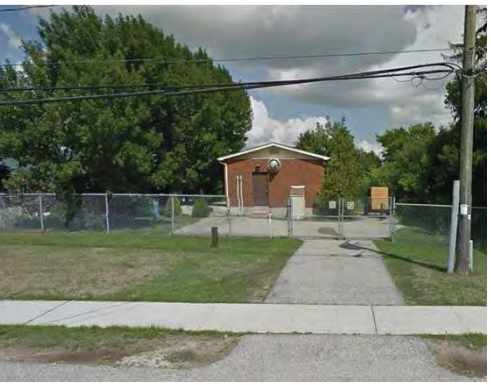
APPENDIX B.2

Public Information Centre No.1



Region of Waterloo

Class Environmental Assessment for Conestogo Plains Water Supply System

Public Consultation Centre No.1

March 18th, 2014

Conestoga Golf & Country Club – Club Room

5:30 p.m. – 7:30 p.m.

Region of Waterloo

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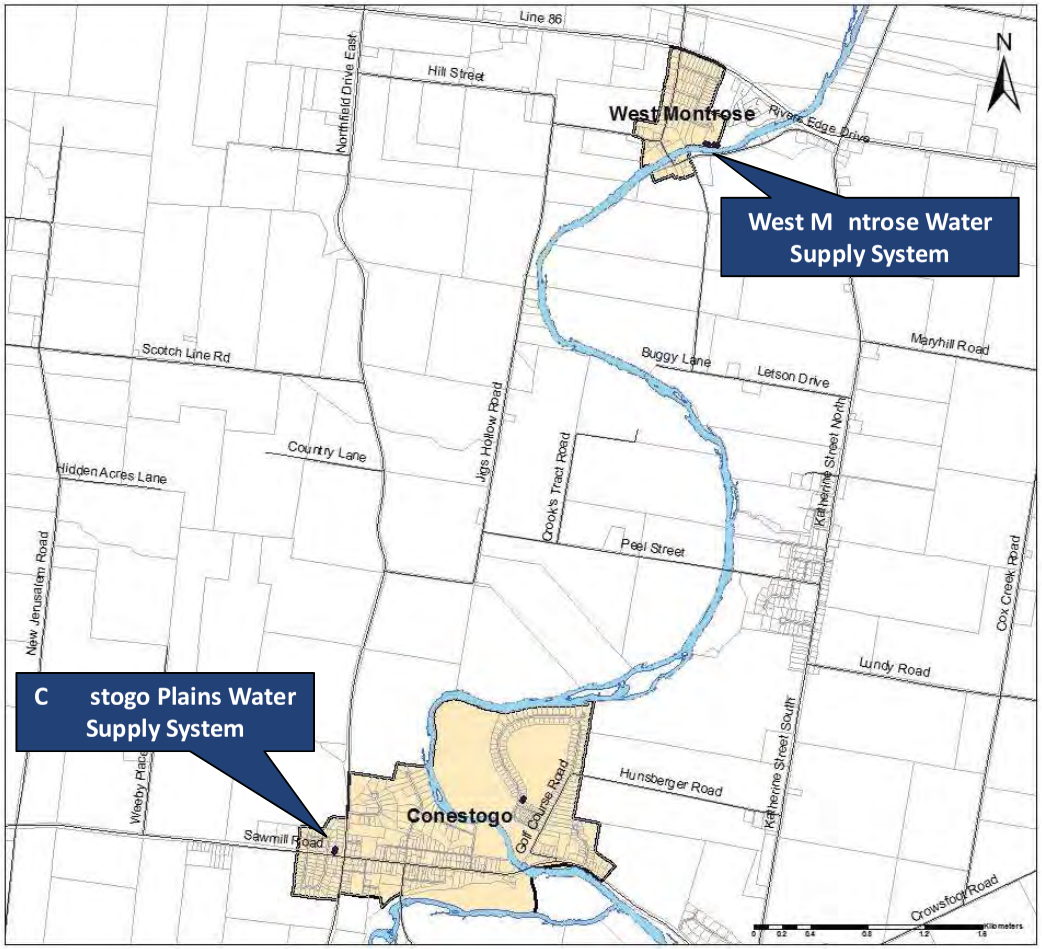
Why are we here tonight?

- The Region is undertaking a Schedule B Class Environmental Assessment study to select the preferred water supply alternative for the Conestogo and West Montrose service areas.
- A permanent solution is necessary to ensure sustainable and long-term water supply to West Montrose, while meeting the water service requirements in Conestogo.
- Public participation is an important part of the Class EA study process.



Objectives f this Public Consultation Centre

This Public Consultation Centre provides an opportunity for the public to:

- Understand the need for this project and review background information
- Review and provide feedback on the proposed water supply alternative solutions
- Provide feedback on the proposed evaluation criteria that will be used to evaluate and select the preferred water supply solution
- Review and discuss the project with Regional staff and their consultants

Please review the information presented tonight and provide us with any comments or concerns which you may have.

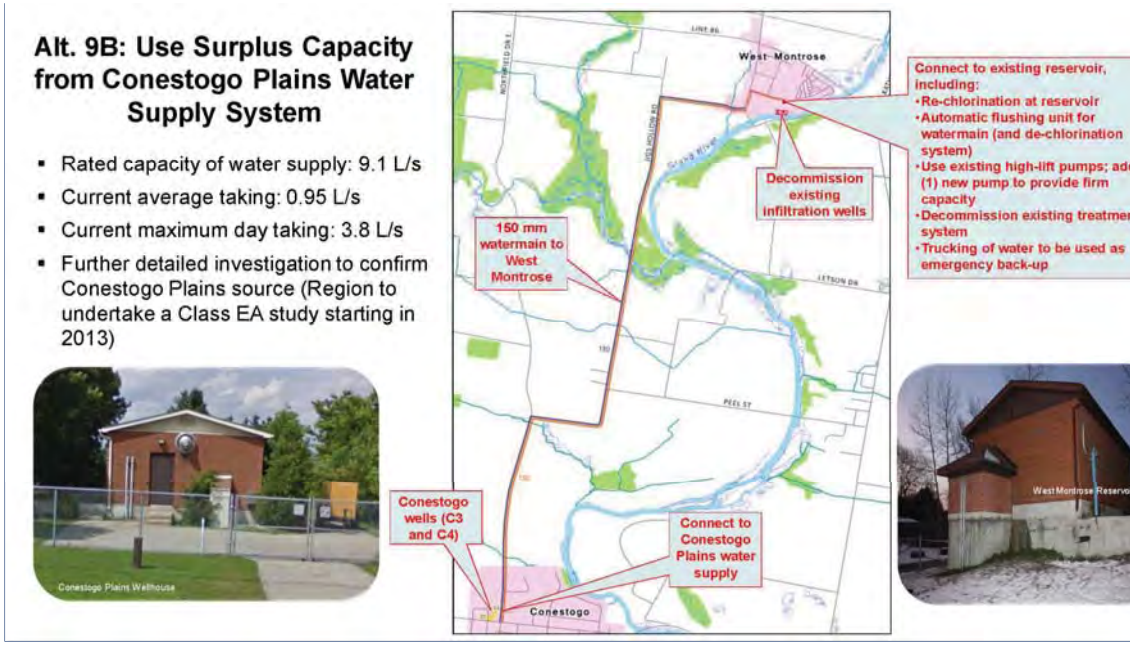
Project Background – West Montrose las EA Study

- Currently West Montrose Water Supply System experiences:
  - Water quantity issues with its supply wells
  - Operational challenges with treatment during periods of high water levels in the Grand River
  - Constant need to truck water into the community during these periods and in the summer

- A Class EA study, completed in 2013 for the West Montrose Water Supply System, recommended a connection from West Montrose to the Conestogo Plains Water Supply System to address the current issues.

- The Conestogo Plains system operates below its capacity and provides an opportunity to also supply water to West Montrose and the whole Conestogo Plains community.

- The current Class EA study will assess the Conestogo Plains Water Supply system in detail and confirm the recommendations of the 2013 West Montrose Class EA study.

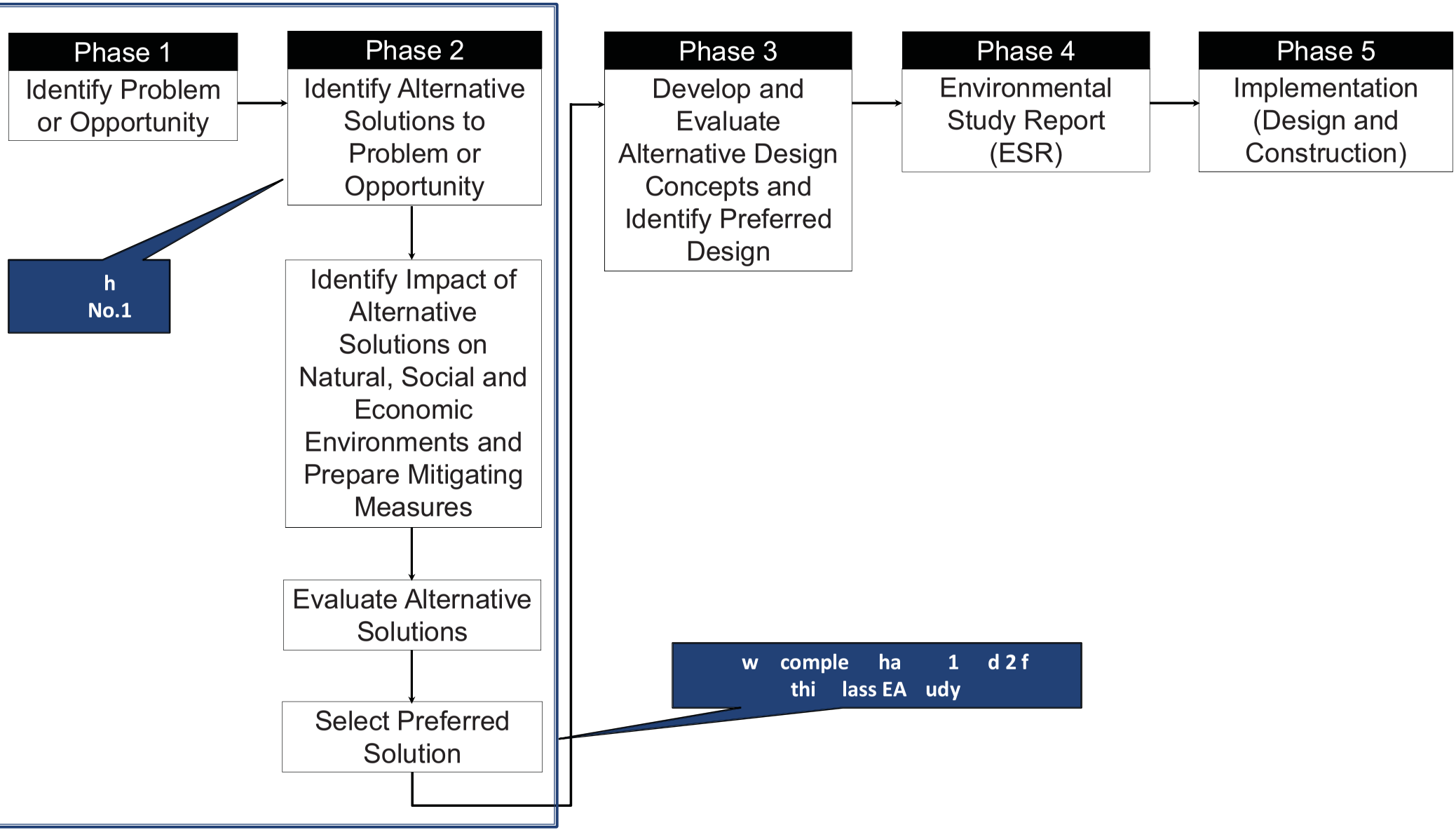


Preferred Water Supply Alternative for West Montrose (West Montrose Class EA Study, Public Meeting #2, September 2012)

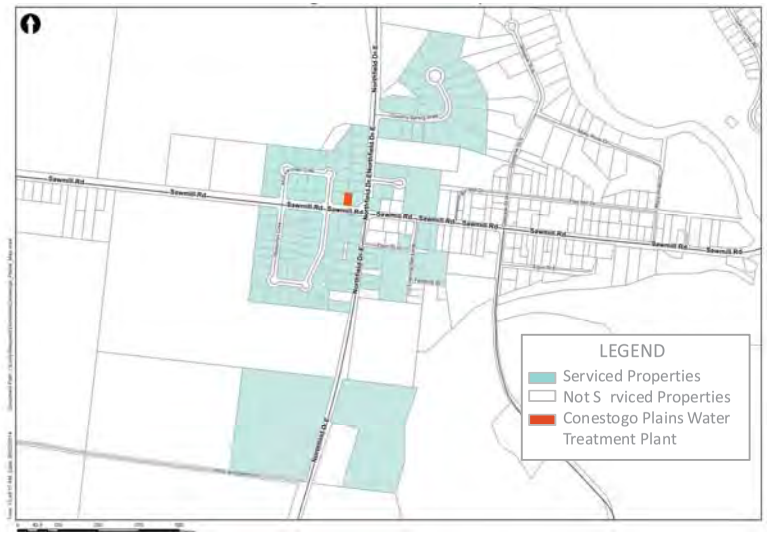
Opportunities of the Conestogo Plains Class EA study:

- To assess the overall present and future water servicing requirements of the Conestogo and West Montrose service areas.
- To explore in detail and confirm the feasibility of connecting West Montrose to the Conestogo Plains Water Supply System.
- To define the water system infrastructure required to maintain the security of water supply in a way that is sensitive to the environment.
- To identify the most sustainable, technically and environmentally sound, and cost-effective water supply solution for the West Montrose and Conestogo service areas.

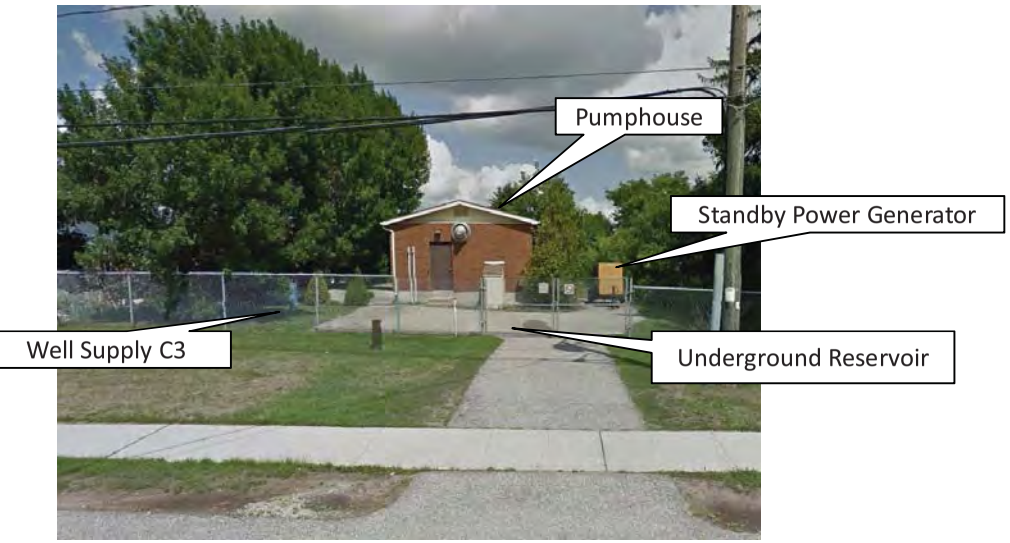
Overview f Activities under he Municipal las EA Process



onesto o Plains Water Supp y System – Existing ondition



Conestogo Plains Service Area



Conestogo Plains Water Supply System

Why does the Conestogo Plains System have Spare Capacity?

- System Rated Capacity = 9.1 L/s
- Current Water Use:
  - Average day demand = 1.0 L/s
  - Maximum day demand = 2.7 L/s

Why is the Conestogo Plains System Safe?

- Existing treatment effectively provides:
  - Disinfection
  - Iron Concentration Control
  - Standby power to avoid interruptions of supply

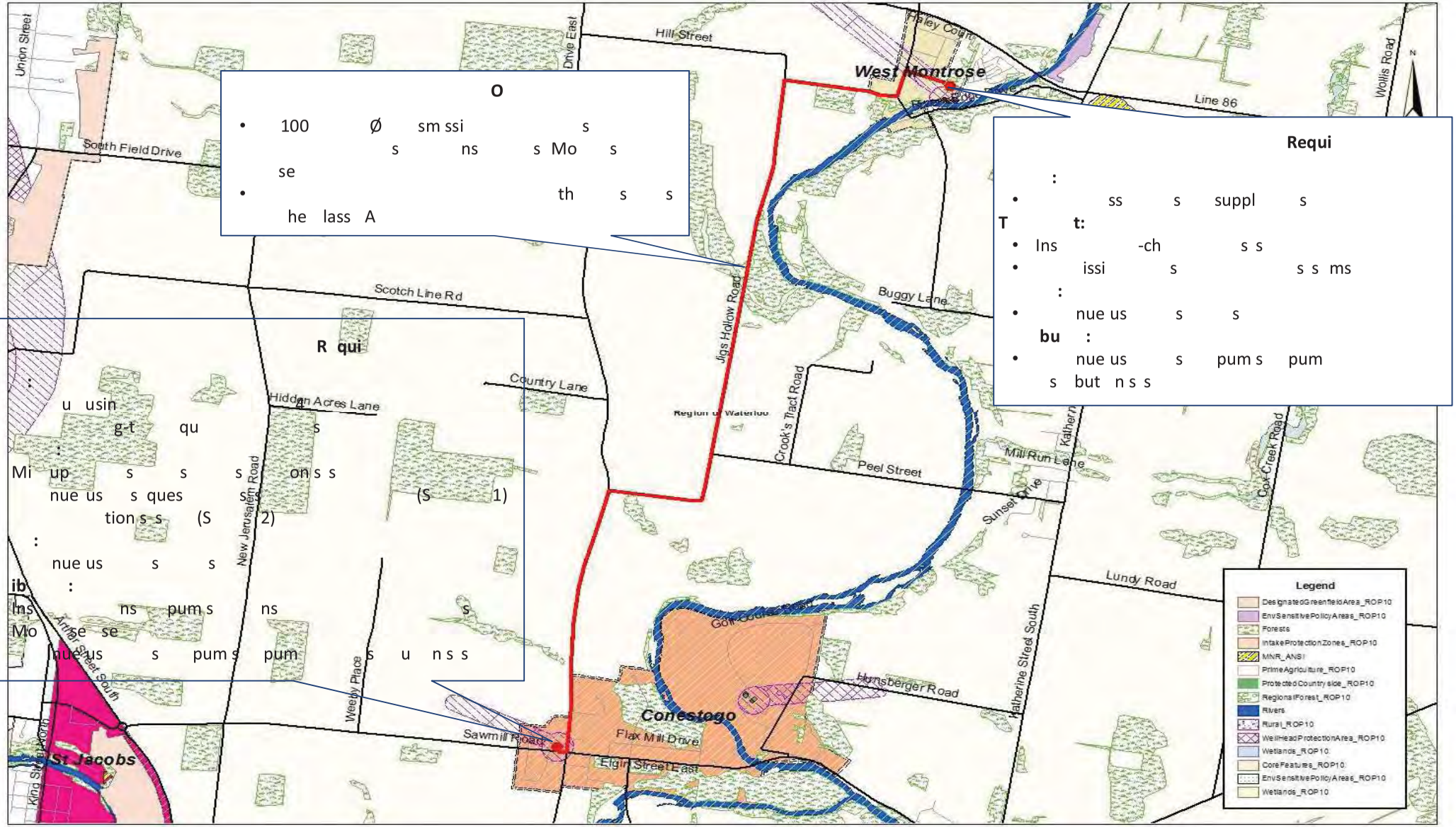
Identification of Water Supply Alternative olution

Nine water supply alternative solutions were identified and assessed. This is how we selected the short-listed alternative solutions:

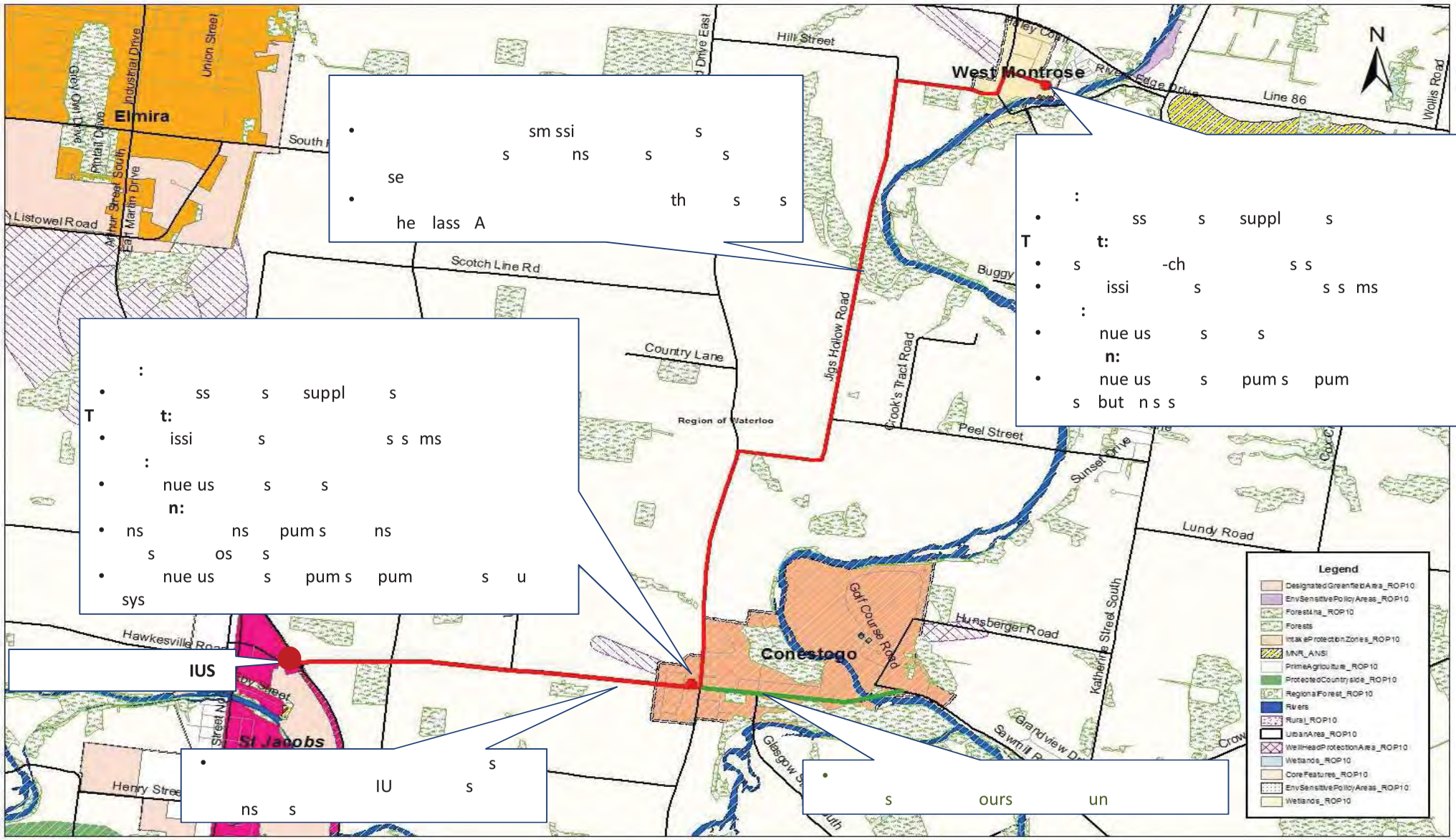
P eliminary eria	Descript
L el f v	As a minimum, he existing l e f se v wi m tained, in te s of e ted wate qua se p essures
System S ur	he sup of tre ted water is protecte from e gency situat s, qui t failures, and he vulner es
Syste Fl xibility and R un	Abi o cont ue to provide adequate water sup i the event of an emergency

Three water supply alternative solutions were short-listed and will be examined in detail in the next phases of the Class EA study.

Water Supp y Alternative Solution No.1 – up y West Montrose with surplus capacity from Conestog Plain ystem



Water Supp y Alternative olution o.2 – Sup y West Montrose and Co esto o Plains from the Integrated Urban ystem (IUS) at t. Jacobs



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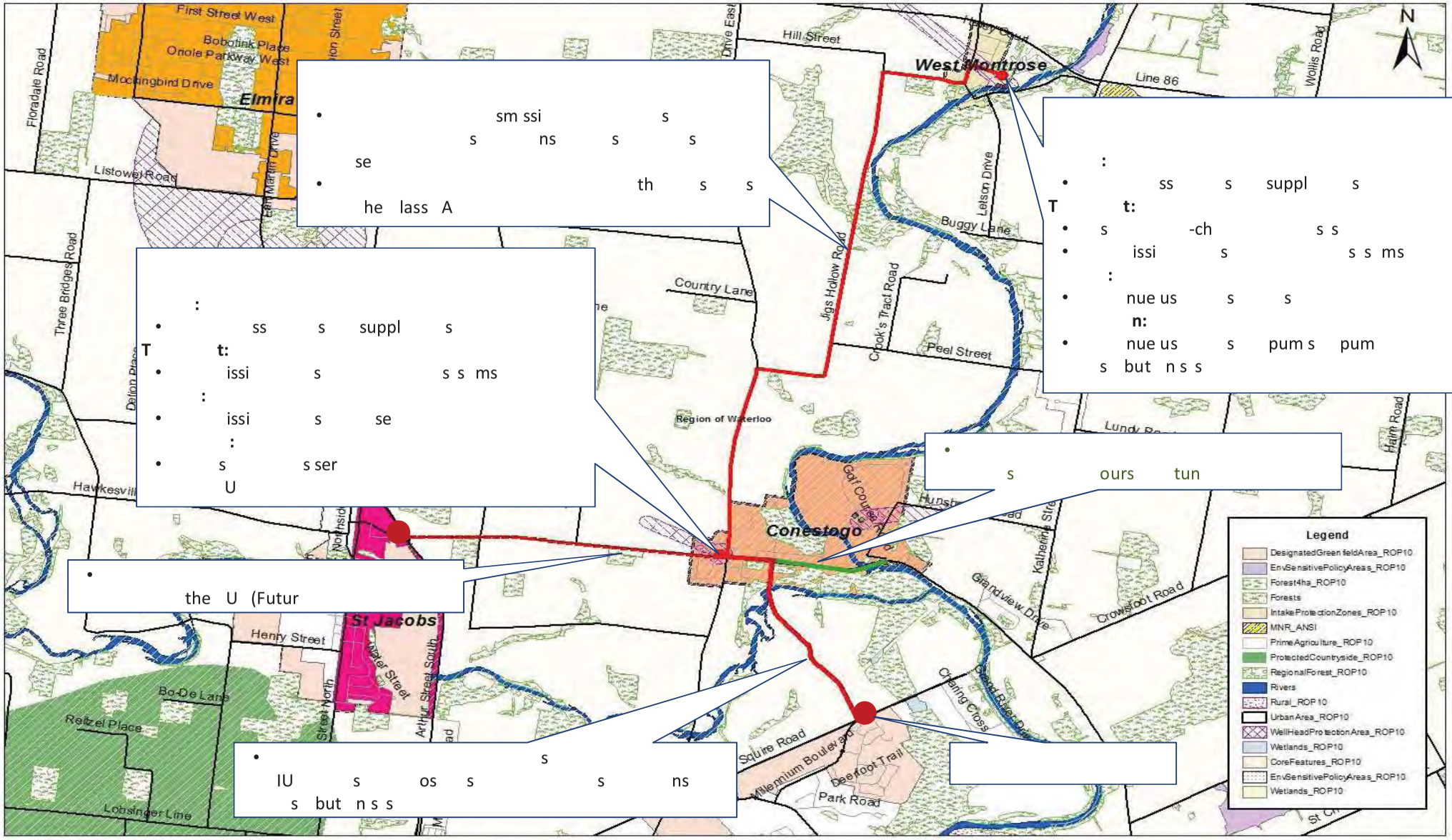
Region of Waterloo

Water Supply Alternative Solution No.3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (I at City of Waterloo with provision for oopin



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Region of Waterloo

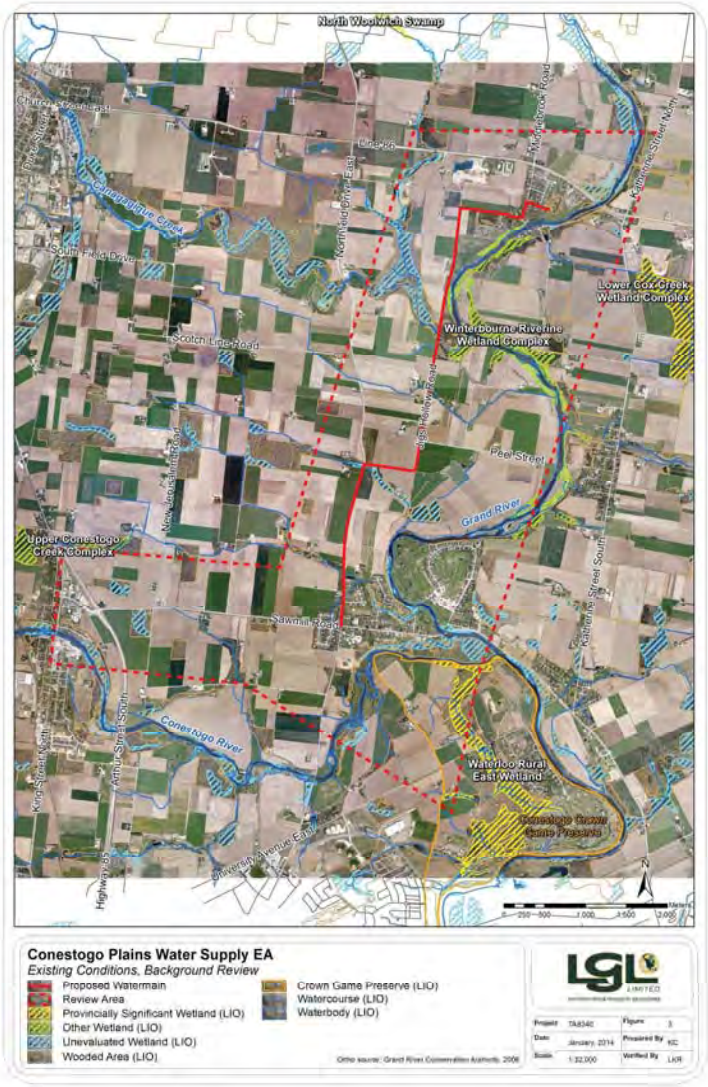
Water Supply Alternative Solutions – Preliminary sse ssment Results

Water Supply A ernative S	Advantage	Disadvantage	C C C	0-year Life Cycle C
Op o. – Supply West Montrose w surplus ca f o Conestogo System	• Use of m st xisting water supply fa s • cur o supply through st Plains reservoir	• M y require new filtration system • Need separat um p to West Mont ose	$7.0 – $8.0 Million	$8.0 – $9.0 Million
Op o. – Supply West Montrose a Conestogo f o IUS at St. Jacobs	• cur o supply through Conestogo Plains reservoir a I rated Urban st (IUS) • tun to connect st Golf Course (CGC)	• Hi her capital and life ycle cost than O 1 • Requires water urse crossing	$8.5 – $10.5 Million	$10.5 – $12.0 Million
Option No.3 – Supply West Montrose a Conestogo f o t IUS at C of Waterloo w provision for looping	• cur o supply through two separate connections t he US • tun to connect CGC • P ovides r un to St. Jacobs • iz es water c culation i Waterloo • L est operational and m tenance costs	• Hi hest c a e ycle costs • Requires water urse crossings	$10.5 – $12.5 Million	$12.0 – $13.5 Million

An inventory of natural heritage features within the project area, completed to date, included:

- Physical geography and soils
- Significant natural features (i.e., core environmental features, wetlands, valleylands, woodlands)
- Wildlife and wildlife habitat (i.e., mammals, birds, reptiles, amphibians)
- Aquatic habitat and fish communities (i.e., rivers, creeks and watersheds)

Potential impacts to the natural heritage features and mitigation measures to be identified



General location of existing Natural Heritage Features within the project area

Natural Heritage Field I vestigation – West Montrose Transmis ion Main

Field investigations for the West Montrose transmission main – common to all options – have been completed

Main considerations:

- 8 watercourses crossings, with 4 regulated: Canagagigue Creek (C6 on adjacent figure) and three minor tributaries of the Grand River (C2 to C4)
- Species at risk (SAR), including fish and mussels in the Grand River

Mitigation measures for impacts to watercourse crossings to be completed

Watercourse Crossings Location – Transmission Main

Prop ed Evaluation Criteria

Criteria to be used to evaluate the three short-listed water supply alternative solutions include:

- **Technical / Natural Environment**
  - Water quality / quantity (including sustainability)
  - Level of service (i.e., service pressures)
  - Ease of implementation
  - Operational complexity
  - System redundancy, flexibility and reliability
  - Use of existing infrastructure
  - Natural heritage features (e.g., stream crossings, sensitive species, wetlands, etc.)
  - Archaeological features
  - Regulatory approvals
  - Coordination with other planned infrastructure projects

- **Community / Social Considerations**
  - Public health and safety
  - Public perception
  - Noise and traffic (temporary, during construction)
  - Potential impacts on private property

- **Economic Considerations**
  - Capital
  - Operation & maintenance costs
  - Life Cycle costs

Next tep

- Water supply alternative solutions and proposed evaluation criteria will be confirmed subject to comments received from this Public Consultation Centre.
- The three alternative solutions will be refined and evaluated based on potential impacts on the proposed criteria and mitigation measures. A preliminary preferred water supply alternative solution will be selected.
- A second Public Consultation Centre will be held to present the results of the evaluation process and the preliminary preferred water supply alternative solution. This will provide another opportunity for you to give feedback on the project.
- Comments received will be considered in finalizing the preferred water supply alternative solution.
- A Project File Report, presenting the Class EA study, will be prepared and made available for a 30-day public review period, where you will have a final chance to comment on the recommendations.

Project C tacts

Please complete a Comment Sheet and leave it here today, or return it to the Region by fax, mail or email (please see the instructions below) by April 2, 2014.

For more information about this project, or to view the Public Consultation Centre displays online Please visit our website:

http://www.regionofwaterloo.ca/en/aboutTheEnvironment/MasterPlansandProjects.asp

Should you have any questions or concerns at any time during the project, please contact either of the following individuals:

Dominika Celmer-Repin
Project Manager, Water Services
Region of Waterloo
150 Frederick Street, 7th Floor
Kitchener, Ontario, N2G 4J3
Telephone: 519-575-4757 Ext.3864
Fax: 519-575-4452
Email: Dcelmer-Repin@regionofwaterloo.ca

Eric Tuson
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7
Telephone: 289-288-0287 Ext. 6839
Fax: 289-288-0285
Email: eric.tuson@cima.ca

Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.1
Tuesday, March 18, 2014
Conestoga Golf & Country Club – Club Room

COMMENT SHEET

The Region of Waterloo is interested in hearing any comments, questions or concerns that you may have regarding the Conestogo Plains Water Supply System project. This study is being conducted according to the requirements of a Schedule B project of the *Municipal Class Environmental Assessment* document (Municipal Engineers Association, October 2000 as amended in 2007 & 2011). Please take some time to complete this Comment Sheet. All comments will be carefully considered in the Class Environmental Assessment Study. Please drop your completed Comment Sheet today in the box provided, or send it to either of the following individuals (see below) by **April 2, 2014**:

Dominika Celmer-Repin
Project Manager, Water Services
Region of Waterloo
150 Frederick Street, 7th Floor
Kitchener, Ontario, N2G 4J3
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Telephone: 289-288-0287 Ext. 6839
Fax: 289-288-0285
Email: eric.tuson@cima.ca

1. Do you have any comments, concerns, questions or suggestions regarding the purpose and the need for this project?

_____

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_____

COLLECTION NOTICE

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2. **Please describe any elements, aspects or features that you feel should be considered during the evaluation and selection of the preferred water supply solution**

Thank you for your participation. All comments will be considered in selecting and finalizing the preferred solution. Please provide your contact information below should you wish to be added to our Project Mailing List.

NAME: _____
(please print)

ADDRESS: _____

POSTAL CODE: _____

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Q & A's
Conestogo Plains Water Supply System
Class Environmental Assessment

May 2014

1. Can the Region repair / upgrade th e existing West Montrose w ater supply system or alternatively supply this area with water from Elmira?

In 2013, the Region completed a study that looked at the West Montrose water supply system. A thorough investigation of the existing West Montrose wells, other local groundwater sources, surface water sources and connections to existing water supplies, including the Elmira water system, was completed as part of this project. The study found that there were no improvements that could be made to the existing infrastructure in West Montrose that would make it able to provide adequate water for the existing community. It further recommended that a permanent connection from West Montrose to the Conestogo Plains water supply system be made to provide the required water supply capacity. A copy of the final 2013 West Montrose Class Environmental Assessment Study Report can be found at:

http://www.regionofwaterloo.ca/en/aboutTheEnvironment/resources/FiinalReport WestMontroseWaterSupplyClassEAJanuary2013.pdf

2. Will increased pum ping rates from th e Conestogo Plains w ells impact the existing private wells in the area?

No. A hydrogeological investigation must be completed to definitely confirm there will be no impacts on the existing wells. In the unlikely event that potential impacts are discovered, mitigation measures will be implemented, or another option chosen.

3. Who will pay for any future remediation w ork on pr ivate wells to avoid any impacts from the increased pumping rate from the Conestogo Plains wells?

The Region will not select an option that could compromise the sustainability and reliability of any of the existing private wells, or will pay for any mitigation required.

4. Will the connection to West Montrose from Conestogo Plains affect the ability of the system to provide for fire protection in the Conestogo area?

No. Fire flow in the Conestogo Plains service area is provided by the existing reservoir and pumps at the Conestogo Plains plant. These pumps will remain dedicated to the Conestogo Plains service area and new pumps will be installed to pump water to West Montrose. The current level of fire protection will be maintained for these communities regardless of the preferred water supply solution selected in this study.

5. Will the two gravel pits in the area influence the wellhead protection zones?

No. It is in the Region's best interest to object to any project, including those proposed by privately owned companies, that may have an impact on the water quality or water quantity of existing municipal or private groundwater wells in the Region.

6. Does the Waterloo Integrated Urban System have enough capacity to supply West Montrose and Conestogo service areas?

Yes, the Waterloo Integrated Urban System (IUS) has sufficient capacity to provide the current and future demands of the service areas currently serviced by the West Montrose, Conestogo Plains and Conestogo Golf Course water supply systems, without affecting the existing level of service in the IUS.

7. Is there an opportunity to provide water to Winterbourne with the watermain connection between Conestogo Plains and West Montrose?

The Region does not have any plans to provide water supply to communities that are currently not serviced by a municipal water supply, which is the case of Winterbourne.

8. How much water does the golf course currently use? Did the golf course's need / use prompt this EA?

The Conestogo Plains Class EA study was initiated to confirm the recommendations of the West Montrose Water Supply System Class EA study, completed in 2013. The Region initiated this project by exploring the feasibility of connecting West Montrose to the Conestogo Plains water supply system, as well as other water supply alternatives including a potential connection to the Integrated Urban System. It was found that some of these water supply alternatives also provide an opportunity for a future connection of the Conestogo Golf Course system, which should be taken into consideration when evaluating the costs, benefits and impacts associated with each alternative. The Conestogo Golf Course water system has an existing average water demand of 2.1 L/s or 178 m^3/day.

9. Will any of the alternatives involve running pipes down the main street?

Each of the water supply alternative solutions under evaluation will require some construction along Sawmill Road for the installation of transmission water mains. The extent and timing of this work will be determined at a future point in this project. The Township of Woolwich is responsible for the water distribution in the area. Installation of watermains on the main street for the purposes of expanding the existing distribution system will be decided by the Township at a later date.

10. Why is the Region promoting development in areas that experience challenges with water quantity?

The Region is not promoting further development in any of the areas being considered. The Region has taken into consideration the approved settlement boundaries when determining the projected water demands within each service area.

11. Will this project affect our taxes?

No. The total cost to operate, maintain and complete any capital upgrades to the municipal water systems throughout the Region are recovered strictly through the usage rates on municipal water bills.

12. How can I obtain water service for my vacant lot located in the area?

The intent of this project is to look at the water supply for the communities of Conestogo and West Montrose. This study will ensure that there is sufficient water supply from the preferred solution to allow residents, within the existing settlement boundaries, who are not currently connected to the system to connect, if they desire in the future, through the Township of Woolwich. This study is not looking at the cost or the timing of expanding the current distribution system.

13. Will water service be available to properties in the Village of Conestogo?

See answer to Question 12.

14. Will a connection to the municipal system be mandatory for those currently on private wells?

See answer to Question 12.

15. What is the timeline for the residential connection to the municipal system?

See answer to Question 12.

16. How much will it cost me to connect?

See answer to Question 12.

17. What are the next steps?

The next steps in the Class EA study involve gathering comments and feedback from the public on the information presented at the first Public Consultation Centre held on March 18, 2014, and evaluating in detail the water supply alternative solutions for the selection of the preferred option. Additional investigations may need to be completed to support the development and evaluation of the alternative solutions.

18. Contact Information:

If you have any questions regarding this study or wish to be placed on the project mailing list, please contact:

Pam Law, P. Eng.
Senior Project Engineer
Region of Waterloo
Water Services
150 Frederick Street, 7th Floor
Kitchener, Ontario, N2G 4J3
Telephone: 519-575-4095
Fax: 519-575-4452
Email: PLaw@regionofwaterloo.ca

APPENDIX B.3

Pubic Information Centre No.2

Region of Waterloo

Class Environmental Assessment for Conestogo Plains Water Supply System

Public Consultation Centre No.2

November 20, 2014

Conestoga Golf & Country Club – Club Room

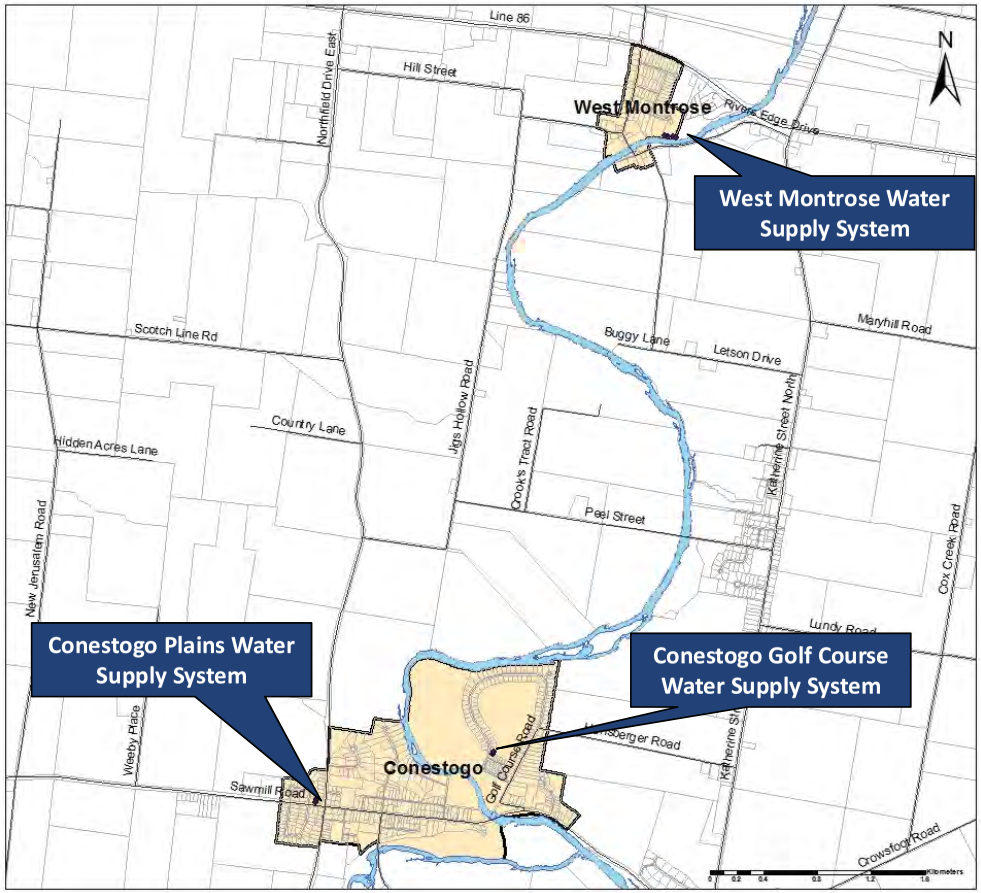
5:30 p.m. – 7:30 p.m.

Region of Waterloo

CIMA+ Partners in excellence

Why are we here tonight?

- The Region is undertaking a Schedule B Class Environmental Assessment study to select the preferred water supply alternative for the Conestogo and West Montrose service areas.
- A permanent solution is necessary to ensure sustainable and long-term water supply to West Montrose, while meeting the water service requirements in Conestogo.
- Public participation is integral to the Class EA study process – your input is important and will be considered in confirming the preferred water supply solution.



Objectives of this Public Consultation Centre

This Public Consultation Centre provides an opportunity for the public to:

- Review the evaluation process used to assess the water supply alternative solutions and the evaluation results
- Provide feedback on the preliminary preferred water supply solution
- Review the potential anticipated impacts associated with the preliminary preferred water supply solution and proposed mitigation measures
- Review and discuss the project with Regional staff and their consultants

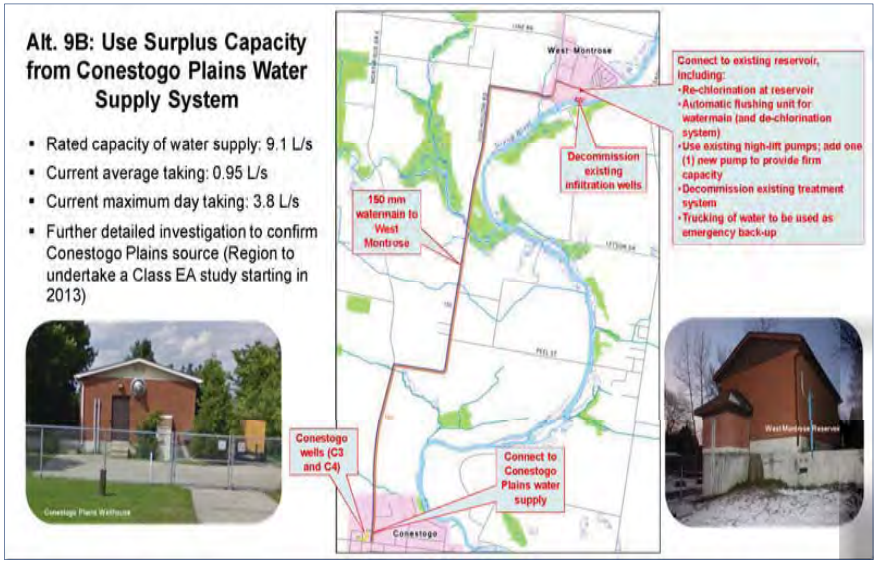
Please review the information presented tonight and provide us with any comments or concerns which you may have.

Project Background – Existing West Montrose Water System and Class EA Study

- Currently West Montrose Water Supply System experiences:
  - Water quantity issues with its supply wells
  - Operational challenges with treatment during periods of high water levels in the Grand River
  - Constant need to truck water into the community during these periods and during periods of elevated water use in the summer

- A Class EA study, completed in 2013 for the West Montrose Water Supply System, recommended connection of West Montrose to the Conestogo Plains Water Supply System to address the above issues, subject to further assessment of the Conestogo Plains system.

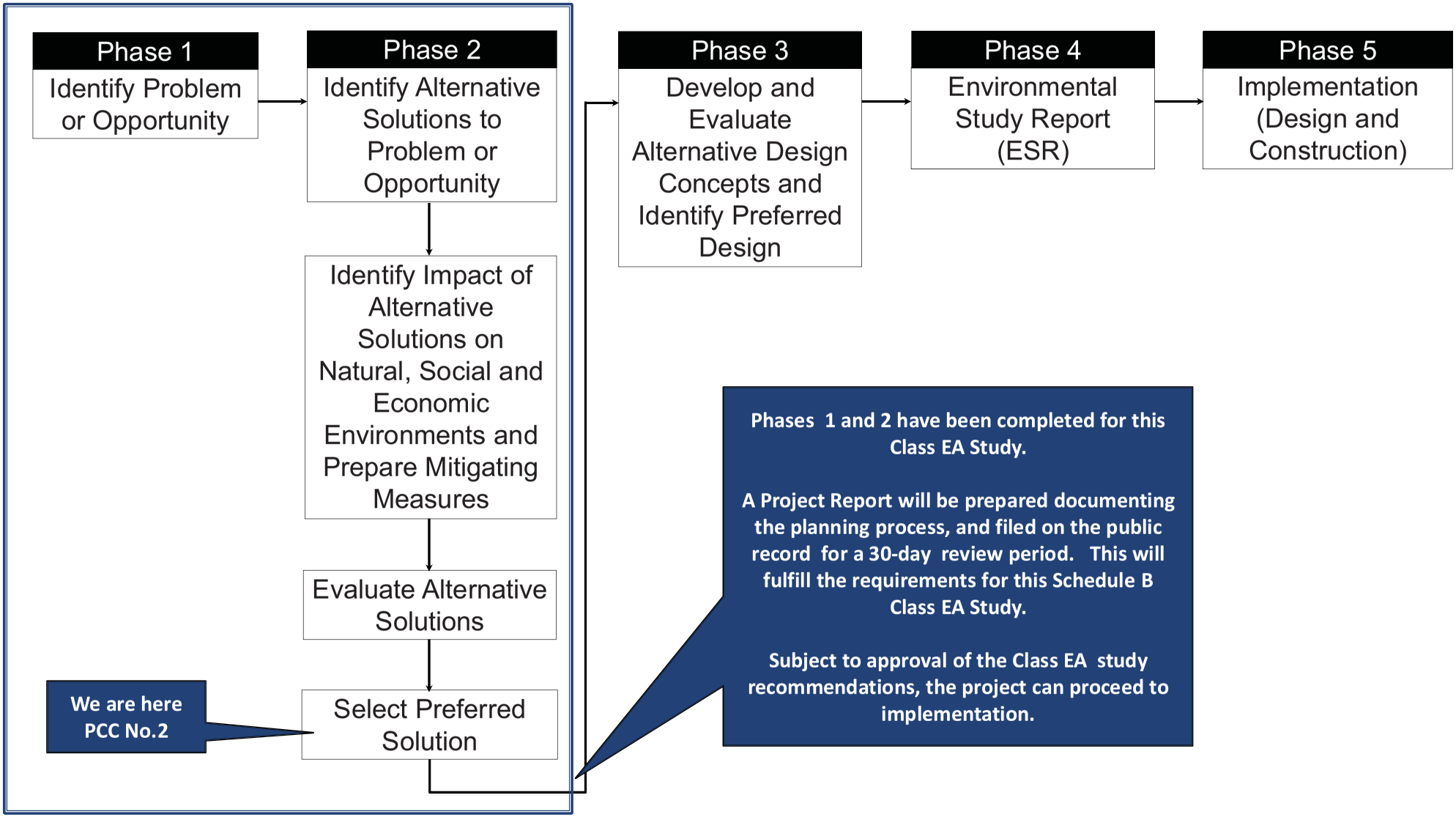
- The Conestogo Plains Class EA Study provided an opportunity to:
  - Assess present and future water servicing requirements of the Conestogo and West Montrose service areas
  - Examine the Conestogo Plains Water Supply system in detail
  - Confirm the feasibility of connecting West Montrose to Conestogo Plains
  - Identify water system infrastructure required to maintain the security of water supply in a way that is financially responsible, technically sound and sensitive to the environment.



Preferred Water Supply Alternative for West Montrose

(West Montrose Class EA Study, Public Meeting #2, September 2012)

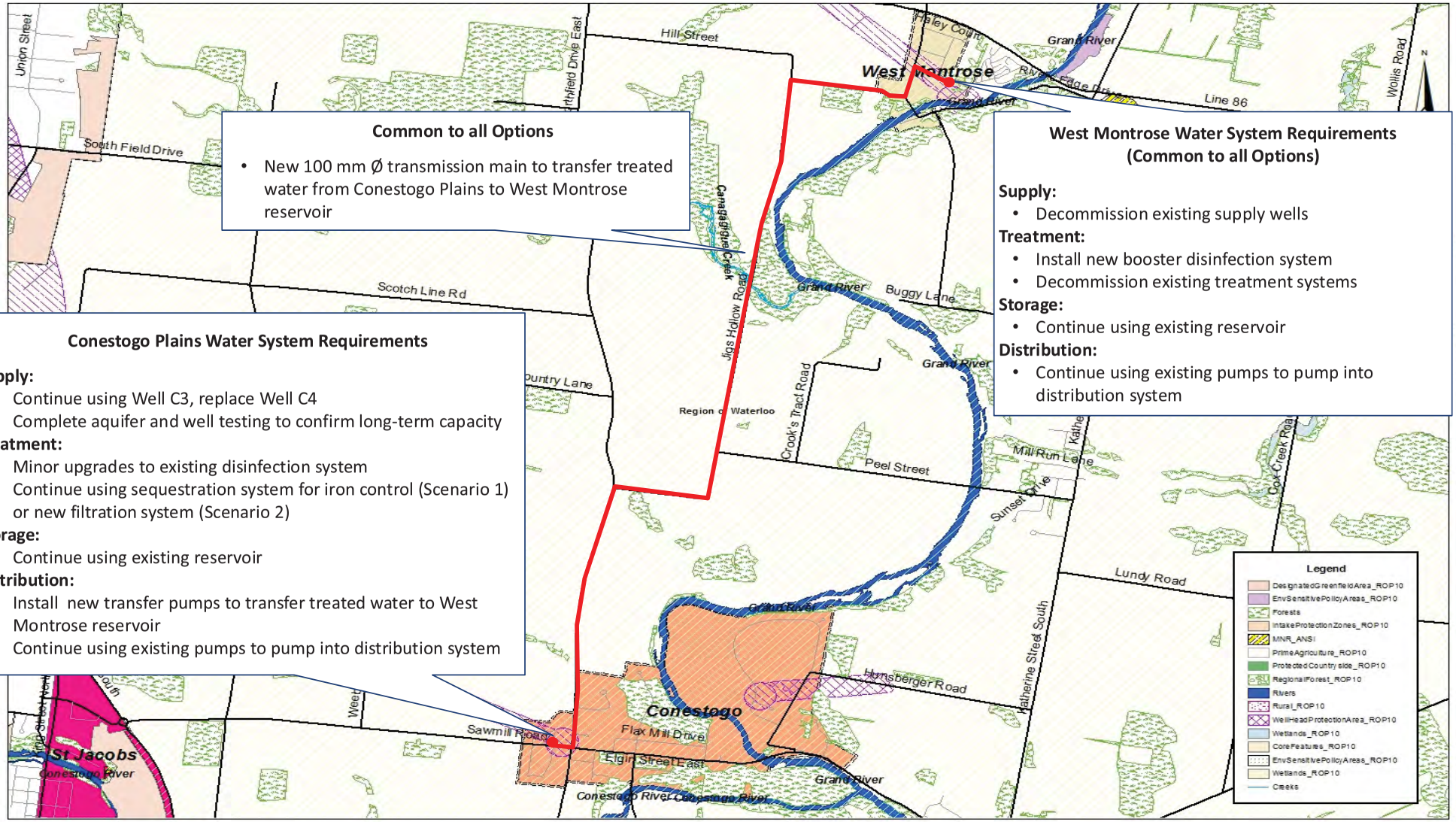
Overview of Activities under the Municipal Class EA Process



Identification of Water Supply Alternative Solutions

- Nine water supply alternative solutions were initially identified and assessed based on the following screening criteria:
  - Level of Service: as a minimum, the existing levels of treated water quality and service pressures will be maintained
  - System Security: the supply of water is protected from emergency situations, equipment failures, and other vulnerabilities
  - System Flexibility and Redundancy: ability to continue to provide water supply in the event of an emergency
- Alternatives that didn't meet the criteria were eliminated.
- Three main water supply alternatives were short-listed and evaluated in more detail. Two separate scenarios were developed for Alternative No. 1 (shown in next panel).

Water Supply Alternative Solution No.1 – Supply West Montrose with surplus capacity from Conestogo Plains System.
Scenario 1.) Continue with sequestration for iron control
Scenario 2.) Install filtration system for iron and manganese removal



Common to all Options

- New 100 mm Ø transmission main to transfer treated water from Conestogo Plains to West Montrose reservoir

West Montrose Water System Requirements (Common to all Options)

Supply:
- Decommission existing supply wells

Treatment:
- Install new booster disinfection system
- Decommission existing treatment systems

Storage:
- Continue using existing reservoir

Distribution:
- Continue using existing pumps to pump into distribution system

Conestogo Plains Water System Requirements

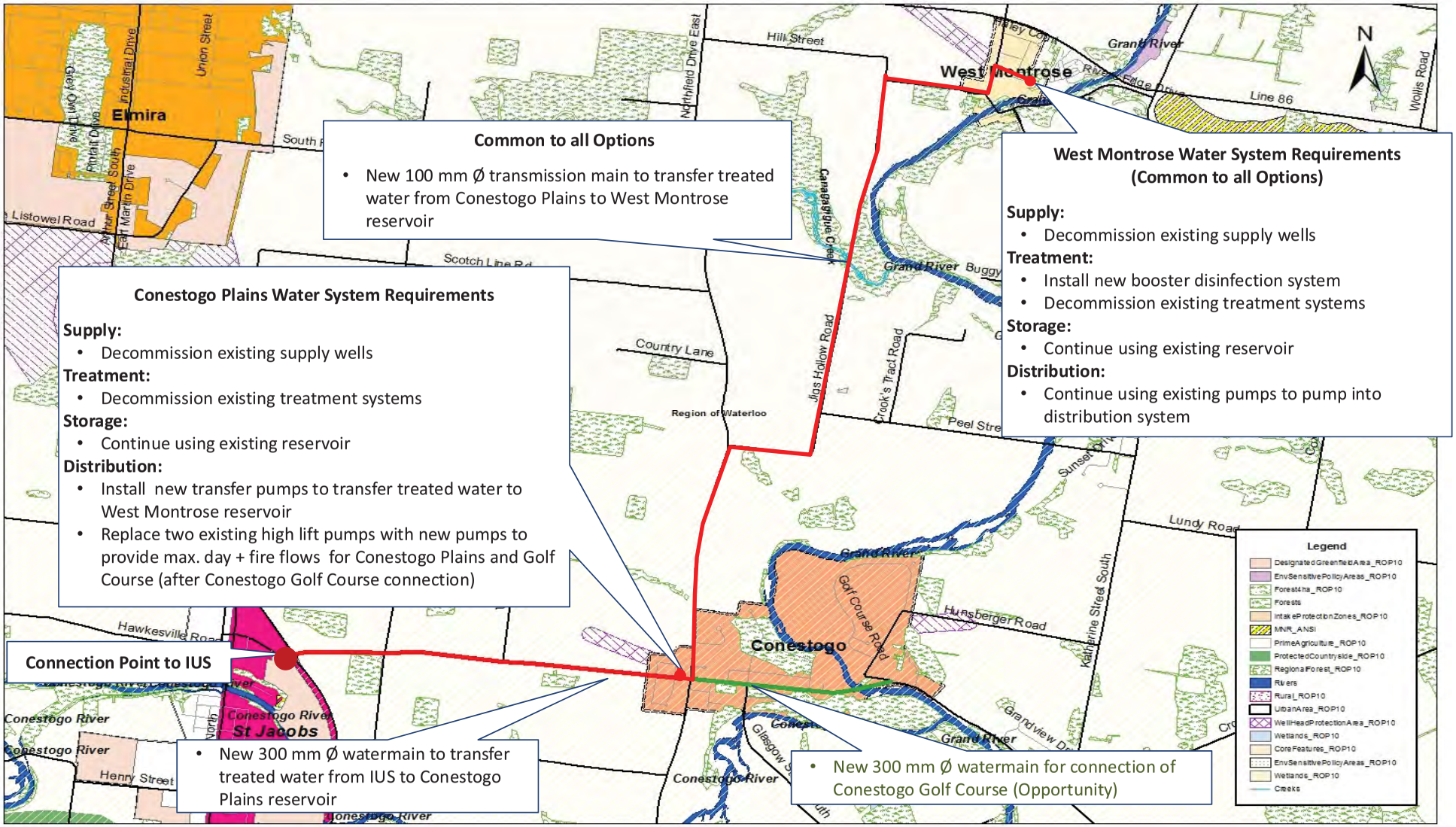
Supply:
- Continue using Well C3, replace Well C4
- Complete aquifer and well testing to confirm long-term capacity

Treatment:
- Minor upgrades to existing disinfection system
- Continue using sequestration system for iron control (Scenario 1) or new filtration system (Scenario 2)

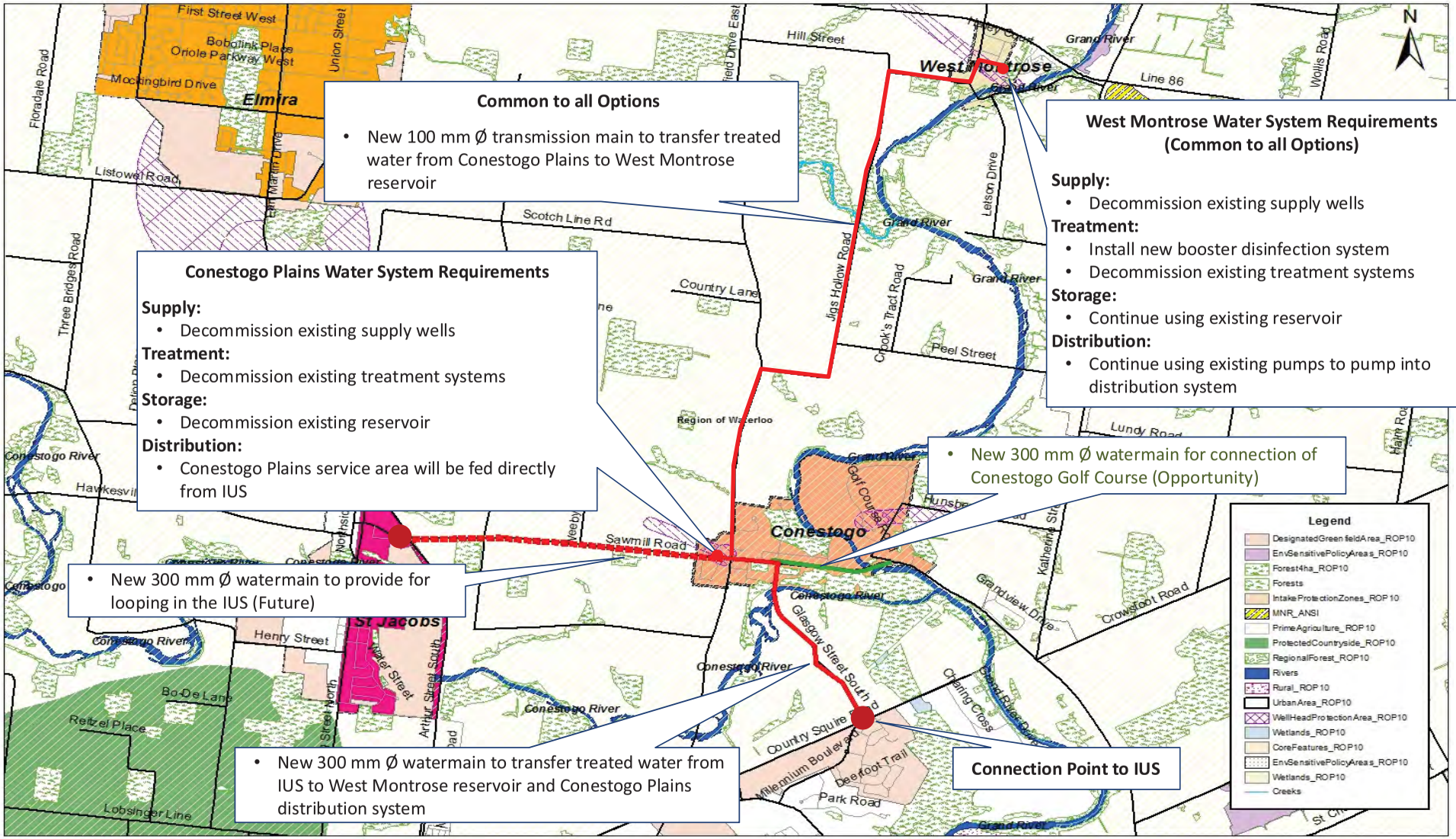
Storage:
- Continue using existing reservoir

Distribution:
- Install new transfer pumps to transfer treated water to West Montrose reservoir
- Continue using existing pumps to pump into distribution system

Water Supply Alternative Solution No.2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs



Water Supply Alternative Solution No.3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with provision for looping

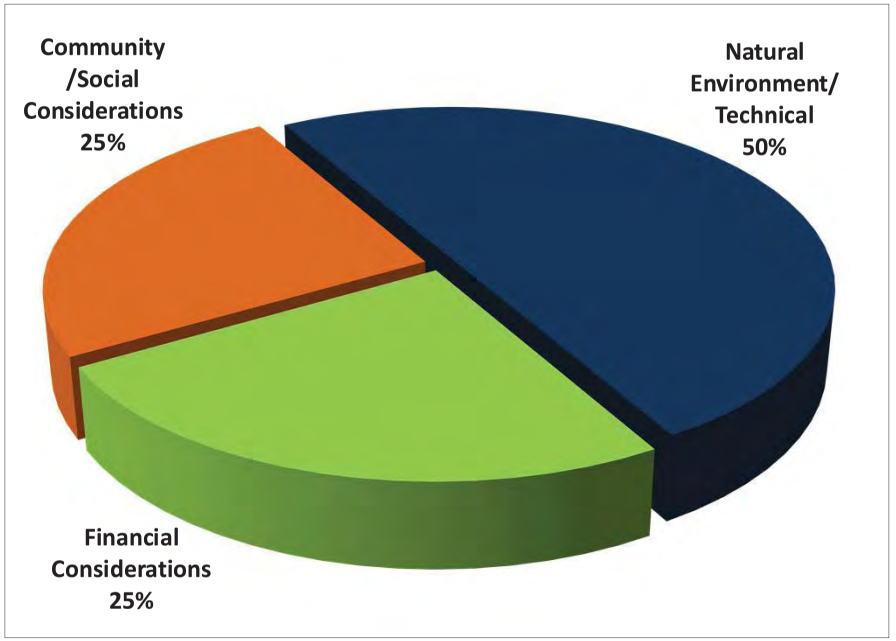


Detailed Evaluation of Short-listed Alternative Solutions

Criteria developed to evaluate the short-listed water supply alternative included:

- **Natural Environment / Technical (50%)**
  - Water quality / quantity protection
  - Level of service (i.e., service pressures)
  - Ease of implementation
  - Operational complexity
  - System reliability
  - System redundancy and flexibility
  - Need for new infrastructure
  - Impact to natural and archaeological features (e.g., stream crossings, sensitive species, wetlands, etc.)
  - Need for regulatory approvals
  - Coordination with other planned infrastructure
  - Benefits for areas outside of project study area
- **Community / Social Considerations (25%)**
  - Public health and safety
  - Public perception
  - Noise and traffic (during construction)
  - Aesthetics
- **Financial Considerations (25%)**
  - Life Cycle costs (Capital and Operation & Maintenance costs)

Alternatives were evaluated against all criteria and scored based on their ability to meet each criterion. Alternatives were evaluated relative to each other.

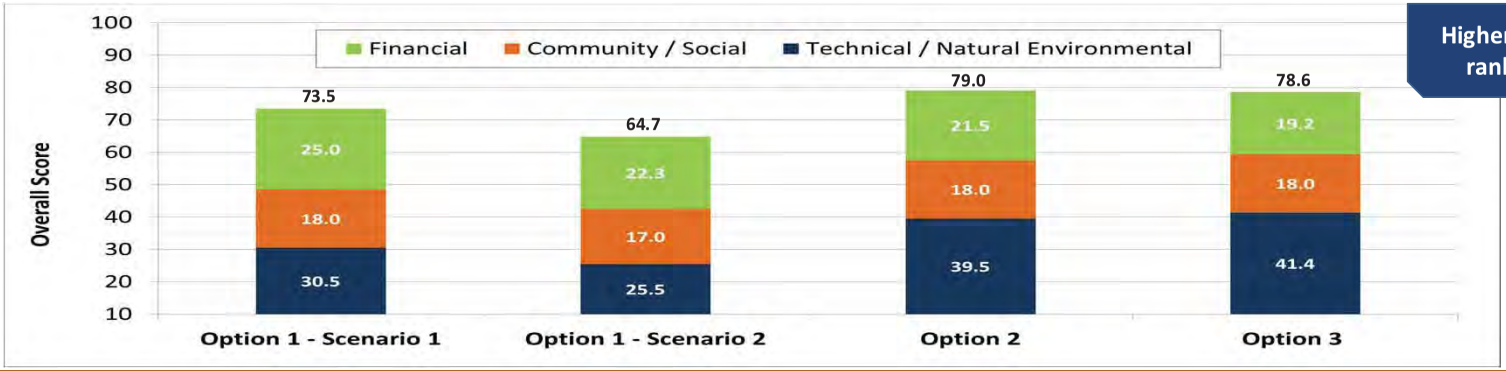


Main Criteria Categories and Weighting Factors

The alternative that obtained the highest overall score was selected as the Preliminary Preferred Solution

Detailed Evaluation – Key Differentiators and Preliminary Results

Option No.1 – Supply West Montrose with surplus capacity from Conestogo Plains (Scenarios 1 & 2)	Option No.2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs	Option No.3 – Supply West Montrose and Conestogo Plains from the IUS at City of Waterloo with provision for looping
▪ Maintains independent water supply, treatment, reservoirs and pumping stations and maximizes use of existing infrastructure ▪ Security of supply dependant on only two wells (Conestogo Plains) ▪ Long-term water supply security depends on performance of the aquifer ▪ Maintains existing levels of service ▪ Improvements localized to two groundwater systems ▪ Minor impacts during construction ▪ Added operational complexity with new filtration system (Scenario 2) ▪ Expensive to operate well systems ▪ 40-year Life Cycle Cost $8.5 Million (Scenario 1) and $9.5 Million (Scenario 2)	▪ Maintains reservoir and pumping station in Conestogo Plains. Uses most of existing infrastructure, additional watermains needed ▪ Added security of supply through Conestogo Plains reservoir and connection to IUS ▪ Opportunity to connect Conestogo Golf Course ▪ Reduced operational complexity ▪ Improves distribution capabilities between communities served by the IUS (e.g., St. Jacobs) ▪ Temporary traffic impacts during watermain installation ▪ Requires crossing of Grand River (to service Conestogo Golf Course) ▪ 40-year Life Cycle Cost $9.9 Million	▪ Replaces reservoirs and pumping stations with new infrastructure (watermains). ▪ Added security of supply and robustness through two connections to the IUS ▪ Opportunity to connect Conestogo Golf Course ▪ Reduced operational complexity ▪ Redundancy to St. Jacobs and optimization of water circulation in Waterloo ▪ Temporary traffic impacts during watermain installation ▪ Requires crossings of Grand River (to service Conestogo Golf Course) and Conestogo River (for looping) ▪ 40-year Life Cycle Cost $11.1 Million



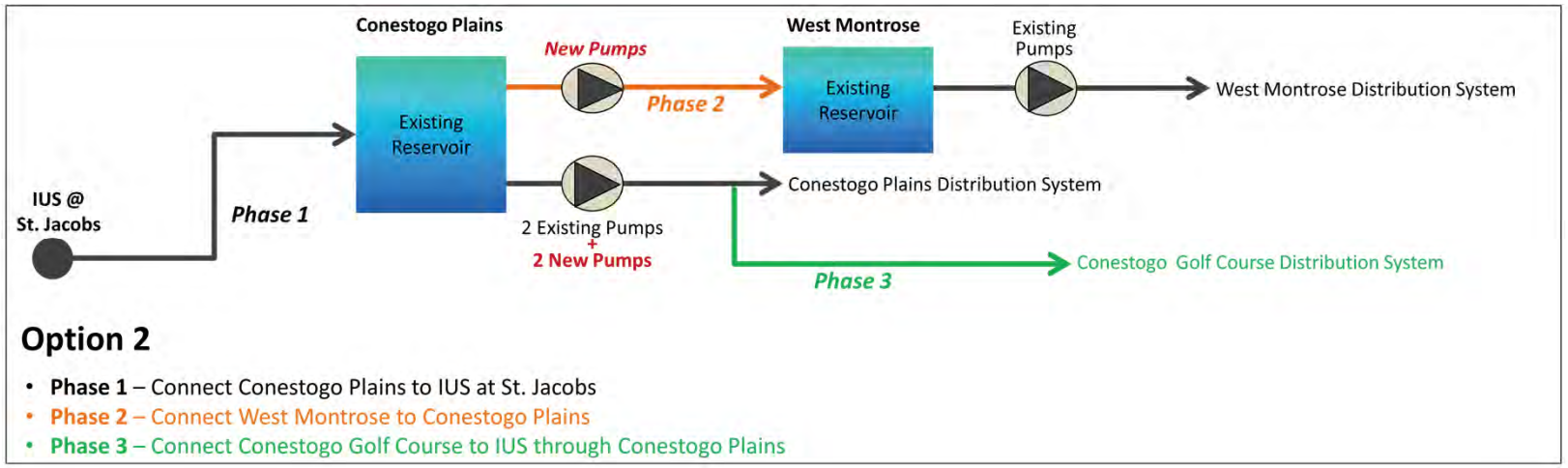
Higher score means higher ranking, lower impact

Preliminary Preferred Solution – Major Components

Water Supply Alternative No.2:

Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs.

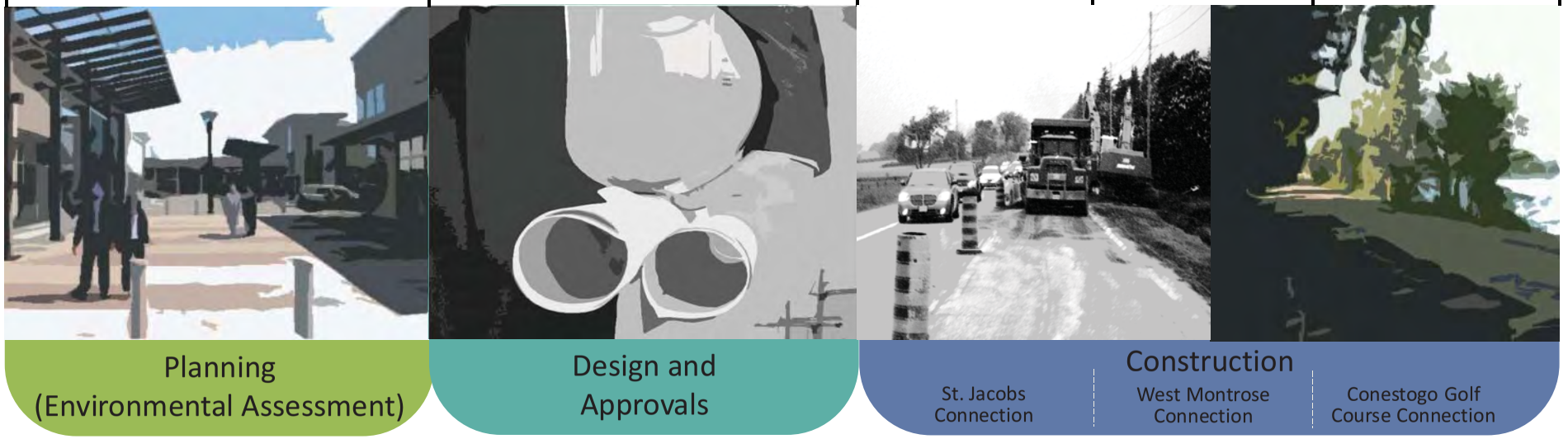
- **Phase 1**
  - Watermain connection from IUS at St. Jacobs to Conestogo Plains
- **Phase 2**
  - Watermain connection from Conestogo Plains to West Montrose
  - Decommission of supply and major treatment systems in West Montrose
  - Installation of booster pumps dedicated to transfer water from Conestogo Plains to West Montrose
- **Phase 3**
  - Watermain connection from Conestogo Plains to Conestogo Golf Course
  - Replacement of two existing high lift pumps in Conestogo Plains with new pumps
  - Decommission of supply and treatment systems in Conestogo Golf Course



Anticipated Impacts and Proposed Mitigation Measures

Impacts	Mitigation Measures
Community / Social **Short Term Construction Impacts on Noise, Dust, Traffic and Safety**	• Health and safety is a priority to the Region. All construction will adhere to strict safety guidelines • Temporary measures will be undertaken during construction to minimize noise, dust, mud and visual impacts • A traffic control plan will be prepared to mitigate any potential traffic disturbance during construction of the watermains • Standard best practices for vehicle and pedestrian safety will be used during construction and installation of watermains • Construction will be completed with planned road upgrades, where applicable
Natural Environment **Impacts to Water, Air, Soil, Natural Heritage Features**	• This project will not affect the quantity or quality of water in existing private wells in the area. Residents on the municipal supply will continue to receive water that meets all drinking water standards • Trenchless methods will be used for watermain installation across watercourses and sensitive wetland communities • An Erosion and Sediment Control Plan will be developed and implemented to mitigate impacts to adjacent vegetation communities and watercourses • Construction during sensitive periods for birds (breeding) and fish (spawning) where habitat have been identified will be avoided • Appropriate setbacks to Grand River and Canagagigue Creek, and associated wetlands and wooded areas will be applied

Anticipated project timeline for the Class EA Study and implementation of the preferred water supply solution:



* Portions of the watermains will be constructed as part of the roadworks planned for Sawmill Road in 2017

Next Steps

- The Project Team will consider the comments received from this Public Consultation Centre to confirm the results of the evaluation process.

- Confirmatory investigations (i.e., geotechnical and topographic) will be carried out to confirm the preliminary preferred water supply solution components and mitigation measures.

- Upon confirmation of the preferred water supply alternative solution, a Project File Report, presenting the Class EA study, will be prepared and made available for a 30-day public review period, where you will have a final chance to comment on the recommendations.

THANK YOU FOR YOUR INPUT!

Project Contacts

Please complete a Comment Sheet and leave it here today, or return it to the Region by fax, mail or email please see the instructions below) by December 5, 2014

For more information about this project, or to view the Public Consultation Centre displays online Please visit our website:

http://www.regionofwaterloo.ca/en/aboutTheEnvironment/MasterPlansandProjects.asp

Should you have any questions or concerns at any time during the project, please contact either of the following individuals:

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Project Manager
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Region of Waterloo

Conestogo Plains Water Supply System
Class Environmental Assessment

Public Consultation Centre No.2
Thursday, November 20, 2014
Conestoga Golf & Country Club – Club Room

COMMENT SHEET

The Region of Waterloo is interested in hearing any comments, questions or concerns that you may have regarding the Conestogo Plains Water Supply System project. This study is being conducted according to the requirements of a Schedule B project of the *Municipal Class Environmental Assessment* document (Municipal Engineers Association, October 2000 as amended in 2007 & 2011). Please take some time to complete this Comment Sheet. All comments will be carefully considered in the Class Environmental Assessment Study. Please drop your completed Comment Sheet today in the box provided, or send it to either of the following individuals (see below) by **December 5, 2014**:

Pam Law
Project Manager, Water Services
Region of Waterloo
150 Frederick Street, 7th Floor
Kitchener, Ontario, N2G 4J3
Telephone: 519-575-4095
Fax: 519-575-4452
Email: PLaw@regionofwaterloo.ca

Eric Tuson
Project Manager
CIMA
3027 Harvester Road, Suite 400
Burlington, Ontario, L7N 3G7
Telephone: 289-288-0287 Ext. 6839
Fax: 289-288-0285
Email: eric.tuson@cima.ca

1. Do you have any comments, concerns, questions or suggestions regarding the water supply alternative solutions evaluated under this study or the evaluation process?

_____

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2. Do you have any comments, concerns, questions or suggestions regarding the preliminary preferred solution being recommended – Option No.2: Supply West Montrose and Conestogo Plains from the Integrated Urban System at St. Jacobs?

3. What impacts will the preliminary preferred solution have on you? and, what mitigation measures would you recommend to be considered during construction of this project?

Thank you for your participation. All comments will be considered in finalizing the preferred solution. Please provide your contact information below should you wish to be added to our Project Mailing List.

NAME: _____
(please print)

ADDRESS: _____

POSTAL CODE: _____

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APPENDIX C
Agency Consultation

	Mr.	Maurice Bryan	Laforme	Chief	RR#6, 2789 Mississaga Road		Hagersville	ON
nal Affairs, Aboriginal and Relationships Branch	Mr	Martin	Rukavina	Advisor, Relationship, Aboriginal and Relationships Branch	160 Bloor Street East 9 th Floor		Toronto	ON
nal Affairs, Aboriginal and Relationships Branch	Ms.	Pam	Wheaton	Director	160 Bloor Street East, Suite 900		Toronto	ON
iver	Ms.	Ava	Hill	Chief	1695 Chiefswood Road, PO Box 5000		Ohsweken	ON
iver				Council	1695 Chiefswood Road, PO Box 5000		Ohsweken	ON
iver Territory	Mr.	Lonny	Bomberry	Director, Land and Resource Department	2498 Chiefswood Road, PO Box 5000		Ohsweken	ON
iver Territory	Mr.	Paul	General	Eco-Centre Manager	2676 Fourth Line Road, PO Box 5000		Ohsweken	ON
ee Confederacy Council	Mr.	Leroy	Hill	Secretary	2634 6th Line , RR #2		Ohsweken	ON
s	Mrs.	Heather	Levecque	Manager, Consultation Unit Aboriginal Affairs and Ministry Parntership Division	160 Bloor Street E., 9th Floor		Toronto	ON
acy Chiefs Council	Chief	Allen	MacNaughton		2634 6th Line Road RR 2		Ohsweken	ON
Credit	Chief	Bryan	LaForme		2789 Mississauga Rd. R.R. #6		Hagersville	ON
Health Department	Dr.	Liana	Nolan	Commissioner of Public Health and Medical Officer of Health	99 Regina Street South, 3rd Floor, Box 1633		Waterloo	ON
	Mr.	Willis	McLaughlin	Director of Public Works and Environment	4639 Lobsinger Line; RR#1		St. Clements	ON
	Mayor	Les	Armstrong	Mayor	60 Snyder's Road West		Baden	ON
	Mr.	Mark	Bauman	Councillor Ward 2	24 Church Street West		Elmira	ON
	Ms.	Bonnie	Bryant	Councillor Ward 3	24 Church Street West		Elmira	ON
	Mayor	Todd	Cowan	Mayor	24 Church Street West		Elmira	ON
erk's Office	Mr.	David	Brenneman	Chief Administrative Officer/City Clerk	24 Church Street West		Elmira	ON
gineering	Mr.	Richard	Sigurdson	Engineering Project Supervisor	24 Church Street West		Elmira	ON
gineering & Planning Services	Mr.	Dan	Kennaley	Director of Engineering & Development Services	24 Church Street West		Elmira	ON
	Mrs.	Diane	Freeman	Councillor, Ward 4 - Northeast	3rd Floor, 100 Regina St. S		Waterloo	ON
Association Inc. (BridgeKeepers)					1245 Rivers Edge Drive		West Montrose	ON
	Mr.	Ken	Monture	Manager	101 Shakespeare Street, 2nd Floor		Stratford	ON
Authority	Ms.	Sandra	Cooke	Senior Water Quality Supervisor	400 Clyde Road, PO Box 729		Cambridge	ON
Authority	Ms.	Melissa	Larion	Resource Planner	400 Clyde Road, PO Box 729		Cambridge	ON
Authority	Ms.	Samantha	Lawson	Supervisor of Resources Planning - Central	400 Clyde Road, PO Box 729		Cambridge	ON
Authority	Mr.	Fred	Natolchny	Supervisor of Resources Planning - North & South	400 Clyde Road, PO Box 729		Cambridge	ON
Food	Ms.	Carol	Neumann	Rural Planner	Elora Resource Centre, Unit 10	6484 Wellington Rd 7	Elora	ON
and Recreation	Ms.	Sonja	Erstic	Regional Advisor - Kitchener Office	2nd Flr, 4275 King St		Kitchener	ON
s and Housing	Mr.	Dwayne	Evans	Planner	659 Exeter Road, 2nd Floor		London	ON
ces	Mr.	Ken	Cornelisse		1 Stone Road West		Guelph	ON
ces	Mr.	Mike	Stone	District Planner	Guelph District Office	1 Stone Road West	Guelph	ON
t	Mr	Jamie	Connelly	Hydrogeologist/Team Leader-Water Resource Director	West Central Region Office	119 King Street West, 12th floor	Hamilton	ON
t	Ms.	Doris	Dumais	Director	Environmental Assessment and Approvals Branch	2 St.Clair Avenue West, Floor 12A	Toronto	ON
t	Ms.	Agatha	Garcia-Wright	Director- EA Section	Environmental Assessment and Approvals Branch	2 St.Clair Avenue West, Floor 12A	Toronto	ON
t	Mr.	Don	Hamilton	Drinking Water Supervisor	Guelph District Office	1 Stone Road West, 4th Floor	Guelph	ON
t	Ms.	Greta	Najcler	District Supervisor	Guelph District Office	1 Stone Road West, 4th Floor	Guelph	ON
t	Mr.	Paul	Odom	Surface Water Group Leader	West Central Region Office	119 King Street West, 12th floor	Hamilton	ON
t	Mrs.	Barbara	Slattery	Environmental Assessment Planning Coordinator	West Central Region Office	119 King Street West, 12th floor	Hamilton	ON
t	Mr	Nadir	Sunderji	Senior Water Engineer	Environmental Assessment and Approvals Branch	2 St.Clair Avenue West, Floor 19	Toronto	ON
	Ms.	Ann	Baldwin	Regional Director - Southwestern Region	659 Exeter Road 4th Floor		London	ON
	Mr.	Julius	Lindsay	Reporting Specialist	1 DundasStreet West, Suite 2000		Toronto	ON
	Ms.	Jennifer	Voss	Manager of Planning	55 COLUMBIA ST E, SUITE 2		Waterloo	ON
	Mr.	Larry	McGratton		PO Box 271		Fergus	ON
	Mr.	John	Jackson		17 Major Street		Kitchener	ON
nmental Education	Ms.	Elizabeth	Straszynski	President	Box 587		Lakefield	ON
tiatives	Mr.	Dave	Sisco		379 Queen Street South		Kitchener	ON
Network c/o Ministry of Natural Resources	Mr.	Stephen	May	Stewardship Coordinator	1 Stone Road West		Guelph	ON
Communities Coalition	Mr.	Marc	Xuereb	Meeting Coordinator, Recorder, Membership Coordinator, Network Coordinator	PO Box 370	10 Parkside Drive	St. Jacobs	ON
ilders Association Cummings Cockburn Ltd.	Mr.	Ian	Rawlings		105 Lexington Road, Suite 17		Waterloo	ON
nities	Ms.	Inga	Rinne		10 Parkside Drive, PO Box 370		St. Jacobs	ON
	Mrs.	Marie	Schroeder	Executive Officer	725 Bridge W		Waterloo	ON
	Mr.	Wes	Rieck		218 Boida Avenue, Unit 6		Ayr	ON
	Ms.	Gayle	Widmeyer	Manager	Access Network Department	575 Riverbend Drive, Floor 2	Kitchener	ON
	Mr.	Rick	Corbin	Wastewater Treatment Specialist	401 9th Avenue SW, Suite 700		Calgary	AB
	Mr.	John	MacTaggart		PO Box 1000		Concord	ON
	Mr.	Russell	McLean		Box 650		Scarborough	ON
	Mr.	Charles S.	Esendal	P. Eng., MBA, Sustainment Manager	483 Bay Street, North Tower		Toronto	ON
Inc.	Ms.	Cara	Clairman	Vice President Sustainable Development	700 University Avenue		Toronto	ON
	Mr.	Ted	Hancocks		85 Grand Crest Place, PO Box 488		Kitchener	ON
ing)	Mr.	Kevin	Schimus	Construction Projects T/L; Waterloo-Brantford	603 Kumpf Drive		Waterloo	ON
	Mr.	G.	Banks		800 Northfield Drive East		Waterloo	ON
	Ms.	Lok Man (Jenny)	Mui	Transmision Lines Sustainment, System Investment	483 Bay Street, 15th Floor, North Tower		Toronto	ON
	Mr.	Junior	Francis	Utilities Coordinator	4 Welding Way		Concord	ON
Group Inc.	Mr.	Paul	Bolger		bolger19@rogers.com			
	Mr.	Robert	Baxter		rbaxter@baxterci			

Ontario
Infrastructure Ontario

One Dundas Street West, Suite 2000, Toronto, ON M5G 2L5
1, rue Dundas Ouest, bureau 2000, Toronto, ON M5G 2L5

December 19, 2014

To whom it may concern,

Thank you for circulating Infrastructure Ontario (IO) on your Notice. Infrastructure Ontario is the strategic manager of the provincial government's real estate with a mandate of maintaining and optimizing value of the portfolio while ensuring real estate decisions reflect public policy objectives of the government.

Identifying IO Managed Lands

As you may be aware, *IO is responsible for managing property that is owned by Her Majesty the Queen in Right of Ontario as represented by the Minister of Economic Development, Employment and Infrastructure (MEDEI)* (Note as of June 2014: Ministry of Infrastructure has changed to Ministry of Economic Development, Employment and Infrastructure since). There is a potential that IO manages lands that fall within your study area. As a result, your proposal may impact IO managed properties and/or the activities of tenants present on IO-managed properties. In order to determine if IO property is within your study area, IO requires that the proponent of the project conduct a title search by reviewing parcel register(s) for adjoining lands, to determine the extent of ownership by MEDEI or its predecessor's ownership (listed below). Please contact IO if any ownership of provincial government lands are known to occur within your study area and are proposed to be impacted. IO managed land can ***include within the title but is not limited to*** variations of the following: Her Majesty the Queen/King, OLC, ORC, Public Works, Hydro One, PIR, MGS, MBS, MEDEI, MTO, MNR, MEI, MOI and MEDEI*. Please ensure that a copy of your notice is also sent to the ministry/agency on title. As an example, if the study area includes a Provincial Park, then MNR is to also to be circulated notices related to your project.

Impacts to Land holdings

Negative impacts to land holdings, such as the taking of developable parcels of IO managed land or fragmentation of utility or transportation corridors, should be avoided. If the potential for such impacts is present as part of this undertaking, you should contact the undersigned to discuss these issues at the earliest possible stage of your study.

IO obligates proponents to complete all due diligence for any realty activity on IO managed lands and this should be considered for project timelines and budget.

The MEDEI Class EA & Associated Due Diligence

All realty undertakings are subject to the *"Ministry of Infrastructure Public Work Class Environmental Assessment 2012 Office Consolidation*" (PW Class EA). The PW Class EA applies to a wide range of realty activities including leasing or letting, disposition, granting of easements, demolition and property maintenance/repairs.

For details on the PW Class EA please visit the Environment and Heritage page of the IO website found at: http://www.infrastructureontario.ca/Templates/Buildings.aspx?id=2147490336&langtype=1033

Please note that completion of an EA process does not automatically provide an approval for MEDEI's Class EA obligations. Class EA processes are developed and in place to assess undertakings associated with different types of projects*. For example, assessing the impacts of disposing of land from the public portfolio is significantly different then assessing the best location for a proposed road.* However, where an undertaking involves multiple proponents/undertakings with different class EAs, Municipalities and other proponents may work together to ensure that the EA processes for related but separate undertakings are not duplicative. That one process can be relied on by both the proponent and MEDEI to evaluate their respective undertakings and meet their respective obligations for the project. MEDEI can rely on an alternative EA process to satisfy MEDEI's obligations under the Environment Assessment Act if:

- The MEDEI lands are clearly articulated in the streamlined EA study area.
- Explicit reference to the corresponding undertaking in the MEDEI Class EA is evaluated (*e.g.,* if the proponent identifies the need to acquire land owned by MEDEI, then "acquisition of MEDEI-owned land", or similar statement, must be referenced in the EA document).
- Sufficient levels of consultation with MEDEI's/IO's specific stakeholders, such as the Ontario Ministry of Natural Resources, must be documented with the relevant information corresponding to MEDEI's/IO's undertaking and the associated maps.
- Details of appropriate mitigation measures and how the MEDEI Class EA 7 point analysis has been fulfilled. Negative environmental impacts associated with the project design and construction, such as the potential for dewatering, dust, noise and vibration impacts, impacts to natural heritage features/habitat and functions, etc should be avoided and/or appropriately mitigated in accordance with applicable regulations best practices as well as Ministry of Natural Resources (MNR) and Ministry of the Environment (MOE) standards. Avoidance and mitigation options that characterize baseline conditions and quantify the potential impacts should be present as part of the EA project file. Details of appropriate mitigation, contingency plans and triggers for implementing contingency plans should also be present.
- The proponent is required to provide to IO, in writing, how it intends to meet MEDEI's environmental obligations and report back on how it has met those obligations.

Other due diligence requirements such a Phase One Environmental Site Assessment (ESA) may also be required for the MEDEI lands proposed to be impacted.

Cultural Heritage:

Should the activities have the potential to impact cultural heritage features on IO managed lands, a request to examine cultural heritage features, which can include cultural landscapes, built heritage, and archaeological potential and/or sites, could be required. This may be a requirement outside of an EA process and must meet the obligations set out under the Standards and Guidelines for Provincial Heritage Properties (Ministry of Tourism, Culture and Sport 2010). All archaeological assessments must be completed by a professional archaeologist licensed by the province of Ontario and must adhere to the Standards and Guidelines for Consultant Archaeologists (Ministry of Tourism, Culture and Sport 2011).

Duty to Consult (DTC)

Please note that the Crown has a duty to consult under the Constitution Act. The requirement for Aboriginal consultation is determined by MEDEI and facilitated by IO. DTC may be triggered for a host of reasons: Aboriginal treaty or treaty rights, established consultation or notification protocols,

government policy and/or program decisions, archaeological potential and/or cultural heritage consultation obligations. For these types of undertakings MEDEI will need to evaluate the potential impact of an undertaking on Aboriginal and treaty rights. A proponent with an established consultation process, under their own EA process, must submit to MEDEI (via IO) their complete Aboriginal consultation documentation. This documentation will be reviewed against IO's and/or MEDEI's assessment for Aboriginal consultation based on the proposed undertaking. Additional consultation may be required to satisfy MEDEI.

Concluding Remarks

In summary, the purchase of MEDEI-owned/IO-managed lands or disposal of rights and responsibilities (e.g. easement) for IO-managed lands triggers the application of the MEDEI Class EA.

Deficiencies in any of these requirements could result in an inability to rely on the EA process proposed to streamline the EA approvals.

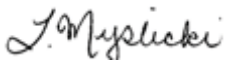
IO is providing this information so that adequate timelines and project budgets incorporate MEDEI's regulatory requirements, which may be required to support a realty activity required for the proponent's project.

If the proposed undertaking directly affects all or in part any IO-managed property, prior to finalizing the report, please contact the undersigned at your earliest convenience to ensure that all MEDEI Class EA requirements can be met through the EA study. Please send the undersigned a copy of the DRAFT EA report and allow a minimum of 30 calendar days for review.

If MEDEI owned lands are not anticipated to be impacted, please remove IO from your circulation list.

Thank you for the opportunity to provide initial comments on this undertaking. If you have any questions I can be reached at the contact information below.

Sincerely,



Lisa Myslicki
Environmental Specialist, Environmental Management
Infrastructure Ontario
1 Dundas Street West,
Suite 2000, Toronto, Ontario
M5G 2L5
(416) 212-3768
lisa.myslicki@infrastructureontario.ca

* Below are the acronyms for agencies/ministries listed in the above letter

(OLC) Ontario Land Corporation
(ORC) Ontario Realty Corporation
(PIR) Public Infrastructure and Renewal
(MGS) Ministry of Government Services
(MBS) Management Board and Secretariat
(MTO) Ministry of Transportation
(MNR) Ministry of Natural Resources
(MEI) Ministry of Energy and Infrastructure
(MOI) Ministry of Infrastructure
(MEDEI) Ministry of Economic Development, Employment and Infrastructure

Region of Waterloo

Transportation and Environmental Services
Water Services
150 Frederick Street, 7th Floor
Kitchener ON N2G 4J3 Canada
Telephone: 519-575-4400
Fax: 519-575-4452
www.regionofwaterloo.ca

Date: January 13, 2015

Joseph Muller, RPP, MCIP
Heritage Planner , Ministry of Tourism, Culture and Sport
401 Bay Street, Suite 1700
Toronto, Ontario M7A 0A7

Dear Mr. Muller:

Conestogo Plains Water Supply EA

Thank you for your comments submitted in December on behalf of the Ministry of Tourism, Culture and Sport (MTCS) in regards to the Conestogo Plains Water Supply EA. In response to your comments, the Region of Waterloo (Region) has completed a Cultural Heritage Evaluation of the preferred alternative from the EA which includes the construction of three watermains connecting the communities of Conestogo and West Montrose to the St. Jacobs water system. Figure 1 shows the extent of the proposed project. The technical memorandum (TM) detailing the evaluation completed by one of the Region's Cultural Heritage Planners has been included with this letter. Comments from the Township of Woolwich's (Township) planning department were also received and are included with this letter. Based on the feedback from the Region and Township's planning departments the "Screening for Impacts to Built Heritage and Cultural Heritage Landscapes" check list was completed and is also included with this letter. Based on the completed checklist it was found that a heritage impact assessment should not be required for the project.

Based on the proximity of the project to both the Grand River and the Canagagigue Creek the Region is in the process of having a Stage 1 Archaeological Assessment completed. The findings of this investigation will be integrated into the EA and a copy of the archaeological report will be forwarded directly to the MTCS for review.

We trust that the information provided within this letter and associated enclosed material addresses the concerns of the Ministry. Should you have any questions or comments please do not hesitate to contact the undersigned.

Sincerely

Senior Project Engineer, Region of Waterloo

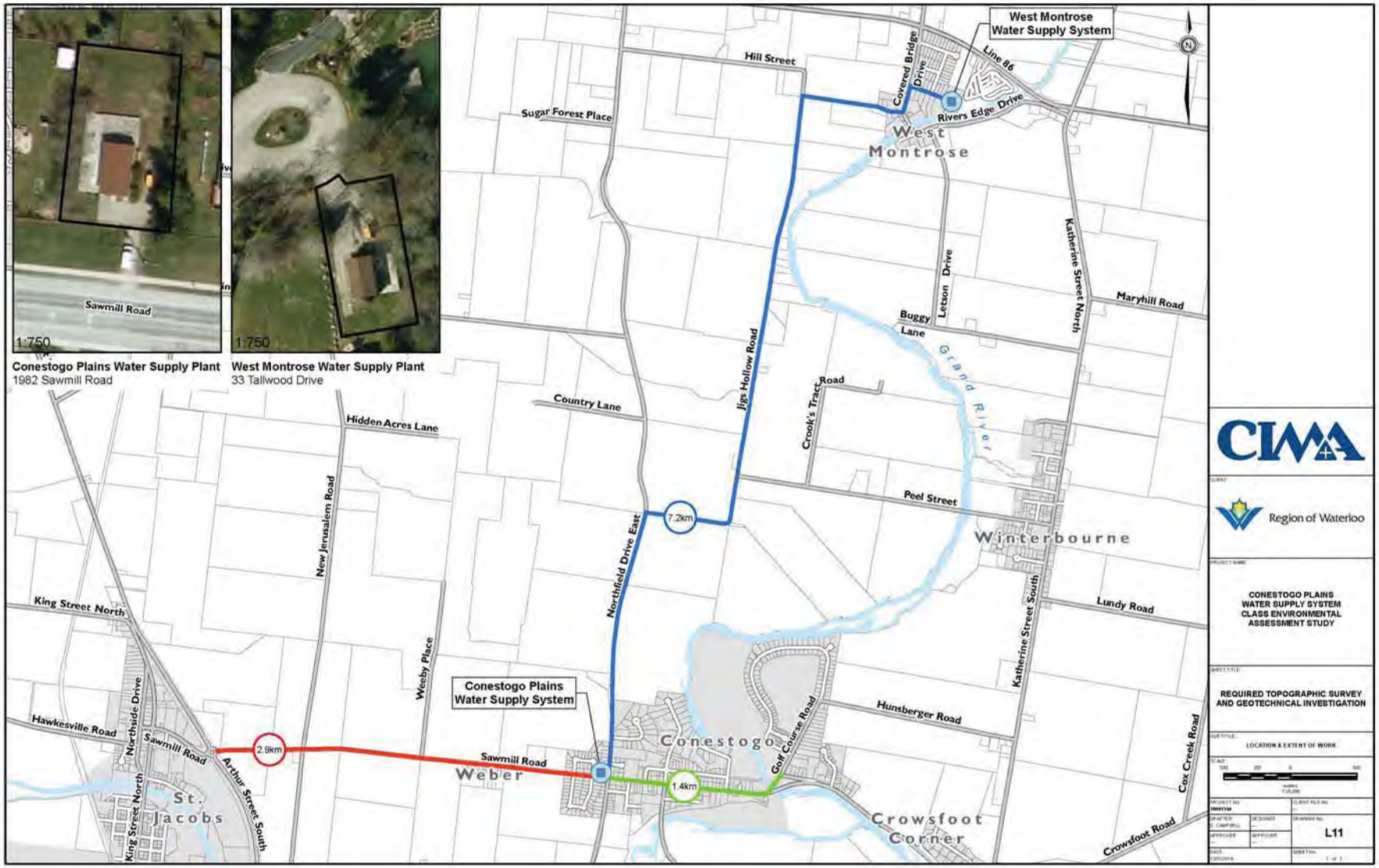


Figure 1: Project extent of preferred alternative for Conestogo Plains Water Supply EA

Region of Waterloo

Transportation and Environmental Services
Water Services
150 Frederick Street, 7th Floor
Kitchener ON N2G 4J3 Canada
Telephone: 519-575-4400
Fax: 519-575-4452
www.regionofwaterloo.ca

Date: January 20, 2015

Lisa Myslicki
Environmental Specialist, Environmental Management
Infrastructure Ontario
1 Dundas Street West,
Suite 2000, Toronto, Ontario
M5G 2L5

Dear Ms. Myslicki:

Conestogo Plains Water Supply EA

Thank you for your comments submitted in December on behalf Infrastructure Ontario (IO) in regards to the Conestogo Plains Water Supply EA. In response to your comments, the Region of Waterloo (Region) has completed a review of property ownership of all properties adjacent to the preferred alternative from the EA which includes the construction of three watermains connecting the communities of Conestogo and West Montrose to the St. Jacobs water system. Figure 1 shows the extent of the proposed project. The review showed that there were no properties owned by the Minister of Economic Development and Infrastructure (MEDEI) or managed by IO within the study area.

Based on the findings of the review IO will be removed from the project mailing list. Should you have any questions or comments please do not hesitate to contact the undersigned.

Sincerely

Senior Project Engineer, Region of Waterloo

cc: Eric Tuson, CIMA

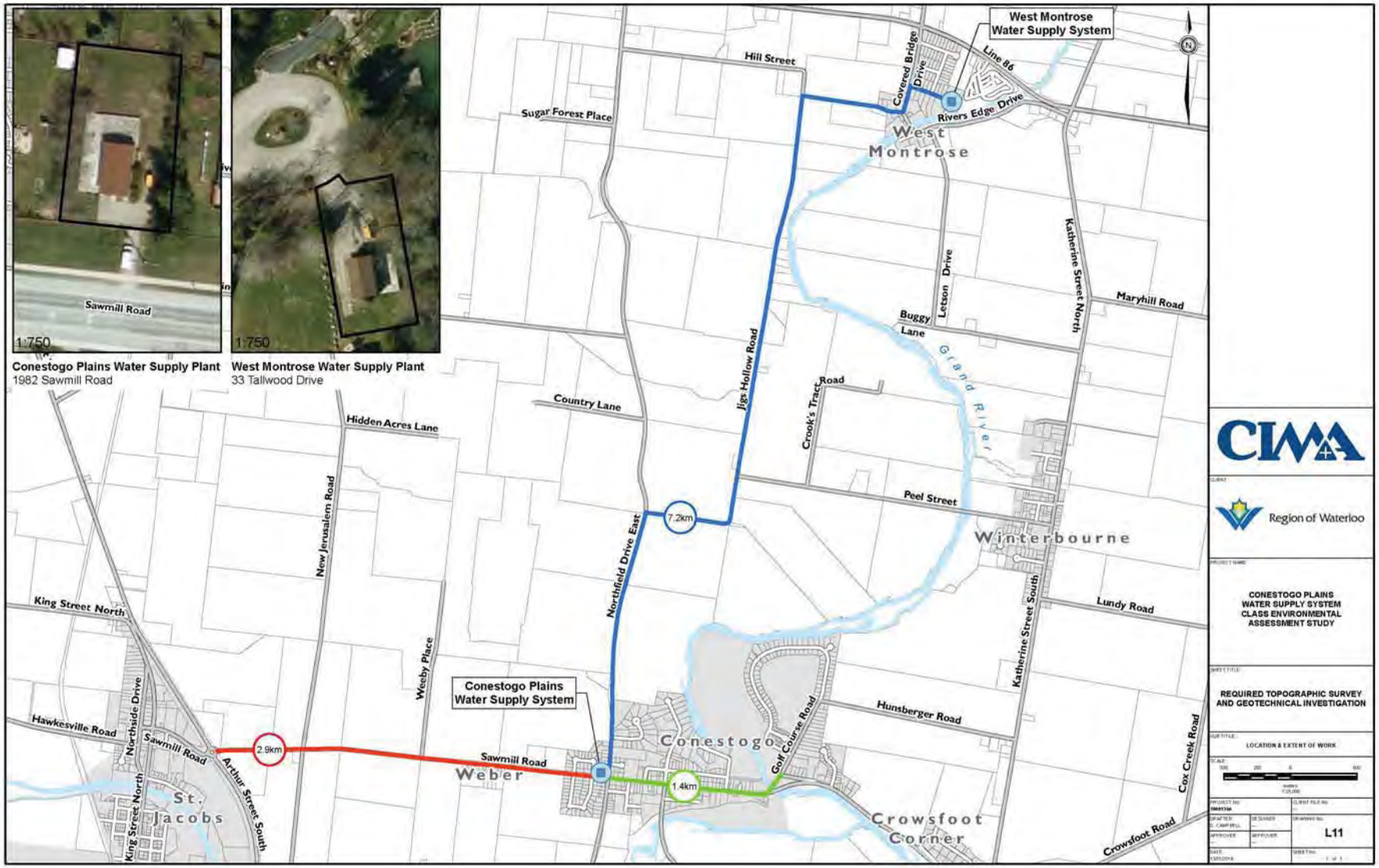


Figure 1: Project extent of preferred alternative for Conestogo Plains Water Supply EA

Region of Waterloo

Planning, Development & Legislative Services

Cultural Services

Date: January 8, 2015

Memorandum

To: Pam Law, Senior Project Engineer, Water Services

Cc: Lucille Bish, Director, Cultural Services

From: Lindsay Benjamin, Cultural Heritage Planner

Subject: Conestogo Water Supply EA – Cultural Heritage Evaluation of Water Supply Alternative Solution No.2

This is a response to a request for an evaluation of the cultural heritage value or interest of the resources located within the Conestogo Water Supply EA - Water Supply Alternative Solution No.2 project area, which encompasses the road allowances of Sawmill Road, Northfield Drive East, Jigs Hollow Road, Hill Street, Covered Bridge Drive and Tallwood Drive in the Township of Woolwich.

The proposed work will include the installation of three watermains that will be located within the road allowances of the above mentioned roads. The installation of a watermain through Conestogo will be done in conjunction with the Sawmill Road rehabilitation project planned for 2017, which has undergone a separate Environmental Assessment process. This same watermain will also cross the Grand River near Bridge #1702. In addition to the watermain work, some modifications will be made to the West Montrose treatment plant, and the Conestogo Plains treatment plant. The Conestogo Golf Course treatment plant, located along Golf Course Road, will be removed.

Modifications to the treatment plants are not anticipated to impact any cultural heritage resources.

To help identify and evaluate the cultural heritage resources located in the project area, a Preliminary Design Report was completed to inventory existing structures and landscapes. The report can be found in Appendix A of this memo.

A number of significant cultural heritage resources were identified adjacent to the project area, notably in the villages of Conestogo and West Montrose. From the description of work proposed, Cultural Heritage staff have determined that there will be no long-term negative impacts to any of the identified resources, and as such the completion of a Heritage Impact Assessment (HIA) for the project is not required.

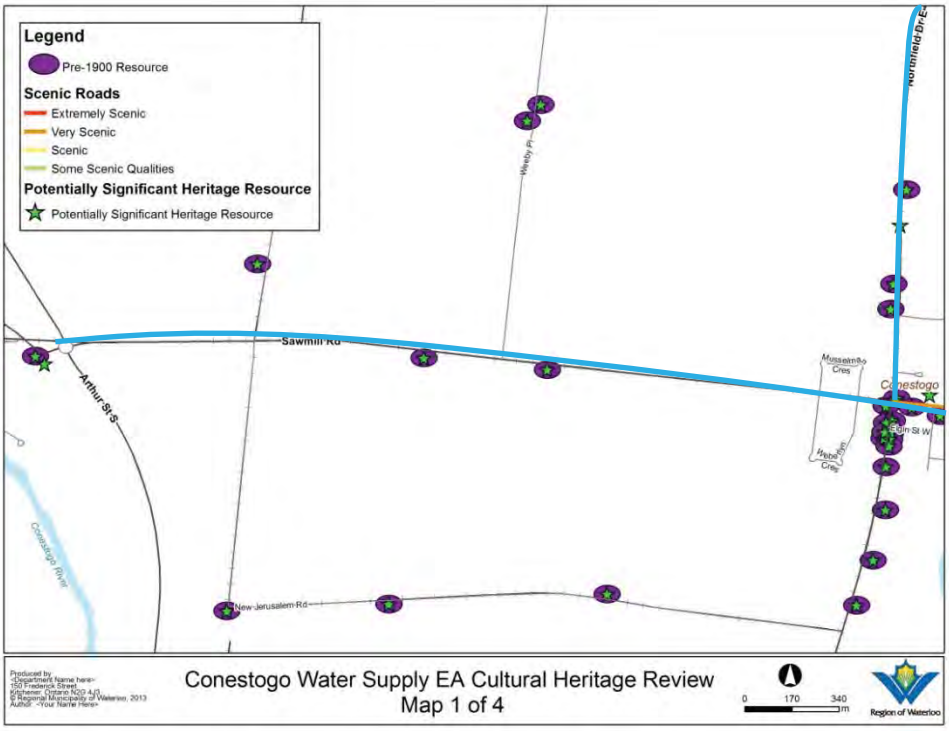
Any temporary impacts to identified cultural heritage resources during construction should be mitigated. In discussion with the Project Team, it has been confirmed that vibration monitoring will be undertaken during construction in an effort to mitigate impacts to the surrounding structures. Many of the buildings inventoried, notably those in Conestogo, as well as 52 Hill St. (Albright House) and 17 Covered Bridge Dr. in West Montrose, have very limited set backs from the road right of way. Care should be taken during construction to monitor and mitigate any potential impacts to these resources.

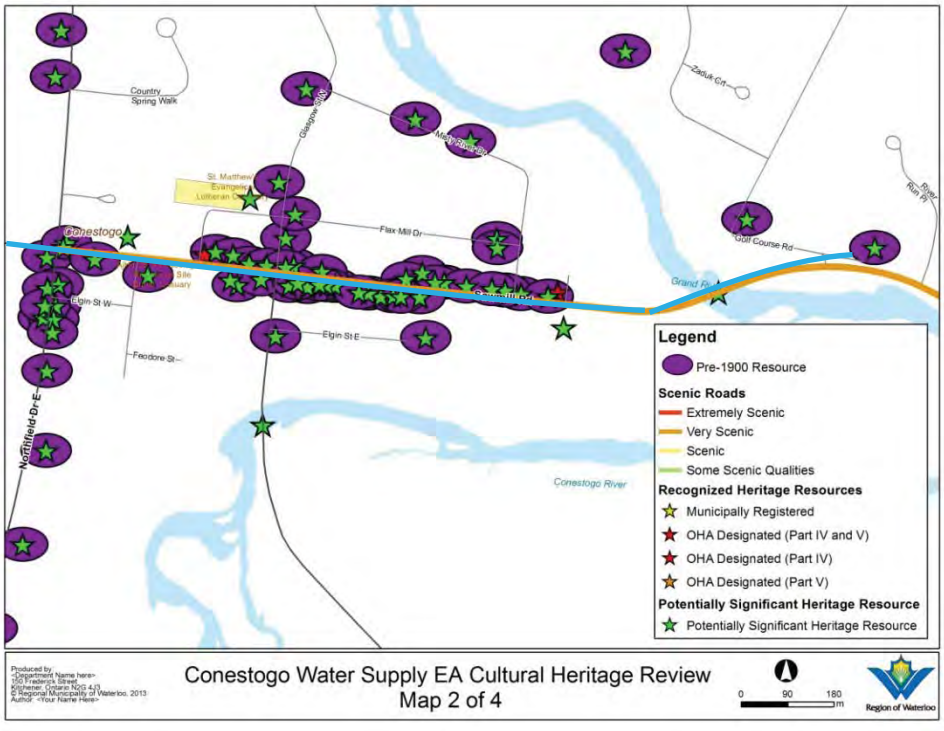
Should the proposed project plans change in nature or scope, such that there would be potential impacts to the identified cultural heritage resources, Cultural Heritage staff should be informed and further evaluation would need to be undertaken.

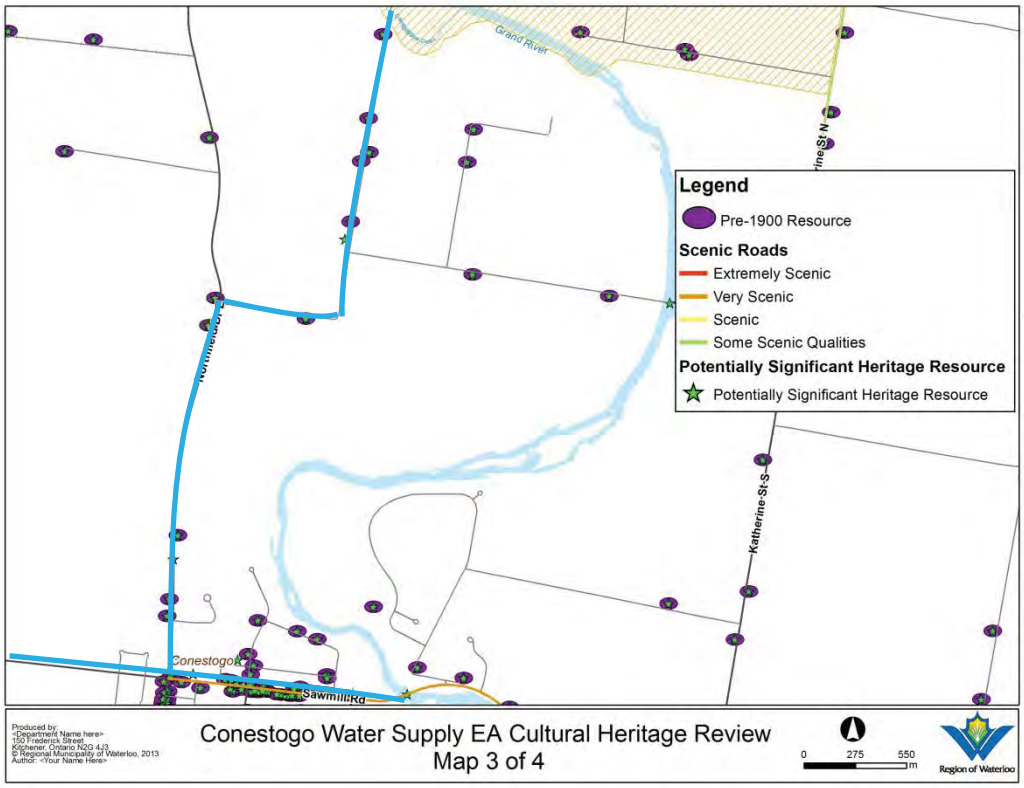
APPENDIX A

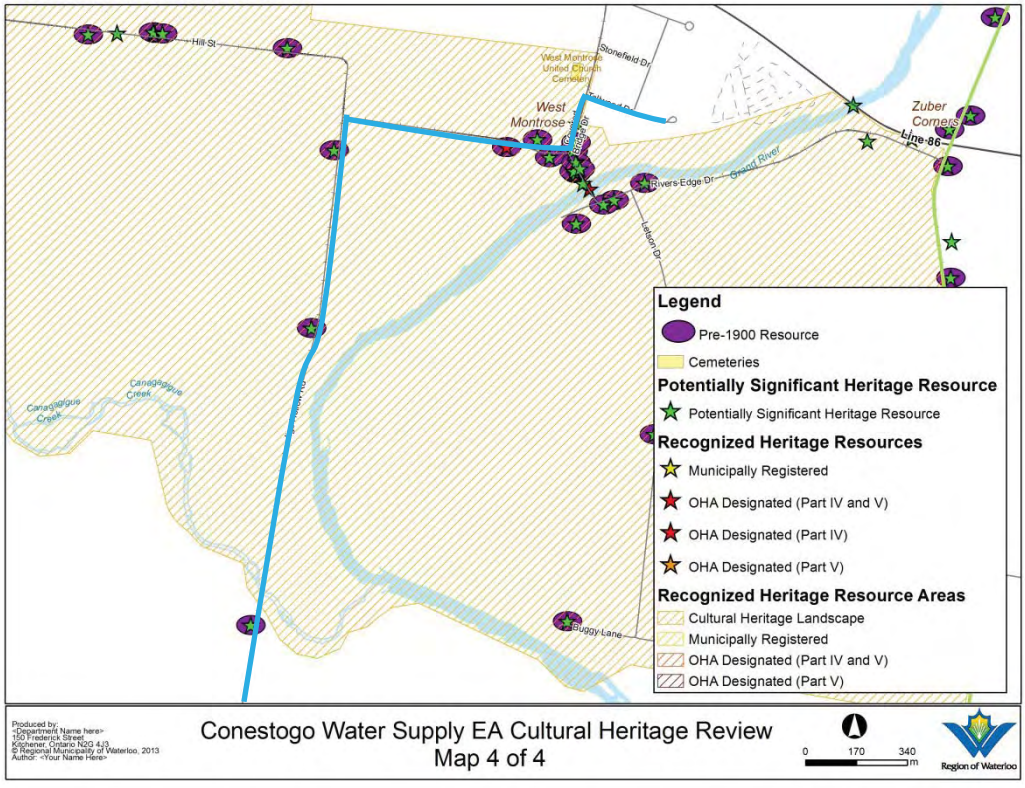
Cultural Heritage Comments - Current as of January 8, 2015

Project: Conestogo Water Supply EA






Grand River
Legend
Pre-1900 Resource
Scenic Roads
Extremely Scenic
Very Scenic
Scenic
Some Scenic Qualities
Potentially Significant Heritage Resource
Potentially Significant Heritage Resource
Katherine St S
Conestogo
Sawmill Rd
Produced by:
<Department Name here>
150 Frederick Street
Kitchener, Ontario N2G 4J3
© Regional Municipality of Waterloo, 2013
Author: <Your Name Here>
Conestogo Water Supply EA Cultural Heritage Review
Map 3 of 4
0 275 550 m
Region of Waterloo


Hill St
West Montrose United Church Cemetery
Stonefield Dr
West Montrose
Zuber Corners
Line 86
Rivers Edge Dr
Grand River
Legend
Pre-1900 Resource
Cemeteries
Potentially Significant Heritage Resource
Potentially Significant Heritage Resource
Recognized Heritage Resources
Municipally Registered
OHA Designated (Part IV and V)
OHA Designated (Part IV)
OHA Designated (Part V)
Recognized Heritage Resource Areas
Cultural Heritage Landscape
Municipally Registered
OHA Designated (Part IV and V)
OHA Designated (Part V)
Canagagigue Creek
Buggy Lane
Produced by:
<Department Name here>
150 Frederick Street
Kitchener, Ontario N2G 4J3
© Regional Municipality of Waterloo, 2013
Author: <Your Name Here>
Conestogo Water Supply EA Cultural Heritage Review
Map 4 of 4
0 170 340 m
Region of Waterloo

Summary

There are three designated properties, no municipally registered properties, 59 unofficially listed properties, and a total of 52 pre-1900 residential properties adjacent to the road corridor, along with two bridges. Many of the structures inventoried, notably those in Conestogo, as well as 52 Hill St. (Albright House) and 17 Covered Bridge Dr. in West Montrose, have very limited set backs from the road right of way. As such, care should be taken during construction to monitor and mitigate any potential impacts to these resources. A portion of road in this project area, Sawmill Rd., is considered scenic or of special character. An archaeological assessment is not required. There is one cemetery adjacent to the project area in West Montrose. The settlement of West Montrose is designated as a Cultural Heritage Landscape (CHL).

The area municipal heritage contact for this project is Jeremy Vink, Senior Planner, Township of Woolwich, jvink@woolwich.ca, 519-669-6038.

Please keep Cultural Heritage staff at the Region involved in this project as it progresses. The study area contains a high concentration of significant cultural heritage resources.

The following information is compiled from an inventory of cultural heritage resources that is maintained by the Region. The inventory is updated regularly with data that is provided by the area municipalities. To ensure the accuracy of the information it should be verified with the area municipality. For more information please contact the Cultural Heritage Specialist at 519-575-4094.

This information is intended to provide a general overview of the cultural heritage resources in the project area. A Heritage Impact Assessment and/or Archaeological Assessment must be completed if identified as a requirement in the Class Environmental Assessment.

Inventory of Heritage Features

	Pre-1900 Date Built	Designated Properties	Municipally Registered	Unofficially Listed
3015 Sawmill Rd.	1870			X
3011 Sawmill Rd. (Picard Peanuts)				X
2269 Sawmill Rd.	1870			X
2195 Sawmill Rd.	1895			X
1030 Northfield Dr. E.	1850			X
1966 Sawmill Rd.	1870			X
1955 Sawmill Rd.	1858			X
1948 Sawmill Rd. (Conestogo Public School)	1904			X
1939 Sawmill Rd.	1859			X
1911 Sawmill Rd.	1894			X
1915 Sawmill Rd.	1916			X
1892 Sawmill Rd. (specifically the garage next to this property)	1880			X
1887 Sawmill Rd.	1890			X

1895 Sawmill Rd.	1880			X
1842 Sawmill Rd. (1842 Bed & Breakfast)	1840			X
1830 Sawmill Rd.	1850			X
1857 Sawmill Rd.				X
1861 Sawmill Rd.	1850			X
1908 Sawmill Rd.	1900			X
1900 Sawmill Rd.	1880			X
1850 Sawmill Rd.	1840			X
1836 Sawmill Rd.	1895			X
1826 Sawmill Rd.	1850			X
1808 Sawmill Rd.	1860			X
1843 Sawmill Rd.	1850			X
1853 Sawmill Rd.	1870			X
1851 Sawmill Rd.	1870			X
1875 Sawmill Rd.	1870			X
1907 Sawmill Rd.	1870			X
1896 Sawmill Rd.	1900			X
1880 Sawmill Rd.	1890			X
1814 Sawmill Rd.	1870			X
1879 Sawmill Rd.	1870			X
1883 Sawmill Rd.	1880			X
1891 Sawmill Rd.	1880			X
1818 Sawmill Rd.	1870			X
1796 Sawmill Rd.	1850			X
1865 Sawmill Rd.	1855			X
1805 Sawmill Rd. (W&S Feed Supplies Mill)				X
1790 Sawmill Rd. (Conestogo United Church)	1878	X		
1924 Sawmill Rd. (Township Hall)		X		
3 Golf Course Rd.	1850			X
1904 Northfield Dr. E.	1885			X
1110 Northfield Dr. E.	1885			X
1183 Northfield Dr. E.	1870			X
1430 Northfield Dr. E.	1850			X
1444 Northfield Dr. E.	1880			X
1095 Jigs Hallow Rd.	1870			X
1210 Jigs Hallow Rd. (one-room school house)	1900			X
1230 Jigs Hallow Rd.	1857			X
1300 Jigs Hallow Rd.	1870			X
1313 Jigs Hallow Rd.	1870			X
1350 Jigs Hallow Rd.	1870			X
1440 Jigs Hallow Rd.	1870			X
1642 Jigs Hallow Rd.	1870	CHL		X
1764 Jigs Hallow Rd.	1880	CHL		X

52 Hill St. (Albright House)	c.1850	X/CHL		
31 Hill St.	1850	CHL		X
28 Hill St.	1897	CHL		X
12 Covered Bridge Dr. (Lost Acres Variety)	1902	CHL		X
15 Covered Bridge Dr.	1900	CHL		X
17 Covered Bridge Dr.	1870	CHL		X

Scenic Road

A section of Sawmill Road, from Northfield Dr. E. to the Conestogo village limits, is classified as a "Rural Village Main Street" and has been ranked as Very Scenic due to the presence of diverse and mature vegetation, views to the Grand River, and the built cultural heritage context. Further information can be found in the Scenic Roads Resource Document (DOCs 675554).

Heritage Bridge

Two bridges are located in the project area:

1) Bridge #1702 carries Sawmill Rd. across the Grand River. It is a continuous steel girder bridge on wall piers with solid concrete parapet walls. Constructed in 1963, the bridge has four spans and carries two-lanes of traffic, with a deck length of 123.5 metres and a total width of 12.3 metres. This type of bridge construction is typical of the era. Bridge #1702 exhibits a utilitarian design with simple solid concrete parapet walls.

   It was not included in *Spanning the Generations*, an inventory of heritage bridges in the Region of Waterloo, or other Grand River watershed-wide heritage bridge inventories. However, a remnant concrete pier from a pervious bridge remains in the Grand River just north of Bridge #1702. Care should be taken during construction not to impact this structure.

2) Bridge #2251 carries Northfield Dr. E. over a creek (name unknown). It is a single-span concrete box culvert constructed in 1950 with a length of 3.1 metres and width of 22.2 metres. This type of culvert construction is typical of the era.

   Bridge #2251 was included on page 6.13 of "Spanning the Generations: Phase 1," an inventory of heritage bridges in the Region of Waterloo. It was not included in other Regional or Grand River watershed-wide heritage bridge inventories.

Cultural Heritage Landscape

The Village of West Montrose has been designated as Cultural Heritage Landscape (CHL) under the Planning Act through an Official Plan Amendment. To see the CHL boundaries as they relate to the project area, please refer to Map 4 above.

The recognition and conservation of significant cultural heritage landscapes takes place in accordance with the Provincial Policy Statement and the Regional Official Policies Plan.

The West Montrose CHL is a defined geographical area of heritage significance that has been modified by human activities and is valued by the community. It is made up of a grouping of individual heritage features that together form a significant type of heritage form, distinctive from that of its constituent attributes or parts. Many of these heritage features have been inventoried in the list above.

More detailed information on the CHL designation and the policies that govern it can be found in the following PDF: http://www.woolwich.ca/en/townshipServices/resources/OP-CHAPTER_12.pdf

Cultural Heritage Definitions

Designated Properties – Protected from demolition and other adverse impacts
A designation confers a legal status on a property by a specific municipal by-law under the Ontario Heritage Act. Designation may fall under one of two categories under the Ontario Heritage Act: Part IV (individual designation) or Part V (district designation). Designation is an Area Municipal responsibility. The Area Municipal Council has the legal authority to refuse an application that will adversely affect the property's heritage attributes.

Municipally Registered/Listed Properties – Interim protection from demolition
The municipal register is the official list or record of cultural heritage properties that have been identified as being important to the community. The register includes all properties in the municipality that are designated under Part IV (individual designation) and Part V (district designation) of the Ontario Heritage Act. In addition, the municipal register may include properties of cultural heritage value or interest that have not been designated under the Ontario Heritage Act. This is commonly known as "listing." The Area Municipal Council must be given at least 60 days notice of intention to demolish or remove a building or structure on the property. This allows time for the municipality to decide whether to begin the designation process to give long term protection to the property.

The Process for Protected (Listed or Designated) Heritage Properties
If there are protected heritage properties located within the project boundaries of a Schedule B or C project a Heritage Impact Assessment (HIA) must be completed and Heritage Planning Staff at the Region and Area Municipality should be notified. The first phase of the HIA will provide an inventory of the heritage resources that are located within the project area. This inventory will provide more detail about the resources that have been identified in the PDR and may identify additional resources. The inventory should be used to identify and evaluate the impacts that the alternative solutions and design concepts will have on the heritage properties. Impacts to protected (listed/designated) heritage properties within the project boundaries should be avoided whenever possible.

Unofficially Identified Cultural Heritage Resources – No legal protection
Cultural Heritage Staff maintain a broad inventory of cultural heritage resources in the Region. These resources have been identified using a variety of sources including walking tours, local inventories, local histories, planning documents, heritage research projects, etc. Although these properties do not have any official heritage status or protection they may be potential candidates for designation or listing on a municipal register. If a historically significant property is threatened, a community may recognize its value and attempt to acquire some sort of heritage protection for the resource.

Cultural Heritage Landscapes
Cultural Heritage Landscapes are a defined geographical area that may have been modified by human activity and are identified as having cultural heritage value or interest by a community, including an Aboriginal community. The area may involve features such as structures, spaces, archaeological sites or natural elements that are valued together for their interrelationship, meaning or association. Examples may include, but are not limited to, heritage conservation districts designated under the Ontario Heritage Act; villages, parks, gardens, battlefields, mainstreets and neighbourhoods, cemeteries,

trailways, viewsheds, natural areas and industrial complexes of heritage significance; and areas recognized by federal or international designation authorities (e.g. a National Historic Site or District designation, or a UNESCO World Heritage Site).

Pre -1900 Residential Properties – For information
Residential structures in the project area that were built prior to 1900 have been identified. These identified historic structures have no formal heritage protection. However, historic buildings that have maintained their heritage value could be candidates for further heritage protection. Property data is taken from the Municipal Property Assessment Corporation (MPAC). The date that is assigned to a property represents the oldest structure on the lot.

Scenic Roads – Identified as possessing cultural value and require additional design consideration
Certain transportation corridors are characterized by natural, cultural heritage and recreational features that contribute to their scenic value or special character. Area municipalities are responsible for the designation of those municipal roads that possess scenic or cultural value. Likewise, the Region has identified sections of Regional road corridors that are considered scenic. The Special Character Streets and Scenic Roads Resource Document is a supplement to the Implementation Guidelines for Regional Transportation Corridor Design. It identifies and provides recommendations for the treatment of Scenic Roads and Special Character Streets that are part of the Regional road system within the Region of Waterloo. These recommendations should be considered before undertaking any work on a road that has been identified as possessing scenic value.

For conservation recommendations please consult the Scenic Road Resource Document (DOCs # 675554).

Additional Definitions

Heritage Bridges
The Region's Heritage Planning Advisory Committee has produced "Spanning the Generations: a Study of Old Bridges in Waterloo Region." Phase I is an inventory and ranking of more than 100 bridges based on their heritage attributes. Phase 2 documents the 10 most historically significant bridges. Phase 3 focuses on steel truss bridges. The document also contains protection and maintenance strategies for historic bridges in the Region. Any road work on an identified historic bridge should be done in conjunction with this document. For a hard copy of this document please contact the Cultural Heritage Planner at 519-575-4094.

A supplemental Regional Bridge Inventory was compiled in July 2012 by Cultural Heritage Planning Staff. The inventory provides a general overview of Regionally owned bridges built post-1930 and contains information and photos on each structure. The inventory was compiled as a resource to help assess the heritage value of the bridge structures. The study does not include Regionally owned culverts. Because the data contained in this report is reviewed and evaluated on a continual basis, it is only accurate as of July 2012. For the most accurate and up-to-date data on Regional bridges please contact Shawn Buckley sbuckley@regionofwaterloo.ca.

For ease, the Regional Bridge Inventory is sorted both by date of construction (DOCs # 1329552) and by Structure ID No. (DOCs # 1329856).

Cemeteries

If a cemetery is located adjacent to the road corridor the area municipality should be informed of any potential impacts to the cemetery. If land acquisition is required then the Cemeteries Regulation Unit at the Ministry of Consumer Services should be contacted.

Pam Law

From: Jeremy Vink
Sent: Tuesday, January 13, 2015 8:52 AM
To: Pam Law
Cc: Richard Sigurdson; Lindsay Benjamin
Subject: RE: Conestogo water supply EA - Cultural impact - input required

Paw

Given the works should have no impact on the existing buildings, and no hydrants etc are proposed on the portion along Jigs Hollow, Hill St and through West Montrose, there should be no heritage issues and from a heritage perspective there are no concerns.

Jeremy Vink MCIP RPP
Senior Planner
Township of Woolwich

From: Pam Law [mailto:PLaw@regionofwaterloo.ca]
Sent: Monday, January 12, 2015 2:15 PM
To: Jeremy Vink
Cc: Richard Sigurdson; Lindsay Benjamin
Subject: RE: Conestogo water supply EA - Cultural impact - input required

Hi Jeremy,

If the watermain within Conestogo, east of Northfield, ends up being used as a distribution main then there is a possibility of hydrants on that watermain, but the other watermains, from St. Jacobs to the edge of Conestogo and the main connecting Conestogo to West Montrose, will be considered Regional transmission mains and will therefore not have hydrants.

We anticipate that the construction of the watermains will be completed within the existing road allowances and should have minimal impacts on vegetation.

Pam

From: Jeremy Vink
Sent: Monday, January 12, 2015 1:04 PM
To: Pam Law
Cc: Richard Sigurdson; Lindsay Benjamin
Subject: Re: Conestogo water supply EA - Cultural impact - input required

Pam

Can you answer a few questions for me, as West Montrose is a cultural heritage landscape and involves more than just buildings.

Will the installation involve hydrants or other similar items?
Will the installation impact any trees or vegetation?

Thanks

Jeremy

Sent from my BlackBerry 10 smartphone on the Bell network.

From: Pam Law
Sent: Monday, January 12, 2015 10:59 AM
To: Jeremy Vink
Cc: Richard Sigurdson; Lindsay Benjamin
Subject: Conestogo water supply EA - Cultural impact - input required

Hi Jeremy,
The Region is working on a Class EA for the Conestogo Plains Water Supply System. The preferred alternative for the EA is connecting the water systems in Conestogo and West Montrose to the water supply in St. Jacobs. This will involve the construction of 3 watermains within the existing road allowances on Sawmill Road, Northfield Dr., Jigs Hollow Road, Hill St., Covered Bridge Dr. and Tallwood Dr. as shown on the attached map.

As part of the EA Lindsay Benjamin, one of the Region's Cultural Heritage Planners, has prepared a Cultural Heritage Evaluation of the proposed works. The memo, attached, has indicated that there are no anticipated long-term cultural impacts from the work as long as proper monitoring is completed during construction.

Would you be able to review the attached memo and let me know if the Township has any additional comments related to cultural impacts that you feel should be included? If possible, I would appreciate comments by next Monday, the 19th.

If you have any questions regarding the project, please to do hesitate to contact me.

Thanks

Pam Law, P. Eng.
Senior Project Engineer
Region of Waterloo
Water Services
PLaw@regionofwaterloo.ca
519-575-4095

Screening for Impacts to Built Heritage and Cultural Heritage Landscapes

This checklist is intended to help proponents determine whether their project could affect known or potential cultural heritage resources. The completed checklist should be returned to the appropriate Heritage Planner or Heritage Advisor at the Ministry of Tourism and Culture.

Step 1 – Screening for Recognized Cultural Heritage Value

YES	NO	Unknown	
☒	☐	☐	1. Is the subject property designated or adjacent* to a property designated under the *Ontario Heritage Act*?
☐	☒	☐	2. Is the subject property listed on the municipal heritage register or a provincial register/list? (e.g. Ontario Heritage Bridge List)
☐	☒	☐	3. Is the subject property within or adjacent to a Heritage Conservation District?
☐	☒	☐	4. Does the subject property have an Ontario Heritage Trust easement or is it adjacent to such a property?
☐	☒	☐	5. Is there a provincial or federal plaque on or near the subject property?
☐	☒	☐	6. Is the subject property a National Historic Site?
☐	☒	☐	7. Is the subject property recognized or valued by an Aboriginal community?

Step 2 – Screening Potential Resources

YES	NO	Unknown	
			Built heritage resources
			1. Does the subject property or an adjacent property contain any buildings or structures **over forty years old**† that are:
☒	☐	☐	▪ Residential structures (e.g. house, apartment building, shanty or trap line shelter)
☒	☐	☐	▪ Farm buildings (e.g. barns, outbuildings, silos, windmills)
☒	☐	☐	▪ Industrial, commercial or institutional buildings (e.g. a factory, school, etc.)
☒	☐	☐	▪ Engineering works (e.g. bridges, water or communications towers, roads, water/sewer systems, dams, earthworks, etc.)
☐	☒	☐	▪ Monuments or Landmark Features (e.g. cairns, statues, obelisks, fountains, reflecting pools, retaining walls, boundary or claim markers, etc.)
☐	☒	☐	2. Is the subject property or an adjacent property associated with a known architect or builder?
☐	☒	☐	3. Is the subject property or an adjacent property associated with a person or event of historic interest?
☐	☒	☐	4. When the municipal heritage planner was contacted regarding potential cultural heritage value of the subject property, did they express interest or concern?
YES	**NO**	**Unknown**	**Cultural heritage landscapes**
			5. Does the subject property contain landscape features such as:
☐	☒	☐	▪ Burial sites and/or cemeteries
☐	☒	☐	▪ Parks or gardens
☐	☒	☐	▪ Quarries, mining, industrial or farming operations
☐	☒	☐	▪ Canals
☐	☒	☐	▪ Prominent natural features that could have special value to people (such as waterfalls, rocky outcrops, large specimen trees, caves, etc.)
☐	☒	☐	▪ Evidence of other human-made alterations to the natural landscape (such as trails, boundary or way-finding markers, mounds, earthworks, cultivation, non-native species, etc.)
☒	☐	☐	6. Is the subject property within a Canadian Heritage River watershed?
☐	☒	☐	7. Is the subject property near the Rideau Canal Corridor UNESCO World Heritage Site?
☐	☒	☐	8. Is there any evidence from documentary sources (e.g., local histories, a local recognition program, research studies, previous heritage impact assessment reports, etc.) or local knowledge or Aboriginal oral history, associating the subject property/ area with historic events, activities or persons?

Note:

If the answer is "yes" to any question in Step 1, proceed to Step 3.

The following resources can assist in answering questions in Step 1:

Municipal Clerk or Planning Department – Information on properties designated under the Ontario Heritage Act (individual properties or Heritage Conservation Districts) and properties listed on a Municipal Heritage register.

Ontario Heritage Trust – Contact the OHT directly regarding easement properties. A list of OHT plaques can be found on the website: Ontario Heritage Trust

Parks Canada – A list of National Historic Sites can be found on the website: Parks Canada

Ministry of Tourism and Culture – The Ontario Heritage Properties Database includes close to 8000 identified heritage properties. Note while this database is a valuable resource, it has not been updated since 2005, and therefore is not comprehensive or exhaustive. Ontario Heritage Properties Database

Local or Provincial archives

Local heritage organizations*, such as the municipal heritage committee, historical society, local branch of the Architectural Conservancy of Ontario, etc.*

Consideration should also be given to obtaining oral evidence of CHRs. For example, in many Aboriginal communities, an important means of maintaining knowledge of cultural heritage resources is through oral tradition.

If the answer is "yes" to any question in Step 2, an evaluation of cultural heritage value is required. If cultural heritage resources are identified, proceed to Step 3.

If the answer to any question in Step 1 or to questions 2-4, 6-8 in Step 2, is “unknown”, further research is required.

If the answer is "yes" to any of the questions in Step 3, a heritage impact assessment is required.

If uncertainty exists at any point, the services of a qualified person should be retained to assist in completing this checklist. All cultural heritage evaluation reports and heritage impact assessment reports must be prepared by a qualified person. Qualified persons means individuals (professional engineers, architects, archaeologists, etc.) having relevant, recent experience in the identification and conservation of cultural heritage resources. Appropriate evaluation involves gathering and recording information about the property sufficient to understand and substantiate its heritage value; determining cultural heritage value or interest based on the advice of qualified persons and with appropriate community input. If the property meets the criteria in Ontario Regulation 9/06 under the Ontario Heritage Act, it is a cultural heritage resource.

† The 40 year old threshold is an indicator of potential when conducting a preliminary survey for identification of cultural heritage resources. While the presence of a built feature that is 40 or more years old does not automatically signify cultural heritage value, it does make it more likely that the property could have cultural heritage value or interest. Similarly, if all the built features on a property are less than 40 years old, this does not automatically mean the property has no cultural heritage value. Note that age is not a criterion for designation under the *Ontario Heritage Act*.

Step 3 – Screening for Potential Impacts

YES	NO	Will the proposed undertaking/project involve or result in any of the following potential impacts to the subject property or an adjacent* property?
❑	☒	**Destruction, removal or relocation** of any, or part of any, heritage attribute or feature.
❑	☒	**Alteration** (which means a change in any manner and includes restoration, renovation, repair or disturbance).
❑	☒	**Shadows** created that alter the appearance of a heritage attribute or change the exposure or visibility of a natural feature or plantings, such as a garden.
❑	☒	**Isolation** of a heritage attribute from its surrounding environment, context or a significant relationship.
❑	☒	**Direct or indirect obstruction** of significant views or vistas from, within, or to a built or natural heritage feature.
❑	☒	**A change in land use** such as rezoning a battlefield from open space to residential use, allowing new development or site alteration to fill in the formerly open spaces.
❑	☒	**Soil disturbance** such as a change in grade, or an alteration of the drainage pattern, or excavation, etc.

* For the purposes of evaluating potential impacts of development and site alteration “adjacent” means: contiguous properties as well as properties that are separated from a heritage property by narrow strip of land used as a public or private road, highway, street, lane, trail, right-of way, walkway, green space, park, and/or easement or as otherwise defined in the municipal official plan.

400 Clyde Road, P.O. Box 729 Cambridge, ON N1R 5W6

Phone: 519.621.2761 **Toll free:** 866.900.4722 **Fax:** 519.621.4844 **Online:** www.grandriver.ca

December 3, 2013

Lynette Renzetti
LGL Limited
445 Thompson Drive, Unit 2
Cambridge, ON N1T 2K7

Dear Ms. Renzetti,

Re: Draft Terms of Reference Conestogo Plains Water Supply Environmental Assessment Natural Heritage Field Studies

We have now had the opportunity to review your letter dated August 20, 2013 for the Terms of Reference for a Natural Heritage Field Study in support of the Conestogo Plains Water Supply Environmental Assessment. We offer the following comments for your consideration:

Aquatic and Terrestrial Resources Comments

1. Please note that Canagagigue Creek is currently classified as warm water fish habitat by Ontario Ministry of Natural Resources. A municipal drain south of the creek is also classified as warm water downstream of Jigs Hollow Road. Art Timmerman at the MNR Guelph District Office should be contacted to obtain fish data and confirm the thermal regime/timing windows for these watercourses.

2. The terms of reference and scope of work being proposed are based on the assumption that the crossing of watercourses and wetlands will be accomplished using trenchless technology. However, until a geotechnical study confirms directional drilling beneath the watercourses is feasible, an open cut remains an option for all crossings. Therefore, the impacts associated with both crossing methods should be assessed.

3. It is important to note that the preliminary preferred alignment necessitates a single crossing of Canagagigue Creek, which is classified as warm water fish habitat. It appears that two additional watercourse crossings would be required if the alignment followed Northfield Drive East to the west. However, this western alignment would avoid wetland and riparian forest areas. It would be beneficial to assess the impacts associated with each of these alternatives in greater detail.

Aquatic and Terrestrial Resources Advisory Comments

4. Please be advised that Canagagigue Creek and the Grand River contain aquatic species at risk. It is recommended that Ontario Ministry of Natural Resources and Fisheries and Oceans Canada be contacted for further details and guidance.

We trust that these comments are of assistance. If you should have any questions, please do not hesitate to contact me.

Member of Conservation Ontario, representing Ontario's 36 Conservation Authorities • The Grand – A Canadian Heritage River

Yours truly,

Melissa Larion
Resource Planner
Grand River Conservation Authority
ML/ah

c.c. Region of Waterloo, Transportation and Environmental Services c/o Dominika Celmer-Repin – 150 Frederick Street, 7th Floor, Kitchener, ON N2G 4J3
CIMA c/o Sandra Rodriguez – 7880 Keele Street, Suite 201, Vaughan, ON L4K 4G7

January 10, 2014

Sandra Rodriquez
Project Engineer
Water and Wastwater
CIMA
7880 Keele Street, Suite 201
Vaughan, ON L4K 4G7
Sandra.rodriquez@cima.ca (1) 905 695-1005

Dear Ms. Rodriquez,

Re: Conestogo Plains Water Supply Project, Waterloo, Ontario

Thank you for your e-mail/letter of September 17, 2013, requesting information held by Aboriginal Affairs and Northern Development Canada (AANDC) on established or potential Aboriginal and treaty rights in the vicinity of the project in noted above.

Consulting with Canadians on matters of interest or concern to them is an important part of good governance, sound policy development and decision-making. In addition to good governance objectives, there may be statutory or contractual reasons for consulting, as well as the common law duty to consult with First Nations, Métis and Inuit when conduct that might adversely impact the section 35 Aboriginal or treaty rights (established or potential) is contemplated.

Section 35 of the *Constitution Act, 1982,* reads, in part:

- The existing aboriginal and treaty rights of the aboriginal peoples of Canada are hereby recognized and affirmed.
- In this Act, "aboriginal peoples of Canada" includes the Indian, Inuit and Métis peoples of Canada.
- For greater certainty, "treaty rights" includes rights that now exist by way of land claims agreements or may be so acquired.

The attached report consists of the following categories of information:

Key Features of the Project Area provides a synopsis of the key section 35 considerations that characterize the location in question and, where appropriate, CIS's methodology in identifying the information provided.

Aboriginal Community Information includes key contact information and any other information such as Tribal Council affiliation.

Treaties includes information on historic and modern treaties, which define established rights of the signatory Aboriginal groups.

Claims includes comprehensive, specific and special claims:

- Comprehensive claims are those which, when accepted for negotiation, address broad assertions of Aboriginal rights and title and are intended to result in a modern treaty or agreement that defines and clarifies s. 35 rights within the treaty area.

- Specific claims are claims made by a First Nation against the federal government related to outstanding lawful obligations, such as the administration of land and other First Nation assets, and to the fulfillment of Indian treaties, although the treaties themselves are not open to re-negotiation. Claims that are closed, settled or not land-related to lands or treaty obligations have been excluded from this response. As the claims progress regularly, it is recommended that the status of each claim be reviewed through the Reporting Centre on Specific Claims at: http://pse5-esd5.ainc-inac.gc.ca/SCBRI_E/Main/ReportingCentre/External/externalreporting.aspx

- Special claims, or claims of a third kind, are those that do not meet the definition of comprehensive or specific claims but deal with some form of historic obligations.

Legal Proceedings usually refer to litigation between the Aboriginal Group and the Crown, often pertaining to section 35 rights assertions or consultation matters. The groups in question may have various other matters being litigated, however, only those that are related to land or s.35 rights are included herein.

Self Government Agreements may be part of comprehensive claims or stand-alone negotiations and may or may not be protected under section 35. Unless they form part of a treaty, they are not geographically defined and address such areas of responsibility as internal governance, education, culture and justice.

Other Considerations may also be included to make you aware of groups, rights assertions or consultation-related matters that may also be relevant.

Should you require further assistance regarding the information provided, or if you have any questions and/or comments about the enclosed response, please do not hesitate to contact me.

Changing Role of the Consultation Information Service

AANDC has now launched the Aboriginal and Treaty Rights Information System (ATRIS). This Web-based system uses a mapping interface to provide information to federal officials and other interested parties on the location and nature of established and potential Aboriginal and Treaty rights. With ATRIS bringing together information regarding Aboriginal groups such as their exact location, their established rights (through treaties and other agreements) and their asserted rights through claim processes and also enabling users to relate many types of AANDC corporate data within a geographical and consultation context, ATRIS has become the main platform for Canada to disseminate its real or constructive knowledge of section 35 rights.

Due to the recent public availability of ATRIS, the role of the Consultation Information Service (CIS) of AANDC's Consultation and Accommodation Unit is currently in transition. That is, the focus of the CIS is shifting away from its former practice of providing written responses to written requests for information on established or potential Aboriginal and treaty rights to managing and supplementing the content in ATRIS. Previously, we prepared these responses to specific requests by drawing on ATRIS. Now that ATRIS is widely available, we are directing requesters to ATRIS so they can locate the information they are seeking. By focusing our attention on building up and improving the content of ATRIS, the CIS will be able to provide consistent and comprehensive information more efficiently.

If you are using ATRIS from outside of the federal government, you can go directly to http://sidait-atris.aadnc-aandc.gc.ca/atris_online/ and begin your research in ATRIS. At the ATRIS "Help" button, there are answers to frequently asked questions, a glossary, and instructions on how to navigate the system. Please familiarize yourself with the information available there so you can carry out your research using ATRIS.

Please keep in mind that some of the information provided by ATRIS will be contextual. Depending on your project, the information that comes up in a search may or may not pertain to Aboriginal or treaty rights in your particular project area. In most cases, therefore, the Aboriginal communities identified by ATRIS are best placed to explain their traditional use of land, their practices, or their claims that may fall under section 35 of the *Constitution Act, 1982.*

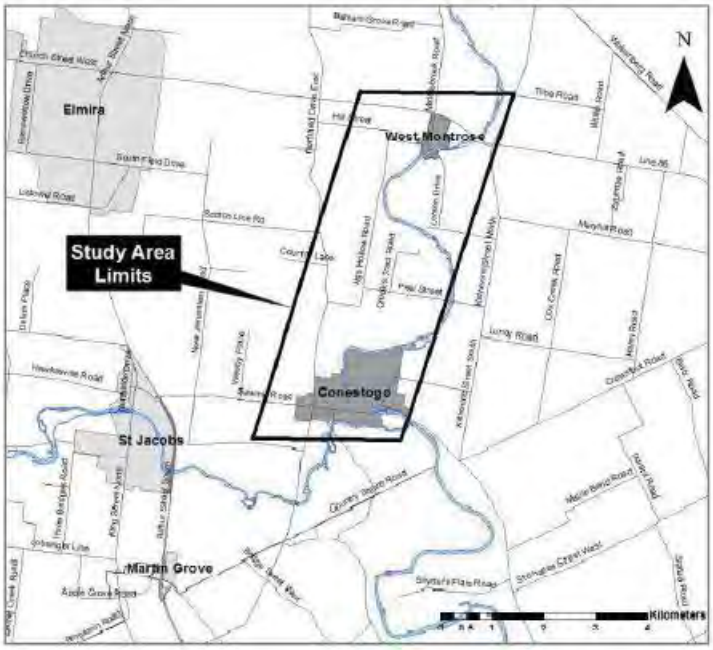
If you have specific questions on how to conduct research using ATRIS, we will endeavour to assist you if you contact the CIS through the e-mail address: UCA-CAU@aadnc-aandc.gc.ca. Should you have comments regarding the contents in ATRIS, please complete the "Provide Feedback" form available in the "Help" or provide them through e-mail. Your input is valuable as ATRIS is continually evolving through the addition of new information and the observations and contributions of users.

Regards,

Allison Berman
Consultation Information Service
Consultation and Accommodation Unit
Aboriginal Affairs and Northern Development Canada
10 Wellington Street, 8th floor
Gatineau, QC K1A 0H4
819-934-1873

CONSULTATION INFORMATION SERVICE RESPONSE – JANUARY 2014

Conestogo Plains Water Supply Project, Waterloo, Ontario



Disclaimer

This information is provided as a public service by the Government of Canada. All of the information is provided "as is" without warranty of any kind, whether express or implied, including, without limitation, implied warranties as to the accuracy or reliability of any of the information provided, its fitness for a particular purpose or use, or non-infringement, which implied warranties are hereby expressly disclaimed. References to any website are provided for information only shall not be taken as endorsement of any kind. The Government of Canada is not responsible for the content or reliability of any referenced website and does not endorse the content, products, services or views expressed within them.

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On the map below, a 50 km radius (red circle) around the project (orange dot) is provided to reflect the proximity of First Nation communities. Blue pins indicate First Nation communities and small red shapes indicate reserve lands.

Key considerations

The project falls within:

1) close proximity to the Six Nations of the Grand River
2) close proximity to the Mississauga of the Credit
3) the Upper Canada Treaties region

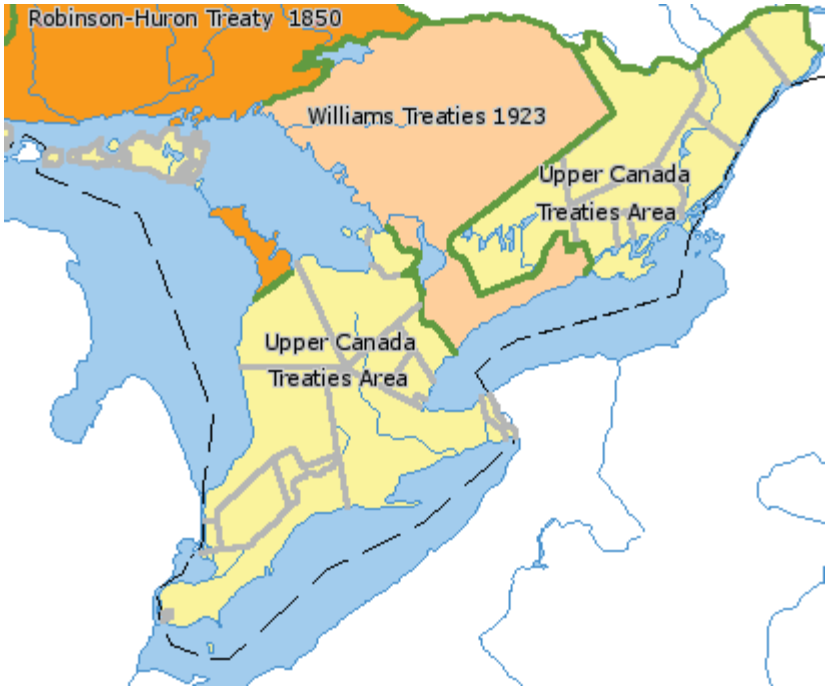
IMPORTANT CONTEXTUAL INFORMATION RELATED TO SECTION 35 RIGHTS

The project area in question falls within the Upper Canada Treaties area. In general, where historic treaties have been signed, the rights of signatory First Nation's are defined by the terms of the Treaty. In many cases, however, there are divergent views between First Nations and the Crown as to what the treaty provisions imply or signify.

Treaties of Southern Ontario The Upper Canada Treaties
There are several treaty making eras which impact the province of Ontario. These eras are known as the Upper Canada Land Surrenders from 1764 to 1862. These surrenders are seen as treaties which transfer all Aboriginal rights and title to the Crown in exchange for one-time

payments or annuities. They tended to be made with individual First Nation groups for tracts of land.

1764-1782 – Early Land Surrenders
The Royal Proclamation of 1763 established the protection from encroachment of an Aboriginal territory outside of the colonial boundaries. Rules and protocols for the acquisition of Aboriginal lands by Crown officials were set out and became the basis for all future land treaties. In response to military and defensive needs around the Great Lakes, the Indian Department negotiated several land surrender treaties in the Niagara region.



*Atlas of Canada

1783-1815- Treaties for Settlement
As part of the plan to resettle some 30,000 United Empire Loyalists who refused to accept American rule, and fled to Montreal, the Indian Department undertook a series of land surrenders west of the Ottawa River with the Mississauga and the Chippewa of the southern Great Lakes. <u>These tended to be uncomplicated arrangements whereby for a particular Aboriginal group was paid a specific sum paid in trade goods, to surrender a stated amount of land.</u>

1815-1862- Treaties to Open the Interior
After the war of 1812, the colonial administration of Upper Canada focused on greater settlement of the colony. The Indian Department completed the last of the over 30 Upper Canada Land Surrenders around the Kawartha, Georgian Bay, and the Rideau and Ottawa Rivers. <u>All of this land which today is known as Southern Ontario, was ceded to the Crown</u>.

FIRST NATION/ ABORIGINAL COMMUNITIES

Mississaugas of the Credit (aka Mississaugas of the New Credit First Nation**)**
Chief Maurice Bryan Laforme
2789 Mississauga Road
RR 6
Hagersville, Ontario, N0A 1H0
Phone: (905) 768-1133 Fax: (905) 768-1225
www.newcreditfirstnation.com

Treaty Area – Southern Ontario treaties for Settlement: 1783 -1815

Associate Organizations:
Association of Iroquois and Allied Indians
Chiefs of Ontario

Specific Claims:
Name: 1923 Williams Treaties
Status: active litigation
Description: The United Indian Council alleged that the Williams Treaty was invalid. They state that compensation has been inadequate for land taken, along with a failure to provide reserves. The First Nations involved are: Alderville, Beausoleil, Chippewas of Georgina Island, Chippewas of Mnjikaning, Curve Lake, Hiawatha, Mississauga's of Scugog Island.

Legal Proceedings:
Name: Mississaugas of the New Credit – Toronto Purchase v.
Status: inactive
Court File No.: not available
Description: This concerns an 1805 surrender of land presumably by the Mississaugas of the New Credit. Documentation concerns discussions for a letter accepting settlement of the issue.

Name: Mississaugas of the New Credit First Nation v. Attorney General of Canada, Maurice Bryan Laforme, Kerri Louise King, Attorney General of Ontario
Status: active
Court File No.: CV-12-373
Description: In this matter, the Mississaugas of the New Credit First Nation seeks a declaration of fee simple interest to a parcel of land in Hagersville which lies adjacent to the Applicant's Reserve. The Applicant also seeks a declaration that the reservation of mines and minerals as set out in the original Crown Patent issued February 18, 1884 is null and void. The Applicant asserts that this property was originally part of a larger tract of land to which the Applicant had aboriginal rights, and that this larger tract of land was sold by the Applicant to the Crown in the 18th century. The Applicant claims that in 1999, the Applicant entered into a Land Claim Settlement Agreement whereby Canada agreed that it would recommend an addition to the Applicant's reserve. The Applicant claims that following their application to the Crown to have the property added to its reserve, the Crown had concerns which prevented the

completion of the Addition to Reserve process. The Crown's concerns were regarding the capacity of a First Nation to hold title to lands in fee simple, and also about a reservation clause found in the original Crown Patent whereby the rights to all mines and minerals were reserved to the Government of Ontario.

Agreements and negotiations:
Grand River Notification Agreement
This Agreement has been renewed between the First Nation and the Province. It is an acknowledgement that there are outstanding land issues in the notification area which are being addressed in other forums, and the Parties wish to work cooperatively to encourage sustainable development on the lands subject to the Agreement. The Parties have agreed to establish a notification protocol to facilitate the sharing of information and consultation among them on economic development, land use and environmental matters.

Six Nations of the Grand River
Chief Ava Hill
1695 Chiefswood Road
PO Box 5000
Ohsweken, Ontario, N0A 1M0
Phone: (519) 445-2201 Fax: (519) 445-4208
www.sixnations.ca

Recognized Leadership and Consultation:
The Federal Government recognizes the elected Chief and Council (who are elected under the Indian Act) as the official Canadian leadership of Six Nations. For consultation purposes, the Federal Government recommends that the elected Chief and Council of Six Nations be engaged.

Associate Organizations:
Chiefs of Ontario

Land Grant:
Haldimand Proclamation of 1784 and Simcoe Patent of 1793
The Six Nations were native to an area that lies within present-day New York State and were allied with the British Crown during the American War of Independence. As compensation for lands lost as a result of the war, the Six Nations and their descendants were granted lands six miles deep on each side of the Grand River, from its mouth to its source. The granted lands were within a portion of territory that the Mississauga surrendered to the Crown in the Between The Lakes Treaty of 1784/1792 (the 1784 agreement contained a boundary description that was geographically impossible and this error was addressed and corrected in 1792).

The Simcoe Patent of 1793 confirmed the lands granted to the Six Nations by the Haldimand Proclamation; However, it included only lands within the corrected 1792 surrender and thus did not extend to the source so the Grand River. It specifies that the Six Nations can surrender and dispose of their land only to the Crown. Any other leases, sales or grants to people other than Six Nations shall be unlawful and such intruders evicted. A link to a map and additional information can be found at:

http://www.aboriginalaffairs.gov.on.ca/english/negotiate/sixnations/sixnations.asp

Specific Claims:
Between 1980 and 1995, Six Nations submitted 28 specific claims to Aboriginal Affairs and Northern Development Canada under its Specific Claims Policy. These claims focus on the government's management of their lands and other assets from 1784 to the present. In March 1995, Six Nations filed a lawsuit against the Government of Canada and the Province of Ontario, which also related to how Six Nations' lands and monies were managed by the Crown (refer to Six Nations of the Grand River Band of Indians v. HMTQ in Right of Canada and HMTQ in Right of Ontario, Court file no. 406/95 in the litigation section below for additional information). As there was significant overlap between the 28 specific claims and the claims put forward in the litigation, work on the specific claims was suspended.

Other Claims:
In 1994, Six Nations submitted a claim to the Minister of Aboriginal Affairs and Northern Development Canada regarding their "right to hunt and fish," which was premised in part on the Nanfan Treaty of 1701. This Treaty (also known as the Treaty of Albany) was related to the protection of hunting and fishing rights in and around Lakes Erie, Huron and Ontario, as well as a portion of the United States. The Treaty was between representatives of the Five Nations (now the Six Nations) and John Nanfan, the acting colonial governor of New York. Six Nations were referred to the Province of Ontario for remedy, as the province has the primary responsibility for harvesting.

Legal Proceedings:
Name: Six Nations of the Grand River Band of Indians v. HMTQ in Right of Canada and HMTQ in Right of Ontario - Superior Court of Justice
Status: active
Court File No.: 406/95
Description: The Plaintiffs claim an accounting of all Six Nations' assets including money and real property held in trust by the Crown for the benefit of the Six Nations since 1784. The Plaintiff seeks a declaration by the Court that the Defendants are in breach of their fiduciary duties towards the Plaintiff, and are liable for replacing all assets or the value of all assets found to be missing, with compound interest. The allegation of repeated breaches of fiduciary duty is supported by examples of breaches, between 1784 and 1970, that can be separated into 14 discrete claims.

Name: Thahoketoteh of Kanekota v. HMTQ
Status: active
Court File No.: T-1396-12
Description: In this claim, the Plaintiff seeks, among other things, the removal of alleged non-native squatters from Lot 1 Concession 11, Clearview Township, Simcoe County. He alleges that the Crown has not respected the Royal Proclamation of 1784 and he also seeks compensation from other parties, such as the Canadian Hydro Developers, Inc. and Enbridge Gas, for their alleged illegal involvement in the area.

Name: Thahoketoteh of Kanekota v. HMTQ
Status: active (November 2012)
Court File No.: T-2007-12

Description: In this action, the Plaintiff alleges that the Defendant Canada has allowed federal and provincial law to apply to a tract of land described in the *Haldimand Proclamation of 1784* in violation of an alleged British Order in Council dating from 1704, the *Royal Proclamation of 1763*, ss. 90, 91(24) and 109 of the *Constitution Act, 1867* and an alleged Canadian Order in Council relating to disallowance, dating from 1875. The Plaintiff particularly alleges that Canada has violated its duty in allowing the *Indian Act*, the *Supreme Court Act* and the *Ontario Public Lands Act* to apply to the Haldimand Tract. The Plaintiff seeks as relief a declaration that Canada has the duty not to allow the application of federal or provincial law to the Haldimand Tract except by a treaty in compliance with the *Royal Proclamation of 1763* with any dispute resolved by a Standing Royal Committee constituted under the alleged Order In Council of 1704. The Plaintiff seeks to have the declaration described above determined under Rule 220(1)(a) of the Federal Courts Rules, and in writing under Rule 369

Name: Six Nations Elected Council on its own behalf and on behalf of the Six Nations of the Grand River v. The Corporation of the City of Brantford
Status: active
Court File No.: CV-08-361454
Description: The Plaintiffs seek various declarations pertaining to Ontario and/or the City of Brantford's constitutional duty to consult with and accommodate the Six Nations of the Grand River before considering or undertaking any planning activities and disposition of lands which could potentially affect the interests of the Six Nations of the Grand River.

Name: Aaron Detlor; the Haudenosaunee Development Institute v. the Corporation of the City of Brantford – Superior Court of Justice
Status: active
Court File No.: CV-08-356782
Description: The Applicants Aaron Detlor and the Haudenosaunee Development Institute intend to question the constitutional validity and applicability of By-laws 63-2008 and 64-2008 of the City of Brantford Municipal Code, made under the Municipal Act, 2001, S.O. 2001, c. 25. The hearing is scheduled for November 2012.

Name: King Chief ah'she hodeeheehonto v. HMTQ in Right of Canada
Status: active
Court File No.: 10-20244 JR
Description: This is a Notice of Constitutional Question which seems to involve an argument involving Six Nations that among other things relies on the Two Row Wampum Treaty and other Aboriginal and treaty rights, as protection from the jurisdictional obligation to follow Canada's laws and other obligatory requirements.

Name: Regina v. Michael Clarence Monture
Status: active
Court File No.: not available
Description: The defendant is a member of the Mohawk Nation from the Six Nations of the Grand River, and is seeking relief under section 35 of the Constitution Act, 1982. The defendant alleges that the sub-standard health facilities are infringing on and limiting his Aboriginal rights, as well as preventing him from delivering contemporary health care.

Name: Gregory John Bloom v. HMTQ
Status: active
Court File No.: not available

Description: Among other things, the Plaintiff appears to be alleging that Canada has committed breaches of fiduciary and treaty obligations to the Mohawk Nation of the Five Nation Confederacy and the Tuscarora Nation by allowing third party access to their lands without first obtaining a valid surrender of the Crown. He seeks a permanent injunction restraining access to these lands as well as declaratory relief and various orders.

Name: Grand River Enterprises Six Nations Ltd., Jerry Bradwick Montour, Kenneth Ryan Hill, Curtis Styres and Gregory Scott Smith v. The Attorney General of Canada
Status: active; filed September 30, 2013
Court File No.: CV-08-466
Description: The Plaintiffs claimed that the CRA has infringed on their Aboriginal right to trade tobacco commercially without the imposition of taxation. Motion to strike was scheduled for November, but Statement of Defence was amended, broadened to include Honour of the Crown.

Out of Court settlement discussions:
Since 1999, the Government of Canada, the Province of Ontario and Six Nations have made several attempts to resolve the historical grievances raised in Six Nations' 1995 lawsuit (refer to Six Nations of the Grand River Band of Indians v. HMTQ in Right of Canada and HMTQ in Right of Ontario, Court file no. 406/95 in the litigation section above for additional information) through out-of-court settlement negotiations.

Information on these discussions, including the negotiation process that commenced after the occupation of the Douglas Creek Estates site in Caledonia, Ontario, can be found on the AANDC website at: http://www.aadnc-aandc.gc.ca/eng/1100100016334/1100100016335.

Agreements and negotiations:
Grand River Notification Agreement
This Agreement has been renewed between the First Nation and the Province. It is an acknowledgement that there are outstanding land issues in the notification area which are being addressed in other forums, and the Parties wish to work cooperatively to encourage sustainable development on the lands subject to the Agreement. The Parties have agreed to establish a notification protocol to facilitate the sharing of information and consultation among them on economic development, land use and environmental matters.

Unilateral Protocol:
The Six Nations of the Grand River published a unilateral consultation and accommodation policy in 2009. You may wish to review this protocol to better understand the First Nation's perspective regarding consultation and accommodation. However, the federal government is not a party to this protocol and does not endorse the content. The link to the protocol is:
http://www.sixnations.ca/admConsultationAccomodationPolicy.pdf

MÉTIS INFORMATION

Aboriginal Rights Assertions

The Métis and Non-Status Indian Relations Directorate of AANDC is aware that the Métis Nation of Ontario (MNO), its regional and community councils, have asserted a Métis right to harvest in a large section of the province.

The provincial government has accommodated Métis rights on a regional basis within Métis harvesting territories identified by the MNO. These accommodations are based on credible Métis rights assertions. An interim agreement (2004) between the MNO and the Ministry of Natural Resources (MNR) recognizes the MNO's Harvest Card system. This means that Harvester's Certificate holders engage in traditional Métis harvest activities within identified Métis traditional territories across the province.

The MNO maintains that Aboriginal 'rights-holders' are Métis communities which are collectively represented through the MNO and its community councils. In partnership with community councils, MNO has established a consultation process. The MNO has published regional consultation protocols on their website which offer pre-consultation stage instructions on engaging the Métis through their community councils (via the consultation committee made up of an MNO regional councilor, a community councilor representative and a Captain of the Hunt). For a map of Métis traditional harvesting territories, visit the MNO website at:
http://www.metisnation.org/harvesting/harvesting-map.aspx

Please note however, that this organization does not represent all Métis in Ontario.

Métis Nation of Ontario
Métis Consultation Unit is located within the MNO head office.
500 Old St. Patrick Street, Unit 3
Ottawa, Ontario, K1N 9G4
Phone: (613) 798-1488 Fax: (613) 725-4225
www.metisnation.org/home.aspx

Métis National Council
4-340 MacLaren Street,
Ottawa, Ontario, K2P 0M6
Phone: (613) 232-3216 Fax: (613) 232-4262
www.metisnation.ca

For an indication of the population in Ontario who self-identify as Métis, visit the Statistics Canada website. The Ontario map indicates populations as small as 250 up to over 2,000 within its borders.
http://geodepot.statcan.gc.ca/2006/13011619/20080513012009031301161 9/16181522091403090112_13011619/15140102151809070914011 2_20152001121305200919090416151 6_0503-eng.pdf

OTHER CONSIDERTIONS

For further information on localized hunting, fishing, trapping activities which may be occurring contact the Ontario Ministry of Natural Resources. mnr.nric.mnr@ontario.ca

First Nation Associate Organizations

First Nations may or may not delegate certain authority and/or powers to tribal councils to administer programs, funding and/or services on their behalf. The best source of information with respect to consultation is through individual First Nations themselves.

Provincial guidelines

Under its responsibility to promote stronger Aboriginal relationships, the Ontario Ministry of Aboriginal Affairs has produced *Draft Guidelines on Consultation with Aboriginal Peoples Related to Aboriginal Rights and Treaty Rights.* These guidelines are for use by ministries who seek input from key First Nations and Métis organizations, all Ontario First Nations and selected non-Aboriginal stakeholders. To review the guidelines, visit:
http://www.aboriginalaffairs.gov.on.ca/english/policy/draftconsultjune2006.pdf

APPENDIX D

Detailed Evaluation Matrix

The Regional Municipality of Waterloo

FINAL

TECHNICAL MEMORANDUM NO.4
DECISION MAKING PROCESS

CONESTOGO PLAINS WATER SUPPLY
CLASS ENVIRONMENTAL ASSESSMENT STUDY

Partners in excellence

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July 23, 2014

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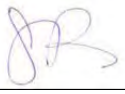
V02	April 16, 2014	S. Rodriguez	E. Tuson	April 16, 2014	Draft Version Issued to the Client
V03	May 15, 2014	S. Rodriguez	E. Tuson	May 26, 2014	Final Version incorporating Client's Comments to V02. Issued to the Client.
V04	June 27, 2014	S. Rodriguez	E. Tuson	June 27, 2014	Final Version incorporating changes to Financial Criterion.
V05	July 22, 2014	S. Rodriguez	E. Tuson	July 23, 2014	Final Version incorporating changes to Technical and Natural Environment Criteria following Project Meeting #6.

CIMA Signatures

Report Prepared By:



Sandra Rodriguez, M.Eng., P.Eng.
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1. INTRODUCTION

1.1 BACKGROUND

The Region of Waterloo (Region) is undertaking the Conestogo Plains Water Supply System Class Environmental Assessment (Class EA) study to identify the preferred long-term sustainable and reliable water supply solution that adequately meets the existing and future water servicing requirements of the West Montrose and Conestogo Plains service areas.

The feasibility of connecting West Montrose to the Conestogo Plains water supply system, as previously recommended in the 2013 West Montrose Class EA study, is being considered during the Conestogo Plains Water Supply System Class EA study, as well as other alternatives including a potential connection to the Waterloo Integrated Urban System (IUS).

As part of this Class EA study, an evaluation methodology must be developed in order to provide the basis for the evaluation and the selection of the preferred water supply alternative solution for the West Montrose and Conestogo Plains service areas. The evaluation methodology and its results will be subject to public and review agencies examination throughout the Class EA process, in order to obtain input on the proposed evaluation methodology and preliminary preferred water supply alternative solution, before any final decisions are made.

1.2 PURPOSE OF TECHNICAL MEMORANDUM NO. 4

The purpose of this Technical Memorandum No.4 (TM-4) is to provide a description of the evaluation framework to be used during the development and evaluation of water supply alternatives, which will further provide the basis for the selection of the preferred water supply solution for the West Montrose and Conestogo Plains service areas.

1.3 OVERVIEW OF THE EVALUATION APPROACH

The evaluation methodology is essential to guiding the decision making process; therefore, a well-structured and comprehensive evaluation methodology provides the foundation for a decision making that is sound, defensible, traceable and in this case, consistent with the project objectives for the Conestogo Plains Water Supply System Class EA study.

The proposed decision-making methodology for this project comprises the following major sequential steps:

1. Development of a list of water supply alternative solutions that include a permanent connection of West Montrose to the Conestogo Plains water supply system, as recommended in the 2013 West Montrose Class EA study
2. Preliminary screening of the water supply alternative solutions endorsed by a set of preliminary screening criteria. Preliminary screening criteria were developed (as outlined in Section 3.1) to reflect the major goals and objectives of the Class EA study.
3. Identification of a short-list of “feasible” water supply alternative solutions
4. Detailed evaluation of the short-listed water supply alternative solutions using a multi-criteria decision analysis based on technical, socio / cultural, natural environment and economic considerations grouped in categories as outlined in this technical memo, and scored comparatively using performance scales
5. Selection and recommendation of the preferred water supply alternative solution.

2. PROJECT GOALS

Specific project goals/objectives have been established to represent the driving factors behind this project as well as those elements that are expected to have an important influence in the decision making process. The success of the evaluation methodology can be measured by the extent to which the outcome of the evaluation process is able to achieve these goals / objectives at the end of the process. Consequently with this philosophy, the following project goals have been developed:

- The preferred water supply solution for the West Montrose and Conestogo Plains service areas will be able to provide a secure water supply that meets or exceeds the Ontario Drinking Water Quality Standards in a fiscally and technically responsible manner.
- The preferred water supply solution will be capable of providing the required water servicing capacity within the settlement boundaries of each service area under consideration, consistent with the planning projections for each area provided by the Region Planning Services group.
- The preferred water supply solution will, to the greatest extent possible, minimize any potential impacts to or interference with existing private groundwater wells in the area.
- The preferred water supply solution will be, to the greatest extent possible, compatible with existing operational practices in the Region. The preferred water supply solution will allow the Region to continue to operate its facilities in a manner that is consistent with the availability of staff resources and in a way that is simple and fiscally responsible by balancing capital and operating costs.
- The preferred water supply solution will allow the Region to continue meeting water production and projected water demands during construction and implementation, while interfering to a minimum with the uninterrupted supply of water within the area and the Region's Integrated Urban System.
- The preferred water supply solution will address in a responsible and practical manner all issues and concerns identified by the different stakeholder groups throughout the Class EA study process.

3. EVALUATION METHODOLOGY

Experience in other projects of similar nature has shown that development of a systematic, step-wise method for making decision at the start of the project helps to focus and clarify decision-making. An evaluation approach has been developed comprising preliminary screening criteria to identify feasible alternatives and a decision-making model that allows the team to compare and evaluate feasible alternatives and identify the preferred alternative solution for this project.

A general schematic of the proposed evaluation methodology that will be used to identify the preferred water supply solution for the West Montrose and Conestogo Service areas is outlined in Figure 1 and described in subsequent sections of this technical memorandum.

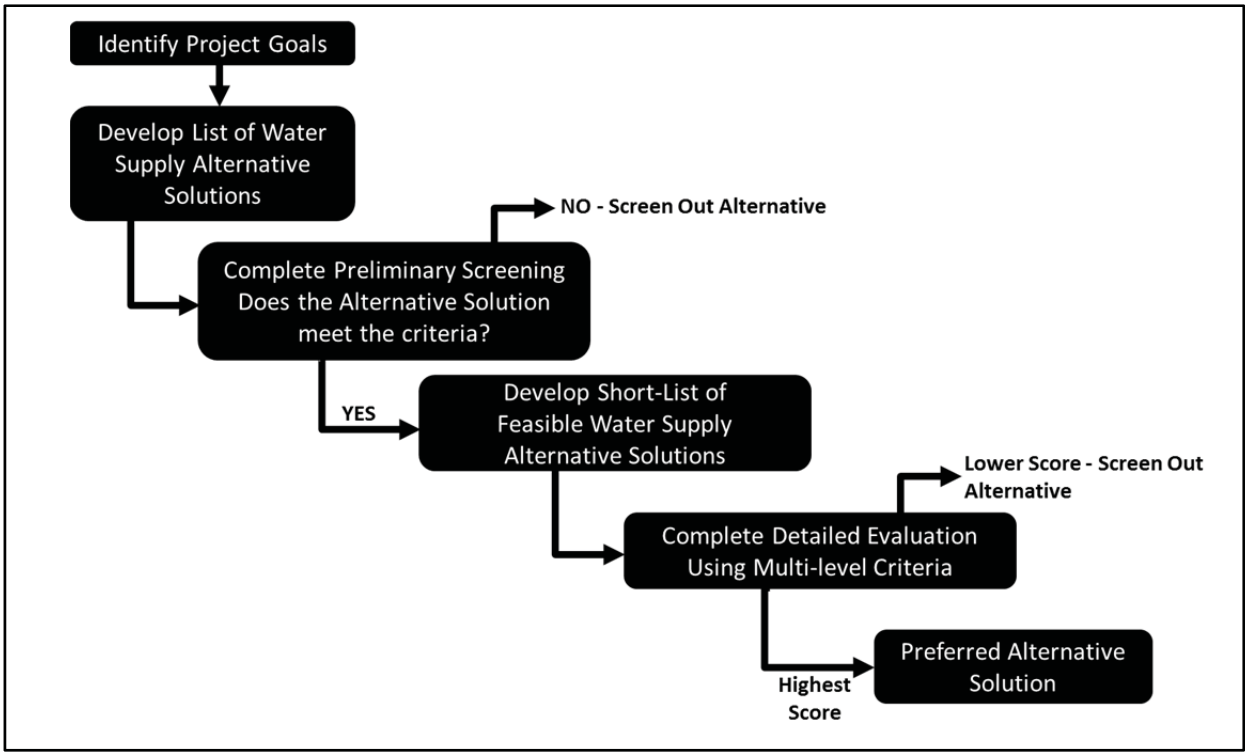

Figure 1 Overview of Evaluation Approach

3.1 PRELIMINARY SCREENING

A long list of possible water supply alternative solutions was developed and screened to identify only those that are considered "feasible" for this project. This step in the evaluation process helps to avoid the need to carry unrealistic alternative solutions through the detailed evaluation step.

Preliminary screening was accomplished by applying the following screening criteria:

- Level of Service: the alternative solution will be able to maintain, as a minimum, the existing level of service, in terms of treated water quality and available system pressures.
- System Security and Reliability: the alternative solution has the capability to prevent accidental actions outside the designed usage of the system and its components and other vulnerabilities (e.g. source water contamination) that may compromise the system's ability to remain operational over time.

- System Flexibility and Redundancy: the alternative solution has the ability to make possible the delivery of drinking water via the existing water system during emergency situations, without relying on an alternate water source(s). This would include provision for redundant pipe connections and strategic location of valves to allow isolation of damage pipe(s) / equipment to minimize the area(s) of lost service, provision for water storage to maintain service while repairs are being made, provision of emergency equipment (e.g., standby generators, spare pipes, valves, pumps, etc.)

Water supply alternative solutions that satisfied all preliminary criteria were short-listed and carried forward to the next step in the evaluation process, described in the next section of this TM-4. Details on the evaluation and selection of the short-listed alternatives have been documented in a separate technical memorandum, TM-2 High Level Option Assessment. The short listed alternatives that met the preliminary criteria were:

- Option 1 – Supply West Montrose with Surplus Capacity from the Conestogo Plains System: This option involves a permanent connection from West Montrose to the existing Conestogo Plains water supply system. This option assumes the replacement of one of the existing Conestogo Plains supply wells. This option also assumes two separate treatment scenarios:
  - Continue to provide iron sequestration or install new iron removal treatment. Either scenario is subject to field verification.

- Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs: This option involves a single connection to the Waterloo IUS at St. Jacobs (east of Conestogo Plains). This is a phased-in option that allows for an initial connection of the West Montrose and Conestogo Plains service areas to the Waterloo IUS and provides the opportunity for a future connection of the Conestogo Golf Course service area to the Waterloo IUS.

- Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with provision for looping: This option involves two separate connections to the Waterloo IUS at the City of Waterloo (intersection of Country Squire Road and Glasgow Street) and St. Jacobs. This is a phased-in option that allows for an initial connection of the West Montrose and Conestogo Plains service areas to the Waterloo IUS at the City of Waterloo, followed by an additional future connection to the IUS at St. Jacobs and the future opportunity for connection of the Conestogo Golf Course service area to the Waterloo IUS.

3.2 DETAILED EVALUATION OF SHORT-LISTED ALTERNATIVES

3.2.1 Evaluation Methodology

The three short-listed water supply alternative solutions will be subjected to a detailed comparative evaluation using a weighting and ranking system that enables a systematic and rational comparison of the alternatives, and identification of those that are preferred. The evaluation methodology is used as a basis to compare the features of each short-listed alternative, relative to each other, and their ability to perform under each evaluation criterion.

For the evaluation of the alternative solutions, a Triple Bottom Line (TBL) evaluation methodology is proposed. This methodology focuses on a set of criteria for three main categories; environmental protection and technical considerations (environmental / technical), social impacts and benefits (socio-cultural), and minimizing cost or financial impacts (financial).

Main categories will be further broken down into evaluation criteria. For each criterion, the project team will compile sufficient information and assign a score unique to each short-listed alternative. Scores from 0 to 5 will be available to score each short-listed alternative under evaluation, with the higher scores given to the better performing options. The score will represent how well the specific short-listed alternative meets the criterion under consideration or in other words, the potential residual impact (i.e., the net impact after mitigation). Therefore, the short-listed alternatives will be rated such that the higher the ability to perform or meet the criterion, the higher the score (5) to be assigned.

The final score for each alternative will be calculated as the sum of: the score of each criterion across all categories multiplied by the value weight assigned to that criterion.

3.2.2 Evaluation Criteria

A preliminary list of evaluation criteria within each main category has been developed, each intended to reflect specific issues and considerations most relevant to this project. The proposed evaluation criteria grouped by main categories, as well as the relative performance scale to be used when assigning scores to each alternative, are shown in Table 1.

All water supply alternative solutions considered in this Class EA study will be developed on the basis that each alternative is able to, as a minimum, consistently meet the applicable Ontario Drinking Water Quality Standards, Objectives and Guidelines.

Table 1 Evaluation Criteria

Category	Criteria	Performance Scales
Technical / Natural Environment	**Water Quality / Quantity Protection–** Minimize the potential for surface water or groundwater contamination, includes potential effects to existing private groundwater wells	• Potential for surface water or groundwater contamination or well interference is minor or negligible, no mitigation is required – 5 • Potential for surface water or groundwater contamination or well interference is moderate, with some potential for mitigation – 3 • Potential for surface water or groundwater contamination or well interference is significant, with limited mitigation available – 0
	Level of Service – Maximize the opportunity to maintain or improve the existing level of service in terms of available service pressures	• Potential opportunity to maintain / improve available service pressures is significant, no mitigation is required – 5 • Potential opportunity to maintain / improve available service pressures is moderate, with some potential for mitigation – 3 • Potential opportunity to maintain / improve available service pressures is minor or negligible, with limited mitigation available – 0
	Ease of Implementation – Maximize the ability to facilitate construction without interfering with the uninterrupted supply of water and within the most reasonable timeframe.	• Potential impact on existing operations is minor, no mitigation is required – 5 • Potential impact on existing operations is moderate, with some potential for mitigation – 3 • Potential impact on existing operations is major or significant, with limited mitigation available – 0
	Operational Complexity – Minimize the risk to existing operational procedures and monitoring requirements and maximize the ability to decrease current operational complexity	• Potential risk to increase operational complexity of existing site/facilities is minor or negligible with significant opportunity(ies) to decrease current operational complexity, no mitigation is required – 5 • Potential risk to increase operational complexity of existing site/facilities is moderate, with some potential for mitigation and some opportunity(ies) to decrease current operational complexity,– 3 • Potential risk to increase operational complexity of existing site/facilities is significant, with limited mitigation available and no opportunity(ies) to decrease current operational complexity – 0

Category	Criteria	Performance Scales
	System Reliability – Maximize the ability for the system to prevent accidental actions outside the designed usage of the system and other vulnerabilities that may compromise the system's ability to remain operational over time.	• Potential for system reliability is significant, no mitigation is required – 5 • Potential for system reliability is moderate, with some potential for mitigation – 3 • Potential for system reliability is minor or negligible, with limited mitigation available – 0
	System Redundancy and Flexibility – Maximize the ability to continue to provide water supply during emergency situations based on provision for redundant equipment, connections, emergency storage, etc.	• Potential for system redundancy and flexibility is significant, no mitigation is required – 5 • Potential for system redundancy and flexibility is moderate, with some potential for mitigation – 3 • Potential for system redundancy and flexibility is minor or negligible, with limited mitigation available – 0
	Need for New Infrastructure – Maximize the ability to use existing infrastructure	• Potential to use existing infrastructure is significant with minimum requirements for new infrastructure, no mitigation is required – 5 • Potential to use existing infrastructure is moderate with some requirements for new infrastructure, with some potential for mitigation – 3 • Potential to use existing infrastructure is minimal with significant requirements for new infrastructure, with limited mitigation available – 0
	Natural and Archaeological Heritage – Minimize the potential impact from construction to existing terrestrial habitats/features, vegetation communities, including watercourse crossings as well as archaeological heritage features	• Potential impact from construction to natural and archaeological heritage is minimal or negligible, no mitigation is required – 5 • Potential impact from construction to natural and archaeological heritage is moderate, with some potential for mitigation – 3 • Potential impact from construction to natural and archaeological heritage is significant, with limited mitigation available – 0
	Regulatory Approvals – Minimize the need and time spent to obtain permits and approvals	• Required infrastructure is compatible with existing land uses and permits and approvals can be easily obtained, no mitigation is required – 5 • Required infrastructure can be compatible with existing land uses and some effort is expected to obtain permits and approvals, with some potential for mitigation – 3 • Required infrastructure is not compatible with existing land uses and significant effort is expected to obtain permits and approvals, with limited mitigation available – 0
	Coordination with Planned Infrastructure – Maximize the opportunity to coordinate with other planned infrastructure projects in the area during project implementation	• Potential opportunity for project implementation in coordination with other infrastructure projects is significant. Multiple projects can be implemented simultaneously reducing overall costs. No mitigation is required – 5 • Potential opportunity for project implementation in coordination with other infrastructure projects is moderate. Project can be implemented without affecting implementation of other planned infrastructure projects. Some potential for mitigation – 3 • Potential opportunity for project implementation in coordination with other infrastructure projects is minimal or negligible. Project may have a conflict with implementation of other planned infrastructure projects. Limited mitigation available – 0

Category	Criteria	Performance Scales
	Benefits for Area outside of Study Area – Maximize the opportunity to provide broader improvements to the Region's water system as a whole	• Proposed infrastructure has the potential for significant benefits to other areas outside of the study area, resulting in an overall greater contribution to the overall system. No mitigation is required – 5 • Proposed infrastructure has the potential for moderate benefits to other areas outside of the study area, resulting in moderate improvements to the overall system. Some potential for mitigation – 3 • Proposed infrastructure has minor or no potential benefits to other areas outside of the study area, resulting in small or negligible improvements to the overall system. No potential for mitigation – 0
Community / Social	**Public Health and Safety –** Minimize the potential risk to community health and safety from a source, treatment and distribution perspective	• Potential ability to provide a multi-barrier approach is significant so there is an extremely small potential risk to public health and safety, no mitigation is required – 5 • Potential ability to provide a multi-barrier approach is moderate so there is minor potential risk to public health and safety, with some potential for mitigation – 3 • Potential ability to provide a multi-barrier approach is minimal so there is moderate potential risk to public health and safety, with limited mitigation available – 0
	Public Perception – Maximize the potential for alternative to receive public support and acceptance	• Potential to receive a high level of support and endorsement from the public, no mitigation is required – 5 • Potential to receive a moderate level of support and endorsement from the public, with some potential for mitigation – 3 • Potential to receive a low level of support and endorsement from the public, with limited mitigation available – 0
	Noise during construction) – Minimize the potential for noise during construction	• Potential for noise during construction is minor or negligible, no mitigation is required – 5 • Potential for noise during construction is moderate, with some potential for mitigation – 3 • Potential for noise during construction is significant, with limited mitigation available – 0
	Traffic (during construction) – Minimize traffic impacts during construction	• Potential for traffic impacts is negligible, no mitigation is required – 5 • Potential for traffic impacts is moderate, with some potential for mitigation – 3 • Potential for traffic impacts is significant, with limited mitigation available – 0
	Aesthetics – Minimize potential visual impacts from water supply infrastructure on private properties	• Potential for visual impacts from water supply infrastructure is minor or negligible, no mitigation is required – 5 • Potential for visual impacts from water supply infrastructure is moderate, with some potential for mitigation – 3 • Potential for visual impacts from water supply infrastructure is significant, with limited mitigation available – 0
Financial	**Life Cycle Cost –** Minimize life cycle cost (includes major capital expenditures every 10 years)	A natural scale between 5 and 0 based on the relative difference in 40-year life cycle cost of each alternative, relative to the others

3.2.3 Weighting Factors

Weighting factors are assigned to each of the main categories to be evaluated during the detailed evaluation of the short-listed water supply alternative solutions. Individual weighting factors should reflect the degree of importance of each category within the overall evaluation scheme. Preliminary weights have been assigned to the three main categories as follows:

- Technical / Natural Environmental – 50%
- Community / Social – 25%
- Financial – 25%

Input will be requested from the Region and the Steering Committee on the weighting factors to be assigned to each of the main categories.

3.2.4 Selection of Preliminary Preferred Water Supply Solution

The three short-listed water supply alternative solutions will be assessed relative to each other and evaluated against all criteria shown in Table 1. A score between 0 and 5 will be assigned to each criterion based on the ability of the alternative site to meet such criterion and with consideration to the performance scales described in Table 1. The scores will be totaled for each water supply alternative. The water supply alternative that scores the highest will be the option that provides the most overall benefits to this project and thus, will be selected as the preliminary preferred water supply solution.

The results of the detailed evaluation will be presented to the public for input. The preferred water supply solution will be confirmed subject to comments and feedback received from the public, review agencies, steering committee and stakeholders involved.

3.3 SENSITIVITY ANALYSIS

The evaluation approach will be subjected to a sensitivity analysis in order to examine how changing the criteria weights affects the scoring results. This analysis will help to assess the impacts of significant changes to the weighting of the evaluation criteria and establish whether the alternative with the original highest score remains the preferred option once criteria weighting factors are changed.

Sensitivity analysis will also be completed on the life cycle costs to examine how changes into the life span of the project affect the overall net present value for each alternative.

The Regional Municipality of Waterloo

FINAL

TECHNICAL MEMORANDUM NO.5
DETAILED EVALUATION OF SHORT-LISTED WATER SUPPLY OPTIONS

CONESTOGO PLAINS WATER SUPPLY
CLASS ENVIRONMENTAL ASSESSMENT STUDY

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APPENDICES

Appendix 1 – Detailed Evaluation Matrices

1. INTRODUCTION

1.1 BACKGROUND

The Region of Waterloo (Region) is undertaking the Conestogo Plains Water Supply System Class Environmental Assessment (Class EA) study to identify the preferred long-term sustainable and reliable water supply solution that adequately meets the existing and future water servicing requirements of the West Montrose and Conestogo service areas.

Previous steps, completed as part of this Class EA study, identified short-listed water supply options and established the evaluation methodology for the assessment of such options, which will ultimately lead to the selection of the preferred water supply solution for the West Montrose and Conestogo service areas. The feasibility of connecting West Montrose to the Conestogo Plains water supply system, as previously recommended in the 2013 West Montrose Class EA study, is being considered during the Conestogo Plains Water Supply System Class EA study, as well as other alternatives including potential connections to the Waterloo Integrated Urban System (IUS). The major findings and results of the previous steps have been documented in separate technical memoranda as follows:

- *Technical Memorandum No.2 – Development and Assessment of High-level Water Supply Options.* This memorandum describes the rationale for the identification and development of the high-level water supply options under consideration in the Class EA study, and summarizes the preliminary results of the high-level assessment of such water supply options in terms of advantages, disadvantages, and conceptual cost estimates.

- *Technical Memorandum No.3 – Groundwater Supply Systems Condition Assessment.* This memorandum describes the findings of the condition assessment completed for the West Montrose, Conestogo Plains and Conestogo Golf Course groundwater supply systems and presents overall recommendations to be considered in the development and detailed evaluation of the high-level water supply options.

- *Technical Memorandum No.4 – Decision Making Process.* This memorandum describes the evaluation framework to be used during the evaluation of high-level water supply options, inclusive of primary and secondary evaluation criteria, weighting factors and performance scales. The implementation of the evaluation methodology will further provide the basis for the selection of the preferred water supply solution.

The next step in the Class EA study is to complete a detailed comparative evaluation of the short-listed water supply options, relative to each other, and consistent with the evaluation framework previously developed. The results of the comparative evaluation will identify the preliminary preferred water supply solution for the Conestogo Plains Class EA study. Similar to the previous steps completed during the Class EA study, the results of the evaluation process and the preliminary preferred solution will be subject to public and review agencies consultation.

1.2 PURPOSE OF TECHNICAL MEMORANDUM NO. 5

The purpose of this Technical Memorandum No.5 (TM-5) is to present the preliminary results of the comparative evaluation of the short-listed water supply options, including the scores assigned to each option under each criterion and the rationale for the assignment of the individual scores.

2. OVERVIEW OF SHORT-LISTED WATER SUPPLY OPTIONS

Development and preliminary evaluation of a long list of water supply alternative solutions identified three high-level water supply options that demonstrated enough merits from a level of service, system security and reliability, and system flexibility and redundancy, to be short-listed and considered for further evaluation in the Class EA study. The three short-listed alternatives previously identified included:

2.1 OPTION 1 – SUPPLY WEST MONTROSE WITH SURPLUS CAPACITY FROM THE CONESTOGO PLAINS SYSTEM

Option 1 involves a permanent connection from the existing Conestogo Plains water supply system to West Montrose. This option assumes the replacement of one of the existing Conestogo Plains supply wells (well C4). A new set of transfer pumps will be installed at Conestogo Plains and dedicated exclusively to transfer water from the Conestogo Plains reservoir to the West Montrose Reservoir. From here, treated water will be conveyed into to the West Montrose distribution system by the existing high lift pumps in West Montrose. Existing high lift pumps in Conestogo Plains will continue to convey treated water into the Conestogo Plains distribution system.

In addition, Option 1 assumes two separate treatment scenarios, either subject to field verification:

- Continue to provide iron sequestration or;
- Install new iron and manganese removal treatment.

A simplified schematic of Option 1 is shown in Figure 1.

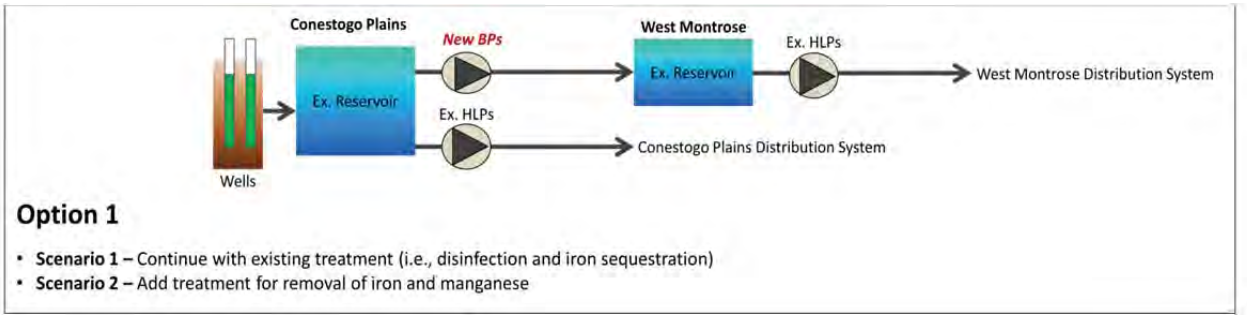

Figure 1 Option 1 – Supply West Montrose with Surplus Capacity from the Conestogo Plains System

2.2 OPTION 2 – SUPPLY WEST MONTROSE AND CONESTOGO PLAINS FROM THE IUS AT ST. JACOBS

Option 2 involves the same concept developed for Option 1 with the main differentiator being the IUS at St. Jacobs as the supply source rather than the Conestogo Plains wells, and the added opportunity to service Conestogo Golf Course. As such, Option 2 involves a single connection to the Waterloo IUS at St. Jacobs (east of Conestogo Plains). This is a phased-in option that allows for an initial connection of the West Montrose and Conestogo Plains service areas to the Waterloo IUS and provides the opportunity for a future connection of the Conestogo Golf Course service area to the Waterloo IUS, through Conestogo Plains.

Similar to Option 1, a new set of transfer pumps will be installed at Conestogo Plains and dedicated exclusively to transfer water from the Conestogo Plains reservoir to the West Montrose reservoir. From here, treated water will be conveyed into to the West Montrose distribution system by the existing high lift pumps in West Montrose. The existing high lift pumps in Conestogo Plains will continue to convey treated water into the Conestogo Plains distribution system. Once connection to the Conestogo Golf Course is provided, two of the existing high lift pumps in Conestogo Plains will be replaced with new pumps to ensure

adequate demands during max. day plus fire flow conditions. A simplified schematic of Option 2 is shown in Figure 2.

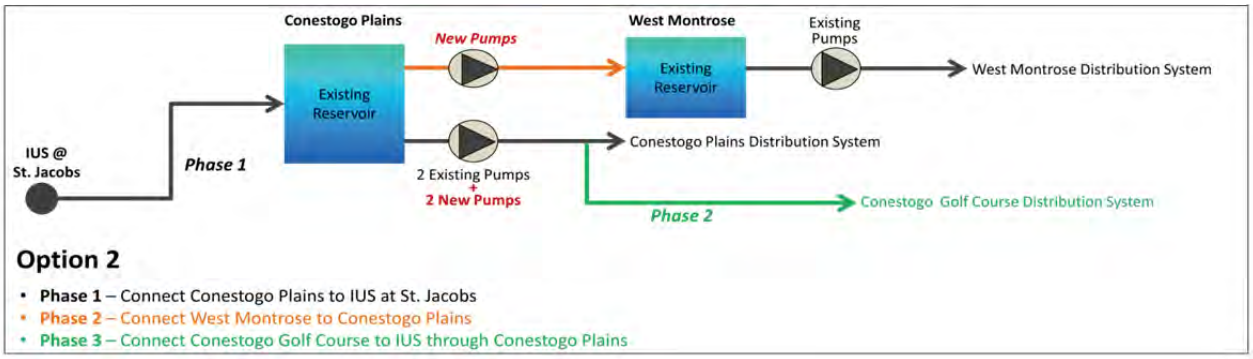

Figure 2 Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs

2.3 OPTION 3 – SUPPLY WEST MONTROSE AND CONESTOGO PLAINS FROM THE IUS AT CITY OF WATERLOO WITH PROVISION FOR LOOPING

Option 3 involves two separate connections to the Waterloo IUS at the City of Waterloo (intersection of Country Squire Road and Glasgow Street) and St. Jacobs. This is a phased-in option that allows for an initial connection of the West Montrose and Conestogo Plains service areas to the Waterloo IUS at the City of Waterloo. Looping in the IUS is provided through the additional future connection to the IUS at St. Jacobs. This option also comprises the future opportunity for connection of the Conestogo Golf Course service area to the Waterloo IUS. A new flow control valve in West Montrose will be used to control filling of the West Montrose reservoir based on the reservoir water levels. With the exception of the West Montrose reservoir and high lift pumps, which will be kept, all other existing supply and treatment infrastructure at Conestogo Plains, West Montrose and Conestogo Golf Course will ultimately be abandoned and decommissioned.

A simplified schematic of Option 3 is shown in Figure 3.

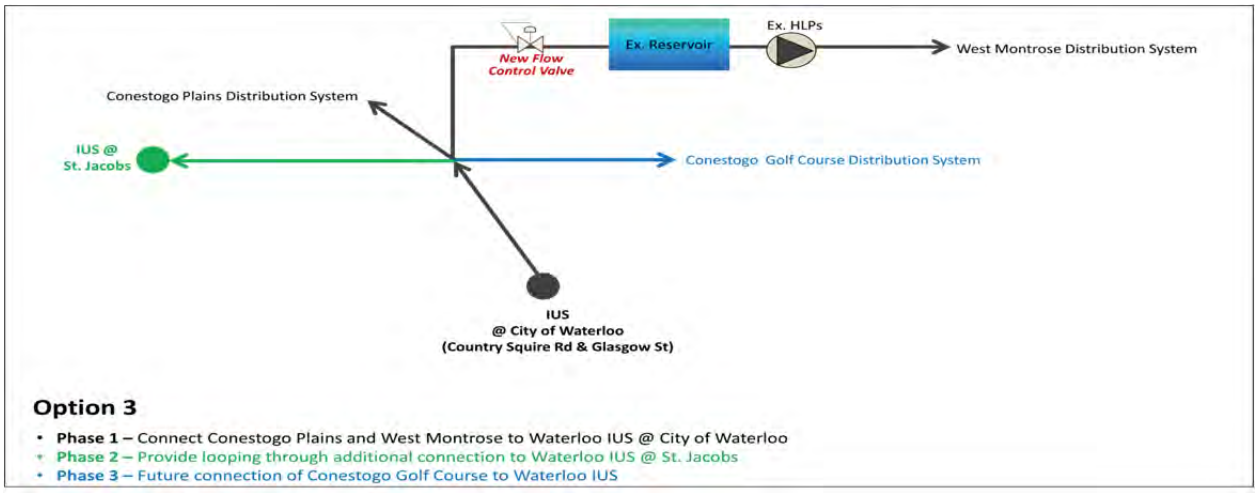

Figure 3 Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping

3. OVERVIEW OF EVALUATION METHODOLIGY

This section summarizes the evaluation methodology that has been used to complete the detailed comparative evaluation of the short-listed options presented in Section 2. Details on the proposed evaluation methodology have been provided in TM-4.

A Triple Bottom Line (TBL) evaluation methodology has been used. This methodology focuses on a set of criteria for three main categories; environmental protection and technical considerations (technical / natural environmental), social impacts and benefits (community / social), and minimizing cost or financial impacts (financial). Weighting factors to reflect the degree of importance within the overall evaluation scheme were assigned to each main category based on project team judgment and previous experience in similar projects, as follows:

- Technical / Natural Environmental – 50%
- Community / Social – 25%
- Financial – 25%

Secondary criteria or sub-criteria were identified within each main category. The secondary criteria describe specific aspects of the category being evaluated. The proposed evaluation criteria to be used during the comparative evaluation of the short-listed options, as well as the criterion's objective and the relative performance scales used when assigning scores, are shown in Table 1.

Scores from 0 to 5 were assigned to each short-listed alternative under evaluation, with the higher scores given to the better performing options. The assigned scores intend to represent how well the specific short-listed alternative meets the criterion under consideration or in other words, the potential residual impact (i.e., the net impact after mitigation). Therefore, the short-listed alternatives were rated such that the higher the ability to perform or meet the criterion, the higher the score (5) assigned. The scores were totaled for each water supply alternative. The water supply alternative that scored the highest is considered the option that provides the most overall benefits to this project and thus, has been selected as the preliminary preferred water supply solution. The scores presented in this TM-5 have been assigned in collaboration with the Project Team.

Table 1 Evaluation Criteria, Objectives and Performance Scales

Category	Criteria	Performance Scales
Technical / Natural Environment	**Water Quality / Quantity Protection–** Minimize the potential for surface water or groundwater contamination, includes potential effects to existing private groundwater wells	• Potential for surface water or groundwater contamination or well interference is minor or negligible, no mitigation is required – 5 • Potential for surface water or groundwater contamination or well interference is moderate, with some potential for mitigation – 3 • Potential for surface water or groundwater contamination or well interference is significant, with limited mitigation available – 0
	Level of Service – Maximize the opportunity to maintain or improve the existing level of service in terms of available service pressures	• Potential opportunity to maintain / improve available service pressures is significant, no mitigation is required – 5 • Potential opportunity to maintain / improve available service pressures is moderate, with some potential for mitigation – 3 • Potential opportunity to maintain / improve available service pressures is minor or negligible, with limited mitigation available – 0

Category	Criteria	Performance Scales
	Ease of Implementation – Maximize the ability to facilitate construction without interfering with the uninterrupted supply of water and within the most reasonable timeframe.	• Potential impact on existing operations is minor, no mitigation is required – 5 • Potential impact on existing operations is moderate, with some potential for mitigation – 3 • Potential impact on existing operations is major or significant, with limited mitigation available – 0
	Operational Complexity – Minimize the risk to existing operational procedures and monitoring requirements and maximize the ability to decrease current operational complexity	• Potential risk to increase operational complexity of existing site/facilities is minor or negligible with significant opportunity(ies) to decrease current operational complexity, no mitigation is required – 5 • Potential risk to increase operational complexity of existing site/facilities is moderate, with some potential for mitigation and some opportunity(ies) to decrease current operational complexity,– 3 • Potential risk to increase operational complexity of existing site/facilities is significant, with limited mitigation available and no opportunity(ies) to decrease current operational complexity – 0
	System Reliability – Maximize the ability for the system to prevent accidental actions outside the designed usage of the system and other vulnerabilities that may compromise the system's ability to remain operational over time.	• Potential for system reliability is significant, no mitigation is required – 5 • Potential for system reliability is moderate, with some potential for mitigation – 3 • Potential for system reliability is minor or negligible, with limited mitigation available – 0
	System Redundancy and Flexibility – Maximize the ability to continue to provide water supply during emergency situations based on provision for redundant equipment, connections, emergency storage, etc.	• Potential for system redundancy and flexibility is significant, no mitigation is required – 5 • Potential for system redundancy and flexibility is moderate, with some potential for mitigation – 3 • Potential for system redundancy and flexibility is minor or negligible, with limited mitigation available – 0
	Need for New Infrastructure – Maximize the ability to use existing infrastructure	• Potential to use existing infrastructure is significant with minimum requirements for new infrastructure, no mitigation is required – 5 • Potential to use existing infrastructure is moderate with some requirements for new infrastructure, with some potential for mitigation – 3 • Potential to use existing infrastructure is minimal with significant requirements for new infrastructure, with limited mitigation available – 0
	Natural and Archaeological Heritage – Minimize the potential impact from construction to existing terrestrial habitats/features, vegetation communities, including watercourse crossings as well as archaeological heritage features	• Potential impact from construction to natural and archaeological heritage is minimal or negligible, no mitigation is required – 5 • Potential impact from construction to natural and archaeological heritage is moderate, with some potential for mitigation – 3 • Potential impact from construction to natural and archaeological heritage is significant, with limited mitigation available – 0

Category	Criteria	Performance Scales
	Regulatory Approvals – Minimize the need and time spent to obtain permits and approvals	• Required infrastructure is compatible with existing land uses and permits and approvals can be easily obtained, no mitigation is required – 5 • Required infrastructure can be compatible with existing land uses and some effort is expected to obtain permits and approvals, with some potential for mitigation – 3 • Required infrastructure is not compatible with existing land uses and significant effort is expected to obtain permits and approvals, with limited mitigation available – 0
	Coordination with Planned Infrastructure – Maximize the opportunity to coordinate with other planned infrastructure projects in the area during project implementation	• Potential opportunity for project implementation in coordination with other infrastructure projects is significant. Multiple projects can be implemented simultaneously reducing overall costs. No mitigation is required – 5 • Potential opportunity for project implementation in coordination with other infrastructure projects is moderate. Project can be implemented without affecting implementation of other planned infrastructure projects. Some potential for mitigation – 3 • Potential opportunity for project implementation in coordination with other infrastructure projects is minimal or negligible. Project may have a conflict with implementation of other planned infrastructure projects. Limited mitigation available – 0
	Benefits for Area outside of Study Area – Maximize the opportunity to provide broader improvements to the Region's water system as a whole	• Proposed infrastructure has the potential for significant benefits to other areas outside of the study area, resulting in an overall greater contribution to the overall system. No mitigation is required – 5 • Proposed infrastructure has the potential for moderate benefits to other areas outside of the study area, resulting in moderate improvements to the overall system. Some potential for mitigation – 3 • Proposed infrastructure has minor or no potential benefits to other areas outside of the study area, resulting in small or negligible improvements to the overall system. No potential for mitigation – 0
Community / Social	**Public Health and Safety –** Minimize the potential risk to community health and safety from a source, treatment and distribution perspective	• Potential ability to provide a multi-barrier approach is significant so there is an extremely small potential risk to public health and safety, no mitigation is required – 5 • Potential ability to provide a multi-barrier approach is moderate so there is minor potential risk to public health and safety, with some potential for mitigation – 3 • Potential ability to provide a multi-barrier approach is minimal so there is moderate potential risk to public health and safety, with limited mitigation available – 0
	Public Perception – Maximize the potential for alternative to receive public support and acceptance	• Potential to receive a high level of support and endorsement from the public, no mitigation is required – 5 • Potential to receive a moderate level of support and endorsement from the public, with some potential for mitigation – 3 • Potential to receive a low level of support and endorsement from the public, with limited mitigation available – 0

Category	Criteria	Performance Scales
	Noise during construction) – Minimize the potential for noise during construction	• Potential for noise during construction is minor or negligible, no mitigation is required – 5 • Potential for noise during construction is moderate, with some potential for mitigation – 3 • Potential for noise during construction is significant, with limited mitigation available – 0
	Traffic (during construction) – Minimize traffic impacts during construction	• Potential for traffic impacts is negligible, no mitigation is required – 5 • Potential for traffic impacts is moderate, with some potential for mitigation – 3 • Potential for traffic impacts is significant, with limited mitigation available – 0
	Aesthetics – Minimize potential visual impacts from water supply infrastructure on private properties	• Potential for visual impacts from water supply infrastructure is minor or negligible, no mitigation is required – 5 • Potential for visual impacts from water supply infrastructure is moderate, with some potential for mitigation – 3 • Potential for visual impacts from water supply infrastructure is significant, with limited mitigation available – 0
Financial	**Life Cycle Cost –** Minimize life cycle cost (includes major capital expenditures every 10 years)	A natural scale between 5 and 0 based on the relative difference in 40-year life cycle cost of each alternative, relative to the others

4. DETAILED EVALUATION RESULTS

The detailed scoring matrix is and scoring reasoning can be found in Appendix 1.

4.1 SUMMARY RESULTS

The unweighted scoring results, on a scale from 0-5, assigned to each option during the detailed evaluation are summarized in Table 2.

Table 2 Evaluation Summary Results

Criteria	Scores (Unweighted)*			
	Option 1 – No Treatment	Option 1 – with Treatment	Option 2	Option 3
Technical / Natural Environmental Criteria				
Water Quality / Quantity Protection	2.5	3.0	5.0	5.0
Level of Service	3.0	3.0	5.0	4.0
Ease of Implementation	4.5	3.0	4.0	3.5
Operational Complexity	3.0	2.0	4.0	4.5
System Reliability	1.0	1.0	3.0	5.0
System Redundancy and Flexibility	3.0	2.0	4.5	5.0
Need for New Infrastructure	4.5	4.0	3.5	2.5
Natural and Archaeological Heritage	4.0	4.0	3.5	3.0
Regulatory Approvals	4.0	2.0	3.0	3.0
Coordination with Planned Infrastructure	3.0	3.0	5.0	5.0
Opportunities for Benefits Outside of Study Area	1.0	1.0	3.0	5.0
Sub-Total Weighted Technical-Natural Score (out of max. 50 points) =	**30.5**	**25.5**	**39.5**	**41.4**
Community / Social Criteria				
Public Health & Safety	5.0	5.0	5.0	5.0
Public Perception	2.0	2.0	3.0	3.0
Noise (during construction)	4.5	4.0	3.5	3.5
Traffic (during construction)	4.5	4.0	3.0	2.0
Aesthetics	2.0	2.0	3.5	4.5
Sub-Total Weighted Score Socio-Cultural (out of max. 25 points) =	**18.0**	**17.0**	**18.0**	**18.0**
Financial Criteria				
40-year Life Cycle Cost	5.0	4.5	4.3	3.8
Sub-Total Financial (out of max. 25 points) =	**25.0**	**22.3**	**21.5**	**19.2**
TOTAL SCORE (out of max. 100 points) =	**73.5**	**64.7**	**79.0**	**78.6**
Ranking =	**3**	**4**	**1**	**2**

Notes:
1. Scores shown in the table are unweighted, unless indicated otherwise.

As shown in Table 2, Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs and Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping, are extremely comparable in terms of the overall benefits they provide to this project.

4.2 VALUE ANALSYIS

A value analysis is an alternative means to determine the approximate value offered by different alternatives. In cases where the results of the detailed evaluation provide extremely comparable results, a value analysis can further provide an indication of the alternative that provides the greatest value to the project, or in other words "points achieved per dollar spent". Under normal circumstances, the option with highest value indicator would be selected as the preliminary preferred solution.

The value analysis is carried out as follows:

- Scores in all criteria categories except costs (financial criteria) are tallied
- Scores are divided by the life cycle costs resulting in a value indicator
- The alternative with the highest indicator offers the greatest value.

Table 3 presents the results of the value analysis for the two highest ranking options, Options 2 and 3.

Table 3 Value Analysis Results

Option	Score points)[1]	40- Year Life Cycle Cost ($ Million, 2013)	Value Indicator (pts/$ million)
Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs	57.5	9.9	5.81
Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping	59.4	11.1	5.35

Note:

1. Score is the total score obtained in the Technical / Natural Environmental and Community / Social categories. Scores obtained in the Financial category are excluded.

Based on the results of the value analysis shown in Table 3, Option 2 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs, provides the greatest value to the project in terms of benefits achieved per dollar spent, when compared to the second highest ranking option, Option 3. Consistently, Option 2 is selected as the preliminary preferred solution, subject to public and agency review and input.

4.3 SENSITIVITY ANALYSIS

The project team took other steps to gain more confidence in the preliminary preferred water supply solution by using a sensitivity analysis. The sensitivity analysis helps to verify the robustness of the evaluation process and the consistency of the evaluation results when variables of the evaluation methodology are subjected to modifications. This test ensures that the preliminary preferred water supply option is appropriate before making a final decision.

The sensitivity analysis was completed for two additional scenarios, each with different weighting factors applied to the three main categories within the evaluation criteria. The two new scenarios reflected different conditions from what was originally developed.

For example, under the original evaluation approach, Technical and Natural Environmental Criteria were assigned a combined total weighting score of 50%, whereas Community and Social Criteria were assigned a weighting score of 25%, with the remaining 25% assigned to the Financial Criteria. One scenario of the sensitivity analysis tipped the weighting factors between the technical and the social criteria, such that the Technical and Natural Environmental Criteria had a score of 25% and the Community and Social Criteria had a score of 50%. The Financial Criteria was left with the original weighting score of 25%, allowing the project team to observe whether these changes had an effect on the original results.

The original and additional scenarios under which the sensitivity analysis was run for the short-listed water supply options are shown in Table 4.

Table 4 Benefit Criteria Weights for Sensitivity Analysis

Criteria Category	Original Weighting Scenario 1	Sensitivity Analysis Scenario 2	Sensitivity Analysis Scenario 3
Technical & Natural Environmental	50	25	33
Community / Social	25	50	33
Financial	25	25	33
TOTAL POINTS	**100**	**100**	**100**

The alternate weights for scenarios No. 2 and No. 3, as shown in Table 4, were applied to the benefit scores presented in Table 2. The resulting scores from the sensitivity analysis are summarized in Table 5.

Table 5 Sensitivity Analysis Results

Short-listed Water Supply Option	Total Score Original Weighting Scenario 1	Overall Ranking	Total Score Sensitivity Analysis Scenario 2	Overall Ranking	Total Score Sensitivity Analysis Scenario 3	Overall Ranking
Option 1 Supply West Montrose with surplus capacity from Conestogo Plains System. **Scenario 1** Iron control through sequestration	73.5	3	76.2	3	77.6	2
Option 1 Supply West Montrose with surplus capacity from Conestogo Plains System. **Scenario 2** Iron and manganese removal through filtration	64.7	4	69.0	4	69.4	4
Option 2 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs	79.0	1	77.3	1	79.0	1
Option 3 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping	78.6	2	75.9	2	77.2	3

Based on the results of the sensitivity analysis, it was concluded that under any of the 3 different scenarios, Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs continues to provide the highest overall score amongst all short-listed options.

Similarly, Option 3 – Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo for Provision for Looping continues to obtain the second highest score under Scenario 2. However, a slight change in rankings is seen under Scenario 3, where all criteria categories are weighted equally. An increase in weight to the financial category favours to some extent the least expensive options, resulting in Option 1 – Supply West Montrose with Surplus Capacity from the Conestogo Plains System, with no provision for additional treatment as the second best option, after Option 2.

After completing the sensitivity analysis, the project team introduced a new variable to the evaluation process, which consisted of using various time periods for the life cycle costs (20-year, 50-year and 60-year LCC) for each short-listed options, under the Financial Criteria. The purpose of this exercise was to evaluate the impacts of the life cycle costs in the evaluation process. Since each of the options includes the construction of watermain(s) which are known to have a life expectancy of up to 75 years, the 50-year and 60-year life cycle cost provide a good indication of the replacement cost of process equipment over the life of the watermains. The 20-year life cycle cost represent the typical time period used for life cycle costs calculations, so it was also evaluated.

Life cycle costs used in the evaluation process have been previously developed, at a conceptual design level and based on available information, and documented in *Technical Memorandum No.2 – Development and Assessment of High-level Water Supply Options.* For completeness purposes the life cycle costs for each option are summarized in Table 6.

Table 6 Life Cycle Costs Summary

Short-listed Water Supply Option	20-year LCC $ Million	40-year LCC $ Million	50-year LCC $ Million	60-year LCC $ Million
Option 1 Supply West Montrose with surplus capacity from Conestogo Plains System. **Scenario 1** Iron control through sequestration	$7.2 M	$8.5 M	$8.7 M	$9.0 M
Option 1 Supply West Montrose with surplus capacity from Conestogo Plains System. **Scenario 2** Iron and manganese removal through filtration	$8.2 M	$9.5 M	$9.8 M	$10.1 M
Option 2 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at St. Jacobs	$9.4 M	$9.9 M	$10.3 M	$10.4 M
Option 3 Supply West Montrose and Conestogo Plains from the Integrated Urban System (IUS) at City of Waterloo with Provision for Looping	$10.7 M	$11.1 M	$11.2 M	$11.2 M

With the additional life cycle costs, all criteria previously used and scores previously assigned remained unchanged. The only difference consisted on the use of the 20-, 50- and 60-year life cycle costs under the financial criterion, and therefore, revisions to the corresponding weighted scores. The results of the evaluation process, assuming the different time periods for the life cycle costs instead of the original 40-year life cycle costs, are shown in Table 7.

Table 7 Additional Life Cycle Costs – Evaluation Summary Results

Short-listed Water Supply Option	Overall Score 20-year LCC	Overall Ranking	Overall Score 40-year LCC	Overall Ranking	Overall Score 50-year LCC	Overall Ranking	Overall Score 60-year LCC	Overall Ranking
Option 1 – Scenario 1	73.5	3	73.5	3	73.5	3	73.5	3
Option 1 – Scenario 2	64.5	4	64.7	4	64.8	4	64.8	4
Option 2	76.7	1	79.0	1	78.8	2	79.2	2
Option 3	76.2	2	78.6	2	79.0	1	79.5	1

Table 7 shows that Option 2 achieves the highest score when assuming a 20-year and 40-year life cycle costs. When the life cycle costs extend beyond 40 years, Option 3 achieves a slightly higher ranking score than Option 2. The results are consistent with current practices which reveal that options that rely on watermains only (Option 3), would incur minor operational and maintenance costs in the long-term, compared to other options that comprise other infrastructure such as reservoirs, pumping stations, etc.

4.4 PRELIMINARY PREFERRED RECOMMENDED SOLUTION

From the results of the detailed comparative evaluation, value analysis and sensitivity analysis exercise, Option 2 – Supply West Montrose and Conestogo Plains from the IUS at St. Jacobs has been chosen as the preliminary preferred water supply solution. Based on the comparative evaluation, it can be seen that Option 2 obtained the highest scores through the evaluation process mainly for the following reasons:

- Connection to the IUS provides security of supply and increases redundancy, flexibility and reliability in the delivery of water supply to Conestogo Plains, West Montrose and Conestogo Golf Course through multiple sources supplying water to the IUS.
- Improves the capabilities of distributing water between the communities served by the IUS (e.g., St Jacobs).
- Option maximizes the ability to use existing infrastructure in good operational condition (e.g., Conestogo Plains and West Montrose reservoir and pumping stations) and the need for new infrastructure (e.g., watermain connections). This in turn, results in a good balance between a reduction of operation and maintenance costs and the capital expenditure required for the new infrastructure.
- The use of high lift pumps in both Conestogo Plains and West Montrose allows for better control of the service pressures within their respective distribution systems. High lift pumps provide system versatility if changes in pressures within the distribution system are required in the future, by changing the pumps.
- Operation and maintenance of wells are known to be onerous and to increase in frequency with time. By eliminating production wells from the Conestogo Plains (2 wells), West Montrose (4 wells) and Conestogo Golf Course (2 wells) water systems, option 2 allows the Region to reduce the overall operational complexity of its drinking water systems by eliminating all three groundwater supply and the major processes at the treatment facilities. This is turn, results in lower operation and maintenance costs.
- It eliminates the potential interference and effects on existing private groundwater wells within the capture zone of the Conestogo Plains production wells, by eliminating the need to rely on the Conestogo Plains system, which would be required to pump at higher rates.
- It provides the opportunity to connect Conestogo Golf Course in the future (similar to Option 3).

4.5 NEXT STEPS

The project team will present the preliminary results of the evaluation process at the next Public Consultation Centre (PCC) and confirm the preliminary preferred water supply solution for the West Montrose and Conestogo service areas, with input and comments received from the public. Following the second PCC, the project team will proceed to prepare the Class EA study report documenting the decision making process and the study recommendations.

APPENDIX 1
DETAILED EVALUATION MATRICES

APPENDIX E

Natural Science Report

CONESTOGO PLAINS WATER SUPPLY CLASS ENVIRONMENTAL ASSESSMENT

NATURAL SCIENCES REPORT

prepared for

THE REGIONAL MUNICIPALITY OF WATERLOO

on behalf of

CIMA
Partners in excellence

By

LGL LIMITED
environmental research associates

DECEMBER 2014
LGL PROJECT TA8340-01

CONESTOGO PLAINS WATER SUPPLY CLASS ENVIRONMENTAL ASSESSMENT

NATURAL SCIENCES REPORT

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DECEMBER 2014
LGL PROJECT TA8340-01

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ABBREVIATIONS AND DEFINITIONS

Core Environmental Features CEF) Core Environmental Features are described within the Region of Waterloo Official Plan (ROP) as "those environmental features identified as being provincially significant or regionally significant" (Region of Waterloo 2010).

DFO – Department of Fisheries and Oceans Canada.

EA – Environmental Assessment.

GRCA – Grand River Conservation Authority.

LIO – Lands Information Ontario database, maintained by the Ministry of Natural Resources.

MNRF– Ministry of Natural Resources and Forestry.

NHIC – Natural Heritage Information Centre Biodiversity database, maintained by the Ministry of Natural Resources.

RMOW – Regional Municipality of Waterloo.

ROP – Region of Waterloo Official Plan.

ROW – road right-of-way.

Study Area – defined in the Conestogo Plains Water Supply Class EA as shown in Figure 1.

West Montrose Class EA – West Montrose Water Supply Class Environmental Assessment, completed January 2013.

1.0 INTRODUCTION

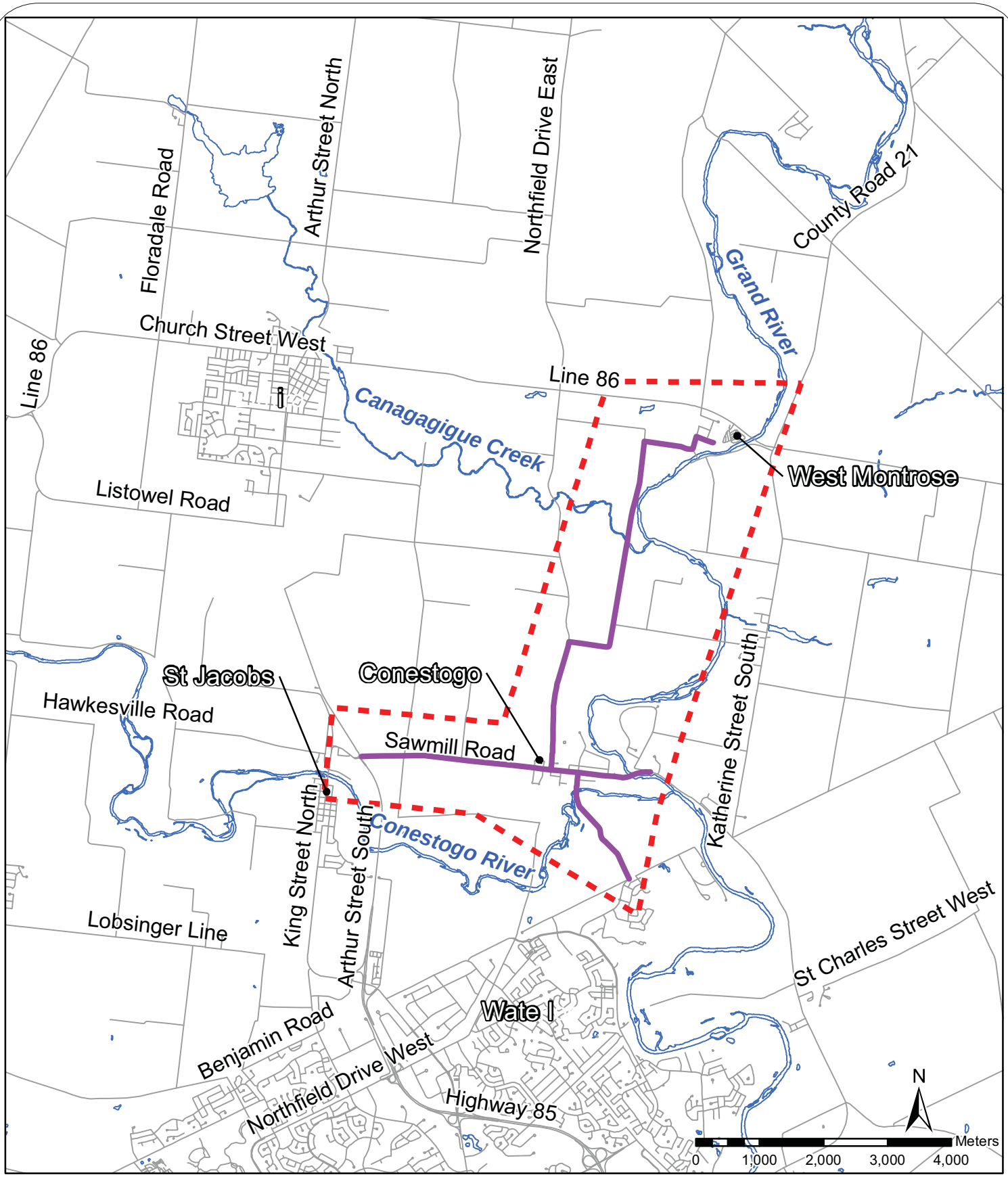
The Regional Municipality of Waterloo (Region) is undertaking the Conestogo Plains Water Supply Schedule B Class Environmental Assessment (Conestogo Class EA) to evaluate water servicing opportunities to meet the demands in the Conestogo Plains and West Montrose areas. LGL Limited has been retained by CIMA+ on behalf of the Region to conduct a natural heritage investigation of lands in the Conestogo Plains Study Area to document existing conditions within and adjacent to this area. Natural heritage features and constraints for consideration in the development and evaluation of alternatives for the Class EA are also provided in this document.

Documentation of existing conditions consists of a desktop assessment of ortho imagery and a review of background data from secondary sources to establish natural heritage conditions within the area, with subsequent field investigation. Field surveys were conducted in the summer of 2013 and 2014 to verify extent, limits, and character of the natural heritage features along the proposed watermain alignment as part of a previous EA (West Montrose Class EA) as well as additional alignments under consideration. A Terms of Reference was circulated to GRCA and MNRF Guelph District office to obtain agency feedback on proposed effort and survey protocols and field work was conducted accordingly (Appendix A).

2.0 BACKGROUND

In January 2013, a Class EA was completed to identify the preferred alternative for a sustainable long term water supply to the community of West Montrose (West Montrose Class EA). Since that time, the Region has identified the opportunity through a subsequent Class EA process (Conestogo Class EA) to undertake a holistic approach in assessing overall servicing requirements of the Conestogo and West Montrose service areas. The scope of the Conestogo Class EA includes a review of the 2013 recommendation from the West Montrose Class EA, to address existing limitations with the West Montrose water system. In addition, the Conestogo Class EA is also exploring the option of connecting the communities of West Montrose and Conestogo to the Waterloo servicing area.

For the purpose of the Natural Science investigation, a study area was defined to specifically capture potential alignments for the connections to the Waterloo service area. Figure 1 illustrates the location and limits of the Study Area and the proposed watermain alignments being considered as part of the water supply alternative solutions.



Conestogo Plains Water Supply EA

Key Map

- Alternative Watermain Alignments
- Natural Science Investigation Study Area

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3.0 BACKGROUND DATA COLLECTION

Existing conditions described in this section have been based on a review of existing background documentation and data layers, including the following resources:

- Site orthophotography;
- GIS data layers obtained from the Ministry of Natural Resources and Forestry (MNRF), Lands Information Ontario (LIO), and the Grand River Conservation Authority (GRCA);
- Background watershed and subwatershed studies;
- The Natural Heritage Information Centre (NHIC) database;
- Winterbourne Riverine Wetland Complex Wetland Evaluation (MNRF 2004/2007);
- Upper Conestogo Creek Complex Wetland Evaluation;
- Waterloo Rural East Wetland Evaluation;
- Regional Municipality of Waterloo Official Plan (ROP);
- Atlas of the Breeding Birds of Ontario;
- Kitchener-Waterloo Field Naturalist, Christmas Bird Count data;
- Agency pre-consultation with GRCA and MNRF via email, phone correspondence and meetings; and,
- West Montrose Water Supply Class Environmental Assessment: Project File Report (AECOM 2013).

Secondary source information was compiled and analyzed in order to develop a general understanding of the terrestrial and aquatic ecosystems, vegetation and wildlife within the Study Area. In addition, correspondence with the GRCA and MNRF was used to confirm the information presented in this report and to request any additional natural heritage information relevant to the Study Area. The area defined for this process is shown in Figure 1 as the Study Area to generally include the central portion of the Grand River between Conestogo and West Montrose and a north east portion of Waterloo. The following sub-sections summarize the information obtained from the resources listed above.

3.1 PHYSIOGRAPHY AND SOILS

The Grand River meanders through the project area in a north-south direction. The area west of the river is largely comprised of the rolling, hummocky terrain of the Waterloo Hills (Chapman and Putnam 1984). This area is characterized by sandy hills, gravel terraces and swampy valleys. The area east of the river is part of the Guelph Drumlin Field. This field is comprised of approximately 300 drumlins of broad oval shaped hills with low slopes comprising an undulating till plain, with soils characterized as sandy to silty in texture. The Conestogo and Grand River valleys presently occupy valleys formed by meltwaters of receding glaciers forming terraces of high quality sand and gravel through successively lower water levels experienced over time. This has resulted in the establishment of several sand and gravel pits in the area. On the whole, Chapman and Putnam (1984) characterise the soils in the area as fertile, easily worked and adaptable to many crops, as is reflected by the predominant agricultural land use of the Study Area.

3.2 SIGNIFICANT NATURAL FEATURES

The Study Area was screened for significant natural areas in the form of significant wetlands, valleylands and woodlands and Core Environmental Features (CEF) as identified in the Official Plan for the Regional Municipality of Waterloo. As well, agency database resources as listed above were used to screen the area for Areas of Natural and Scientific Interest (ANSIs), and provincially significant wetlands (PSWs).

3.2.1 Core Environmental Features (CEFs)

Core Environmental Features (CEFs) are described within the Region of Waterloo Official Plan (ROP) as “those environmental features identified as being provincially significant or regionally significant” (Region of Waterloo 2010). The CEF designation applies to lands that meet the criteria for the following:

- Significant Habitat of Endangered or Threatened Species;
- Provincially Significant Wetlands;
- Environmentally Sensitive Policy Areas;
- Significant Woodlands; and,
- Environmentally Significant Valley Features.

Figure 2 displays the location of CEFs within the Study Area (outlined in red). Significant valleys, wetlands and woodlands are further described in subsequent sections.

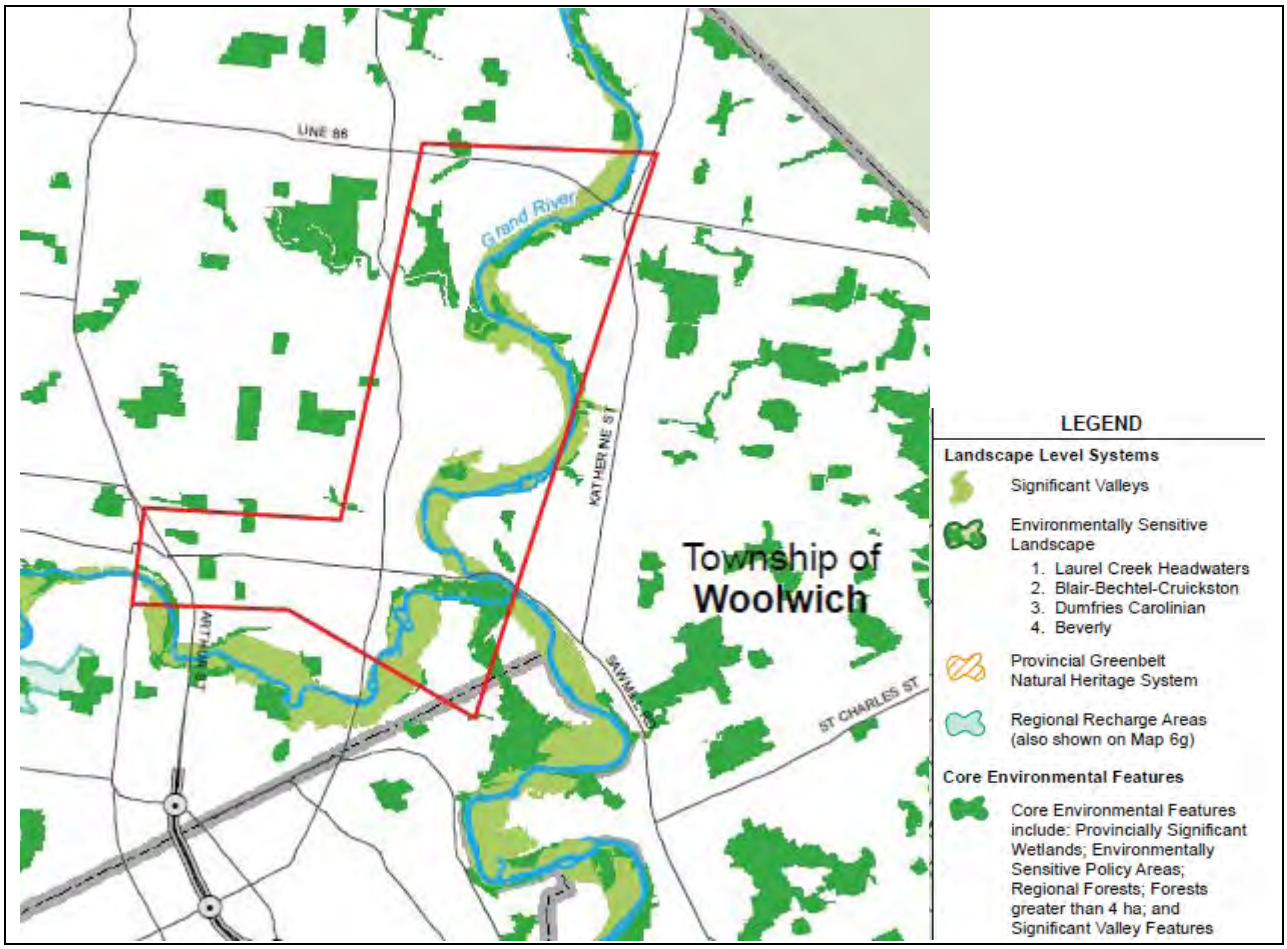


Figure 2. Significant Valleys and other Core Environmental Features (CEFs) identified in the Region of Waterloo Official Plan (2010), Map 4

3.2.2 Wetlands

Wetland features were largely identified using GIS data layers available for the Study Area and provided by MNRF (through LIO) and GRCA as shown on Figure 3. Three types of wetland features were identified through this process: provincially significant wetlands (PSW); unevaluated wetlands; and, other wetlands. PSWs are those for which an evaluation, according to the Ontario Wetland Evaluation System (OWES), has resulted in a score sufficient to qualify as a provincially significant feature. PSWs are identified by MNRF. Unevaluated wetlands have not undergone an OWES evaluation; while, those presented as 'other' wetlands are features where an OWES evaluation has determined them to be non-provincially significant.

3.2.2.1 Unevaluated Wetlands

Several unevaluated wetlands occur throughout the Study Area in the GIS data layers for wetlands obtained through LIO. These features are largely associated with the Grand River and its tributaries (Figure 3).

3.2.2.2 Other Wetlands

Two locally significant wetlands are found within the Study Area as identified by MNRF. These include the Winterbourne Riverine Wetland Complex and the Upper Conestogo Creek Complex (Figure 3).

Winterbourne Riverine Wetland Complex

The northern portion of the Winterbourne Riverine Wetland Complex that lies adjacent to the Conestogo River occurs within the Study Area (Figure 3). The wetland evaluation conducted by MNRF (2004, 2009) on this feature describes it as comprised of 19 wetland units of swamp and marsh covering 54.47 ha along the Grand River. This Complex is hydrologically connected by surface water to other wetlands in the area. Within the MNRF wetland evaluation, there is opportunity to document the presence of habitat within the feature for endangered or threatened, provincially significant and regionally significant species. The only species documented under this section of the evaluation of the Winterbourne Complex is Snapping Turtle (*Chelydra serpentine*), a species of Special Concern (SC) and provincially significant species.

Upper Conestogo Creek Complex

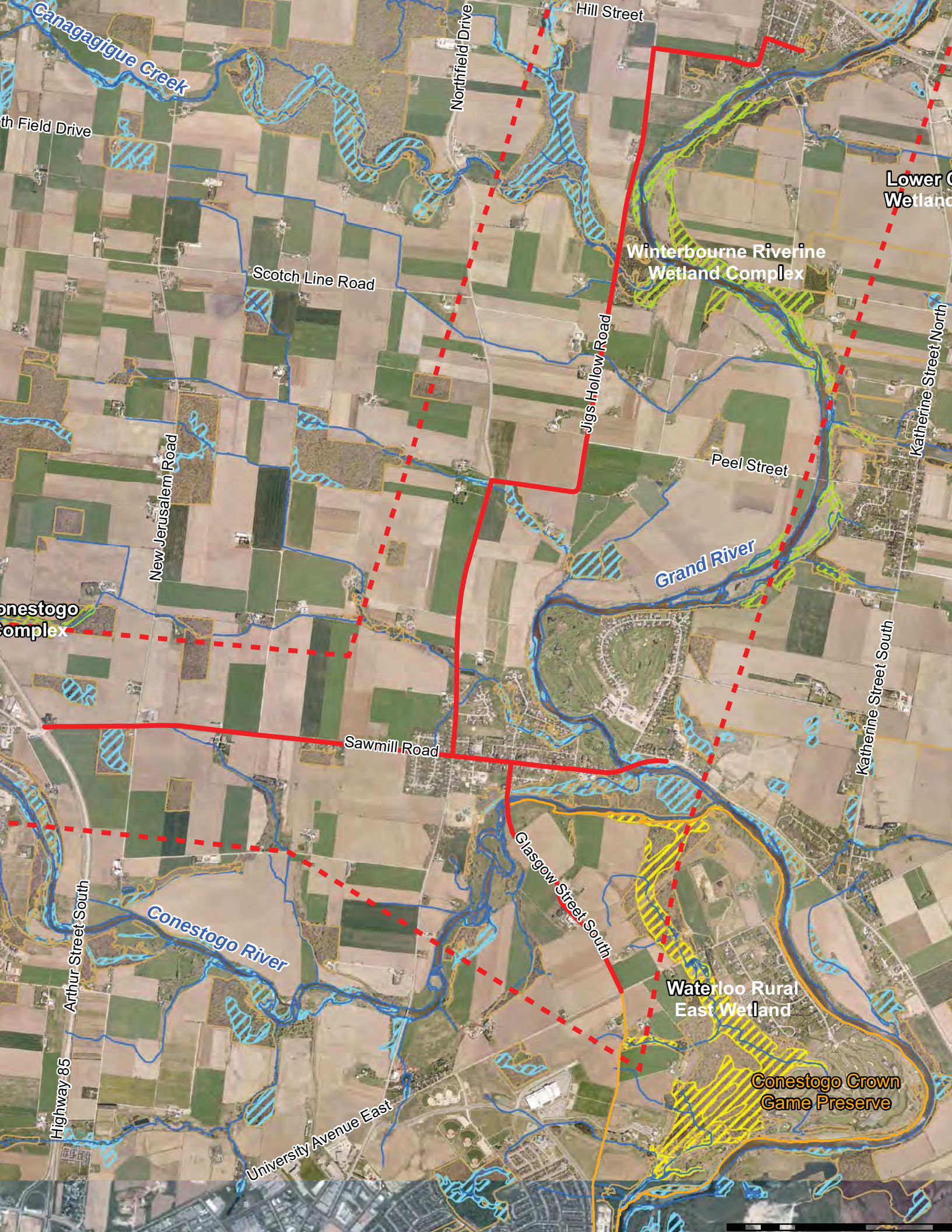
An edge of the Upper Conestogo Creek Complex lies adjacent to the western most portion of the Study Area (Figure 3). This feature is greater than 500 m from the closest of the proposed alignments for watermain routing. A request for information regarding this feature was made to the Guelph District MNRF, but had not yet been received at the time of reporting.

3.2.2.3 Provincially Significant Wetlands

One provincially significant wetland (PSW) straddles the south east corner of the Study Area, namely the Waterloo Rural East Wetland (Figure 3). This feature is described in the 1999 wetland evaluation conducted by MNRF as a mostly palustrine type wetland totalling 52.55 ha. The feature is dominated by swamp (80%) with the remainder occurring as marsh. The complex is hydrologically connected to marsh communities associated with the Grand River. Snapping Turtle (*Chelydra serpentine*), a species of Special Concern (SC) and provincially significant species, is documented to occur within this feature. In addition, Beaver, Muskrat, Striped Skunk, Coyote, Red Fox, Raccoon,

Ermine and Deer are listed as furbearers in the area. Cooper's Hawk is documented as a species of regional significance, while locally significant species include Scarlet Tanager, Winter Wren, Pileated Woodpecker, Mourning Warbler, Ruby-throated Hummingbird, and Ovenbird (Appendix C). Locally significant plant species include Brown Creeper, Shade Horsetail, and Small-flowered Leafcup.

MNRF consultation indicates that the mapping of the Waterloo Rural East Wetland is thought to be out of date in the area that includes the confluence of the Grand and Conestogo Rivers, and recommends that the boundary be updated should the preferred alternative for watermain routing include this area (pers. comm. Anne Marie Laurence, Guelph District MNRF July 2014).


Canagagigue Creek
th Field Drive
Northfield Drive
Hill Street
Lower
Wetland
Winterbourne Riverine
Wetland Complex
Scotch Line Road
Jigs Hollow Road
Katherine Street North
New Jerusalem Road
Peel Street
Grand River
onestogo
Complex
Sawmill Road
Katherine Street South
Glasgow Street South
Conestogo River
Arthur Street South
Waterloo Rural
East Wetland
Conestogo Crown
Game Preserve
Highway 85
University Avenue East

3.2.3 Valleylands

The ROP documents significant valleys in the area associated with the Grand and Conestogo Rivers as shown in Figure 2. GRCA data indicates that the valleys associated with Canagagigue Creek and the Grand River are considered steep to oversteep, particularly where Jigs Hollow Road crosses or lies adjacent to these two watercourses (GRCA 2013).

3.2.4 Woodlands

Significant woodlands are identified in the ROP as features that meet the criteria of a woodland according to the provisions of the Regional Woodland Conservation By-law, consist primarily of native tree species and are greater than 4 ha in size. Significant woodlands are included in the features identified within the ROP as Core Environmental Features (CEFs) as shown in Figure 2 above. Several significant woodlands are identified within the Study Area, most of which are relatively small in size. Those associated with the riparian area of Canagagigue Creek and the area between the Conestogo River and the Grand River to the south comprise the largest significant woodland features in the Study Area.

3.2.5 Areas of Natural and Scientific Interest (ANSIs)

MNRF NHIC data indicates that the St. Jacob's Hill Regional Earth Science Area of Natural and Scientific Interest (ANSI) is found within the Study Area for the Project. This ANSI is located on the banks of the Conestogo River in the Village of St. Jacobs as shown in Appendix B, Figure 1. St. Jacob's Hill ANSI is a 2.4 ha feature believed to be a Middle Wisconsin – Cherrytree Stadial glacial deposit (NHIC 2013). The Guelph Esker Regional Earth Science ANSI occurs along the north eastern border of the Study Area (Appendix B, Figure 1); this feature belongs to the Guelph-Eramosa-Ariss esker complex created by the wasting Wentworth ice (NHIC 2013).

3.3 WILDLIFE AND WILDLIFE HABITAT

Records of wildlife that occur within the Study Area were primarily obtained from accessible databases (e.g. Ontario Breeding Bird Atlas) and requests for data from local groups (e.g. Kitchener Waterloo Field Naturalists) as presented in Appendix C, Table 1.

3.3.1 Mammals

Records for 10 mammalian species were obtained for the Study Area through a review of background information (Appendix C, Table 1). All records were for species considered to be common and secure in Southern Ontario to include: Beaver, Eastern Gray Squirrel, Mink, Muskrat, Raccoon, Deer, Red Fox, Coyote, Ermine and Striped

Skunk. The Winterbourne Riverine Wetland Complex was scored as locally significant for provision of winter cover for wildlife (deer). MNRF LIO data indicates that a Crown Game Preserve (CGP) occurs within the Study Area to include the lands south of the Grand and Conestogo River confluence on the west side of the Grand River (Figure 3). The CGP includes part of the Waterloo Rural East PSW as well as the deer winter congregation area.

3.3.2 Birds

The wetland evaluation for the Winterbourne Riverine Wetland Complex indicates that waterfowl hunting occurs in the wetland feature; however, no significant features for water bird nesting or staging are documented in the feature (MNRF 2004/2007). Further consultation with MNRF indicates that a heron rookery is located approximately 250-300 m north of the Sawmill Road proposed watermain routing; and, that an active Bald Eagle nest is documented 210 m southwest of the Glasgow Street alignment (pers. comm. MNRF Guelph District Office, August 2014). MNRF Management Biologist (A. Timmerman) indicates that, to his knowledge, this is the first successful Bald Eagle nest ever recorded in the RMOW.

Data for species occurrence within the Study Area is compiled in Appendix C, Table 1. Records of the Ontario Breeding Bird Atlas (Bird Studies Canada et. al. 2008) were accessed to summarize the bird species known to occur in the area searched, as shown in Appendix B, Figure 2. The areas searched represent 10 km x 10 km squares. A total of 116 bird species are documented to occur within the data squares that comprise the majority of the Study Area (17NJ32 and 17NJ42), while an additional 20 species were documented in 17NJ31 and 17NJ41 which include a very small portion of the Study Area (Appendix B, Figure 2). The Kitchener-Waterloo Field Naturalists also provided data for the group's 2013 Christmas Bird Count (CBC) conducted in Area 1 of ONKT as shown in Appendix B, Figure 3. This data is included in Appendix C, Table 1 and incorporates a larger area than that defined for the review process. A total of 5 additional species were documented in the CBC for the larger area to include: Common Goldeneye, Northern Shrike, Ring-billed Gull, Rough-legged Hawk, and Snow Bunting.

3.3.3 Reptiles

The wetland evaluation for the Winterbourne Riverine Wetland Complex indicates that the wetland feature provides habitat for Snapping Turtle (MNRF 2004/2007). No other records were found specific to the Study Area in background documents or databases searched for reptiles.

3.3.4 Amphibians

No records were found specific to the Study Area in background documents or databases searched for amphibians.

3.4 AQUATIC HABITAT AND FISH COMMUNITIES

The Study Area includes several watercourses that flow through and adjacent to areas that may accommodate infrastructure related to the Project. These include the Grand River, the Conestogo River, and Canagagigue Creek as shown in Figure 3; all of which are part of the Grand River Watershed.

3.4.1 Grand River Watershed

The Grand River Watershed is the largest inland river system in southern Ontario. The watershed covers 6,800 km^2 and is home to approximately 925,000 people (GRCA 2013). The watershed contributes about ten percent of the drainage to Lake Erie (LESPC 2012). The major tributaries of the Grand River are the Nith and Conestogo Rivers that drain the western portion of the watershed, and the Speed River which drains the north-east section.

3.4.2 Central Grand River Subwatershed

The Study Area lies within the Central Grand River subwatershed and borders the Conestogo Sub-basin (LESPC 2012). The Central Grand includes the middle portion of the watershed extending from Belwood Reservoir in the north to the Cockshutt Bridge in Brantford to the south. Physiography and hydrology are described as complex within the 1998 GRCA Fisheries Management Plan (FMP) due to the extensive moraines and glacial spillways resulting in large amounts of groundwater which generate relatively high baseflows. Land use in the area is dominated by agriculture which contributes sediment and nutrient loads to the tributaries and main stem of the Grand River. Major watercourses within the Study Area include the Grand River, the Conestogo River and Canagagigue Creek, each of which is further described below.

3.4.2.1 Grand River

The Grand River was designated Canadian Heritage River in 1994 due to its significant cultural and natural heritage features. The river extends 280 km from its headwaters north of Dundalk to Port Maitland on Lake Erie. The river is home to 80 confirmed fish species and 18 probable species to include several aquatic species at risk (SAR). Further consideration is given to SAR in Section 5.0.

Fisheries records obtained from the Guelph MNRF District Office for Grand River sampling stations within the Study Area are included in Appendix D, Table 1. A total of 24 species are documented to occur in the central reaches of the Grand River. MNRF records (1992) indicate an area of excellent spawning habitat for Northern Pike is located along the west shore of the river below the confluence with Canagagigue Creek.

3.4.2.2 Conestogo River

The Conestogo River Watershed is a runoff dominated system, largely comprised of Tavistock Till Plain which generates high runoff. Stream flow in the lower portion of the river that lies within the Study Area is controlled by discharges from the Conestogo Dam. Although groundwater discharge from the Waterloo Moraine contributes some stream flow in this area, most of the flow during the summer dry period is provided by reservoir augmentation (LESPC 2013).

Tributaries of the Conestogo River receive large amounts of groundwater discharge which allows for opportunities to restore water quality in the lower portions of the river. Stocking of Brown Trout (*Salmo trutta*) in the Conestogo River began in November 2003 and population monitoring of the species indicates that stocks are surviving well (GRFMPC 2006).

A small portion of the lower Conestogo as it approaches its confluence with the Grand River lies within the Study Area. Fish records obtained from MNRF for the station upstream of Northfield drive indicate 7 species were documented in August 2012 to include Brook Stickleback, Brown Bullhead, Central Mudminnow, Common Shiner, Pumpkinseed, Rock Bass and Smallmouth Bass (Appendix D, Table 1).

3.4.2.3 Canagagigue Creek

The Canagagigue is a minor tributary of the Grand River. The creek flows from its headwaters in the Waterloo hills of Peel Township to the flatter Guelph drumlin fields of Woolwich Township in a southeasterly direction to the Grand River. The portion of the Canagagigue that lies within the Study Area is the lower portion downstream of Elmira and the confluence of West Montrose Creek to its mouth at the Grand River (Figure 3). The Canagagigue has been impacted historically by the poor disposal practices of toxic waste resulting from Agent Orange production in the Elmira area during the 1960s. The creek currently receives inputs from the Region's water pollution control plant (WPCP) and private industry as it flows through the community. Extensive water quality monitoring is conducted by the Region upstream and downstream of the WPCP to monitor potential impacts to the creek as they relate to wastewater. Data from these efforts suggests that nutrient levels in these reaches of the creek are relatively high (above the PWQOs for phosphorus and nitrate) independent of operations at the WPCP

(LGL 2013). Water quality issues identified for the Canagagigue in the 1998 Fisheries Management Plan (GRCA 1998) indicate potential impacts associated with on-stream impoundments, as well as degradation of fish habitat related to loss of natural habitat through channelization and reduced riparian buffers.

Historical data for benthos surveys reported by Carey et al. (1983) characterize the reach of the Canagagigue downstream of Elmira as more diverse relative to the upstream condition.

The Canagagigue as it flows through the Study Area is classified by MNRF as warmwater fish habitat. Fisheries records for the lower Canagagigue, downstream of the community of Elmira, were obtained from the Guelph District MNRF Office and are presented in Table 1 of Appendix D. A total of 27 species were recorded in the reaches of the creek downstream of Elmira.

3.5 RECORDS FOR RARE SPECIES

In order to determine the potential for rare species (including SAR) to occur within the project area, a review of MNRF's NHIC Biodiversity Explorer database was conducted and an MNRF Species at Risk Biologist at the Guelph District office was consulted. Results of those efforts appear below.

In addition, background reports were screened for records of SAR. The results of that screening were combined with SAR documented through site investigation conducted by LGL in 2013 and are further considered in Section 6.0.

3.5.1 MNRF NHIC Records

A preliminary desktop search for rare species using the NHIC Biodiversity Explorer database for a 43km^2 area that included the Study Area (shown in Appendix B, Figure 4), returned records dating from 1892 to 2007 (Appendix G, Table 1). For the purpose of this background review, records greater than 50 years old were considered historical; and, although they appear in Appendix G, are not discussed herein. Records were found for three plant species (Braun's Holly Fern, S3; Scarlet Beebalm, S3; and White-tinged Sedge, S3); three fish species (Black Redhorse, THR; Silver Shiner, THR; and Greater Redhorse S3); one mussel species (Wavy-rayed Lampmussel, THR); three reptiles (Snapping Turtle, SC; Milksnake, SC; and Eastern Ribbonsnake, SC); and, one bird species (Bobolink, THR).

3.5.2 Consultation with Guelph District MNRF

LGL Limited received additional information from the Guelph District MNRF Office on July 30, 2013 and October 11, 2013 pertaining to species at risk (SAR). Correspondence from MNRF indicated an occurrence of Snapping Turtle (Special Concern) with Silver Shiner (Threatened), Black Redhorse (Threatened), Wavy-rayed Lampmussel (Threatened) and Rainbow Mussel (Threatened) as likely in the Grand River. Further contact was made with MNRF in June 2014 when the Study Area was expanded to consider additional alternatives. In response, MNRF indicated there were additional known occurrences in the area for Butternut (Endangered), Barn Swallow (Threatened), Chimney Swift (Threatened), Bald Eagle (Special Concern) and American Gromwell (S3). SAR lists for Woolwich Township and the Region of Waterloo were also provided by MNRF and further considered along with the SAR documented through the above sources in Section 5.0. Consultation and Information obtained from MNRF is included in Appendix I.

4.0 FIELD INVESTIGATIONS

Field investigations to date have focused on areas along the road right-of-way (ROW) of the proposed watermain alignments under consideration as part of this Class EA (Figure 1). Table 1 lists the field surveys conducted in 2013 and 2014.

Table 1. Field Surveys Conducted along Proposed Alignments in 2013 and 2014

Date	Type of Survey	Weather Conditions
June 13, 2013	Aquatic habitat assessment of Canagagigue Creek at Jigs Hollow Road (C5 and C6, Figure 4).	Clear, 21C 9.6 mm of rain in 24hours
August 21, 2013	Aquatic habitat assessment of C1 to C4 (Figure 4).	Clear, 27C No precipitation
August 28, 2014	ELC, wildlife and vegetation survey from road right of way.	Overcast, 26C 1.8 mm of rain in 24hours
October 5, 2013	Aquatic habitat assessment of C8 (Figure 4).	Clear, 16C 0.3 mm of rain in 24hours
October 12, 2013	Aquatic habitat assessment of C7 (Figure 4).	Clear, 22C No precipitation
July 7, 2014	Aquatic habitat assessment of Grand River at Sawmill Road (C9), Conestogo River at Glasgow Street (C10) and tributaries and drainage swales (C11-C13) as shown in Figure 4. ELC, wildlife and vegetation survey from road right of way. Survey conducted within the breeding bird timing window.	Overcast, 24C 49.1 mm of rain in 24hours
July 22, 2014	Confirmation of substrate and in-stream conditions under improved water clarity, to supplement July 7 investigation.	Clear, 30C No precipitation

4.1 AQUATIC HABITAT

Field surveys to characterize watercourse crossings associated with the watermain alignments proposed as part of the water supply alternative solutions being considered in the Class EA study (Figure 1) were conducted on June 13, August 21, October 5, and October 12, 2013. Additional investigations were conducted on July 7 and July 22, 2014 to document conditions along the additional routing proposed on Sawmill Road and Glasgow Street as observed from the ROW, to include crossings of the Grand River and Conestogo River (Figure 1).

For the purpose of field investigation, watercourses were located using the MNRF LIO layer and subsequent ground truthing of potential alignment routes from within the road ROW. Where a proposed alignment was found to cross a feature, an aquatic habitat survey was conducted to characterize the watercourse. A total of 13 watercourse crossings were documented in the site investigation; the location of each is displayed in Figure 4. A description of each crossing identified along the proposed watermain alignments is provided in Appendix E, with site photos provided in Appendix H. Crossings included:

- intermittent swales conveying flow through agricultural fields;
- intermittent drainage ditches conveying flow along and across roadways;
- enclosed watercourses conveying flow through a residential subdivision;
- permanent flow in the form of tributaries of the Grand River; and,
- permanent flow in the form of the Grand River at Sawmill Road, the Conestogo River at Glasgow Street South, and the Canagagigue Creek at Jigs Hollow Road.

Of the 13 crossings investigated, 6 represent Regulated watercourses (GRCA 2013), identified in Figure 4 as C2, C3, C4, C6, C9 and C10. Crossings C6, C9 and C10 represent crossings associated with the main stem of the Grand River and two of its major tributaries (Conestogo River and Canagagigue Creek). All of the remaining Regulated watercourses listed are tributaries to the Grand River with potential to provide fish habitat.

The fishery supported by the Grand River and its tributaries is considered well documented (Section 3.4) such that no fisheries surveys were completed as part of the aquatic investigation described herein. Also known to occur are aquatic species at risk as described in Section 3.5 and considered further in Section 5.0.

Field Drive
C7
C6
C5
Scotch Line Road
C4
Jigs Hollow Road
Peel Street
C3
New Jerusalem Road
Northfield Drive East
Grand River
C2
C1
C13
C12
Weeby Place
Sawmill Road
C11
C9
C10
Glasgow Street
Conestogo River
Arthur Street South
Country Squire Road

4.2 VEGETATION AND VEGETATION COMMUNITIES

The geographical extent, composition, structure and function of the vegetation communities were identified through a combination of air photo interpretation and field investigation. Air photos were interpreted to determine the limits and characteristics of the vegetation communities in the Study Area. A field investigation of the vegetation communities within the Study Area and along the alternative watermain alignments was conducted on August 28th, 2013. Additional survey of the alternative routing along Sawmill Road to the Grand River, and south along Glasgow Street South were conducted from within the ROW on July 7, 2014. The focus of the field survey was to ground truth the boundaries of vegetation communities, conduct a botanical survey and screen for plant SAR.

Vegetation communities documented during the survey were classified according to the *Ecological Land Classification for Southern Ontario: First Approximation and Its Application* (Lee et al. 1998). In addition, a plant list and description of the general structure of vegetation were obtained during the field survey. Plant species status was reviewed for Ontario (Oldham 2009) and the Region of Waterloo (ROW 1999). Vascular plant nomenclature follows Newmaster and Ragupathy (2012).

4.2.1 Vegetation Communities

Natural vegetation cover within the Study Area has been cleared in the past to make way for agriculture and residential development. Row crops of corn, grain, hayfield (timothy, alfalfa) and the occasional cattle farm dominate the landscape. As a result, all remaining vegetation features within the Study Area have either been subject to some form of disturbance and are the result of secondary regeneration; or, are too difficult to farm and left alone due to topography and/or moisture conditions. The ROW contains typical roadside features of ditches dominated by upland and wet meadow species. Within the urbanized areas amenity trees and manicured lawns abut the roadways. Natural features within the Study Area are associated with valleyland of the Grand and Conestogo Rivers and their tributaries, as well as remnant woodlots. These vegetation features include forest and wetland communities (FOC2, FOD4, FOD5, FOM4, MAM2, MAM2-2, MAM2-10, MAS2-1, and SWC1and SWD3) as shown in Figures 5 to 8. Anthropogenic vegetation communities found within the Study Area include cultural meadows (CUM1-1), cultural plantations (CUP3-2 and CUP3-8), cultural savannah (CUS1) and cultural woodland (CUW1) (Figures 5 to 8).

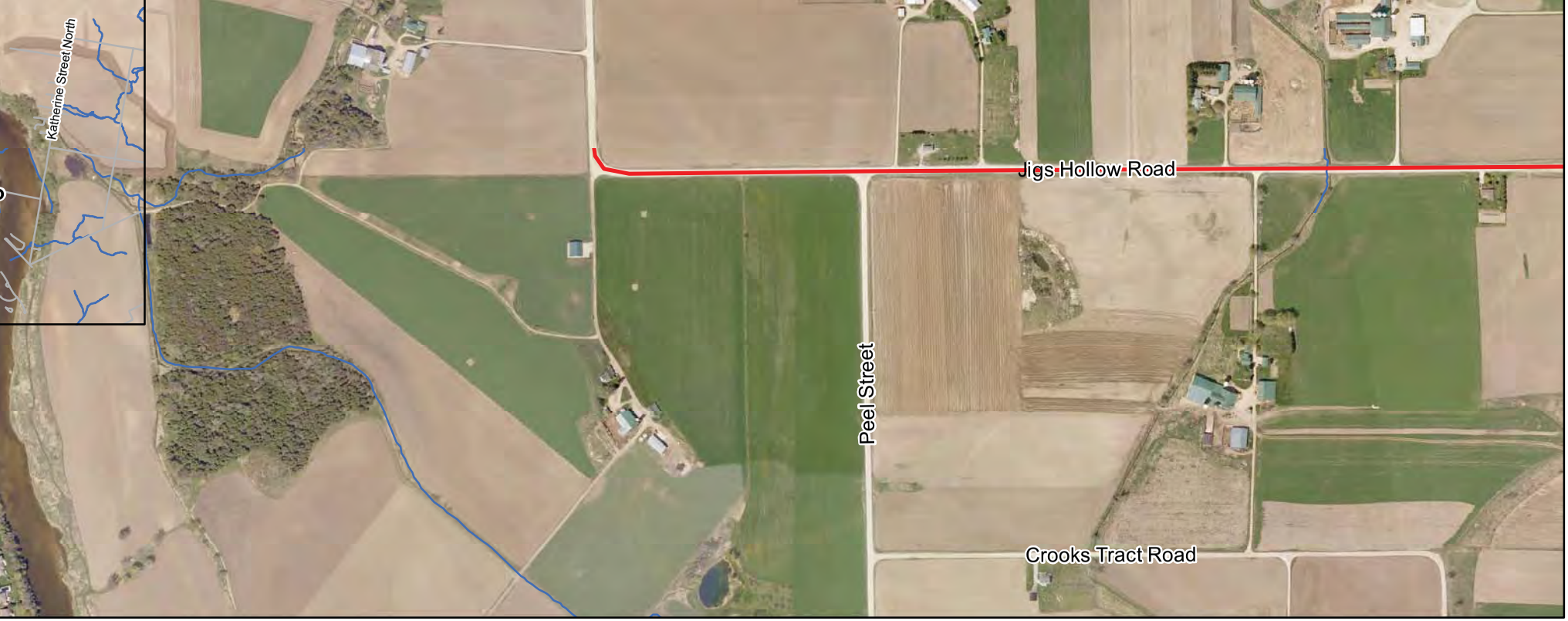
The Winterbourne Riverine Wetland Complex is a locally significant wetland. It is associated with the floodplain of the Grand River and contains a mixture of meadow marsh and coniferous swamp communities.

All vegetation communities identified within the Study Area are delineated in Figures 5 through 8 and described in Appendix F, Table 1. Site photos of the Study Area are provided in Appendix H.

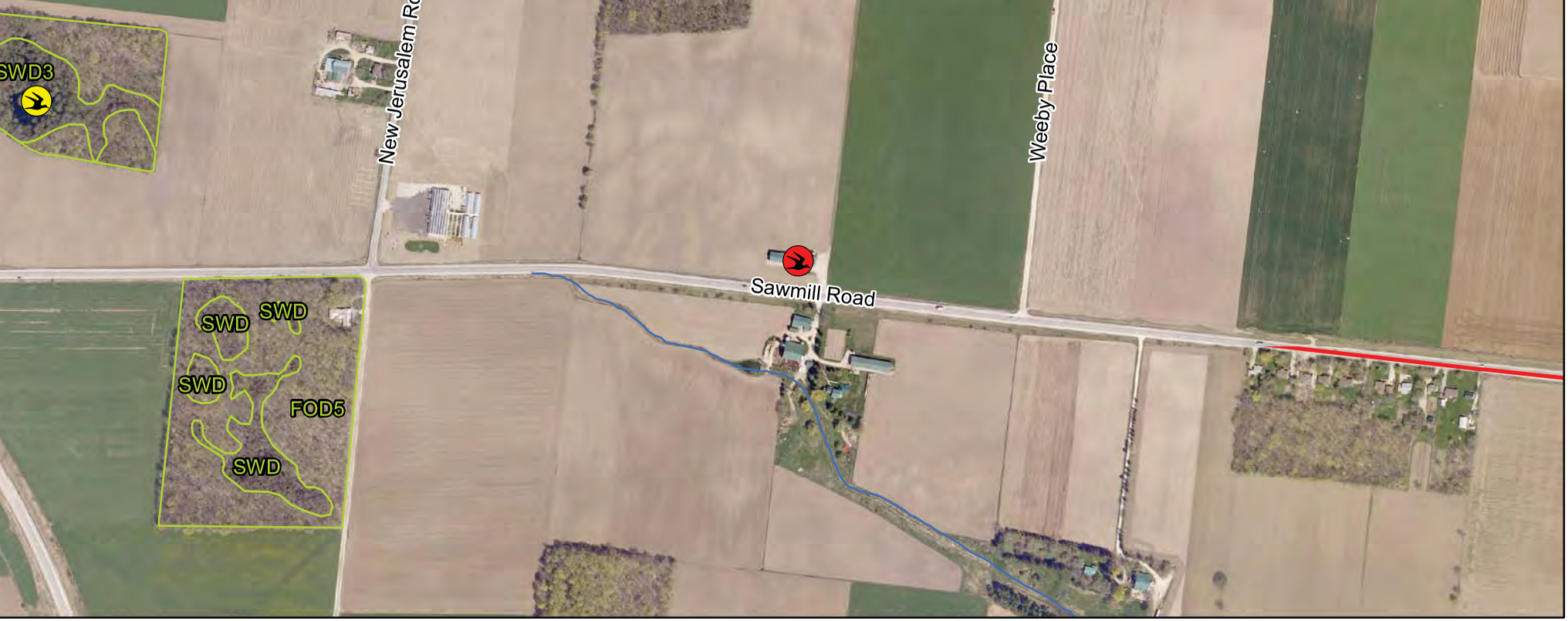
4.2.2 Vegetation

A total of 158 vascular plant species have been recorded within the Study Area. Three of these plants could only be identified to genus and are not included in the following summary calculations. Of the species documented, 81 (52% of the total identified) are native to Ontario and 74 plant species (47% of the total identified) are considered introduced and non-native to Ontario. A vascular plant list is presented as Appendix F, Table 2.

SWC1 M
FOM4
FOM4
FOM4
FOM4
CUW1
Jigs Hollow Road
CUP2-1
Hill Street
FOM4
Letson Drive
Rivers Edge Driv
West Montrose
Katherine Street North


Katherine Street North
Jigs Hollow Road
Peel Street
Crooks Tract Road

MAS2-1/
MAM2-0
CUM1-
Dug Pond
CUM1-1
MAM2-2
SWC1
FOC2-2
Jigs Hollow Road


SWD3
New Jerusalem Rd
Weeby Place
Sawmill Road
SWD
SWD
SWD
FOD5
SWD

wmill Road
Northfield Drive East
Grand River
MAM - 2
M
CUM - 1
SWD3
FOD4
MAS - 1
MAM - 0
MAM - 2
FOD4
MAM - 5
CUS1
FOD4
MAM - 2
CUS1
Conestogo River
Pasture
MAM - 2
CUM - 1
Glasgow
st Montrose
Katherine Street North
N

Sawmill Road
CUS1
MAM 2
FOD4
Pasture
MAM 2
Glasgow Street South
FOD4
CUM 1
CUM 1
MAM 2
CUM 1
Country Squire Road
Northfield Drive East
t Montrose
Line 86
Katherine Street North

4.3 WILDLIFE AND WILDLIFE HABITAT

Pedestrian surveys along the road ROW were completed August 28th 2013, and July 7th 2014 to determine the use of the area by breeding birds and wildlife in general. It should be noted that the field investigation was completed late in the breeding season during 2013, and outside of the typical breeding bird window (April 1-July 31) and was primarily intended to serve as a screening of suitable habitat for wildlife and SAR. The 2014 survey timing is considered suitable for detecting breeding birds. Bird species and other wildlife were identified through visual and auditory observations.

4.3.1 Wildlife

A total of 45 birds, two amphibian, one reptile, and two mammal species were documented during the visit. A complete list of wildlife species is found in Appendix C, Table 1. The species documented are relatively common overall and within the vegetation communities found on site.

One of the bird species documented; the Savannah Sparrow, is considered to be an area-sensitive species according to MNRF's Significant Wildlife Habitat Technical Guide (MNRF 2000), and is typically found in areas with >50ha of grassland. No active nests, cavities, hibernacula, or dens were observed, and no species were confirmed to be breeding within the alignment during the 2013 survey. However, 5 species were confirmed to be breeding within the additional alignment areas investigated in 2014, including American Robin, Barn Swallow, Cliff Swallow, Red-winged Blackbird, and Tree Swallow. Active nesting sites were documented for the Barn Swallow and Cliff Swallow and approximate locations are shown in Figures 6, 7 and 8. One active Barn Swallow nest was found on a building approximately 40m north of Sawmill Road, while 4-5 pairs of Cliff Swallow were found nesting on the south side of the bridge where Sawmill Road crosses the Grand River.

Gray Tree Frogs were heard calling within the moist riparian areas surrounding the tributary at creek crossing C4 along the east side of Jigs Hollow Road in the 2013 survey and a single Painted Turtle was observed near the shoreline of the Conestogo River at the Glasgow Street bridge crossing in 2014.

4.3.2 Wildlife Habitat

Given the agricultural nature of the Study Area, screening of the area for SAR birds such as Bobolink and Eastern Meadowlark was completed. Many of the areas along the alternative alignment were residential, planted with corn, or forested (natural and/or cultural). These areas do not represent suitable breeding habitat for these two SAR

birds and neither of these species were observed or heard along the alignment during the survey.

Breeding habitat for birds is limited along the road ROW, as much of the vegetation has been cleared as part of the regular maintenance. Areas along the alternative alignments that border the Grand River, Conestogo River, and Canagagigue Creek present greater opportunities for breeding efforts within the naturally forested or riparian areas that are adjacent to roads. These areas had the greatest diversity of species observed during the field investigation. These naturalized areas surrounding the larger watercourse crossings represent higher quality habitat options for wildlife in the area and may also act as movement corridors. Sandy natural shorelines of the river and creeks could present opportunities for turtles, aquatic mammals, or amphibians.

The FOD5 community identified to the northeast of the Sawmill Road and Arthur Street intersection (Figure 7) is also believed to host breeding efforts by colonial nesting Great Blue Herons as dozens of stick nests can be observed within this woodlot during winter months. Although Great Blue Herons were observed in the vicinity of the woodlot and in several other sections of the Study Area, current use of the site for colonial breeding could not be confirmed during 2013 or 2014 field investigations. This location is consistent however with information obtained from MNRF regarding the location of a heron rookery in proximity to Sawmill Road.

The dug pond feature on the east side of Northfield Road, just south of creek crossing C2 is man-made with grassy banks and surrounded by agricultural and residential land use. Use of this feature by wildlife is likely limited to foraging or stop-over purposes rather than breeding efforts. The C2 crossing includes some rock piles and an old concrete structure on the west side of Northfield Drive at the culvert that may act as shelter, though proximity to a busy road is not optimal for wildlife. Additional habitat opportunities for wildlife such as woody debris, rocky crevices, tree cavities, or burrows were not found along the alignment, but may exist in adjacent vegetation communities.

5.0 RARE SPECIES

5.1 RARE PLANT OBSERVATIONS

No plant species that are regulated by COSEWIC or the Ontario *Endangered Species Act, 2007* were encountered during the botanical investigation. Four species identified by the Region of Waterloo as significant in the region were identified during the field investigation and are presented in Table 2.

Table 2. Plant Species Documented in August 2013 and Listed as Regionally Significant

Scientific Name	Common Name	Location - Vegetation Community
Picea glauca	White Spruce	CUP3-8, FOM4
Celtis occidentalis	Common Hackberry	FOM4 – along Jig's Hollow Road and the Grand River
Juglans nigra	Black Walnut	ROW, CUP2-1, FOM4, CUP3-8 – planted throughout the landscape
Heracleum maximum	Cow-parsnip	MAS2-1 of the Grand River at Sawmill Road

None of the plant species noted in Table 2 are of provincial conservation concern; all of these plants are identified as either S5 or S4 with 'secure' and 'apparently secure' populations. Two of the three regionally significant species are planted within vegetation features. The Hackberry was located in the FOM4 on the slope of the Grand River adjacent to the old Apple orchard (CUW1) along Jig's Hollow Road.

5.2 RARE WILDLIFE OBSERVATIONS

All wildlife species documented on site were screened for those listed as at risk provincially, federally, or locally. Through correspondence with the MNRF several reptile species at risk were listed with increased potential to occur in the area. Occurrences of these species and their corresponding habitat were also screened for, but none were observed. Three species observed on site are listed as at risk by COSEWIC and the Ontario *Endangered Species Act, 2007*; the Barn Swallow (Threatened), Chimney Swift (Threatened), and Eastern Wood Pewee (Special Concern).

Numerous Barn Swallow were observed perching on hydro wires and flying over agricultural fields (planted with alfalfa) directly west of the cultural plantation (CUP2-1) along Hill Street during the 2013 survey. There were approximately 50-75 individuals observed foraging at that location. Some of the birds documented were juveniles from the recently passed breeding season; however, the location of the breeding efforts is unknown. Given the agricultural nature of the majority of the Study Area, it is likely that the birds were nesting in the nearby barn structures, but outside of the alternative

alignment. During the 2014 survey, an active nest was located on a farm building about 40 m north of Sawmill Road, with the location indicated in Figure 7. According to the MNRF, general habitat for the species includes the nest and surrounding 200 m for foraging and rearing of young birds. Development or construction within this area, or alteration of any buildings containing nests may require a permit, and/or compensation.

The Chimney Swift observations were limited to areas in town, with approximately 5 birds observed near the intersection of Sawmill Road and Glasgow Street (Figures 6, 7 and 8). Given the age of many residential buildings in the area, it is highly likely that the birds are using some of these nearby structures for nesting, as there are suitable chimneys in the area.

The Eastern Wood Pewee was documented within the FOM4 community along Jigs Hollow Road (Figure 5). This bird was previously identified by COSEWIC as a species of Special Concern, but as of June 2014 the bird has also been up listed to Special Concern under the ESA.

Several additional species observed during the 2013 and 2014 surveys are considered locally significant or as conservation priorities for the region (See Appendix C, Table 1).

5.3 SCREENING FOR POTENTIAL SAR HABITAT

The list of SAR that appears in Table 3 was compiled to include records for SAR obtained through the background review process as described in Section 3.5, observations made during site investigations in 2013 and 2014 as described in Section 4.0, and a list of SAR with potential to occur in Woolwich Township and Waterloo Region (as provided by Guelph District MNRF). Background information and field data was then used to determine habitat potential for the species list compiled and develop recommendations for further effort in Detailed Design, if warranted.

In addition to the species listed in Table 3, two provincially tracked S3 (vulnerable) vascular plants species were included in MNRF consultation received June 2014 (Appendix I), namely American Gromwell (*Lithospermum latifolium*) and White-tinged Sedge (*Carex albicans var. albicans*). Neither of these species was documented to occur within the ROW during the 2013 and 2014 vascular plant surveys (Appendix F, Table 2), and no further work is planned specific to these species.

	Designation (COSSARO)	ESA Protection (MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
)	Endangered	Species Protection and Habitat Regulation	Inhabit deciduous and mixed deciduous forests with suitable breeding areas which generally consist of ephemeral (temporary) bodies of water that are fed by spring runoff, groundwater, or springs (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014).	Investigations from road right of way to document ELC. No targeted surveys conducted. Field survey completed in 2013 and 2014 included documentation of potential habitat.	FOM and FOD communities occu within the Study Area.
	Endangered	Species and General Habitat Protection	Generally requires large areas of mature, undisturbed forest; avoids the forest edge; often found in well wooded swamps and ravines (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. OBBA records for species occur within the area searched in the background review (Appendix A, Figure 2, Appendix C)	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species was not documented to oc in August 2013 or J 2014 surveys. This interior species is known to avoid for edges, such as thos that occur along RO where works are anticipated to occu
	Special Concern	N/A	Prefers deciduous and mixed-deciduous forest; and habitat close to water bodies such as lakes and rivers; Roost in super canopy trees such as Pine (MNRF 2013b: MNRF 2014).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other	Species was not documented to oc in August 2013 or J 2014 surveys. FOM community along J Hollow Road, at th confluence of Canagagigue Creek

	Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
				that an active Bald Eagle nest occurs 210m southwest of the Glasgow Street alignment (Appendix I, August 2014).		the vicinity of C9 a C10 (Figure 4) have the greatest poten to provide habitat this species.
)	Threatened	Species and General Habitat Protection	Bank swallows nest in burrows in natural and human-made settings where there are vertical faces in silt and sand deposits. Many nests are on banks of rivers and lakes, but they are also found in active sand and gravel pits or former ones where the banks remain suitable. The birds breed in colonies ranging from several to a few thousand pairs. (MNRF 2014)	Species was not included in any records or correspondence received from MNRF. OBBA records for species occur within the area searched in the background review (Appendix A, Figure 2, Appendix C).	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species was not documented durin surveys conducted 2013 or 2014. Potential habitat exists along the exposed banks of t Conestogo River in the area of the Glasgow St. bridge
a)	Threatened	Species and General Habitat Protection	Prefers farmland; lake/river shorelines; wooded clearings; urban populated areas; rocky cliffs; and wetlands. They nest inside or outside buildings; under bridges and in road culverts; on rock faces and in caves etc. (MNRF 2013b, MNRF 2014).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Species is documented in the OBBA records obtained for the area. Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species was obser foraging in agricultural fields adjacent to roadwa in 2013 survey (50 individuals). In Jul 2014 an active nes was identified on a farm building approximately 40m north of Sawmill Road (Figure 7).
a)	Special Concern	N/A	Generally prefer freshwater marshes and wetlands; nest either on floating material in a marsh or on the ground very close to water (MNRF 2014).	'Historically known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area	Species not documented in August 2013 or Jul 2014 surveys. Potential habitat does exist in areas where alignment

	Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
				Species is documented in the OBBA records obtained for the area. Not included in NHIC records for area shown in Appendix B, to include the Study Area.	purposes.	
	Threatened	Species and General Habitat Protection	Generally prefers open grasslands and hay fields. During staging for migration uses freshwater marshes and grasslands (MNRF 2013b: MNRF 2014).	'Suspected to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Species documented in the OBBA records obtained for the area. Included in NHIC records. Most recent record is from 2003 (Appendix C).	Screening of potential alignment for suitable habitat concluded that much of the area was residential, planted with corn, or forested (natural and/or cultural) and that suitable habitat was limited given crop present in agricultural fields (Section 4.3).	Species was not observed during 20 or 2014 field effort Potential habitat within the Study A is largely associate with agricultural fields.
er	Special Concern	N/A	Generally prefers wet coniferous, deciduous and mixed forest types, with a dense shrub layer. Nests on the ground, on logs or hummocks, and uses dense shrub layer to conceal the nest (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). OBBA records for 1981-1985 include this species. Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys. Considered an interior species, an no interior habitat present directly adjacent to ROW
	Threatened	Species and General Habitat Protection	Generally found in mature deciduous forests with an open understorey; also nests in older, second-growth deciduous forests (MNRF 2013b, MNRF 2014).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Included in NHIC records. Most recent record is from 1969	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys. This area-sensitive spec not typically found disturbed, edge habitats, which are found along ROW.

Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
			2002 record for the species was found in OBBA survey square adjacent to the Study Area.		
Threatened	Species and General Habitat Protection	Historically found in deciduous and coniferous, usually wet forest types, all with a well-developed, dense shrub layer; now most are found in urban areas in large uncapped chimneys (MNRF 2013b, MNRF 2014).	'Suspected to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Guelph District MNRF confirmed species is known to occur or has occurred in the area (Appendix I, June 2014). Species documented in the OBBA records obtained for the area (Appendix C). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Several individuals were observed dur July 2014 field wor Approximately 5 bi were observed wit residential areas n Sawmill Rd and Glasgow Street Sou intersection. Potential habitat within the Project Area is largely associated with residential chimne
Special concern	N/A	Generally prefer open, vegetation-free habitats, including dunes, beaches, recently harvested forests, burnt-over areas, logged areas, rocky outcrops, rocky barrens, grasslands, pastures, peat bogs, marshes, lakeshores, and river banks. This species also inhabits mixed and coniferous forests. Can also be found in urban areas (nest on flat roof-tops) (MNRF 2013b, MNRF 2014).	'Suspected to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Species documented in the OBBA records obtained for the area (Appendix C).	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Not detected. This species wasn't identified in OBBA data, 1979 studies by 2004-2013 LGL field investigations where it may be incidentally encountered durin evening frog monitoring.
Threatened	Species and General Habitat Protection	Generally prefers grassy pastures, meadows and hay fields. Nests are always on the ground and usually hidden in or under grass clumps	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of	Screening of potential alignment for suitable habitat concluded that much of the area was	Species was not observed during 20 or 2014 field effort Potential habitat

Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
			I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Included in NHIC records. Most recent record is from 2010 (Appendix G). Species documented in the OBBA records obtained for the area (Appendix C).	corn, or forested (natural and/or cultural) and that suitable habitat was limited given crop present in agricultural fields (Section 3.3.2).	is largely associate with agricultural fields
Threatened	Species and General Habitat Protection	Generally prefer semi-open deciduous forests or patchy forests with clearings; areas with little ground cover are also preferred; In winter they occupy primarily mixed woods near open areas (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Not included in OBBA data obtained for the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species was not observed during 20 or 2014 field effort Potential habitat exists adjacent to ROW.
Special Concern	N/A	The eastern wood-pewee lives in the mid-canopy layer of forest clearings and edges of deciduous and mixed forests. It is most abundant in intermediate-age mature forest stands with little understory vegetation.	Species was not included in any records or correspondence received from MNRF. OBBA records for species occur within the area searched in the background review (Appendix A, Figure 2, Appendix C)	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys.
Special Concern	N/A	Generally prefer areas of early successional vegetation, found primarily on field edges, hydro or utility ROWs, or recently logged areas (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation	Species was not observed during 20 or 2014 field effort Potential habitat exists along much ROW.

Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
			MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Not included in OBBA data obtained for the Study Area.	for breeding and other purposes.	
Endangered	Species and General Habitat Protection	Generally found in old fields, pastures and wet meadows. They prefer areas with dense, tall grasses, and thatch, or decaying plant material (MNRF 2014).	'Historically known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records. Not included in OBBA data obtained for the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species was not observed during 20 or 2014 field effort Limited habitat fou within Study Area, most fields are currently being actively farmed.
Threatened	Species and General Habitat Protection	Generally located near pools of open water in relatively large marshes and swamps that are dominated by cattail and other robust emergent plants (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Not included in OBBA data obtained for the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys. Potential habitat exists at river crossings with associated wetland (i.e. C9 & C10).
Special Concern	N/A	Generally inhabits mature forests along steeply sloped ravines adjacent to running water. It prefers clear, cold streams and densely wooded swamps (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys. Habi not present in area directly adjacent to ROW.

	Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
				Not included in OBBA data obtained for the Study Area.		
	Endangered	Species and General Habitat Protection	Generally inhabits a variety of edge and grassland type - habitats including non-intensively farmed agricultural lands (MNRF 2014).	'Historically known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Not included in OBBA data obtained for the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys. Man of the agricultural fields within Study Area are actively being farmed.
on	Special Concern	N/A	Generally nest on tall, steep cliff ledges adjacent to large waterbodies; some birds adapt to urban environments and nest on ledges of tall buildings, even in densely populated downtown areas (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Included in OBBA data obtained for the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys. No steep cliffs or ledge present within ROW
s)	Special Concern	N/A	Generally prefer open oak and beech forests, grasslands, forest edges, orchards, pastures, riparian forests, roadsides, urban parks, golf courses, cemeteries, as well as along beaver ponds and brooks (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. OBBA records for species occur	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys. No t cavities document within ROW.

	Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information, Agency Liaison	How Addressed in Field Studies	Results, Habitat Potential
				background review (Appendix A, Figure 2, Appendix C)		
wl s)	Special Concern	N/A	Generally prefers a wide variety of open habitats, including grasslands, peat bogs, marshes, sand-sage concentrations, old pastures and agricultural fields (MNRF 2014).	'Suspected to Occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Not included in OBBA data obtained for the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey.	Species not documented in August 2013 or Jul 2014 surveys. Habi generalist, may occ within Study Area a potential open habitat areas exist.
	Special Concern	N/A	The wood thrush lives in mature deciduous and mixed (conifer-deciduous) forests. They seek moist stands of trees with well-developed undergrowth and tall trees for singing perches. These birds prefer large forests, but will also use smaller stands of trees. They build their nests in living saplings, trees or shrubs, usually in sugar maple or American beech.	Species was not included in any records or correspondence received from MNRF. OBBA records for species occur within the area searched in the background review (Appendix A, Figure 2, Appendix C)	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys.
d	Endangered	Species and General Habitat Protection	Generally prefer dense thickets around wood edges, riparian areas, and in overgrown clearings (MNRF 2014).	'Historically known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in 'provincially tracked records' of species known to occur in the Study Area as obtained from Guelph District MNRF (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Not included in OBBA data obtained for the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from road ROW, through ELC survey and observation of birds using the area for breeding and other purposes.	Species not documented in August 2013 or Jul 2014 surveys. Limi habitat available within Study Area near river crossing
ger	Endangered	Species Protection and Habitat Regulation	Generally prefer open habitats, whether natural (grasslands) or man-made (agricultural fields, road ROWs, golf courses) (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for	Field survey completed in 2013 and 2014 included documentation of potential habitat from	Species not documented in August 2013 or Jul 2014 surveys. No

Designation (COSSARO)	Designation (MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
			include the Study Area.	through ELC survey.	identified along ro right of way.
Endangered	Species and General Habitat Protection	Overwintering habitat: Caves and mines that remain above 0 Maternal Roosts: Often associated with buildings (attics, barns etc.). Occasionally found in trees (25-44 cm dbh) (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from within road ROW, through ELC survey.	Species not documented in August 2013 or Jul 2014 surveys. Maternal roosting opportunities may exist in residential areas, or farm structures.
Endangered	Species and General Habitat Protection	Overwintering habitat: Caves and mines that remain above 0 Maternal Roosts: Often associated with cavities of large diameter trees (25-44 cm dbh). Occasionally found in structures (attics, barns etc.) (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Field survey completed in 2013 and 2014 included documentation of potential habitat from within road ROW, through ELC survey.	Species not documented in August 2013 or Jul 2014 surveys. Maternal roosting areas may be prese in residential areas or farm structures.
Threatened	Species and General Habitat Protection	Generally occur in freshwater lakes, permanent or temporary pools, slow-flowing streams, marshes and swamps. They prefer shallow water that is rich in nutrients, organic soil and dense vegetation. Adults are generally found in open or partially vegetated sites, and juveniles prefer areas that contain thick aquatic vegetation including sphagnum, water lilies and algae. They dig their nest in a variety of loose substrates,	'Suspected to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area. Not included in records of 'provincially tracked species' obtained from Guelph District	No targeted basking surveys conducted. Field survey completed in June and August 2013, and July 2014 for proposed watermain alignment as shown in Figure 1 included documentation of potential habitat in the form of ponds and marshes.	No specific habitat identified along RC however, species known to traverse relatively long distances overland (7km) and may therefore be encountered incidentally.

Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
		and cobblestone. Overwintering occurs in permanent pools that average about one metre in depth, or in slow-flowing streams (MNRF 2013b, MNRF 2014).	June 2014).		
Special concern	N/A	The Eastern Ribbonsnake is usually found close to water, especially in marshes, where it hunts for frogs and small fish. A good swimmer, it will dive in shallow water, especially if it is fleeing from a potential predator. At the onset of cold weather, these snakes congregate in underground burrows or rock crevices to hibernate together (MNRF 2013b, MNRF 2014).	'Suspected to occur' in the Township of Woolwich (MNRF 2013). (Appendix I, Table 1 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Included in NHIC records. Most recent record is from 1977 (Appendix G). Guelph District MNRF confirmed species is known to occur or has occurred in the area (Appendix I, June 2014).	No targeted surveys conducted. Field survey completed in June and August 2013, and July 2014 for proposed watermain alignment as shown in Figure 1 included documentation of potential habitat in the form of burrows and marshes in proximity to the ROW.	Burrows were not found in ROW duri 2013 or 2014 field investigations. Potential for incidental encount
Special concern	N/A	Generally occur in rural areas, where it is most frequently reported in and around buildings, especially old structures. It is also found in a wide variety of habitats, from prairies, pastures, and hayfields, to rocky hillsides and a wide variety of forest types. They must also be in proximity of water, and suitable locations for basking and egg-laying (MNRF 2013b, MNRF 2014).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). NHIC/Biodiversity Explorer data includes a 1971 record for this species (Appendix G). Guelph District MNRF confirmed species is known to occur or has occurred in the area (Appendix I, June 2014).	No targeted surveys conducted. Field survey completed in 2013 and 2014 included documentation of potential habitat from within road ROW, through ELC survey.	Habitat generalist. Likely occurs in Stu Area. Potential for incidental encount
Special	N/A	Generally inhabits both lakes and	'Known to occur' in the Region of	No targeted surveys	Species not

	Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
			moving currents, muddy bottoms, and abundant aquatic vegetation. These turtles need suitable basking sites (such as rocks and logs) and exposure to the sun for at least part of the day (MNRF 2014).	I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	completed in June and August 2013, and July 2014 for proposed watermain alignment as shown in Figure 1 included documentation of potential habitat in the form of burrows and marshes in proximity to the ROW.	August 2013 or Jul 2014 surveys. Potential habitat does exist in areas where alignment crosses river featu
	Endangered	Species and General Habitat Protection	Generally require a permanent body of water, flowing or still, with a temperature remaining at or above 18.3°C throughout most of the active season; abundant cover, such as flat rocks submerged and/or on the bank; and an abundance of crayfish. Other important habitat features may include rocky, gravelly, or slate stream-bed substrates, swift to moderate current, and woodland surroundings (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	No targeted surveys conducted. Field survey completed in June and August 2013, and July 2014 for proposed watermain alignment as shown in Figure 1 included documentation of potential habitat in the form of water bodies in proximity to the ROW.	Species not documented in August 2013 or Jul 2014 surveys. Greatest potential associated with the Grand River.
e	Special concern	N/A	Generally inhabit shallow waters where they can hide under the soft mud and leaf litter. Nesting sites usually occur on gravely or sandy areas along streams. Snapping Turtles often take advantage of man-made structures for nest sites, including roads (especially gravel shoulders), dams and aggregate pits (MNRF 2013b, MNRF 2014).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 2). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Record of species documented by MNRF in Winterbourne Riverine Wetland Complex and the Waterloo Rural East Wetland. NHIC/Biodiversity Explorer data includes a 1996 record for this species (Appendix G).	No targeted surveys conducted. Field survey completed in 2013 and 2014 included documentation of potential habitat from within road ROW, through ELC survey.	Potential overwintering habi in the form of dug ponds. Also, confirmed in Winterbourne Riverine Complex a Waterloo Rural Eas Wetland PSW.

Designation (COSSARO)	Legislation (MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
			species is known to occur in the area (Appendix I, June 2014).		
Endangered	Species Protection and Habitat Regulation	Generally inhabit fresh-water rivers and streams with sandy or gravely-sandy bottoms and prefers clear meandering watercourses with a moderate current. They nest on sand or gravel-sand beaches and banks. Although they prefer riparian areas with diverse, patchy cover, females also lay in gravel holes, at the edges of roads and railways, in utility ROWs, in farming fields, pastures and former fields – any sunny and easily dug spot (MNRF 2014).	'Historically known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	No targeted surveys conducted. Field survey completed in June and August 2013, and July 2014 for proposed watermain alignment as shown in Figure 1 included documentation of potential habitat in the form of water bodies in proximity to the ROW.	Species not documented in August 2013 or Jul 2014 surveys. Greatest potential associated with the river crossings.
Special concern	N/A	Exist primarily wherever milkweed and wildflowers exist; abandoned farmland, along roadsides, and other open spaces (MNRF 2013b, MNRF 2014).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Targeted insect surveys not completed. Vegetation survey completed in August 2013 and July 2014 for proposed watermain alignments as shown in Figures 5 to 8 to include documentation of where host plant for the species occurs (Milkweed).	Milkweed present within ROW. Spec may be encountere incidentally.
Endangered	Species and General Habitat Protection	Generally inhabits a range of diverse habitats including mixed farmland, sand dunes, marshes, urban and wooded areas. Usually nests underground in abandoned rodent burrows. Oak savannah is characterized by a moderately open tree canopy, well-drained sandy soils	'Formerly Occurred and May Still Occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Formerly Occurred and May Still Occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2).	Targeted insect surveys not completed. Vegetation survey completed in August 2013 and July 2014 for proposed watermain alignments as shown in Figures 5 to 8 to include	Host plants repres commonly occurri plants (e.g. (goldenrod, asters, dandelion, and milkweed) that we documented withi the ROW. In the p

Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
		(Lee et al. 1998). These habitat characteristics provide optimal nesting and foraging conditions for this species (MNRF 2013b, MNRF 2014).	area shown in Appendix B, to include the Study Area.	host plants for the species occur.	patched bumble be is only known to inhabit the followi areas within Ontar Pinery Provincial Park, the Humber River and High Par Toronto, Manestar Tract in Norfolk County, University Western Ontario Campus, Darlingto Provincial Park and Guelph (Colla, S.R. and A. Taylor-Pinda 2011). Burrows we not found in ROW during 2013 field investigation.
Special concern	N/A	Generally prefer moist, deciduous woodlands. The larvae feed only on the leaves of the two-leaved toothwort (*Cardamine diphylla*), which is a small, spring-blooming plant of the forest floor (MNRF 2013b, MNRF 2014).	'Historically Known to Occur; Suspected to Occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Formerly Occurred and May Still Occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2 Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Targeted insect surveys not completed. Vegetation survey completed in August 2013 and July 2014 for proposed watermain alignments as shown in Figures 5 to 8 to include documentation of where host plant for the species occur (*Cardamine diphylla*).	The preferred host plant, *Cardamine diphylla* was not identified in road ROW during ELC survey. Garlic mustard is identifie as leading cause of decline and extirpation of the species over much its range outside Ontario (Burke 201 Garlic mustard was identified in the FC and FOM communities withi the Project Area. Species may be encountered incidentally.

	Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
	Concern		clear streams of varying sizes. Adults spawn in gravelly riffles (MNRF 2014). Adults inhabit clean, clear riffles and runs of small rivers with gravel and sand substrates; ammocoetes occupy quiet water with sand, silt and detritus substrates (Ontario Freshwater Fisheries Database).	Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in records of 'provincially tracked species' obtained from Guelph District MNRF for Study Area (Appendix I, June 2014). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	have been conducted specific to this project. Aquatic habitat assessments of watercourses crossed by potential alignments were conducted in 2013 and 2014.	records obtained from MNRF (Appendix D). Clea riffle habitat is primarily associate with conditions observed at C6 (Canagagigue Cree
e	Threatened	Species and General Habitat Protection	Description from SARA website: Generally lives in moderately sized rivers and streams, with moderate to fast currents. Prefers pools and riffle areas, usually less than 2 m deep, over cobble, gravel, sand, boulders and silt. Spawning habitat described as areas within fast water (i.e. riffles), over fine gravel to cobble substrates. Summer and overwintering habitat in pools. It is rarely associated with aquatic vegetation, although vegetated areas could support juveniles (Bunt et al., 2013). Juveniles and Larvae have strong preference for run habitat and course substrates mixed with sand in low to moderate flows in Grand River. (Bunt et al. 2012. Intolerant of turbidity, siltation and pollution (Eakins 2013).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). NHIC/Biodiversity Explorer data includes a 1982 record for this species (Appendix G). Guelph District MNRF confirmed species is known to occur in the Grand River (Appendix I, June 2014).	No targeted fish surveys have been conducted specific to this project. Aquatic habitat assessments of watercourses crossed by potential alignments were conducted in 2013 and 2014.	Data collected by L Limited for anothe purpose document this species in the Grand River in 200
	Threatened	Species and General Habitat	Generally prefer moderate to large, deep, relatively clear streams with	'Known to occur' in the Township of Woolwich (MNRF 2013)	No targeted fish surveys have been conducted	Not included in fish records obtained

	Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
			riffle-pool sequences. Spawning likely to take place in deep riffles, runs and flowing pools of stream and rivers, occasionally over nests of other minnow species. Presence of species positively correlated with depth, in pools up to 200 cm deep. Shallow, slow flowing nearshore habitat may serve as refuge areas for juveniles and adults. Research suggests that there is a negative relationship between macrophyte density and site occupancy as well as avoidance to siltation (Eakins 2013).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). DFO mapping for species includes Grand River in this area. NHIC/Biodiversity Explorer data includes a 1989 record for this species (Appendix G). Guelph District MNRF confirmed species is known to occur in the Grand River (Appendix I, June 2014).	Aquatic habitat assessments of watercourses crossed by potential alignments were conducted in 2013 and 2014.	(Appendix D); however, DFO mapping indicates potential habitat in the Study Area.
el	Threatened	Species and General Habitat Protection	Most abundant in shallow, well-oxygenated reaches of small to medium sized rivers and sometimes lakes, on cobble, gravel, sand and occasionally mud substrates. Often found in moderate to strong currents, and along edges of emergent vegetation. Fish hosts for the Rainbow mussel could include the Striped Shiner, Smallmouth Bass, Largemouth Bass, Green Sunfish Greenside Darter, Rainbow Darter and Yellow Perch.	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). DFO mapping for species includes Grand River in this area. Not included in NHIC records for area shown in Appendix B, to include the Study Area. Guelph District MNRF confirmed species is known to occur in the Grand River (Appendix I, June 2014).	No targeted mussel presence/absence surveys were completed specific to this project. Aquatic habitat assessments of watercourses crossed by potential alignments were conducted in 2013 and 2014.	The Grand River provides habitat fo the species.
	Threatened	Species and General Habitat Protection	Generally inhabit clear rivers and streams of a variety of sizes, where the water flow is steady and the substrate is stable (MNRF 2013b, MNRF 2014). Found in or around riffles areas in gravel or sand, often stabilized by cobble or boulders. Wavy-rayed Lampmussels (WRLM) fish hosts are the Largemouth Bass	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). DFO mapping for species includes Grand River in this area. NHIC/Biodiversity Explorer data	No targeted mussel presence/absence surveys were completed specific to this project. Aquatic habitat assessments of watercourses crossed by potential alignments were conducted in 2013	The Grand River provides habitat fo the species.

Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
		of fish hosts is one of the key features for an area to support a healthy mussel population.	species (Appendix G). Guelph District MNRF confirmed species is known to occur in the Grand River (Appendix I, June 2014).		
Endangered	Species and General Habitat Protection	Found in deciduous forest communities; this tree prefers arid forests with acid and sandy soils (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Vegetation survey completed in August 2013 and July 2014 along proposed watermain alignments from road ROW, as shown in Figures 5 to 8.	Species not documented in August 2013 or Jul 2014 surveys withi road ROW.ROW
Endangered	Species and General Habitat Protection	Grows in rich, moist, undisturbed and relatively mature deciduous woods in areas of neutral soil (such as over limestone or marble bedrock) (MNRF 2013b, MNRF 2014).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Vegetation survey completed in August 2013 and July 2014 along proposed watermain alignments from road ROW, as shown in Figures 5 to 8.	Species not documented in August 2013 or Jul 2014 surveys withi road ROW.
Endangered	Species and General Habitat Protection	Generally grows in rich, moist, and well-drained soils often found along streams. It may also be found on well-drained gravel sites, especially those made up of limestone. It is also found, though seldom, on dry, rocky and sterile soils. In Ontario, the Butternut generally grows alone or in small groups in deciduous forests as well as in hedgerows (MNRF 2013b, MNRF 2014).	'Known to occur' in the Township of Woolwich (MNRF 2013) (Appendix I, Table 1). 'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Vegetation survey completed in August 2013 and July 2014 along proposed watermain alignments from road ROW, as shown in Figures 5 to 8. Survey included screening for Butternut (by MNRF certified Butternut Health Assessor).	Species not documented in August 2013 or Jul 2014 surveys withi road ROW.
Endangered	Species Protection and Habitat Regulation	Generally grows in deciduous and mixed forests, in the drier areas of its habitat, although it is occasionally found in slightly moist environments; Also grows around edges and	'Known to occur-Planted' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to	Vegetation survey completed in August 2013 and July 2014 along proposed watermain alignments	Species not documented in August 2013 or Jul 2014 surveys withi road ROW.

	Designation (COSSARO)	(MNRF 2013b & 2014)	Habitat Description	Background Information/Agency Liaison	How Addressed in Field Studies	Results/Habitat Potential
					shown in Figures 5 to 8.	
	Special Concern	N/A	Generally grows in damp deciduous forests and along streams (MNRF 2014).	'Known to occur' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Vegetation survey completed in August 2013 and July 2014 along proposed watermain alignments from road ROW, as shown in Figures 5 to 8.	Species not documented in August 2013 or Jul 2014 surveys withi road ROW.
ee-	Threatened	Species and General Habitat Protection	Generally inhabits open areas of floodplains and the edges of wetlands. Shade-intolerant MNRF 2014).	'Known to occur-Planted' in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Vegetation survey completed in August 2013 and July 2014 along proposed watermain alignments from road ROW, as shown in Figures 5 to 8.	Species not documented in August 2013 or Jul 2014 surveys withi road ROW.
s	Special Concern	N/A	Moist, barren soil, typically clay, often associated with forests MNRF 2014).	'Known to occur in North Dumfries" in the Region of Waterloo (MNRF 2014) (Appendix I, Table 2). Not included in NHIC records for area shown in Appendix B, to include the Study Area.	Vegetation survey completed in August 2013 and July 2014 along proposed watermain alignments from road ROW, as shown in Figures 5 to 8.	Species not documented in August 2013 or Jul 2014 surveys withi road ROW.

6.0 NATURAL HERITAGE CONSTRAINTS IN THE STUDY AREA

The desktop review has found the Study Area to contain agricultural, residential lands and natural features primarily related to watercourses and associated valleylands and wetlands. There are a total of 6 regulated watercourse crossings to include crossings of Canagagigue Creek, the Conestogo River and the Grand River, as well as 3 minor tributaries of the Grand River. Of these, the crossings of Canagagigue Creek and the Grand River represent significant valleyland. As well, Canagagigue Creek and the confluence of the Grand and Conestogo Rivers include woodlands associated with CEFs as identified in the ROP, with the potential to provide a linkage function for wildlife. The area of C6 also represents steep to overstep topography from Jigs Hollow Road down to the Grand River. Secondary source reviews reveal the potential for SAR where potential habitat exists. Aquatic SAR including fish and mussel species have been confirmed in the Grand River through agency consultation and bird SAR were observed by LGL Limited in proximity to the alternative alignments in 2014.

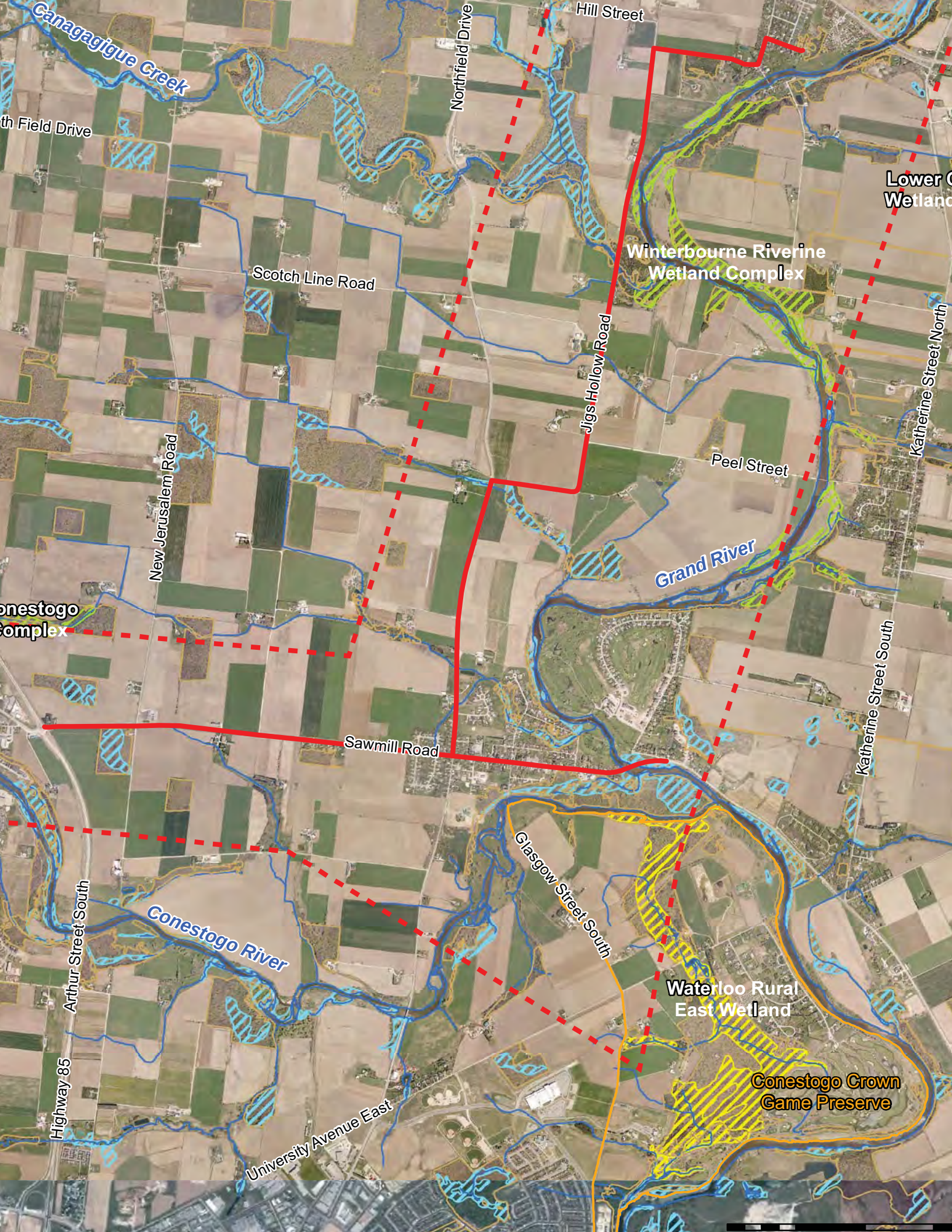
This report represents a natural heritage overview on which the assessment of water supply alternatives is based. Although the desktop review reveals a number of constraints within the overall landscape, the alternative watermain alignments are anticipated to be within right-of-ways of existing roads and no intrusion to existing natural heritage features are proposed, with the exception of watercourse crossings. Watercourse crossings represent habitat for fish and aquatic species at risk. To avoid impacts to aquatic SAR and associated habitat it is recommended that trenchless technology and associated best management practices, such as those outlined in DFO operational statements (e.g. high pressure directional drilling), be employed to cross these features. Opportunities for the use of trenchless technology would also include areas within the road ROW that coincide with overly steep topography, such as the area along Jigs Hollow Road in closest proximity to the Grand River. Mitigation measures are outlined to the degree possible at this stage of the planning in Section 8.0.

7.0 IMPACTS OF PREFERRED ALTERNATIVE SOLUTION

Impact assessments completed for three alternative solutions considered as part of the Class EA (CIMA 2015, Section 10) resulted in a preferred alternative as shown in Figure 9. Both direct and indirect impacts may occur as a result of project works associated with construction of the preferred alternative. In identifying impacts to the natural environment LGL Limited has assumed that construction activities will be restricted to road rights of way; and, that operational impacts will be avoided since the infrastructure will either be buried underground (watermain) or is of a type that will have a similar above ground size and location of footprint to its predecessor (pumps, reservoirs).

Direct impacts may include removal of vegetation and direct and indirect disturbance to fish and wildlife and their habitats as a result of construction activities. Communities most sensitive to disturbance would be those associated with the Grand River and Canagagigue Creek corridors where valleys are steep and vegetation occurs in the form of wetland and forest communities. Direct impacts are also possible to aquatic habitat associated with the Grand River and Canagagigue Creek, particularly in the areas where watermain installation is proposed to cross or lie in close proximity to the associated valleylands of these watercourses. There is potential for silt or sediment to enter the watercourses from adjacent construction activities, aquatic habitat disturbance from construction commotion and potential impacts associated with the removal of riparian vegetation, including bank destabilization. Although the majority of wildlife species observed to be utilizing habitat within the road right of way were limited mostly to common species, typical to the community types found on site, the majority of bird species observed are considered migratory and are regulated under the *Migratory Birds Convention Act* (MBCA). SAR are also documented both within aquatic and terrestrial habitats such that further consultation with MNRF may be required once the details of project works are identified and potential impacts to SAR are further assessed; particularly where bird SAR are breeding in proximity to alternative alignments (Barn Swallow, Chimney Swift, and Eastern Wood Pewee) and where crossings of aquatic SAR habitat are proposed.

Where impacts are unavoidable, efforts to reduce impacts through vegetation management plans, vegetation protection measures, silt/sediment controls to protect aquatic habitat and timing windows to avoid impacting wildlife or aquatic habitat and communities should be employed. In areas where urban trees or streetscape trees may be impacted, it is recommended that an Arborist review the potential tree-construction conflict areas to prescribe measures (protective fencing, pruning, etc.) to protect and retain trees where possible. Where feasible, works should occur within the existing road pavement or disturbed shoulder areas to minimize impacts to trees.


Canagagigue Creek
th Field Drive
Northfield Drive
Hill Street
Lower
Wetland
Winterbourne Riverine
Wetland Complex
Scotch Line Road
Jigs Hollow Road
Katherine Street North
New Jerusalem Road
Peel Street
Grand River
onestogo
Complex
Sawmill Road
Katherine Street South
Glasgow Street South
Conestogo River
Arthur Street South
Waterloo Rural
East Wetland
Conestogo Crown
Game Preserve
Highway 85
University Avenue East

8.0 MITIGATION & MONITORING

As works associated with construction of the preferred alternative are further determined, mitigation measures that are site-specific should be developed to protect both terrestrial and aquatic environments. As discussed in the previous section, identified impacts to the natural environment are associated with the construction phase of the project since infrastructure will either be buried underground (watermain) or is of a type that will have a similar above ground footprint and location to its predecessor (pumps, reservoirs). For this reason, the mitigation measures and monitoring recommendations that follow are focused on the construction phase.

The use of trenchless technology is identified below as a means of mitigating potential impacts to aquatic habitat, including that for SAR. However, because the method of construction for the installation of watermain piping across watercourses has not been confirmed at this time, reference to open trench construction and associated mitigation has also been included. Open trench construction of watercourse crossings can further be separated into work performed 'in the wet' or 'in the dry' (work area is isolated from the river flow), each of which is associated with specific mitigation. A range of mitigation measures have been provided below to indicate that although trenchless technology is the preferred method of watermain installation across sensitive watercourses, open trench methods have not been ruled out at this time.

Once construction methodologies are confirmed for the crossings of watercourses, further consultation with DFO will be necessary to review the project activity to determine if an Authorization under the Fisheries Act is required. Similarly, further consultation with MNRF to ensure compliance with the *Endangered Species Act, 2007* will be necessary at the detailed design stage. Much of this determination will depend upon the method of construction used for watercourse crossings (i.e. trenchless vs. open trench).

8.1 CONSTRUCTION MITIGATION

Where feasible, avoidance of natural heritage features would provide the least impact. Where this is not possible, the following protective mitigation measures and timing windows should be employed at a minimum.

General mitigation measures for vegetation and wildlife include the following:

- Develop and implement an Erosion and Sediment Control Plan to include monitoring in order to mitigate impacts of construction to adjacent vegetation communities and watercourses;

- Prior to the commencement of construction, all appropriate erosion and sediment control measures (such as silt fencing) should be installed and maintained (with regular inspection) during construction and until the site has been stabilized;
- Avoid construction during sensitive periods for birds (breeding) and fish (spawning) where habitat for these important life stages is identified:
    - Any vegetation removal (including dead standing trees) may be influenced by conditions set by the *Migratory Birds Convention Act* (MBCA) including, but not limited to, timing restrictions during breeding season for tree pruning or removal during construction activities. The breeding bird season typically extends from March 25 to August 31. In order to maintain compliance with the MBCA, any construction activity planned during the breeding season (as a result of start-up or a prolonged construction window) should only be completed after consultation with a qualified avian biologist to ensure no impacts to breeding birds; and,
    - Adhere to construction timing windows to avoid impacts to fish where works are proposed within fish habitat. Warmwater timing window typically extends from July 1 to March 31. A Department of Fisheries and Oceans (DFO) screening may be required for proposed construction within the regulated flood lines as the Conservation Authorities no longer have an agreement to screen projects on behalf of the DFO.
- Utilize trenchless technology for installation of piping across watercourses and sensitive wetland communities to the extent possible to avoid impacts to aquatic species, including fish and mussel SAR. Where this is not possible further consultation with MNRF would be required regarding impacts to SAR fish and mussel habitat that occurs in the Grand River and Canagagigue Creek;
- Should open trench construction be identified for the installation of piping across watercourses, a series of mitigation measures will be required to avoid impacts to aquatic habitat depending on whether work is planned to occur ‘in the wet’ or ‘in the dry’. Mitigation measures such as the following would apply in these cases:
    - Timing in-water work to respect timing windows to protect fish, including their eggs, juveniles, spawning adults and/or organisms used as food sources;
    - Designing and planning activities and works in the watercourse so that loss or disturbance to aquatic habitat is minimized and sensitive habitat is avoided;
    - Ensuring all in-water activities and associated structures do not interfere with fish passage, constrict the channel, or reduce flow;

  - Relocating fish and mussel SAR and restoring SAR habitat (to be determined in consultation with MNRF and in accordance with the Endangered Species Act);
  - Avoiding use of explosives in or near water; and,
  - Operating machinery on land above the high water mark or from a floating barge in a manner to minimize disturbance to the banks and bed of the watercourse whenever possible.

- Refuelling of equipment and fuel storage must be conducted at a safe distance from the watercourses at a designated location, along with spill protection;
- Complete hydrogeological and geotechnical assessments, to ensure no temporary or permanent impacts to adjacent surface water features through the construction methods proposed;
- Minimize the construction footprint within proximity to the riparian area of watercourses;
- Restore areas with native, non-invasive plant species upon completion to achieve a character similar to the surrounding vegetation communities;
- Seed area with native seed mix for the appropriate conditions on all disturbed areas to stabilize the area prior to re-vegetation;
- Apply appropriate setbacks to Grand River and Canagagigue Creek, and associated wetlands and wooded areas, in order to maintain the character and quality of the natural areas providing habitat;
- Clearly demarcate setbacks from natural features and edge of disturbance limits with the installation of protective fencing to protect remaining natural vegetation communities, associated wildlife habitat, and to exclude wildlife from the disturbance area; and,
- Limit the disturbance of floodplain vegetation where possible, to avoid disturbance to the riparian areas, and prevent soil compaction.

8.2 ADDITIONAL MITIGATION

It is assumed that any other infrastructure works such as decommissioning or installation of water supply components will be within existing cleared areas or within the reservoir footprint. The extent of works has not been determined in detail and is expected to be done during detailed design. Mitigation for other infrastructure works generally consist of the following:

- Fencing will help to isolate construction area, and help to deter wildlife from entering the work zone;
- Nest search completed prior to removal of any building components, to ensure SAR birds not using structures;
- Refueling of equipment and fuel storage will be conducted at a safe distance from the watercourses at a designated location, along with the implementation of spill protection; and,
- Tree removal and or pruning is recommended to be completed by a qualified arborist or tree professional, within the appropriate timing window, for protection of breeding birds as regulated by the Migratory Birds Convention Act, 1994.

8.3 ENVIRONMENTAL MONITORING

As the project location includes the construction of linear infrastructure across watercourses that provide habitat for fish and aquatic SAR, it is recommended that an independent Environmental Monitor be retained to provide support during the construction and restoration phases that occur in proximity to these features. The Environmental Monitor would:

- Ensure compliance with monitoring requirements in the approvals and permits;
- Complete inspections prior to the start, during and post-construction to document site conditions, ensure that erosion and sediment control plan is initiated and maintained and that natural heritage features/functions are stabilized and rehabilitated;
- Provide timely and effective advice in regards to the environment management of the site; and,
- Provide support and advice in the event of any animal-construction conflicts.

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APPENDIX A
TERMS OF REFERENCE

LGL LIMITED
environmental research associates

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Cambridge, Ontario CANADA N1T 2K7
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: cambridge@lgl.com : www.lgl.com

Head Office 22 Fisher St., P.O. Box 280, King City, ON CANADA L7B 1A6 905-833-1244 905-833-1255 kingcity@lgl.com www.lgl.com

MEMORANDUM

TO: **Andrew Herreman, GRCA**
Lorraine Norminton, MNR Guelph District

FROM: **Lynette Renzetti, LGL**

CC: **Sandra Rodriguez ,CIMA+**
Eric Tuson, CIMA+
Dominika Celmer-Repin, Region of Waterloo
Arnel Fausto, LGL

DATE: **August 20, 2013**

RE: **Terms of Reference**
Conestogo Plains Water Supply EA
Natural Heritage Field Studies

Introduction

The West Montrose Water Supply Class Environmental Assessment (AECOM, 2013) identified a watermain connection between the villages of Conestogo and West Montrose as part of the preferred alternative for extending municipal water services into the area. Subsequent to the West Montrose EA it was determined that the Region would assess water demand and supply over a broader geographical area to include delivery to West Montrose and possible connectivity to the City of Waterloo in the form of the Conestogo Plains Water Supply Class EA. Although a connection to the City of Waterloo water supply has been identified as a possible inclusion of the preferred alternative, at this time the details regarding the feasibility or potential location of such a connection are unknown. The Region has determined that the watermain connection between Conestogo and West Montrose (as shown in Figure 1) would be necessary regardless of whether or not a connection to the City of Waterloo is determined as part of the preferred alternative through the EA process. The watermain alignment between the villages of Conestogo and West Montrose is the subject of this memo (**Figure 1**).

The following provides a Terms of Reference for field investigations associated with the proposed watermain connection of Conestogo and West Montrose as part of the Conestogo Pains Water Supply EA. The scope of work provided herein is based on the assumption that the crossing of water features in the form of tributaries and associated riparian wetlands will be achieved using trenchless technology and that works will be conducted within existing road right of ways to minimize impacts.

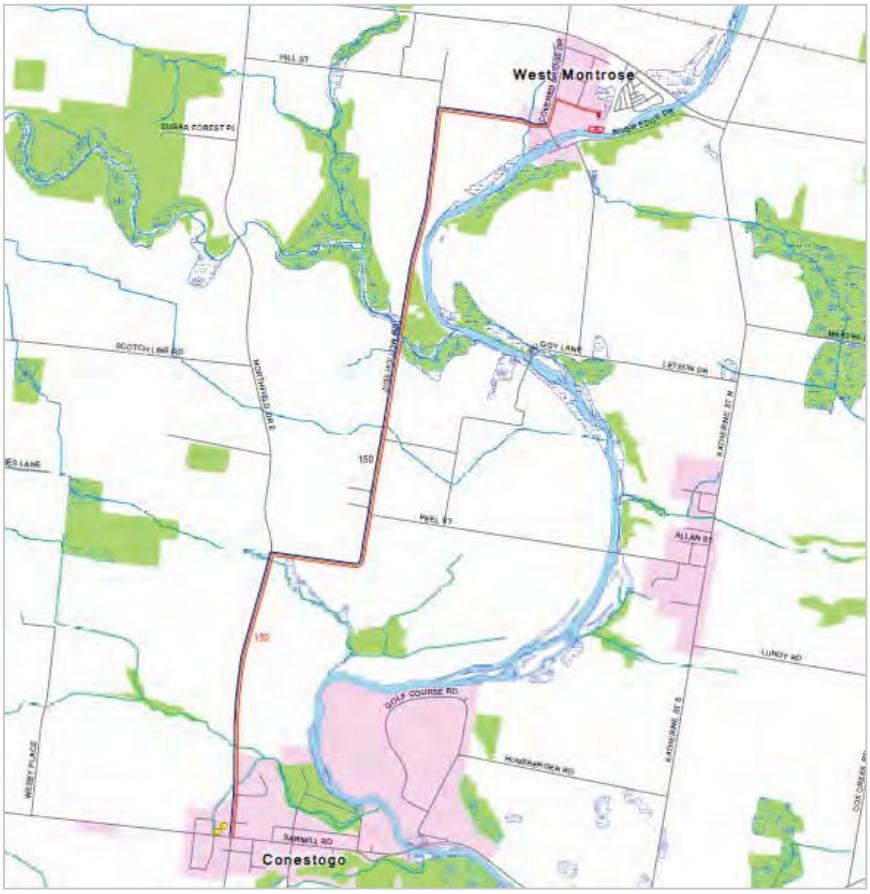

Figure 1: Preferred Alignment of the Watermain Identified (in red/blue)

The Study Area

The proposed watermain route is located west of the Grand River corridor as it flows through the communities of West Montrose and Conestogo and is largely comprised of agricultural lands with remnant woodlands, watercourses and wetlands (**Figure 2**). The study area is defined as the area that includes the alignment of the watermain and the area within the road right of way.

Initial background information obtained from the MNR Guelph District Office and the GRCA indicates that no Life Science or Earth Science ANSI's are located along the alignment. Records also indicate that four watercourse crossings and associated wetland complexes are within the study area, to include the non-provincially significant Winterbourne Riverine Complex.

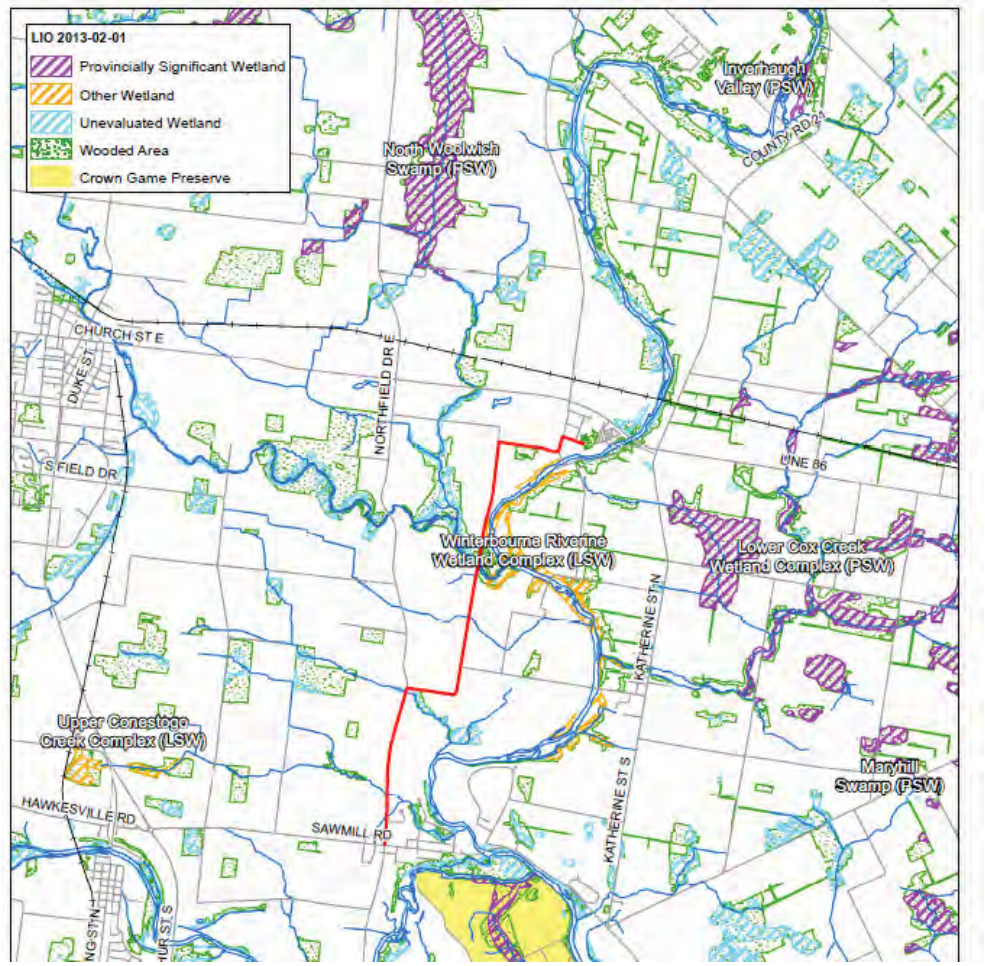

Figure 2. Summary of Natural Heritage information obtained through LIO.

Work Plan Approach

A field investigation will be performed along the water supply route to inventory aquatic habitat and communities, vegetation and vegetation communities, and wildlife and wildlife habitat and delineate the limits of these communities. The investigation will follow provincially recognized protocols such as the Ecological Land Classification for Southern Ontario (Lee *et al.* 1998), the Ontario Wetland Evaluation System (MNR 1993), and the Significant Wildlife Habitat Technical Guide (MNR 2000). The sensitivity/significance of natural heritage features identified within the study area will be determined in relation to provincial, regional and local municipal policies and through consultation with appropriate agencies. A preliminary screening for the Woolwich Township listing of Species at Risk (SAR) based on potential habitat will be conducted in consultation with Guelph District MNR. LGL does not propose any detailed surveys for SAR at this time.

Detailed Work Plan

The following table describes the surveys planned for the project. No access to property has been obtained; therefore all surveys will be conducted from within the road right of way.

Ecological Component	Sample Method/Protocol	Timing
Vegetation	• pedestrian survey using a plotless method • vegetation communities classification according to Ecological Land Classification for Southern Ontario identification of general tree constraints along road right of way	August/September
Fish habitat	• fish habitat will be mapped according to the Ontario Stream Assessment Protocol (OMNR 2007) • no new fish collections are proposed as there is background data available for the area and no in water works are proposed for the project. • seeps/springs survey within the valley	August
Reptiles and amphibians	• pedestrian survey /incidental observations	August
Birds	• incidental observations • potential habitat use, habitat delineation • documentation of stick nests, snags and cavity trees along road right of way	August/September
Mammals	• incidental observations (tracks, scents, scat, dens or other signs)	August/Sept, in conjunction with other field investigations
Wildlife habitat	• Significant Wildlife Habitat Technical Guide (MNR 2000)	August/Sept, in conjunction with other field investigations

The purpose of this Memo is to present the workplan for the natural environment scope of work planned along the alignment of the watermain connection between Conestogo and West Montrose as part of the Conestogo Plains Water Supply Schedule B Class EA for agency review and comment regarding the level of scope, timing, and protocols planned for the natural sciences investigation.

Sincerely,

Lynette Renzetti, B.Sc.
Planning Ecologist

LGL Limited
environmental research associates
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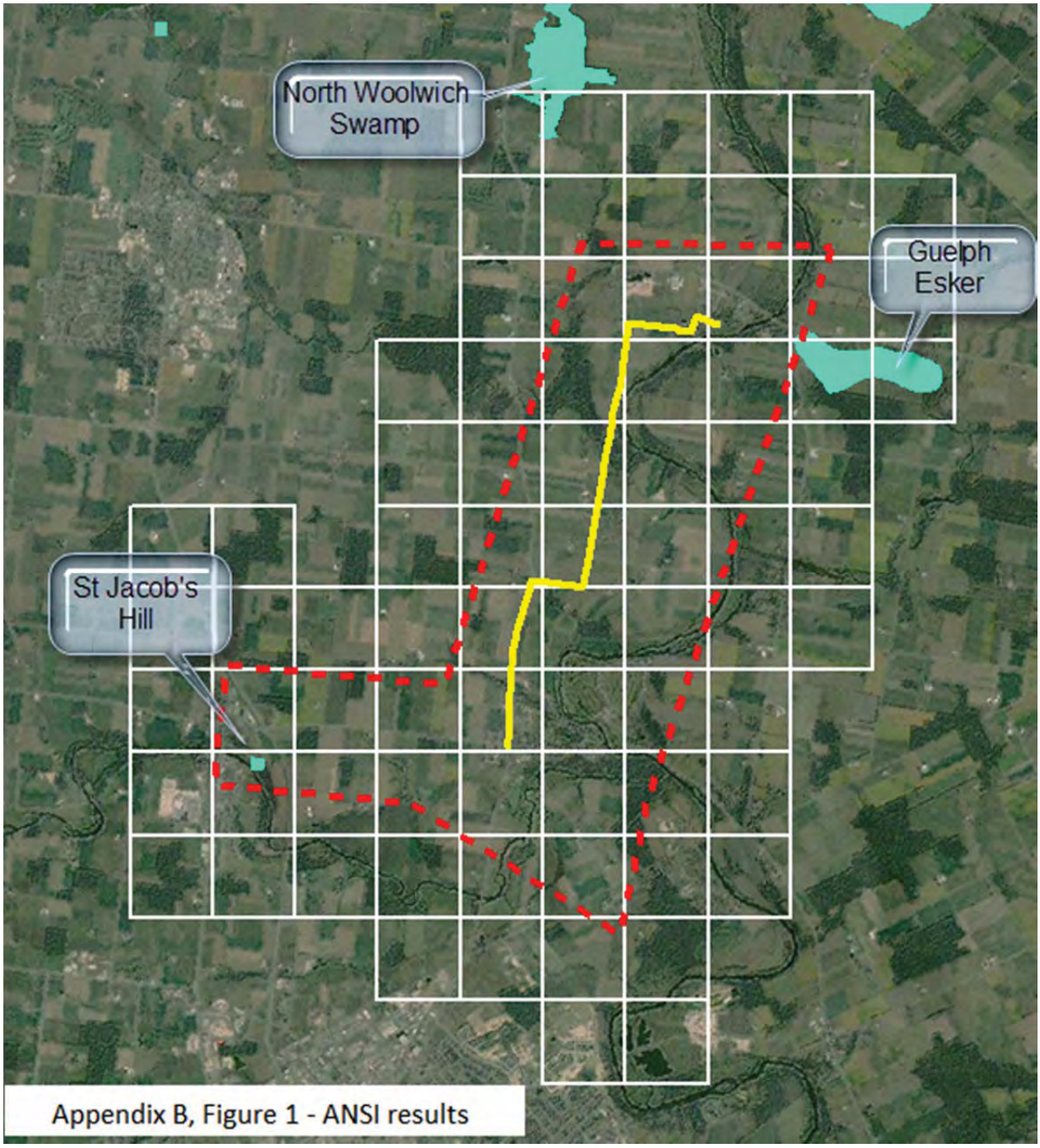
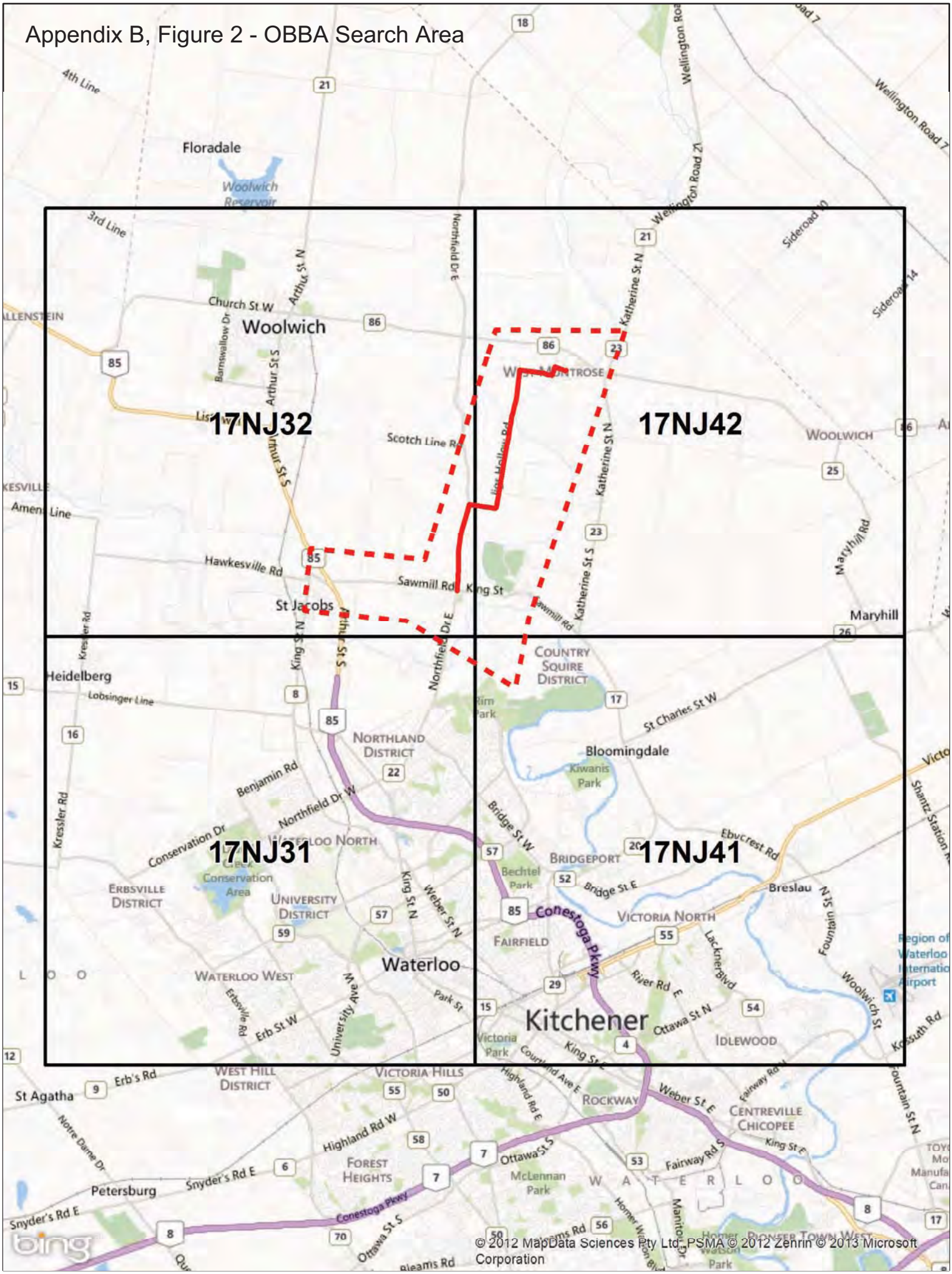
APPENDIX B
BACKGROUND DATA



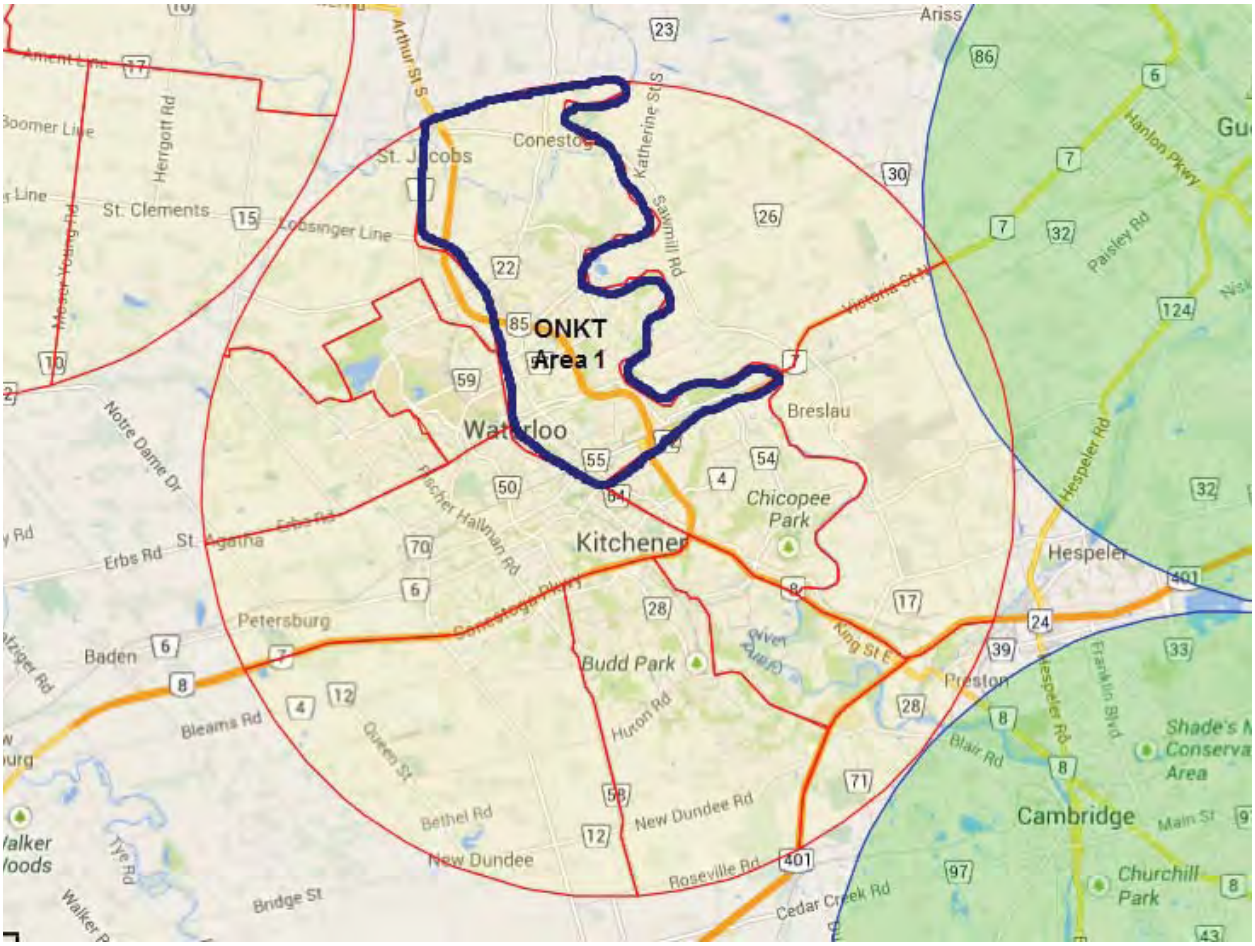
Appendix B, Figure 1 - ANSI results

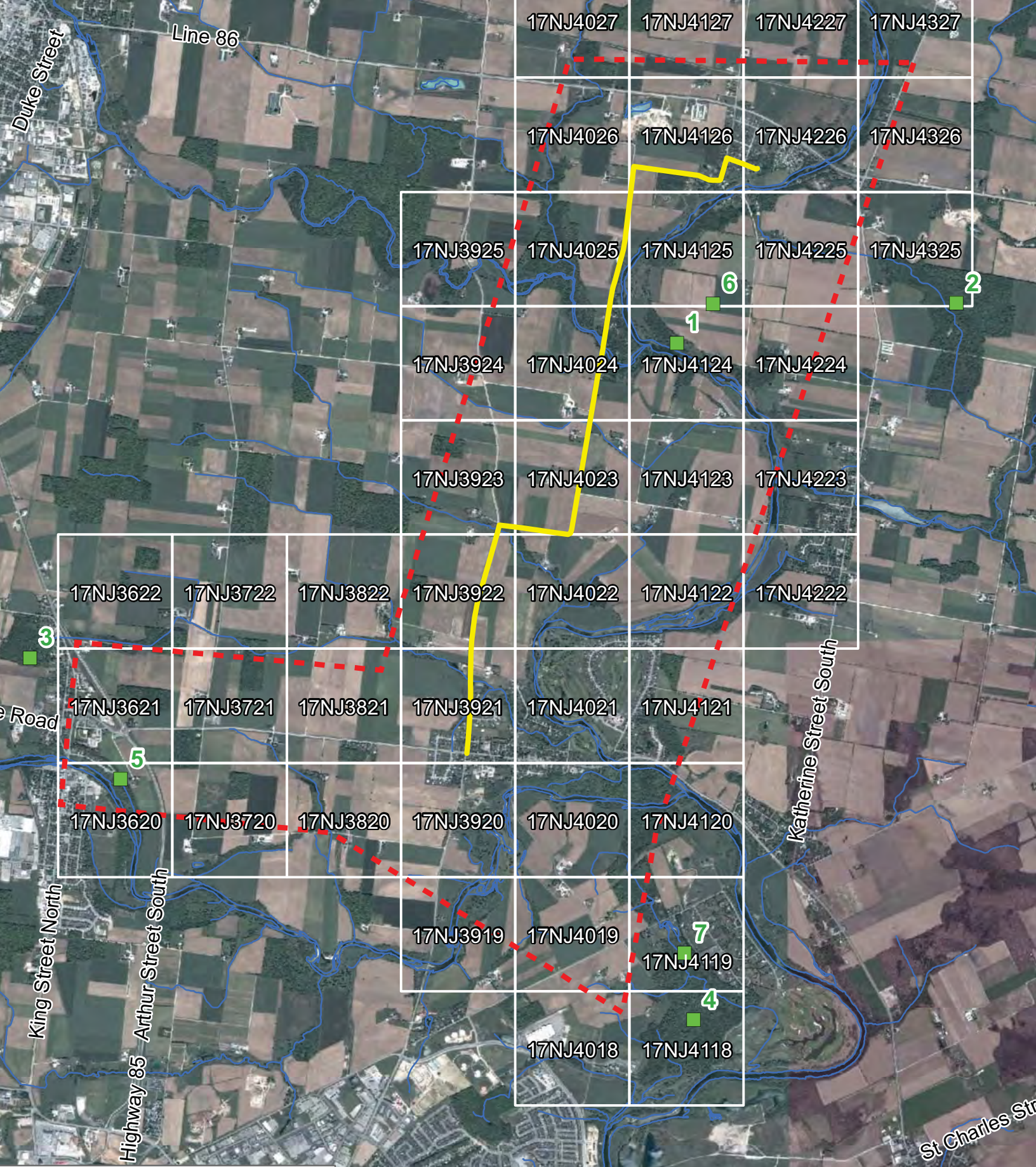
Appendix B, Figure 2 - OBBA Search Area



Appendix B, Figure 3: Area coverage of ONKT Area 1 as defined by the Kitchener-Waterloo Field Naturalists and viewed at:

https://maps.google.com/maps/ms?ie=UTF8&hl=en&msa=0&msid=214970151258015239036.00047ad9407de14b9b2e7&z=10





Areas:

erbourne Riverine Wetland Complex
er Cox Wetland Complex
er Conestogo Creek Complex
erloo Rural East Wetland
acobs Hill
el Creek Conservation Area

APPENDIX C
WILDLIFE DATA

Name	KW Field Naturalists (2013)	OBBA (2008) 17NJ32 and 17NJ42	OBBA (2008) 17NJ31 and 17NJ41	Waterloo Rural East Wetland Evaluati (MNR 1999)	Winterbourne Riverine Wetland Evaluation (MNR 2004/2007)	FOM2-2	FOM4	MAM2-2	MAM2-10	MAS2-1	SWC1	CUP2-1	CUP3-8	CUM1-1	CUW1	AGR	Dug Pond	Artificial Channel	Roadside/ Residential	FOD4	FOD5	MAM2-2	MAM2-5	MAM2-10	MAS2-1	SWD3	CUS1	CUM1-1	AGR/ROW	G-Rank	S-Rank	COSEWIC	SARA	SARO	FWCA
Bobolink	X	X												X															X	G5	S5				P
Bobolink - Dickcissel		X																X												G5	S5	NAR			
Bobolink - Eastern Meadowlark		X																												G5	S2S3B	END		END	
Bobolink - Grasshopper Sparrow		X																												G5	S5B				
Bobolink - Savannah Sparrow		X																												G4	S4B				
Bobolink - Upland Sandpiper	X	X																												G5	S4				
Boreal Chorus Frog			X																											G5	S4B	NAR			
Bullfrog											X									X										G5	S5B				
Bullfrog - Green Frog										X		X		X		X	X	X	X		X				X					G5	S5B				
Bullfrog - Northern Leopard Frog																														G5	S4				
Bullfrog - Wood Frog																														G5	S5B				
Cliff Swallow																														G5	S4B				
Cliff Swallow - Eastern Kingbird																														G5	S4B				
Cliff Swallow - Eastern Phoebe																														G5	S4B				
Cliff Swallow - Great Crested Flycatcher																														G5	S5B				
Cliff Swallow - Northern Rough-winged Swallow																														G4	S4B				
Cliff Swallow - Tree Swallow																														G5	S4				
Common Nighthawk																														G5	S4B	NAR			
Common Nighthawk - Eastern Whip-poor-will																														G5	S5B	THR			
Common Nighthawk - Whip-poor-will																														G5	S4B	THR			
Eastern Meadowlark																														G5	S5				
Eastern Meadowlark - Eastern Towhee																														G5	S4B				
Eastern Meadowlark - Field Sparrow																														G5	S5B				
Eastern Meadowlark - Song Sparrow																														G5	S5B				
Eastern Meadowlark - Willow Flycatcher																														G5	S5				
Eastern Meadowlark - Yellow Warbler																														G5	S3B,S3N				
Eastern Meadowlark - Yellow-breasted Chat																														G5	S5B				
Eastern Meadowlark - Yellow-throated Vireo																														G5	S5B				

Name	KW Field Naturalists (2013)	OBBA (2008) 17NJ32 and 17NJ42	OBBA (2008) 17NJ31 and 17NJ41	Waterloo Rural East Wetland Evaluati (MNR 1999)	Winterbourne Riverine Wetland Evaluation (MNR 2004/2007)	FOM2-2	FOM4	MAM2-2	MAM2-10	MAS2-1	SWC1	CUP2-1	CUP3-8	CUM1-1	CUW1	AGR	Dug Pond	Artificial Channel	Roadside/ Residential	FOD4	FOD5	MAM2-2	MAM2-5	MAM2-10	MAS2-1	SWD3	CUS1	CUM1-1	AGR/ROW	G-Rank	S-Rank	COSEWIC	SARA	SARO	FWCA
Bobolink		X																												G5	S4B		THR		
Bobolink		X																												G5	S4B		THR		
Bobolink		X																												G5	S4B		THR		
Bobolink		X																												G5	S4B		THR		
Bobolink		X		X																										G5	S5B		THR		
Bobolink		X																												G5	S4

Name	KW Field Naturalists (2013)	OBBA (2008) 17NJ32 and 17NJ42	OBBA (2008) 17NJ31 and 17NJ41	Waterloo Rural East Wetland Evaluati (MNR 1999)	Winterbourne Riverine Wetland Evaluation (MNR 2004/2007)	FOM2-2	FOM4	MAM2-2	MAM2-10	MAS2-1	SWC1	CUP2-1	CUP3-8	CUM1-1	CUW1	AGR	Dug Pond	Artificial Channel	Roadside/ Residential	FOD4	FOD5	MAM2-2	MAM2-5	MAM2-10	MAS2-1	SWD3	CUS1	CUM1-1	AGR/ROW	G-Rank	S-Rank	COSEWIC	SARA	SARO	FWCA
Barn Swallow	X	X													X															G5	S5				
Bobolink		X																												G5	S5B	NAR			
Brown Thrasher		X																												G5	S4B	THR		THR	
Canada Goose		X																												G5	S5B				P
Common Grackle		X	X																											G5	S4B	THR			
Common Yellowthroat	X	X																												G5	S5B			SC	
Eastern Kingbird		X																												G5	SNA				
Eastern Meadowlark		X																												G5	S4B				
Eastern Phoebe		X																												G5	S5B				
Field Sparrow		X																												G5	S4B	NAR			
Green Heron		X																												G5	S4B				
House Wren		X																												G5	S5B				
Killdeer		X																												G5	S4B				
Mallard		X																												G5	S5				
Northern Cardinal		X																												G5	S3B	NAR			
Northern Flicker		X																												G5	S5B				
Red-winged Blackbird		X																												G5	SNA				
Song Sparrow		X																												G5	S5B				
Spotted Sandpiper		X																												G5	S4B				
Tree Swallow		X																												G5	S5B,S5N				

Name	KW Field Naturalists (2013)	OBBA (2008) 17NJ32 and 17NJ42	OBBA (2008) 17NJ31 and 17NJ41	Waterloo Rural East Wetland Evaluati (MNR 1999)	Winterbourne Riverine Wetland Evaluation (MNR 2004/2007)	FOM2-2	FOM4	MAM2-2	MAM2-10	MAS2-1	SWC1	CUP2-1	CUP3-8	CUM1-1	CUW1	AGR	Dug Pond	Artificial Channel	Roadside/ Residential	FOD4	FOD5	MAM2-2	MAM2-5	MAM2-10	MAS2-1	SWD3	CUS1	CUM1-1	AGR/ROW	G-Rank	S-Rank	COSEWIC	SARA	SARO	FWCA
Belted Kingfisher		X																												G5	S4B				
Black-billed Cuckoo	X																													G5	S5				
Blue Jay		X	X				X			X																				G5	S4B				
Brown Thrasher		X																												G5	S5				
Canada Goose		X																												G5	S4B				
Chimney Swift		X																												G5	S4B				
Common Grackle		X																												G5	S4B				
Common Loon		X																												G5	S4B				
Common Merganser		X																												G5	S4B				
Common Nighthawk		X																												G5	S4B				
Common Tern		X																												G5	S4B				
Double-crested Cormorant		X																												G5	S4B				
Eastern Kingbird		X																												G5	S4B				
Eastern Phoebe		X																												G5	S4B				
Eastern Wood-Pewee		X																												G5	S4B				
Great Blue Heron		X																												G5	S4B				
Great Crested Flycatcher		X																												G5	S4B				
Great Egret		X																												G5	S4B				
Green Heron		X																												G5	S4B				
Herring Gull		X																												G5	S4B				
Killdeer		X																												G5	S4B				
Least Flycatcher		X																												G5	S4B				
Mallard		X																												G5	S4				
Northern Flicker		X																												G5	S5				
Osprey		X																												G5	S5B				
Ovenbird		X																												G5	S4B				
Red-eyed Vireo		X																												G5	S5B				
Red-tailed Hawk		X																												G5	S4B				
Red-winged Blackbird		X																												G5	S4B				
Ring-billed Gull		X																												G5	S4B				
Rose-breasted Grosbeak		X																												G5	S4B				
Ruby-throated Hummingbird		X																												G5	S4B				
Song Sparrow		X																												G5	S4B				
Spotted Sandpiper		X																												G5	S4B				
Tree Swallow		X																												G5	S4B				
Turkey Vulture		X																												G5	S4B				
Veery		X																												G5	S4B				
Warbling Vireo		X																												G5	S4B				
Wood Duck		X																												G5	S4B				
Yellow Warbler		X																												G5	S4B				

Name	KW Field Naturalists (2013)	OBBA (2008) 17NJ32 and 17NJ42	OBBA (2008) 17NJ31 and 17NJ41	Waterloo Rural East Wetland Evaluati (MNR 1999)	Winterbourne Riverine Wetland Evaluation (MNR 2004/2007)	FOM2-2	FOM4	MAM2-2	MAM2-10	MAS2-1	SWC1	CUP2-1	CUP3-8	CUM1-1	CUW1	AGR	Dug Pond	Artificial Channel	Roadside/ Residential	FOD4	FOD5	MAM2-2	MAM2-5	MAM2-10	MAS2-1	SWD3	CUS1	CUM1-1	AGR/ROW	G-Rank	S-Rank	COSEWIC	SARA	SARO	FWCA
Bobolink		X																												G5	S4B				P
Bobolink	X		X																											G5	S5	NAR			P
Bobolink		X																												G5	S5B,S4N				
Bobolink	X	X																												G5	SNA				G
Bobolink		X																												G5	SNA				
Bobolink		X																												G5	S4B				
Bobolink	X																													G5	S1B,S4N	NAR		NAR	P
Bobolink		X		X										X																G5	S5B				
Bobolink																														G5	S4				G
Bobolink		X																											X	G5	S4B				
Bobolink		X		X																										G5	S4B				
Bobolink		X	X																											G5	S4B	NAR			
Bobolink	X	X																												G5	S5	NAR			P
Bobolink	X	X																												G5	SNA				
Bobolink																	X	X											X	G5	S5B				
Bobolink		X																												G5	S4B				
Bobolink		X																												G5	S5				
Bobolink		X																												G5	S5B				
Bobolink		X																												G5	S4B				
Bobolink		X																											X	G5	S4B				
Bobolink		X																												G5	S4B				
Bobolink		X																												G5	S5B				
Bobolink		X																												G5	S5B				
Bobolink		X																												G5	S4B	THR	THR	THR	

Name	KW Field Naturalists (2013)	OBBA (2008) 17NJ32 and 17NJ42	OBBA (2008) 17NJ31 and 17NJ41	Waterloo Rural East Wetland Evaluation (MNR 1999)	Winterbourne Riverine Wetland Evaluation (MNR 2004/2007)	FOM2-2	FOM4	MAM2-2	MAM2-10	MAS2-1	SWC1	CUP2-1	CUP3-8	CUM1-1	CUW1	AGR	Dug Pond	Artificial Channel	Roadside/ Residential	FOD4	FOD5	MAM2-2	MAM2-5	MAM2-10	MAS2-1	SWD3	CUS1	CUM1-1	AGR/ROW	G-Rank	S-Rank	COSEWIC	SARA	SARO	FWCA
sted	X	X																												G5	S5				
ated		X																												G5	S5B				
y	X	X																											X	G5	S5				G
		X																												G5	S5B				
en		X		X																										G5	S5B				
k		X																												G5	S5				
sh		X																												G5	S4B	THR		SC	
rbler		X																										X		G5	S5B				
ied			X												X															G5	S5B				
ied		X																												G5	S5B				
ed			X																											G5	S4B				
ped			X																											G5	S5B				
				X	X																	X								G5	S5				F
ay											X																			G5	S5				G
Mink				X	X																								X	G5	S4				F
				X	X																									G5	S5				F
				X	X																	X								G5	S5				F
d				X																										G5	S5				G
				X																										G5	S5				F
				X																										G5	S5				F
				X																										G5	S5				
nk				X																										G5	S5				F
urtle				X	X																									G5	S3	SC	SC	SC	G

nsensus of the network of Conservation Data Centres (CDCs), scientific experts and The Nature Conservancy to designate a rarity rank based on the range-wide status of species, s
monstrably secure under present conditions

in the political boundaries of Ontario.
imperilled in the nation or state/province because of extreme rarity
nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer)
nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines
n but not rare; some cause for long-term concern due to declines or other factors
d and abundant in the nation or state/province
not yet assigned
; SZN-non-breeding migrants/vagrants
Endangered Wildlife in Canada
es that has been evaluated and found to be not at risk of extinction given the current circumstances
es likely to become endangered if limiting factors are not reversed
ies facing imminent extirpation or extinction
ger existing in the wild in Canada but occurring elsewhere
ecies that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats
cies for which there is in adequate information to make a direct, or indirect, assessment of its risk of extinction

e species at risk
es likely to become endangered if limiting factors are not reversed
ies facing imminent extirpation or extinction
ger existing in the wild in Canada but occurring elsewhere
ecies that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats

change (as per EBR Registry 012-1553, posted April 11, 2014)
ng imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's ESA
o longer exists in the wild in Ontario but exists elsewhere
is at risk of becoming endangered in Ontario if limiting factors are not reversed
th characteristics that make it sensitive to human activities or natural events
ct, 1997
species, F – furbearing species
1994

iorities (CP) within the jurisdiction of the Grand River Conservation Authority
equirements and considered 'area sensitive' as a result (Ontario Ministry of Natural Resources (OMNR). 2000. Significant Wildlife Habitat Technical Guide. Queen's Printer for C
equires interior habitat
s considered a conservation priority and regionally significant
sidered by Bird Studies Canada to be conservation priorities for Waterloo area as viewed at: http://www.bsc-eoc.org/conservation/conservmain.html

APPENDIX D
FISHERIES DATA

Appendix D, Table 1: Summary of Fish Species Documented for Canagagigue Creek and the Grand River, 1976-2012

Common Name	Scientific Name	S RANK	Status		Watercourse		
			COSEWIC	SARO	Canagagigue Creek	Grand River	Conestogo River
Blacknose Shiner	*Notropis heterolepis*	S5			X[4]		
Black Redhorse	*Moxostoma duquesnei*	S2	THR/ No Status	THR		X[6]	
Blackside Darter	*Percina maculata*	S4				X[6]	
Bluntnose Minnow	*Pimephales notatus*	S5	NAR	NAR	X[2,3,4]	X[1]	
Brassy Minnow	*Hybognathus hankinsoni*	S5			X[3,4]		
Brook Stickleback	*Culaea inconstans*	S5			X[2,3,4]	X[1]	X[7]
Brown Bullhead	*Ameiurus nebulosus*	S5			X[2,3]	X[5,6]	X[7]
Central Mudminnow	*Umbra limi*	S5					X[7]
Common Carp	*Cyprinus carpio*	SE			X[2,3,4]		
Common Shiner	*Luxilus cornutus*	S5			X[2,3,4]	X[1,5,6]	X[7]
Creek Chub	*Semotilus atromaculatus*	S5			X[2,3,4]	X[1]	
Emerald Shiner	*Notropis atherinoides*	S5			X[2]		
Fantail Darter	*Etheostoma flabellare*	S4			X[3,4]	X[1,6]	
Fathead Minnow	*Pimephales promelas*	S5			X[3,4]		
Golden Shiner	*Notemigonus crysoleucas*	S5			X[3,4]		
Greater Redhorse	*Moxostoma valenciennesi*	S3				X[6]	
Greenside Darter	*Etheostoma blennioides*	S4				X[6]	
Hornyhead Chub	*Nocomis biguttatas*	S4	NAR		X[2,3,4]	X[1,5,6]	
Johnny Darter	*Etheostoma nigrum*	S5			X[2]	X[1,6]	
Least Darter	*Etheostoma microperca*	S4	NAR		X[3,4]		
Largemouth Bass	*Micropterus salmoides*	S5				X[6]	
Longnose Dace	*Rhinichthys cataractae*	S5			X[2,3,4]	X[6]	
Mottled Sculpin	*Cottus bairdii*	S5			X[4]		

Common Name	Scientific Name	S RANK	Status		Watercourse		
			COSEWIC	SARO	Canagagigue Creek	Grand River	Conestogo River
Northern Hog Sucker	*Hypentelium nigricans*	S4				X[1,5,6]	
Northern Pike	*Esox Lucius*	S5			X[2]	X[1,5]	
Pumpkinseed	*Lepomis gibbosus*	S5				X[6]	X[7]
Rainbow Darter	*Etheostoma caeruleum*	S4			X[2,3,4]	X[1,6]	
Redhorse Sucker	*Moxostoma spp.*				X[2]	X[5]	
River Chub	*Nocomis micropogon*	S4	NAR	NAR	X[4]	X[1]	
Rock Bass	*Ambloplites rupestris*	S5			X[2,3,4]	X[1,5,6]	X[7]
Smallmouth Bass	*Micropterus dolomieu*	S5			X[2]	X[1,6]	X[7]
Stonecat	*Noturus flavus*	S4			X[3]	X[1,6]	
Western Blacknose	*Rhinichthys obtusus*	SNR			X[3,4]		
White Sucker	*Catostomus commersoni*	S5			X[2,3,4]	X[1,5,6]	
Yellow Perch	*Perca flavescens*	S5			X[2]		

[1]Coleman, J. 1991. Assessment of Fish and Fish Habitat Associated with Urban and Agricultural Areas in the Grand River. 1989 Data from stations in Grand River, upstream of Canagagigue Creek (Stations RV4, R4 and RV5).

[2]Carey, L.H., Fox, M.E., Brownlee, B.G., Metcalfe, J.L., Mason, P.D. and W.H. Yerex. 1983. The Fate and Effects of Contaminants in Canagagigue Creek. National Water Research Institute Canada Centre for Inland Waters. Scientific Series No. 135. 1980 data from stations in Canagagigue Creek, downstream of Elmira (CN-3, CN-4 and CN-5)

[3]MNR Records for Canagagigue Creek (Station Grand 45-33) for July 1976, obtained from Guelph District MNR Office

[4] MNR Records for Canagagigue Creek (Station Grand 45-33) for August 1976, obtained from Guelph District MNR Office

[5] MNR Records for Grand River (Station Grand 1-80) for October 1992, obtained from Guelph District MNR Office

[6] LGL Records for Surface Water Monitoring Program for the Grand and Nith Rivers (Waterloo Upstream Station) for August 2009 (LGL 2009)

[7] MNR Records for Conestogo River (Station 1065422, upstream of Northfield Drive) for August 2012, obtained from MNR LIO

Definitions

S Rank - Provincial (or Subnational) rank used by the Natural Heritage Information Centre to set protection priorities for rare species and natural communities. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario.

SX-presumed extirpated; species or community is believed to be extirpated from the nation or state/province, not located despite intensive searches of historical sites and other appropriate habitat and virtually no likelihood it will be rediscovered
SH-possibly extirpated (historical); species or community occurred historically in the nation or state/province and three is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years
S1-critically imperilled; critically imperilled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor (s) such as very steep declines making it especially vulnerable to extirpation from the state/province
S2-imperilled; imperilled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines or other factors making it very vulnerable to extirpation from the nation or state/province
S3-vulnerable; vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines or other factors making it vulnerable to extirpation
S4-apparently secure; uncommon but not rare; some cause for long-term concern due to declines or other factors
S5-secure; common, widespread and abundant in the nation or state/province
SNR-unranked; nation or state/province conservation status not yet assessed
SU- unrankable; currently unrankable due to lack of information or due to substantially conflicting information about status or trends
SNA- not applicable; a conservation status rank is not applicable because species is not a suitable target for conservation activities
S#S#-range rank; a numeric range rank is used to indicate any range of uncertainty about the status of the species or community
C-captive/cultivated; existing in the province only in a cultivated state; introduced population not yet fully established and self-sustaining
S?-not ranked yet- species rank not yet assigned
SA-accidental; accidental or casual occurrence in the province; far outside its normal range, some species may occasionally breed in the province
SAB- breeding accidental
SAN- non-breeding accidental
SE-exotic; not believed to be a native component of Ontario's flora
SR-reported for Ontario; no documentation which would provide a basis for either accepting or rejecting the report
SRF-reported falsely in Ontario
SX-apparently extirpated from Ontario with little likelihood of rediscovery
SZ-not of practical conservation concern; no clearly definable occurrences
COSEWIC– Committee on the Status of Endangered Wildlife in Canada
NAR- not at risk; a wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances
THR-threatened; a wildlife species likely to become endangered if limiting factors are not reversed
END-endangered; a wildlife species facing imminent extirpation or extinction
EXT-extirpated; a species no longer existing in the wild in Canada but occurring elsewhere
SC-special concern; a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats
DD-data deficient; a wildlife species for which there is in adequate information to make a direct, or indirect, assessment of its risk of extinction
SARO –Species at Risk in Ontario
END-Endangered; a species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's ESA
EXP-Extirpated; a species that no longer exists in the wild in Ontario but exists elsewhere
THR-Threatened; a species that is at risk of becoming endangered in Ontario if limiting factors are not reversed
SC-Special Concern; a species with characteristics that make it sensitive to human activities or natural events

APPENDIX E
WATERCOURSE DESCRIPTIONS

Appendix E: Description of Watercourse Crossings as displayed in Figure 4

Photos of watercourses included in Appendix H

Crossing C1

This feature was observed from Northfield Drive East, north of Sawmill Road and is not a regulated watercourse (GRCA, 2013). Overland drainage is received from agricultural fields on the west side of Northfield Drive through a catch basin and conveyed through a 1.5m CSP to the east side of the road through a naturalized channel, into a stormwater management (SWM) pond (Appendix H, Photos 1 to 5). At the time of survey (August 21, 2013) floating mats of algae were observed in the naturalized channel which was approximately 0.3m deep (wetted depth) with a wetted width of 3.5m. The bottom of the channel was lined with paving stones and very little flow was evident. Riparian area was largely manicured lawn upstream of the road with more naturalized cover evident downstream in the form of sumac, grasses, and herbaceous vegetation. A weir associated with the SWP located downstream of the road represents a barrier to fish. No fish were observed at the time of survey. See Appendix H, Photos 1-5.

Crossing C2

This feature flows in an easterly direction across Northfield Drive north of Sawmill Road (Appendix H, Photos 6 to 8). This tributary to the Grand River has an unknown thermal regime. The roadside edge was at a very steep grade to the watercourse which made ROW access on the east side of the road particularly difficult. Therefore, most observations of this feature were made from the upstream (west) side of Northfield Drive. On the west side of Northfield Drive, there are two concrete culverts crossing the watercourse; the one furthest upstream was in disrepair and appeared to function as a farm lane and pedestrian crossing (Appendix H, Photo 6). The concrete culvert at the Northfield Drive crossing was approximately 3m wide. Creek morphology between the road and farm lane crossing was predominately riffle with a boulder/cobble/gravel mix of substrate. The wetted width of the channel varied from 1 to 2m, with water depth at the time of survey ranging from 0.1m in the riffle zone on the west side of the road to approximately 0.4m on the east side of Northfield Drive. Fine substrates were observed downstream of the road crossing where the watercourse ran parallel to a dug pond. Riparian vegetation was limited to a narrow border of grasses and herbaceous vegetation (particularly east of the road) with a few trees on the west side (Appendix H, Photos 7 and 8). No fish were observed at the time of survey. Surrounding land use was primarily agricultural. See Appendix H, Photos 6-8.

Crossing C3

This feature is a tributary of the Grand River which flows in an easterly direction across Northfield Drive just south of Jigs Hollow Road toward a coniferous swamp (Appendix H, Photos 9 to 10). The tributary is classified as coolwater upstream of Northfield Drive. The roadside edge was at a very steep grade to the watercourse which made observations of the watercourse from ROW difficult. The channel upstream (west side) of the road was ill defined through a mix of cattail and meadow marsh vegetation. A concrete culvert of approximately 1.5m in width supported the crossing. Wetted width of the channel on the east side was approximately 1.5m at the road and narrowed to 0.5m downstream as it flowed between two agricultural fields (Appendix H, Photo 10). Riparian vegetation was limited on the east side to a narrow grassed area adjacent to the corn and hay fields, while the west side had a wider riparian buffer of grasses, herbaceous vegetation and some willow. No fish were observed at the time of survey. See Appendix H, Photos 9-10.

Crossing C4

The C4 crossing is at a tributary of the Grand River classified as warmwater downstream (east) of Northfield Drive and with an unknown thermal regime upstream of this crossing. The upstream channel at C4 consists of a 3-4 m grassed channel (Appendix H, Photos 11 to 12). Standing water was observed in a 1.5m CSP at roadside. Agricultural fields used for veal and corn production are located directly adjacent to the grassed channel. On the downstream (east) side of the road the channel continues through agricultural fields of corn and soy, and across a residential driveway. Natural riparian cover is limited to a few trees of the downstream side. Orthoimagery suggests there is very little in the way of a riparian buffer associated with this feature as it flows toward the Grand River. No fish were observed at the time of survey. See Appendix H, Photos 11-12.

Crossing C5

Crossing C5 is classified as a warmwater municipal drain that was dry at the time of survey in August 2013. The portion of the drain that crosses Jigs Hollow Road falls within GRCA Regulation limits.

Fish were observed in the channel at the time of survey (Shiner spp., Rock Bass).

Crossing C6

The crossing of Canagagigue Creek at C6 represents a significant watercourse crossings given the size of the watercourse and presence of steep valley walls (Appendix H, Photos 13 and 14). West (upstream) of the Jigs Hollow bridge, the creek is braided with a small island of cedars, willow and grasses in the middle of the channel. The wetted width of the braided channels at the downstream end of the bridge are 5.0m and 7.2m. These channels are predominantly riffle and change to a run as they converge. The wetted width of the creek is 8.7m at the bridge. Downstream (east) of the bridge the creek can be characterized as a slower moving pool. Orthoimagery suggests that the extent of the riparian zone is greater upstream and downstream of this crossing; however, at the crossing the riparian is relatively narrow (8 to 30m) and bordered by agricultural land use. The exception to this is the area downstream of the bridge between Canagagigue Creek and the Grand River where rural residential properties have preserved the tree cover. Water temperature at the time of survey (August 19, 2013) was recorded as 21˚C with ambient air temperature of 26˚C, which suggests that coldwater inputs to the creek may occur in this area. Undercut banks and overhanging trees provide cover. Rock Bass and Shiner spp. were observed at the time of survey. Additional fish species documented by MNR and others in this reach of the Canagagigue are listed in Appendix C. See Appendix H, Photos 13-14.

Crossing C7

An elliptical CSP culvert of approximately 1 m in diameter was observed at C7 (Appendix H, Photos 15 and 16). The culvert receives intermittent flow from upland on the west side of Jigs Hollow Road and conveys it across to a steeply sloped channel of mostly boulder and cobble that flows toward the Grand River. Minimum flow was observed in the channel at time of survey (October 12, 2013). The steep slope at this location acts as a barrier to fish passage. This feature is not a regulated watercourse (GRCA, 2013). See Appendix H, Photos 15-17.

Crossing C8

The water feature that is crossed at C8 comes from a buried PVC pipe of approximately 0.3m in diameter that approaches the crossing through a manicured lawn north of Hill Street (Appendix H, Photos 18 to 20). This feature is not a regulated watercourse and does not fall within the GRCA's Regulation limit until it approaches the Grand River. At the crossing, flows are conveyed from north of Hill Street to the south (Grand River) through two elliptical CSPs, approximately 1.5m in size. Wetted depth at the time of survey (October 2013) was approximately 0.01m. Watercress at this crossing suggests

groundwater inputs occur at this location. The channel also receives road runoff on the south side of Hill Street. The riparian area is largely comprised of manicured lawn and includes a few trees on the south side of Hill Street. Orthoimagery suggests that this feature connects online ponds to the Grand River. See Appendix H, Photos 18-20.

Crossing C9

The Grand River crosses Sawmill Road approximately 700 m upstream of the confluence with Conostogo Creek (Figure 4, C9). Stream morphology within 100 m upstream on the Sawmill Road bridge were estimated to be 55% riffle, 35% flats and 10% pool. Note that the pool was an inlet alongside Sawmill Road on the east side of the river. Wetted widths were estimated to be 30 m through riffle sections and 40 m through flat sections upstream of the bridge. Downstream of the bridge the wetted width was estimated to be 100 m in riffle sections and 50 m in flat sections. Bankfull widths were estimated to be 90 m across riffles upstream and 50 m in flats upstream of the bridge; and 110 and 60 m in riffles and flats, respectively, downstream of the bridge. At the time of the July 7th investigation conditions were turbid; therefore, substrate composition was confirmed in a subsequent visit as 80% cobble upstream of the bridge with the remainder comprised of equal parts boulder, gravel, and 5% silt. Banks upstream of the bridge appeared to be stable with no erosion observed. Banks downstream of the bridge appeared to be stable, although minor erosion was noted on the downstream right (west) bank. Instream cover was provided mainly by cobble, with interspersions of boulders, and woody debris under an overhanging willow tree (*Salix* sp.) Riparian tree species include black walnut (*Juglans nigra*), willow, abundant Manitoba maple (*Acer negundo*), and red ash (*Fraxinus pennsylvanica*). See Appendix H, Photos 27-28.

Crossing C10

Conostogo River crosses Glasgow Street South prior to its confluence with the Grand River approximately 1.5 km downstream (east). Through aerial photography interpretation, it is evident that the Conestogo River routinely meanders and develops braided channels upstream of Glasgow Street South and underneath the bridge. Stream morphology is comprised mainly of riffles and runs in the 100 m immediately upstream and downstream of Glasgow Street, with 55% riffle, 40% run, and 5% pool habitat. Downstream of the bridge the morphology consists of 60% run and 40% riffle. Wetted channel widths in upstream and downstream runs were estimated to be 30 m. Riffles upstream and downstream were estimated to be 25 and 50 m, respectively. As conditions were turbid during the investigation, the substrate composition was confirmed in a subsequent visit as mostly cobble (60%), with gravel (20%), boulders (1%), sand

(5%) and silt (5%) comprising the remainder. Instream habitat is provided by cobble, sparse boulders, and emergent vegetation. Woody debris and emergent macrophytic vegetation were scant, both upstream and downstream. Stream banks appeared to be moderately stable, with erosion and channel braiding occurring on both upstream and downstream banks. Overhead shading is almost nil, and what little amount of shading is provided by herbaceous vegetation such as *Phalaris arundinacea*, *Solidago sp*., *Lythrum salicaria*, and *Bromus inermis ssp. inermis*. See Appendix H, Photos 29-32.

Crossing C11

Culvert 17029 is a catch-basin on the south side of Sawmill Road and captures intermittent flow from a roadside ditch. Flow is conveyed north across Sawmill Road and into a catch-basin where it is enclosed through a small subdivision, eventually outletting north of Musselman Crescent. See Appendix H, Photos 33-34.

Crossing C12 and C13

This watercourse was conveying flow during the assessment and was probably a result of the recent thunderstorm activity. Flow is conveyed from a northwest to southeast direction draining agricultural lands and acts as a roadside ditch for approximately 100 metres. Two culverts, identified by signage at 17030 and 17031 cross Sawmill Road. Culvert 17031, the easterly culvert, is a corrugated round plastic pipe approximately 0.6m diameter. The watercourse has been ditched along the north and south ROW of Sawmill Road. The channel wetted width was approximately 0.2 m and 0.05-0.1 m in depth. Riparian vegetation was limited to herbaceous species with generally no trees. Dominant herbaceous species included *Phalaris arundinacea*, *Typha angustifolia*, and regenerating *Fraxinus pennsylvanica*. Culvert 17030, the westerly culvert, conveys flow from the upstream roadside ditch to the south side of the road where it confluences with roadside drainage from Culvert 17030 and conveys flow through cropped corn field in an incised channelized boundary. The culvert is a corrugated steel pipe approximately 1.0 m in diameter. Wetted depths were approximately 0.25 m and width was approximately 1.25 m. Dominant herbaceous species included *Solanum dulcamara*, *Phalaris arundinacea*, *Typha angustifolia*, and *Bromus inermis* ssp. *inermis*. Due to dense herbaceous growth along the banks, the channel appeared to be stable. See Appendix H, Photos 35-38.

APPENDIX F
ELC & VASCULAR PLANT DATA

Appendix F, Table 1. Summary of Ecological Land Classification (ELC) Vegetation Communities along Proposed Watermain Alignment as Shown in Figure 1.

ELC Code	Vegetation Type	Species Association	Community Characteristics
TERRESTRIAL – NATURAL/SEMI-NATURAL			
FOC	**CONIFEROUS FOREST**		
FOC2-2	Dry-Fresh Cedar Coniferous Forest	**Canopy:** Eastern White Cedar (*Thuja occidentalis*)	Tree cover > 60 % (FO). Coniferous trees > 75 % of canopy cover (C). Dry to fresh soils with rapid drainage typically occurring on upper to middle slope and tableland. Shallow soils over bedrock. Cedar Forest (2) dominated by white cedar (-2).
FOM	**MIXED FOREST**		
FOM4	Dry Fresh White Cedar Mixed Forest	**Canopy:** Eastern White Cedar (*Thuja occidentalis*) dominant with Austrian Pine (*Pinus nigra*), White Spruce (*Picea glauca*), Black Walnut (*Juglans nigra*), Basswood (*Tilia amaricana*), White Elm (*Ulmus americana*), Sugar Maple (*Acer saccharum*) and American Beech (*Fagus grandifolia*)	Tree cover > 60 % (FO). Coniferous trees > 25 % and Deciduous trees >25% of canopy cover (M). Moderately dry to fresh soils. Dominated by White Cedar (4). Result of secondary growth arising from heavily managed and disturbed sites. Naturalized areas associated with residential properties on the tableland and slope of the Grand River. Contains a real mix of coniferous and deciduous species.
FOD	**DECIDUOUS FOREST**		
FOD4	Dry-Fresh Deciduous Forest	**Canopy:** dominated by Black Walnut (*Juglans nigra*), and Manitoba Maple (*Acer negundo*), with associations of White Ash (*Fraxinus americana*), White Elm (*Ulmus americana*), Silver Poplar (*Populus alba*) and Norway Maple (*Acer platanoides*)	Tree cover > 60 % (FO). Deciduous trees >75% of canopy cover (D). Uncommon associations of tree species or associations that are the result of disturbances or management (4). Well to moderately well drained sands and loams in upper to middle slopes positions, or tablelands (Dry-Fresh)
FOD5	Fry-Fresh Sugar Maple Deciduous Forest	**Canopy:** dominated by Sugar Maple (*Acer saccharum*)	Tree cover > 60 % (FO). Deciduous trees >75% of canopy cover (D). Sugar Maple dominant (5). Dry to fresh soils with rapid to well drainage. Community occurs on the tableland and along valley slopes.
TERRESTRIAL – CULTURAL			
CUP	**CULTURAL PLANTATION**		
CUP2	**MIXED PLANTATION**		
CUP2-1	White Pine – Black Walnut Mixed Plantation	**Canopy:** Eastern White Pine (*Pinus strobus*) and Black Walnut.	Communities resulting from or maintained by cultural or anthropogenic-based disturbances (CU). Tree Cover >60% (P). Mixed Plantation (2) dominated by White Cedar and Black Walnut (-1)
CUP3	**CONIFEROUS PLANTATION**		

ELC Code	Vegetation Type	Species Association	Community Characteristics
CUP3-8	White Spruce Coniferous Plantation	**Canopy:** White Spruce (*Picea glauca*) dominant with associations of Eastern Cottonwood (Populus deltoides), Black Walnut.	Communities resulting from or maintained by cultural or anthropogenic-based disturbances (CU). Tree Cover >60% (P). Coniferous Plantation (3) dominated by White Spruce (8). Result of secondary growth arising from heavily managed and disturbed sites. Trees planted in an old clearing presumably a fallow farm field.
CUM1	**CULTURAL MEADOW**		
CUM1-1	Dry-Moist Old Field Meadow	**Ground Cover:** dominated by Awnless Brome (*Bromus inermis ssp. inermis*), Canada Goldenrod (Solidago canadensis).and wild carrot (*Daucus carota*).	Communities resulting from or maintained by cultural or anthropogenic-based disturbances (CU). Tree cover and shrub cover < 25 % (M). This community can occur on a wide range of soil moisture regimes (Dry-Moist) (1-1). Grass and forb dominant. Community resulting from, or maintained by, anthropogenic-based influences.
CUS	**CULTURAL SAVANAH**		
CUS1	Mineral Cultural Savannah	**Canopy:** Apple (*Malus pumila*) dominant	Communities resulting from or maintained by cultural or anthropogenic-based disturbances (CU). Tree cover and shrub cover between 25 and 35 % (S). This community can occur on a wide range of soil moisture regimes (Dry-Moist) (1-1). Community resulting from, or maintained by, anthropogenic-based influences.
CUW	**CULTURAL WOODLAND**		
CUW1	Mineral Cultural Woodland	**Canopy:** Apple (*Malus pumila*) dominant associations of White Cedar and White Elm.	Communities resulting from or maintained by cultural or anthropogenic-based disturbances (CU). Tree cover ≥ 35 and ≤60% (W). Dominated by apple. Community resulting from, or maintained by, anthropogenic-based influences. An old orchard on the slope of the Grand River.
WETLAND -NATURAL			
SWC	**CONIFEROUS SWAMP**		
SWC1	White Cedar Conifer Swamp	**Canopy:** Eastern White Cedar	Tree and shrub cover >25% (SW). Coniferous tree species > 75% of canopy cover (C). Cedar Deciduous swamp (1). Associated with floodplain of a tributary of the Grand River. Wetland community likely associated with Locally significant wetland.
SWD	**DECIDUOUS SWAMP**		

ELC Code	Vegetation Type	Species Association	Community Characteristics
SWD3	Maple Deciduous Swamp	**Canopy:** dominated by Manitoba Maple (*Acer negundo*) with associations of Willow (*Salix sp*.) and Black Walnut (*Juglans nigra*)	Tree and shrub cover >25% (SW). Deciduous tree species > 75% of canopy cover (D). Maple deciduous swamp (3) associated with the Grand River.
WETLAND - CULTURAL			
MAM2	**MINERAL MEADOW MARSH**		
MAM2-2	Reed Canary Meadow Marsh	**Ground Cover:** dominated by Reed Canary Grass (*Phalaris arundinacaea*)	Seasonally flooded and dominated by emergent hydrophytic macrophytes (MAM). Mineral soil (2). Dominated by Reed Canary Grass (-2)
MAM2-10	Mineral Meadow Marsh	**Ground Cover:** composed of a mixture of Spotted touch-me-not (*Impatiens capensis*), Pepper Mint (*Mentha* x *piperita*), Great Lobelia (*Lobelia siphilitica*), Purple-stemmed Aster (*Aster puniceus* var. *puniceus*), and Spotted Joe-pye-weed (*Eupatorium maculatum var. maculatum*).	Seasonally flooded and dominated by emergent hydrophytic macrophytes (MAM). Mineral soil (2). Dominated by forb species (10) Low-lying area associated with a tributary of the Grand River.
MAS2	**MINERAL SHALLOW MARSH**		
MAS2-1	Cattail Mineral Shallow Marsh	**Ground Cover:** dominated by Narrow Leaved Cattail (*Typha angustifolia*).	Variably flooded, with standing water for much or all of the growing season and dominated by emergent hydrophytic macrophytes (MAS) Mineral Soil (2). Dominated by Cattail (-1) Low-lying area associated with a tributary of the Grand River.
OTHER*	MANICURED		
Dug Pond	Dug pond	Created pond with aquatic vegetation along the periphery, mowed to bank or water edge	
M	Manicured	Manicured grass and/or planted trees and/or shrubs.	

	Common Name	GRank	SRank	MNR	COSEWIC	Local Statu	ROW	dug pond	FOC2-2	FOM4	FOD4	FOD5	CUP2-1	CUP3-8	CUM1-1	CUS1	CUW1	SWC1	SWD3	MAM2	MAM2-2	MAM2-10	MAS2-1
	HORSETAIL FAMILY																						
	field horsetail	G5	S5															x				x	
	WOOD FERN FAMILY																						
lvanica	ostrich fern	G5	S5																x				
	PINE FAMILY																						
	balsam fir	G5	S5				x																
	European larch	G?	SE2				x																
	Norway spruce	G?	SE3				x																
	white spruce	G5	S5			S				x				x									
	Colorado spruce	G5	SE1				x			x													
	Austrian pine	G?	SE2				x																
	eastern white pine	G5	S5							x			x										
	scotch pine	G?	SE5				x			x													
	CEDAR FAMILY																						
	eastern red cedar	G5	S5				x																
	eastern white cedar	G5	S5				x		x	x					x		x	x					
	YEW FAMILY																						
	Japanese Yew						x																
	MAGNOLIA FAMILY																						
	saucer magnolia						x																
	BUTTERCUP FAMILY																						
	Canada anemone	G5	S5										x										
	tall buttercup	G5	SE5				x																
	POPPY FAMILY																						
	celandine	G?	SE5							x													
	bloodroot	G5	S5						x														
	ELM FAMILY																						
	common hackberry	G5	S4			S	x		x	x													
	white elm	G5?	S5						x	x	x						x						
	NETTLE FAMILY																						
	European stinging nettle	G5T?	SE2																		x	x	
	WALNUT FAMILY																						
	black walnut	G5	S4			S	x			x	x		x	x					x			x	
	BEECH FAMILY																						
	American beech	G5	S5						x			x											
	bur oak	G5	S5				x		x	x			x									x	

	Common Name	GRank	SRank	MNR	COSEWIC	Local Status	ROW	dug pond	FOC2-2	FOM4	FOD4	FOD5	CUP2-1	CUP3-8	CUM1-1	CUS1	CUW1	SWC1	SWD3	MAM2	MAM2-2	MAM2-10	MAS2-1
	BIRCH FAMILY																						
	white birch	G5	S5				x																
	ironwood	G5	S5						x														
	GOOSEFOOT FAMILY																						
	lamb's quarters	G5T5	SE5							x													
	SMARTWEED FAMILY																						
	water-pepper	G5	SE5					x													x		
	curly-leaf dock	G?	SE5								x									x	x		
	ST. JOHN'S-WORT FAMILY																						
	common St. John's-wort	G?	SE5				x				x				x								
	LINDEN FAMILY																						
	basswood	G5	S5						x													x	
	small leaf linden	G?	SE1				x																
	GOURD FAMILY																						
	prickly cucumber	G5	S5							x			x						x	x	x		
	WILLOW FAMILY																						
	silver poplar	G5	SE5								x					x							
a	balsam poplar	G5T?	S5							x													
	cottonwood									x	x			x									
	trembling aspen	G5	S5						x	x													
	pussy willow	G5	S5				x																
	Missouri willow	G5	S5																		x		
	slender willow	G4	S5																			x	
	reddish willow	HYB	SE4																			x	
	MUSTARD FAMILY																						
	garlic mustard	G5	SE5						x	x	x												
	yellow rocket	G?	SE5																x		x		
	dame's rocket	G4G5	SE5								x												
	water-cress	G?	SE?																	x			
	GOOSEBERRY FAMILY																						
	wild black currant	G5	S5							x			x										
	wild red currant	G5	S5															x					
	ROSE FAMILY																						
	juneberry						x																
	large-fruited thorn	G5	S5							x	x		x			x	x						
	woodland strawberry	G5T?	S5							x							x						

	Common Name	GRank	SRank	MNR	COSEWIC	Local Statu	ROW	dug pond	FOC2-2	FOM4	FOD4	FOD5	CUP2-1	CUP3-8	CUM1-1	CUS1	CUW1	SWC1	SWD3	MAM2	MAM2-2	MAM2-10	MAS2-1
	Siberian crabapple	G?	SE1				x																
	common apple	G5	SE5				x										x						
	rough-fruited cinquefoil	G?	SE5							x													
	black cherry	G5	S5							x													
	Shubert choke cherry												x										
	choke cherry	G5T?	S5						x	x			x										
	rose												x										
	wild red raspberry	G5T	S5										x	x				x			x		
	European mountain-ash	G5	SE4				x																
	PEA FAMILY																						
	bird's-foot trefoil	G?	SE5												x								
	black medick	G?	SE5				x																
	alfalfa	G?T?	SE4				x																
	alsike clover		SE5				x																
	red clover	G?	SE5				x																
	tufted vetch	G?	SE5																		x		
	LOOSESTRIFE FAMILY																						
	purple loosestrife	G5	SE5												x				x			x	
	EVENING-PRIMROSE FAMILY																						
	yellowish enchanter's nightshade	G5T5	S5							x			x										
	great hairy willow-herb	G?	SE5				x																
	willow-herb																			x	x		
	DOGWOOD FAMILY																						
	alternate-leaved dogwood	G5	S5							x			x										
	round-leaved dogwood	G5	S5										x										
	red-osier dogwood	G5	S5															x	x	x			
	SPURGE FAMILY																						
	leafy spurge	G5	SE5							x													
	BUCKTHORN FAMILY																						
	common buckthorn	G?	SE5				x			x			x			x	x	x					
	GRAPE FAMILY																						
	inserted Virginia-creeper	G5	S5						x	x	x		x										
	riverbank grape	G5	S5				x			x													
	MAPLE FAMILY																						
	amur maple	G?	SE1				x																

Common Name	GRank	SRank	MNR	COSEWIC	Local Statu	ROW	dug pond	FOC2-2	FOM4	FOD4	FOD5	CUP2-1	CUP3-8	CUM1-1	CUS1	CUW1	SWC1	SWD3	MAM2	MAM2-2	MAM2-10	MAS2-1
Norway maple	G?	SE5				x			x	x												
red maple	G5	S5				x																
silver maple	G5	S5				x																
sugar maple	G5T?	S5				x		x	x													
SUMAC FAMILY																						
staghorn sumac	G5	S5				x								x								
GERANIUM FAMILY																						
herb-robert	G5	SE5							x			x										
TOUCH-ME-NOT FAMILY																						
spotted touch-me-not	G5	S5					x										x	x	x	x	x	x
glandular touch-me-not	G?	SE4						x	x									x			x	
PARSLEY FAMILY																						
wild carrot	G?	SE5				x				x		x		x		x						
cow-parsnip	G5	S5			S															x		
MILKWEED FAMILY																						
common milkweed	G5	S5				x				x				x								
POTATO FAMILY																						
bitter nightshade	G?	SE5										x					x		x	x		
MORNING-GLORY FAMILY																						
field bindweed	G?	SE5				x								x				x		x		
BORAGE FAMILY																						
blueweed	G?	SE5				x								x								
smaller forget-me-not	G5	S5																x				
common comfrey		SE5																	x		x	
VERVAIN FAMILY																						
white vervain	G5	S5				x																
MINT FAMILY																						
creeping Charlie	G?	SE5							x													
common motherwort	G?T?	SE5							x	x												
American wild mint	G5T5	S5															x					
pepper mint	HYB	SE4																	x			
catnip	G?	SE5				x																
PLANTAIN FAMILY																						
ribgrass	G5	SE5				x								x								
common plantain	G5	SE5				x								x								
OLIVE FAMILY																						

	Common Name	GRank	SRank	MNR	COSEWIC	Local Statu	ROW	dug pond	FOC2-2	FOM4	FOD4	FOD5	CUP2-1	CUP3-8	CUM1-1	CUS1	CUW1	SWC1	SWD3	MAM2	MAM2-2	MAM2-10	MAS2-1
	red ash	G5	S5				x		x		x						x		x				
	common lilac	G?	SE5				x			x						x							
	FIGWORT FAMILY																						
	turtlehead	G5	S5																	x			
	butter-and-eggs	G?	SE5				x																
	common mullein	G?	SE5				x																
	water speedwell	G5	SE5																		x		
	BLUEBELL FAMILY																						
	great lobelia	G5	S5																	x			
	MADDER FAMILY																						
	white bedstraw	G?	SE5				x			x			x										
	HONEYSUCKLE FAMILY																						
	tartarian honeysuckle	G?	SE5										x				x						
	TEASEL FAMILY																						
	wild teasel	G?T?	SE5												x					x	x		
	ASTER FAMILY																						
	common ragweed	G5	S5				x								x								
	giant ragweed	G5	S5																		x		
	common burdock	G?T?	SE5													x			x		x		
	tall white aster	G5T?	S5				x			x			x		x		x					x	
	purple-stemmed aster	G5T?	S5																	x			
	stick-tight	G5	S5					x															
	devil's beggar-ticks	G5	S5				x																
	musk thistle	G?T?	SE5												x								
	chicory	G?	SE5												x								
	Canada thistle	G?	SE5				x						x			x				x		x	
	horseweed	G5	S5				x																
	daisy fleabane	G5	S5												x								
	daisy fleabane	G5	S5				x																
tum	spotted joe-pye-weed	G5T5	S5												x					x			
	flat-topped bushy goldenrod	G5	S5				x																
	hawkweed						x																
	elecampane	G?	SE5																x				
	seaside camomile	G5T?	SE?				x																
	canada goldenrod	G5	S5				x		x	x	x				x		x			x			
	tall goldenrod	G5	S5				x						x			x							

	Common Name	GRank	SRank	MNR	COSEWIC	Local Statu	ROW	dug pond	FOC2-2	FOM4	FOD4	FOD5	CUP2-1	CUP3-8	CUM1-1	CUS1	CUW1	SWC1	SWD3	MAM2	MAM2-2	MAM2-10	MAS2-1
	rough goldenrod	G5T?	S5										x										
	field sow-thistle	G?T?	SE5				x			x			x							x			
	New England aster	G5	S5				x																
	common tansy	G?	SE5				x			x	x				x								
	common dandelion	G5	SE5				x																
	coltsfoot	G?	SE5				x																
	WATER-PLANTAIN FAMILY																						
	broad-leaved arrowhead	G5	S5					x															
	SEDGE FAMILY																						
	American great bulrush	G?	S5					x															
	GRASS FAMILY																						
	awnless brome	G4G5T?	SE5				x			x			x	x	x								
	orchard grass	G?	SE5				x																
	quack grass	G?	SE5								x		x										
	Virginia wild rye	G5T?	S5				x																
	fowl manna grass	G5	S5																	x			
	rice cut grass	G5	S5					x														x	
	reed canary grass	G5	S5															x	x		x	x	
	timothy	G?	SE5				x																
	common reed	G5	S5																		x		
	Canada blue grass	G?	S5				x								x								
	CATTAIL FAMILY																						
	narrow-leaved cattail	G5	S5				x	x												x			x
	broad-leaved cattail	G5	S5																		x		
	LILY FAMILY																						
	orange day-lily	G?	SE5							x	x												
	ORCHID FAMILY																						
	common helleborine	G?	SE5										x										

ensus of the network of Conservation Data Centres, scientific experts, and the Nature
ank based on the range-wide status of a species, subspecies or variety.
red in assigning global ranks are the total number of known, extant sites world-wide,

pecies and varieties have not been included.
or fewer occurrences in the overall range or very few remaining individuals;
r(s) making it especially vulnerable to extinction.
en 5 and 20 occurrences in the overall range or with many individuals in
cause of some factor(s) making it vulnerable to extinction.
lly between 20 and 100 occurrences; may have fewer occurrences, but with
uals in some populations; may be susceptible to large-scale disturbances.
han 100 occurrences; usually not susceptible to immediate threats.
ably secure under present conditions.
e past 20 years.
ecause of low search effort or cryptic nature of the species; more data

nt records despite specific searches.
rank (i.e. G4?).
y a blank space means that the NHIC has not yet obtained the Global Rank
ancy.
; a ranking, rank tentatively assigned (e.g. G3?).
mic status of the species, subspecies, or variety is questionable.
plies to a subspecies or variety.

e used by the Ontario Ministry of Natural Resources Natural Heritage Information
rities for rare species and natural communities. These ranks are not legal designations.
anner similar to that described for the global ranks, but consider only those factors
ntario. By comparing the global and provincial ranks, the status, rarity, and the urgency
ained. The NHIC evaluates provincial ranks on a continual basis and produces updated

tario because of extreme rarity (often 5 or fewer occurrences) or because of some
ep declines making it especially vulnerable to extirpation.
use of rarity due to very restricted range, very few populations (often 20 or fewer
es or other factors making it very vulnerable to extirpation.
e to a restricted range, relatively few populations (often 80 or fewer), recent and
ther factors making it vulnerable to extirpation.
common but not rare; some cause for long-term concern due to declines or other
factors.
read, and abundant in Ontario.
ecie or community is believed to be extirpated from Ontario.
status in Ontario not yet assessed
rankable due to lack of information or due to substantially conflicting information

vation status rank is not applicable because the species is not a suitable target for

langered Wildlife in Canada (COSEWIC) assesses the national status of wild species that are

cies that no longer exists.
cies no longer existing in the wild in Canada, but occurring elsewhere.
cies facing imminent extirpation or extinction.
cies likely to become endangered if limiting factors are not reversed.
cies that may become a threatened or an endangered species because of a combination of
racteristics and identified threats.
cies that has been evaluated and found to be not at risk of extinction given the current
s.
at applies when the available information is insufficient (a) to resolve a wildlife species'
assessment or (b) to permit an assessment of the wildlife species' risk of extinction.

The Status Of Species At Risk In Ontario/Ontario Ministry Of Natural Resources

cies at Risk in Ontario (COSSARO)/Ontario Ministry of Natural Resources (OMNR)
pecies that are considered to be at risk in Ontario.
A species that no longer exists anywhere.
A species that no longer exist in the wild in Ontario but still occurs elsewhere.
A species facing imminent extinction or extirpation in Ontario which has been regulated under Ontario's *Endangered Species Act*.
A species facing imminent extinction or extirpation in Ontario which is a candidate for regulation under Ontario's Endangered Species Act.
A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed.
A species with characteristics that make it sensitive to human activities or natural events.
A species that has been evaluated and found to be not at risk.
A species for which there is insufficient information for a provincial status recommendations.

f Waterloo was used to determine local vascular plant status for the study area.
of occurrences within the physiographic region. The following species status was taken
d by the Region of Waterloo 1999.

APPENDIX G
RARE SPECIES DATA

Appendix E, Table 1: List of Rare Species Obtained through MNR NHIC Biodiversity Explorer Database Search, January 14, 2014.

Common Name	Scientific Name	S Rank	COSEWIC	MNR Status	Date of Last Observation
American Gromwell	*Lithospermum latifolium*	S3			1941-06-22
Black Redhorse	*Moxostoma duquesnei*	S2	THR	THR	1982------
Bobolink	*Dolichonyx oryzivorus*	S4B	THR	THR	2003-06-07
Braun's Holly Fern	*Polystichum braunii*	S3			1979-11-02
Carolina Vetch	*Vicia caroliniana*	S2			1948-05-14
Eastern Ribbonsnake	*Thamnophis sauritus*	S3	SC	SC	1977-10-02
Greater Redhorse	*Moxostoma valenciennesi*	S3			1997-11-19
Milksnake	*Lampropeltis triangulum*	S3	SC	SC	1971-06-15
Moss Phlox	*Phlox subulata*	S1?			1974-06-10
Scarlet Beebalm	*Monarda didyma*	S3			1892-07
Silver Shiner	*Notropis photogenis*	S2S3	THR	THR	1989-09-01
Snapping Turtle	*Chelydra serpentina*	S3	SC	SC	1996-00-00
Wavy-rayed Lampmussel	*Lampsilis fasciola*	S1	END	THR	2007-06-10
White-tinged Sedge	*Carex albicans var. albicans*	S3			1968-06-06

APPENDIX H
PHOTO APPENDIX

PROJECT #TA8340
August 2013

PHOTO APPENDIX

LGL LIMITED
environmental research associates

Photo 1: Grate on west side of Northfield Drive East at C1, August 19, 2013.

Photo 2: Area of drainage on west side of Northfield Drive East at C1, August 19, 2013.

Photo 3: Channel downstream (east side) of Northfield Drive East at C1, August 19, 2013.

Photo 4: Channel downstream (east side) of Northfield Drive East at C1, August 19, 2013.

Photo 5: Riparian area downstream (east side) of Northfield Drive East at C1, August 19, 2013.

Photo 6: Farm lane crossing located within 10m upstream (west side) of Northfield Drive at C2, August 19, 2013.

PROJECT #TA8340
August 2013

PHOTO APPENDIX

Photo 7: Concrete culvert at C2. Photo taken from west side of Northfield Drive East, August 19, 2013.

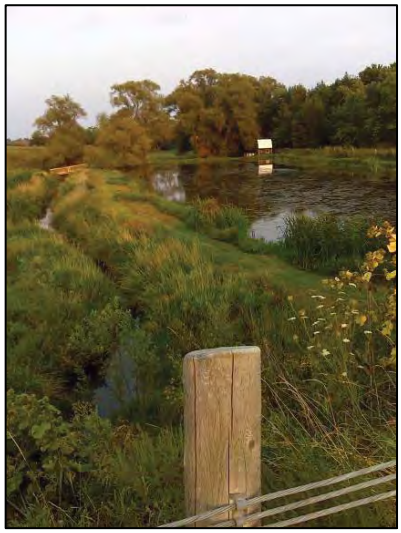


Photo 8: C2 downstream (east side) of Northfield Drive runs alongside a dug pond. Photo taken August 19, 2013.

Photo 9: Channel associated with wetland vegetation on upstream (west side) of Northfield Drive East at C3. Photo taken August 19, 2013.

Photo 10: Watercourse flows between two agricultural fields toward white cedar swamp (SWC1) on west side of Northfield Drive East at C3. Photo taken August 19, 2013.

Photo 11: Grassed channel on upstream (east) side of Jigs Hollow Road at C4. Photo taken August 19, 2013.

Photo 12: Watercourse at C4 continues to flow east toward the Grand River through agricultural lands. Photo taken August 19, 2013.

PROJECT #TA8340
August 2013

PHOTO APPENDIX

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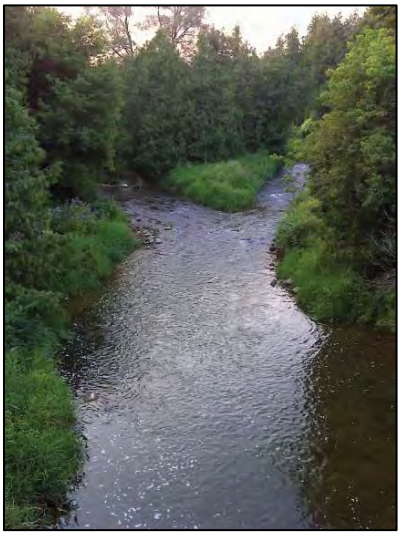

Photo 13: Canagagigue Creek at C6. Photo taken from west (upstream) side of Jigs Hollow Road on August 19, 2013.

Photo 14: : Canagagigue Creek at C6. Photo taken from east (downstream) side of Jigs Hollow Road on August 19, 2013.

Photo 15: Channel in ROW conveys drainage at C7 from west side of Jigs Hollow Road. Photo taken October 12, 2013.

Photo 16: Steep eroded channel at C7 flowing toward Grand River from east side of Jigs Hollow Road. Photo taken October 12, 2013.

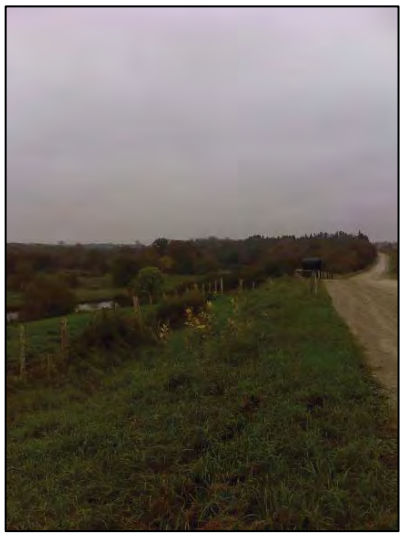

Photo 17: Topography along Jigs Hollow Road. Photo taken October 5, 2013 north of C7, facing south. Grand River visible on left side of photo and in the background along the tree line.

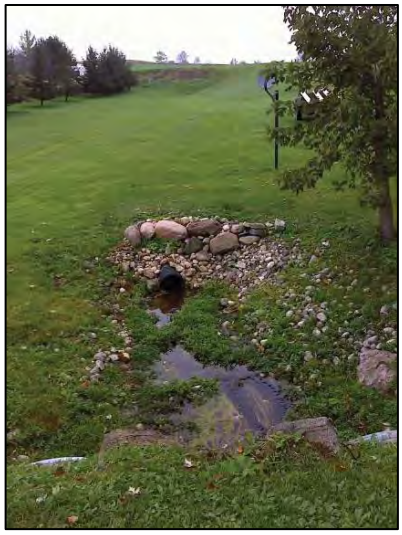

Photo 18:. Water from PVC pipe at C8 as it approaches the double culvert crossing of Hill Street. Watercress and filamentous algae in channel. Photo taken October 5, 2013.

PROJECT #TA8340
August 2013

PHOTO APPENDIX

Photo 19: Manicured condition at C8 on south side of Hill Street. Photo taken on October 5, 2013.

Photo 20: Condition of channel and immediate riparian on south side of Hill Street at C8. Photo taken on October 5, 2013.

Photo 21: East view of the White Pine and Black Walnut Cultural Plantation (CUP2-1) along Hill Street. Photo taken during ELC field survey on August 28, 2013.

Photo 22: Mixed forest (FOM4) along Jig's Hollow Road. Photo taken during ELC field survey on August 28, 2013.

PHOTO APPENDIX

Photo 23: Cultural meadow (CUM1-1) used for archery practice along Jig's Hollow Road. Photo taken during ELC field survey on August 28, 2013.

Photo 24: Facing east at Cedar coniferous swamp (SWC1) and Reed Canary marsh (MAM2-2) near Jig's Hollow and Northfield Drive East. Photo taken during ELC field survey on August 28, 2013.

Photo 25: West view of Cattail and Meadow Marsh (MAS2-1 and MAM2-10) at the intersection along Northfield Drive East near Jig's Hollow Road. Photo taken during ELC field survey on August 28, 2013.

Photo 26: East view of dug pond along Northfield Drive East at C2. Photo taken during ELC field survey on August 28, 2013.

PROJECT #TA8340
July 2014

PHOTO APPENDIX

LGL LIMITED
environmental research associates

Photo 27: Grand River downstream of Sawmill Road (C9, Figure 4). Photo taken July 7, 2014

Photo 28: Grand River upstream of Sawmill Road (C9, Figure 4). Photo taken July 22, 2014

Photo 29: Conestogo River (C10, Figure 4) downstream of Glasgow Street South. Photo taken July 7, 2014

Photo 30: Conestogo River upstream of Glasgow Street (C9, Figure 4). Photo taken July 22, 2014

PROJECT #TA8340
July 2014

PHOTO APPENDIX

Photo 31: Conestogo River bridge at Glasgow Street South crossing. Photo taken July 22, 2014

Photo 32: Conestogo River substrates at C9 (Figure 4). Photo taken July 22, 2014

Photo 33: Crossing C11 (Figure 4) at downstream end of culvert crossing Sawmill Road. Photo taken July 22, 2014

Photo 34: Culvert 17029 at upstream catch basin (C11, Figure 4). Photo taken July 7, 2014

PROJECT #TA8340
July 7 2014

PHOTO APPENDIX

LGL LIMITED
environmental research associates

Photo 35: Culvert 17030 (C12) at downstream side (north) of Sawmill Road. Photo taken July 22, 2014

Photo 36: Culvert 17030 (C12) on upstream side (north) of Sawmill Road. Photo taken July 22, 2014

Photo 37: Culvert 17031 (C13) at downstream side (north) of Sawmill Road. Photo taken July 22, 2014

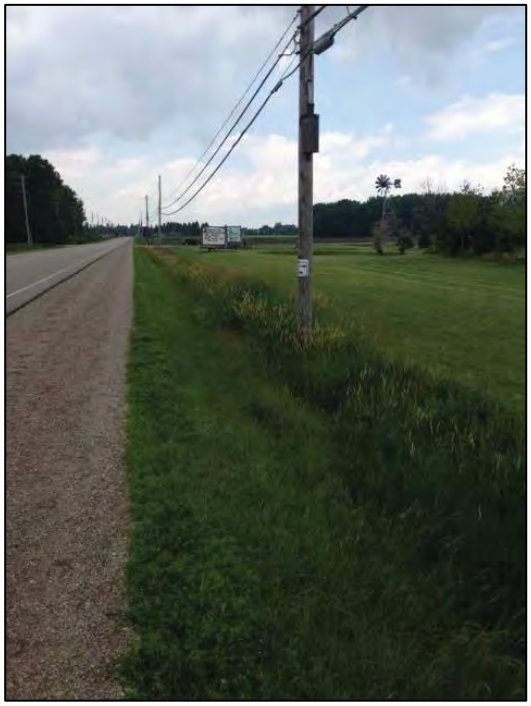

Photo 38: Culvert 17031 (C13) on upstream side (north) of Sawmill Road. Photo taken July 7, 2014

APPENDIX I
AGENCY CORRESPONDENCE

400 Clyde Road, P.O. Box 729 Cambridge, ON N1R 5W6

Phone: 519.621.2761 **Toll free:** 866.900.4722 **Fax:** 519.621.4844 **Online:** www.grandriver.ca

December 3, 2013

Lynette Renzetti
LGL Limited
445 Thompson Drive, Unit 2
Cambridge, ON N1T 2K7

Dear Ms. Renzetti,

Re: Draft Terms of Reference Conestogo Plains Water Supply Environmental Assessment Natural Heritage Field Studies

We have now had the opportunity to review your letter dated August 20, 2013 for the Terms of Reference for a Natural Heritage Field Study in support of the Conestogo Plains Water Supply Environmental Assessment. We offer the following comments for your consideration:

Aquatic and Terrestrial Resources Comments

1. Please note that Canagagigue Creek is currently classified as warm water fish habitat by Ontario Ministry of Natural Resources. A municipal drain south of the creek is also classified as warm water downstream of Jigs Hollow Road. Art Timmerman at the MNR Guelph District Office should be contacted to obtain fish data and confirm the thermal regime/timing windows for these watercourses.

2. The terms of reference and scope of work being proposed are based on the assumption that the crossing of watercourses and wetlands will be accomplished using trenchless technology. However, until a geotechnical study confirms directional drilling beneath the watercourses is feasible, an open cut remains an option for all crossings. Therefore, the impacts associated with both crossing methods should be assessed.

3. It is important to note that the preliminary preferred alignment necessitates a single crossing of Canagagigue Creek, which is classified as warm water fish habitat. It appears that two additional watercourse crossings would be required if the alignment followed Northfield Drive East to the west. However, this western alignment would avoid wetland and riparian forest areas. It would be beneficial to assess the impacts associated with each of these alternatives in greater detail.

Aquatic and Terrestrial Resources Advisory Comments

4. Please be advised that Canagagigue Creek and the Grand River contain aquatic species at risk. It is recommended that Ontario Ministry of Natural Resources and Fisheries and Oceans Canada be contacted for further details and guidance.

We trust that these comments are of assistance. If you should have any questions, please do not hesitate to contact me.

Member of Conservation Ontario, representing Ontario's 36 Conservation Authorities • The Grand – A Canadian Heritage River

Yours truly,

Melissa Larion
Resource Planner
Grand River Conservation Authority
ML/ah

c.c. Region of Waterloo, Transportation and Environmental Services c/o Dominika Celmer-Repin – 150 Frederick Street, 7th Floor, Kitchener, ON N2G 4J3
CIMA c/o Sandra Rodriguez – 7880 Keele Street, Suite 201, Vaughan, ON L4K 4G7

Lynette Renzetti

To: Norminton, Lorraine (MNR)
Subject: RE: Data Request Conestogo Plains Water Supply EA

From: Norminton, Lorraine (MNR) [mailto:lorraine.norminton@ontario.ca]
Sent: July-30-13 10:36 AM
To: Lynette Renzetti
Subject: RE: Data Request Conestogo Plains Water Supply EA

Subject: RE: Conestoga Plains Water Supply EA

Hi Lynette,

Ministry staff have had an opportunity to review the natural heritage records and information available at the MNR Guelph District Office, for the proposed project. Please see the below for the following information and comments to address your questions noted in the email.

Areas of Natural Scientific Interest

Ministry staff notes that there are no Life Science or Earth Science ANSI's located on this property or adjacent to it.

Digital mapping for ANSIs can be obtained from Land Information Ontario (LIO). The Warehouse Dataset Name is "ANSI" within LIO. LIO manages key provincial datasets, and is responsible for housing most of the Ministry's digital natural heritage and resource data. The LIO Warehouse also includes spatial data from a variety of other sources and agencies, including federal ministries and conservation authorities. The LIO website provides instructions on how to request/obtain data, and a full listing of all data in the Warehouse. The link to the LIO website is as follows: http://www.mnr.gov.on.ca/en/Business/LIO/index.html. In addition, LIO staff can be contacted at lio@ontario.ca or at (705) 755-1878.

Wetlands

Ministry staff note that there are wetland complexes within the study area. It includes the Winterbourne Riverine Wetland Complex. It is identified as non-provincially significant. This means it has been evaluated and is not considered provincially significant. We have attached the wetland evaluation for this wetland. Please note that digital mapping for Wetlands can be obtained from LIO as stated above. The Warehouse Dataset Name is "Wetland Unit" within LIO.

Species at Risk

Ministry staff notes that there are 'known' records of species at risk within the study area. We have identifies an element occurrence of Snapping Turtle which is listed as Special Concern.

The Natural Heritage Information Centre (NHIC) is responsible for maintaining a central repository of data and information on rare species in the province of Ontario. This data can be searched via the Biodiversity Explorer internet tool available at www.biodiversityexplorer.mnr.gov.on.ca. The Biodiversity Explorer can be used to find locations of species at risk (referred to as Element Occurrences (EO)) in any part of the province. MNR's Guelph District forwards its EO data to the NHIC at regular intervals in support of the NHIC's mandate.

Please be advised that because the province has not been surveyed comprehensively for the presence of listed species, the absence of records is not an indicator for the absence of species at risk from an area. The presence of an EO is useful to flag the presence of the species in the area, but is not an appropriate tool to determine whether a species is absent from the area, or whether it should be surveyed for.

To determine the presence of species at risk for a given study area, the Ministry's recommended approach includes:

I. Habitat Inventory

Ministry staff recommends undertaking a comprehensive botanical inventory of the entire area that may be subject to direct and indirect impacts from the proposed activity. The vegetation communities should be classified as per the "Ecological Land Classification (ELC) for Southern Ontario" system, to either the "Ecosite" or "Vegetation Type" level. With respect to aquatic habitats in the study area, we recommend you collect data on the physical characteristics of the waterbodies and inventory the riparian zone vegetation, so that these habitats can be classified as per the Aquatic Ecosites described in the ELC manual.

II. Potential Species at Risk within the Study Area

A list of species at risk that have the potential to occur in the area can be produced by cross-referencing the ecosites described during the habitat inventory with the habitat descriptions of species at risk known to occur within the planning area. The list of species at risk known to occur in the Township of Woolwich are attached. The species-specific COSEWIC status reports (www.cosewic.gc.ca) are a good source of information on species at risk habitat needs and will be helpful in determining the suitability of the study areas ecosites for a given species.

Please note that the Species at Risk in Ontario list (SARO) is a living document and is amended periodically as a result of species assessment and re-assessments conducted by the Committee on the Status of Species at Risk in Ontario (COSSARO). The SARO list can be accessed on the webpage http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/276722.html.

COSSARO also maintains a list of species to be assessed in the future. It is recommended to take COSSARO's list of anticipated assessments into consideration, especially when the proposed start date of the activity is more than 6 months away, or the project will be undertaken over a period greater than 6 months. The list can be viewed by going to http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/244543.html and clicking on the link Priority List of Species to be Assessed and Classified by COSSARO.

Species at risk habitat prescribed under regulation can be accessed on the Environmental Registry and searching for postings related to Ontario Regulation 242/08 under the *Endangered Species Act*.

III. Species at Risk Surveys

Ministry staff are of the opinion that each species at risk identified under Step II should be surveyed for, regardless of whether or not the species has been previously recorded in the area. The survey report should describe how each species at risk was surveyed for, and provide a rationale for why, if any, certain species appearing on the attached list were not afforded a survey (e.g. habitat within the study area is not suitable for a specific species at risk). Some species at risk surveys require an authorization under the *Endangered Species Act* (permit) and/or a Scientific Collector's Permit. Please contact Graham Buck (MNR Species at Risk Biologist) at 519-826-4505, for a copy of a permit application or for further information on the implications on the legislation.

If you have any questions please feel free to give me a call.

Lorraine Norminton
District Planner
Ministry of Natural Resources, Guelph District
1 Stone Rd West
Guelph, ON N1G 4Y2
(P) 519-826-4912
(F) 519-826-4929
email: lorraine.norminton@ontario.ca

Lynette Renzetti

To: Buck, Graham (MNR)
Subject: RE: Fisheries data

From: Buck, Graham (MNR) [mailto:Graham.Buck@ontario.ca]
Sent: October-11-13 9:43 AM
To: Lynette Renzetti
Subject: FW: Fisheries data

Hello,

For the Grand River at this location Silver Shiner, Black Redhorse, Wavy-rayed Lampmussel and Rainbow Mussel are likely. All are listed as either endangered or threatened on the Species at Risk in Ontario list, so they have species and general habitat protection. Since Black Redhorse and Rainbow Mussel received habitat protection on June 30th, 2013 they are eligible for the transition exemption.

Graham

Graham Buck
Species at Risk Biologist
Ministry of Natural Resources – Guelph District
1 Stone Road Guelph ON N1G 4Y2
519 826 4505
graham.buck@ontario.ca

Lynette Renzetti

From: Buck, Graham (MNR) <Graham.Buck@ontario.ca>
Sent: June-24-14 3:17 PM
To: Lynette Renzetti
Subject: RE: SAR records Conestogo Water Supply EA

Hello,

I can confirm that all four species occur in this area. Below are the details of the provincially tracked records known to occur or have occurred in this area.

Sci	Com	LIOCount	DistrictCount	TotalCount
Lampsilis fasciola	Wavy-rayed Lampmussel	5	5	10
Villosa iris	Rainbow Mussel	3	4	7
Haliaeetus leucocephalus	Bald Eagle	18	19	37
Moxostoma duquesnei	Black Redhorse	2	0	2
Lithospermum latifolium	American Gromwell	2	0	2
Notropis photogenis	Silver Shiner	7	0	7
Lampropeltis triangulum	Milksnake	1	0	1
Thamnophis sauritus	Eastern Ribbonsnake	1	0	1
Carex albicans var. albicans	White-tinged Sedge	1	0	1
Chaetura pelagica	Chimney Swift	1	0	1
Chelydra serpentina	Snapping Turtle	0	2	2

Graham Buck
Management Biologist
Ministry of Natural Resources
1 Stone Road West
Guelph ON
N1G 4Y2
519 826 4505
graham.buck@ontario.ca

From: Lynette Renzetti [mailto:LRenzetti@lglcambridge.com]
Sent: June-03-14 3:02 PM
To: Buck, Graham (MNR)
Subject: SAR records Conestogo Water Supply EA

Hi Graham
Back in the fall of 2013 you had confirmed that Silver Shiner, Black Redhorse, Wavy-rayed Lampmussel and Rainbow Mussel were likely to occur in the area of the Grand River shown outlined by the black circle below. Since that time, the study area for the Conestogo Water Supply EA has expanded to include consideration of watermain routing to include a crossing of the Grand River at the Sawmill Road bridge in Conestogo and a crossing of the Conestogo River at the Glasgow St. bridge in Conestogo (circled in red below). Consultation of DFO mapping indicates that aquatic SAR habitat is present in these 2 additional areas, can you confirm if the 4 previously mentioned SAR from the original request are also relevant at these new locations, or if there are additional SAR to consider?

Lynette Renzetti

From: Timmerman, Art (MNR) <art.timmerman@ontario.ca>
Sent: August-19-14 9:15 AM
To: Lynette Renzetti
Cc: Laurence, Anne Marie (MNR); Buck, Graham (MNR); Thompson, Melinda (MNR)
Subject: RE: Data Request Conestogo Plains Water Supply EA

Lynette:

The active heron rookery is approximately 250 – 300m north of the Sawmill Road route and the active Bald Eagle nest is 210m southwest of the Glasgow Street route. 2014 was the first year this nest was active and the pair fledged two young. To my knowledge this is the first successful Bald Eagle nest ever recorded in the Regional Municipality of Waterloo. Please let me know if you need more detailed information.

Art timmerman
Management Biologist
Guelph District

From: Laurence, Anne Marie (MNR)
Sent: Monday, August 18, 2014 9:30 AM
To: Timmerman, Art (MNR)
Subject: FW: Data Request Conestogo Plains Water Supply EA

Hi Art – see Lynette's question below. You had provided the highlighted comments to me for this info request. Please let me know what additional info can be provided, if any.

Thanks
Anne Marie

From: Lynette Renzetti [mailto:LRenzetti@lglcambridge.com]
Sent: August-15-14 2:55 PM
To: Laurence, Anne Marie (MNR)
Subject: RE: Data Request Conestogo Plains Water Supply EA

Hi Anne Marie
In review of the information you have provided I am wondering if you are able to provide additional details with regard to the location of the eagle and heron nest sites you have noted below? Ie. Proximity to study area/ general location? Any additional information you are able to provide would be appreciated.
Lynette

From: Laurence, Anne Marie (MNR) [mailto:annemarie.laurence@ontario.ca]
Sent: July-04-14 11:30 AM
To: Lynette Renzetti
Subject: FW: Data Request Conestogo Plains Water Supply EA

Hi Lynette

I have reviewed your request for additional natural heritage information available at the Guelph District MNR office.

The Waterloo Rural East PSW is adjacent to the new routes being considered. I have attached the wetland evaluation report for your information. Please note that there are also unevaluated wetlands on adjacent lands. MNR notes that the recommends

In addition to the natural heritage information available through bald eagle nest.

As you are aware, there is a Crown Game Preserve (CGP) in the area. I have attached some general information for you. CGPs are an old form of wildlife management (at one time there were many across the province and in the District). Note that they occur on private land. The Conestogo Game Preserve contains part of a PSW and a deer winter congregation area.

There are no provincially significant Areas of Natural and Scientific Interest (ANSI) on or adjacent to the study area.

I conducted a species at risk (SAR) screening for the study area including the new routes being considered. In addition to Snapping Turtle (Special Concern) which was previously noted, there are known occurrences for the following SAR in the area: Butternut (Endangered), Barn (Threatened), Chimney Swift (Threatened) and Bald Eagle (Special Concern). Please be advised that because the province has not been surveyed comprehensively for the presence of SAR, the absence of a record in is not an appropriate indicator for the absence of SAR from a geographic area. The approached described in Lorraine's previous correspondence, is the method recommended by the Guelph District MNR. I have attached an up-to-date list of SAR known to occur in Waterloo Region.

Given that new areas are being considered, the District also recommends contacting the conservation authority and municipality to determine if they have any additional information or records of interest for the site.

I trust that the above information will be of assistance.

Best regards,

Anne Marie

Anne Marie Laurence
A/District Planner
Ministry of Natural Resources
Guelph District Office
1 Stone Road West
Guelph, ON N1G 4Y2
(519) 826-4912

From: Lynette Renzetti [mailto:LRenzetti@lglcambridge.com]
Sent: July-02-14 12:16 PM
To: Laurence, Anne Marie (MNR)
Subject: RE: Data Request Conestogo Plains Water Supply EA

Hi Anne Marie
We are in the process of scheduling some field work for this project to cover off the expansion of the study area. Last I heard you were still waiting for info specific to the game preserve. Just wondering, are you able to send the other data while we wait to hear about that particular feature? Wetland evaluations (if available digitally) would be most valuable to help our crew prepare for their visit.
Thank you,

Lynette Renzetti

SPECIAL CONCERN	
EXTIRPATED	

AMPHIBIANS		ESA Protection

BIRDS		ESA Protection
Bald Eagle *Haliaeetus leucocephalus*)	Known to Occur	*N/A*
Barn Swallow (Hirundo rustica)	Known to Occur	*Habitat Protection*
Bobolink *Dolichonyx oryzivorus*)	Suspected to Occur	*Habitat Protection*
Cerulean Warbler *(Dendoica cerulea*)	Known to Occur	*Habitat Protection*
Chimney Swift *Chaetura pelagica*)	Suspected to Occur	*Habitat Protection*
Common Nighthawk *Chordeiles minor*)	Suspected to Occur	*N/A*
Eastern Meadowlark *Sturnella Magna*)	Known to Occur	*Habitat Protection*

FISH		ESA Protection
Black Redhorse *(Moxostoma duquesnei)*	Known to Occur	*Species Protection Only*
Silver Shiner *(Notropis photogenis)*	Known to Occur	*Habitat Protection*

INSECTS		ESA Protection
Monarch Butterfly *(Danaus plexippus)*	Known to Occur	*N/A*
Rusty-patched Bumble Bee (Bombus affinis)	Formerly Occurred and May Still Occur	*Habitat Protection*
West Virginia White (Pieris virginiensis)	Historically Known to Occur; Suspected to Occur	*N/A*

MAMMALS		ESA Protection

MOLLUSCS		ESA Protection
Rainbow Mussel *(Villosa iris)*	Known to Occur	*Species Protection Only*
Wavy-rayed lampmussel *(Lampsilis fasciola)*	Known to Occur	*Habitat Protection*

MOSSES		ESA Protection

PLANTS		ESA Protection
American Ginseng *(Panax quinquefolius)*	Known to Occur	*Species Protection Only*
Butternut *(Juglans cinerea)*	Known to Occur	*Species Protection Only*

REPTILES		ESA Protection
Blanding's Turtle *(Emydonidea blandingii)*	Suspected to Occur	*Species Protection Only*

WATERLOO - Upper Tier

Species At Risk Designations	
ENDANGERED	
THREATENED	
SPECIAL CONCERN	
EXTIRPATED	

AMPHIBIANS		ESA Protection
Jefferson Salamander (*Ambystoma jeffersonianum*)	Known to Occur	*Species Protection and* ***Habitat Regulation***

BIRDS		ESA Protection
Acadian Flycatcher (*Empidonax virescens*)	Known to Occur	*Species and General Habitat Protection*
Bald Eagle (*Haliaeetus leucocephalus*)	Known to Occur	*N/A*
Barn Swallow (Hirundo rustica)	Known to Occur	*Species and General Habitat Protection*
Black Tern (*Childonias niger*)	Historically Known to Occur	*N/A*
Bobolink (*Dolichonyx oryzivorus*)	Known to Occur	*Species and General Habitat Protection*
Canada Warbler (*Cardellina canadensis*; formerly *Wilsonia canadensis*)	Known to Occur	*N/A*
Cerulean Warbler (*Setophaga cerulea;* formerly *Dendoica cerulea*)	Known to Occur	*Species and General Habitat Protection*

Chimney Swift (*Chaetura pelagica*)	**Known to Occur**	*Species and General Habitat Protection*
Common Nighthawk (*Chordeiles minor*)	**Known to Occur**	*N/A*
Eastern Meadowlark (*Sturnella Magna*)	**Known to Occur**	*Species and General Habitat Protection*
Eastern Whip-poor-will *(Caprimlugus vociferus)*	**Known to Occur**	*Species and General Habitat Protection*
Golden-winged Warbler (Vermivora chrysoptera)	**Known to Occur**	*N/A*
Henslow's Sparrow *(Ammodramus henslowii)*	**Historically Known to Occur**	*Species and General Habitat Protection*
Least Bittern *(Ixobrychus exilis)*	**Known to Occur**	*Species and General Habitat Protection*
Louisiana Waterthrush *(Seiurus motacilla)*	**Known to Occur**	*N/A*
Northern Bobwhite (Colinus virginianus)	**Historically Known to Occur**	*Species and General Habitat Protection*
Peregrine Falcon *(Falco peregrinus)*	**Known to Occur**	*N/A*
Red-Headed Woodpecker *(Melanerpes erythrocephalus)*	**Known to Occur**	*N/A*

Short-eared Owl *(Asio flammeus)*	**Suspected to Occur**	*N/A*
Yellow-breasted Chat *(Icteria virens)*	**Historically Known to Occur**	*Species and General Habitat Protection*

FISH		ESA Protection
Northern Brook Lamprey (Ichthyomyzon fossor)	**Known to Occur**	*N/A*
Black Redhorse *(Moxostoma duquesnei)*	**Known to Occur**	*Species and General Habitat Protection*
Silver Shiner *(Notropis photogenis)*	**Known to Occur**	*Species and General Habitat Protection*

INSECTS		ESA Protection
Monarch Butterfly *(Danaus plexippus)*	**Known to Occur**	*N/A*
Rusty-patched Bumble Bee (Bombus affinis)	**Formerly Occurred and May Still Occur**	*Species and General Habitat Protection*
West Virginia White (Pieris virginiensis)	**Formerly Occurred and May Still Occur**	*N/A*

MAMMALS		ESA Protection

American Badger *(Taxidea taxus jacksoni)*	**Known to Occur**	*Species Protection and **Habitat Regulation***
Little Brown Myotis (Myotis lucifugus)	**Known to Occur**	*Species and General Habitat Protection*
Northern Myotis (Myotis septentrionalis)	**Known to Occur**	*Species and General Habitat Protection*

MOLLUSCS		ESA Protection
Rainbow Mussel *(Villosa iris)*	**Known to Occur**	*Species and General Habitat Protection*
Wavy-rayed lampmussel *(Lampsilis fasciola)*	**Known to Occur**	*Species and General Habitat Protection*

MOSSES		ESA Protection
Pygmy Pocket Moss *(Fissidens exilis)*	**Known to Occur (in North Dumfries)**	*N/A*

PLANTS		ESA Protection
American Chestnut *(Castanea dentata)*	**Known to Occur**	*Species and General Habitat Protection*
American Ginseng *(Panax quinquefolius)*	**Known to Occur**	*Species and General Habitat Protection*

Butternut *(Juglans cinerea)*	**Known to Occur**	*Species and General Habitat Protection*
Eastern Flowering Dogwood *(Cornus florida)*	**Known to Occur - Planted**	*Species Protection and* ***Habitat Regulation***
Green Dragon *(Arisaema dracontium)*	**Known to Occur**	*N/A*
Kentucky Coffee-tree *(Gymnocladus dioicus)*	**Known to Occur - Planted**	*Species and General Habitat Protection*

REPTILES		ESA Protection
Blanding's Turtle *(Emydonidea blandingii)*	**Known to Occur**	*Species and General Habitat Protection*
Eastern Ribbonsnake *(Thamnophis sauritus)*	**Known to Occur**	*N/A*

Milksnake *(Lampropeltis triangulum)*	**Known to Occur**	*N/A*
Northern Map Turtle *(Graptemys geographica)*	**Known to Occur**	*N/A*
Queensnake *(Regina septemvittata)*	**Known to Occur**	*Species and General Habitat Protection*
Snapping Turtle *(Chelydra serpentina)*	**Known to Occur**	*N/A*
Wood Turtle *(Glyptemys insculpta)*	**Historically Known to Occur**	*Species Protection and* ***Habitat Regulation***

APPENDIX F

Preliminary Geotechnical Report

September 2015

PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION REPORT

Conestogo Plains Water Supply System Class Environmental Assessment Regional Municipality of Waterloo, Ontario

Submitted to:
CIMA Canada Inc.
236 Victoria Street North
Suite 301
Kitchener, Ontario
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REPORT

Report Number: 1521180

Distribution:

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Golder Associates

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by CIMA Canada Inc. (CIMA) on behalf of the Regional Municipality of Waterloo (the Region) to provide geotechnical engineering services in support for the proposed Conestogo Plains Water Supply (water supply line) Class Environmental Assessment. The new water supply line will extend along Sawmill Road from Arthur Street South (Hwy. 85) to the north side of the Grand River, along Northfield Drive East from Sawmill Road to Jigs Hollow Road, along Jigs Hollow Road from Northfield Drive East to Hill Street, along Hill Street from Jigs Hollow Road to Covered Bridge Drive, along Covered Bridge Drive from Hill Street to Tallwood Drive and on Tallwood Drive to the West Montrose Pump Station in the Region of Waterloo as shown on Figures 1 to 5 following the text of this report.

The scope of work for the geotechnical engineering services of this project is outlined in Golder's proposal titled "Response to CIMA for the Region of Waterloo, Conestogo Plains Water Supply System Class Environmental Assessment" dated January 21, 2015.

This report addresses the geotechnical investigation carried out for the proposed water supply line installations. The purpose of this investigation was to explore the subsurface conditions along the alignments by advancing a limited number of boreholes . The data obtained from this investigation was used in the preparation of this report which includes Borehole Location Plan drawings, Record of Boreholes sheets, laboratory test results, a description of the subsurface conditions and preliminary design recommendations associated with the water supply line installation.

The following documents are referenced in the preparation of this report:

- Golder Associates Ltd., "Geotechnical Pavement Investigation Report, Sawmill Road and Northfield Drive, Region of Waterloo, File No. 11-1186-0205", dated April, 2012.

The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within eighteen (18) months of the date of the report, Golder should be given an opportunity to confirm that the recommendations are still valid.

The professional services retained for this project include only the geotechnical (physical) aspects of the subsurface conditions at the site and exclude construction cost, regulatory and schedule considerations. The presence or implication of possible surface or subsurface contaminants from any source are outside the terms of reference for this study and have not been investigated or addressed. Use of this report is subject to the Important Information and Limitations of this Report, which follows the text of this report and forms an integral part of this document.

2.0 PROJECT DESCRIPTION

The project involves the accumulation of background information, the completion of technical studies and the preparation of preliminary designs as part of the Class Environmental Assessment (EA) process for a new water supply system. The new water supply line (watermain) is approximately 11.5 km in length and crosses both the Grand River (on Sawmill Road) and Canagagigue Creek (on Jigs Hollow Road).

The final location and vertical alignment of the proposed water supply line including other pertinent design features such as pipe diameters, maintenance holes, valves, drain chambers and fire hydrants are not known at this time.

In general, the proposed water supply line installation involves the watermain extensions as follows:

- Open-cut excavation and backfill along the watermain route where possible; and
- Possible trenchless watermain pipe installation methods at the watercourse crossings (i.e., Grand River and Canagagigue Creek crossings).

3.0 INVESTIGATION PROCEDURES

3.1 Current Investigation

The field work for this investigation was carried out during the period of March 12 to March 27, 2015, and consisted of drilling and sampling twenty-seven boreholes to depths ranging from approximately 3 m to 13 m below ground surface. The boreholes were numbered as Boreholes BH-1 to BH-27 and their approximate locations are shown on Figures 1 to 5.

The borehole locations were staked in the field by Golder field staff and surveyed by surveyors from MacDonald Tamblyn Lord Surveying Limited (MTLSL Subsidiary of J.D. Barnes Limited), a licensed surveying company who provided Golder with the borehole co-ordinates and ground surface elevations.

The boreholes were drilled using conventional D55 and Geoprobe 6620DT track mounted drill rigs supplied and operated by Altech and Investigative Services Inc. of Elmira, Ontario. The borings were extended through the overburden soils using both hollow stem and solid stem augering techniques and soil samples were obtained at intervals of depth ranging from 0.75 m to 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler in conjunction with the Standard Penetration Test (SPT) procedures as specified in ASTM Method D1586[1].

The groundwater conditions in the open boreholes were observed during the drilling operations and piezometers or monitoring wells were installed in eight of the boreholes to permit monitoring of the groundwater levels at the site. The piezometers (Boreholes BH-3, BH-9, BH-16 and BH-22) and monitoring wells (Boreholes BH-10, BH-11, BH-20 and BH-21) consisted of 38 mm diameter PVC pipe, with a slotted screen sealed at select depths within the boreholes. A sand filter pack was installed around the well screen. Above the screens, the borehole annulus surrounding the well/piezometer pipes was backfilled to the ground surface with bentonite holeplug. The well/piezometer installation details and water level readings are described on the Record of Borehole sheets following the text of this report.

The field work was monitored by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, and recorded the subsurface conditions encountered in the boreholes. The soil samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Cambridge geotechnical laboratory where the soil samples underwent further detailed visual examination and geotechnical classification testing including water content determinations, Atterberg limit tests and grain size distribution tests.

[1] ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

Following the installation of the monitoring wells in boreholes BH-10, BH-11, BH-20 and BH-21; in-situ hydraulic conductivity testing (falling head tests) were performed on March 24, 2015. Based on the test results, the hydraulic conductivity of the native soil types in the immediate vicinity of the wells has been estimated and the results are discussed in Section 4.7. These hydraulic conductivity values should only be considered an indicator of the hydraulic properties and not a definitive measure of the overall formation behaviour.

Select soil samples were subjected to a laboratory testing programme consisting of natural water content, grain size distribution and Atterberg limits in accordance ASTM Standards as appropriate. The results of the soil testing program are presented on the Record of Borehole sheets in Appendix A and on the figures included in Appendix B.

Soil samples were also submitted to ALS Environmental Laboratory (ALS) for soil chemical testing to assess disposal options for excess soils generated during construction. The results of the soil chemical tests are outlined below.

The field work in the area of the proposed trenchless crossings was carried out on March 12, 26 and March 27, 2015, at which time four boreholes (designated as Boreholes BH-10, BH-11, BH-20 and BH-21) were advanced at the crossing locations (two at the Grand River and two at the Canagagigue Creek). The general locations, and the depths, of the boreholes drilled for each crossing are summarized below:

Crossing Site	Borehole	Approximate Borehole Depth (m) Below Existing Ground Surface (bgs)
Grand River Crossing	BH-10 (south side), BH-11 (north side)	10.4 m to 9.3 m
Canagagigue Creek Crossing	BH-20 (south side), BH-21 (north side)	11.3 m to 12.8

3.2 Previous Investigation

A previous geotechnical and pavement investigation was carried out by Golder for the Region on Sawmill Road and Northfield Drive.

> The report was entitled “Geotechnical Pavement Investigation Report, Sawmill Road and Northfield Drive, Region of Waterloo, File No. 11-1186-0205”, dated April, 2012 (2011 Investigation).

Six boreholes (Boreholes GA 11-1 to GA 11-5 and GA 11-8) from this previous investigation were used to supplement the current investigation since they are located along the proposed watermain alignment. These boreholes were advanced to depths ranging from 3.4 m to 4.4 m below ground surface and the Record of Borehole sheets are provided in Appendix A. The approximate locations of these boreholes are shown on Figure 2.

3.3 Borehole Locations

The borehole locations in MTM NAD83 northing and easting coordinates and the ground surface elevations referenced to Geodetic datum are summarized in the following table.

Borehole No.	MTM NAD 83 Coordinates		Ground Surface Elevation (m)
	Northing (m)	Easting (m)	
BH-1	4,821,291.86	536,758.34	342.63
BH-2	4,821,294.51	537,039.64	341.40
BH-3	4,8212,98.49	537,315.74	339.67
BH-4	4,8212,97.28	537,576.41	338.89
BH-5	4,821,261.20	537,871.00	339.28
BH-6	4,821,222.93	538,207.91	340.00
BH-7	4,821,199.15	538,470.10	339.96
BH-8	4,821,160.57	538,824.60	337.67
BH-9	4,821,131.13	539,103.85	336.47
BH-10	4,820,986.74	540,800.36	316.98
BH-11	4,821,071.49	540,838.04	312.44
BH-12	4,821,815.97	539,603.62	332.82
BH-13	4,822,264.33	539,638.28	339.89
BH-14	4,822,686.19	539,743.62	338.48
BH-15	4,823,085.21	539,902.16	331.76
BH-16	4,823,012.99	540,509.92	331.57
BH-17	4,823,324.78	540,537.48	332.49
BH-18	4,823,801.56	540,622.29	341.84
BH-19	4,824,335.25	540,711.64	335.99
BH-20	4,824,613.12	540,761.02	325.30
BH-21	4,824,701.54	540,776.21	325.36
BH-22	4,825,193.90	540,862.10	333.52
BH-23	4,825,749.52	540,979.83	339.68
BH-24	4,826,214.40	541,096.75	345.10
BH-25	4,826,152.22	541,525.93	342.82
BH-26	4,826,262.34	541,841.10	334.08
BH-27	4,826,206.35	542,096.05	324.24
GA 11-1	4,820,964.20	540,697.48	319.94
GA 11-2	4,820,990.90	540,408.46	326.59
GA 11-3	4,821,044.25	539,957.92	335.90
GA 11-4	4,821,075.40	539,639.20	337.10
GA 11-5	4,821,098.85	539,498.55	336.13
GA 11-8	4,821,358.14	539,597.30	334.96

* MTM NAD83 northing and easting coordinates estimated from borehole locations depicted on drawings provided by MTLSL.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The study area is located in the physiographic region known as the Waterloo Hills, which lies mainly in the Regional Municipality of Waterloo. The site is located within an extensive area of alluvial terraces/drumlinized till plains that are prominent throughout the northern portion of the Waterloo Hills. The Waterloo Hills physiographic region is composed of sand hills, ridges of sandy till, kames and moraines in the highlands and outwash sand and gravels in the intervening hollows.

The Waterloo moraine is the main physiographic feature within the area and encompasses portions of the Cities of Kitchener, Waterloo and the Townships of Wilmot, Wellesley and Woolwich.

The Waterloo moraine is located on the eastern part of the Michigan Basin. The glacial landforms and deposit features that make up the moraine were part of the last ice age. The Huron-Georgian Bay and the Erie-Ontario ice lobes advanced through the Waterloo moraine and added to the complexity of the geographical area. The Waterloo moraine is an irregular tract of hummocky to steeply rolling ground underlain by fine sand and/or sand and gravel capped by fine tills.

4.2 Subsurface Conditions

Reference is made to the Record of Borehole sheets in Appendix A which provide details of the encountered soil stratigraphy at the locations of boreholes advanced along the proposed watermain alignment. A List of Abbreviations and Symbols is also provided to assist in the interpretation of the Record of Borehole sheets.

An overall description of the stratigraphy is given in the following sections; however, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions.

The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling as well as observations during drilling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

The subsurface stratigraphy descriptions, outlined below, have been separated for each road section, creek and river crossing.

A total of nine boreholes (BH-1 to BH-9) were drilled along Sawmill Road between Arthur Street and Weberlyn Crescent. The boreholes were drilled along the south shoulder of the roadway. Also five boreholes (GA11-1 to GA11-5) were previously advanced on Sawmill Road between Weberlyn Crescent and the Grand River as part of the 2011 investigation. In general, the subsurface conditions in this portion of the study area consist of sand and gravel fill or asphalt overlying silty clay or silty clay till with local silty sand interlayers. The cohesive soils were underlain by or contained interlayers of silty sand to sandy silt at some of the borehole locations.

Two boreholes (BH-10 and BH-11) were drilled at the location of the Grand River Crossing. Borehole BH-10 was drilled on the south side of the river and Borehole BH-11 was advanced on the north side of the river in the area of the proposed crossing. In general, the subsurface conditions consist of surficial deposits of organic silt, and silty clay overlying deposits of silty sand, and silty sand and gravel to gravelly silty sand that extended to the borehole termination depths.

Boreholes BH-12 to BH-14 were drilled along Northfield Drive between Sawmill Road and Jigs Hollow Road. The boreholes were drilled along the west shoulder of the roadway. One borehole (GA11-8) was previously advanced on Northfield Drive near Country Spring Walk during the 2011 investigation. In general, the subsurface conditions consist of sand and gravel fill overlying silty sand and silty clay till.

Seven boreholes (BH-15 to BH-19, and BH-22 and BH-23) were drilled along Jigs Hollow Road between Northfield Drive and Hill Street. The boreholes were drilled along the north and west shoulders of the roadway. In general, the subsurface conditions consist of sand and gravel fill overlying layered deposits of silty clay and/or silty sand to silty sand and gravel.

Boreholes BH-20 and BH-21 were drilled at the location of the Canagagigue Creek Crossing from within the road allowance. One borehole was drilled on the south side of the creek and the second borehole was advance on the north side of the creek in the area of the proposed crossing. The subsurface conditions on the south side of the creek consist of sand and gravel over silt which is in turn underlain by silty sand till. The subsurface conditions on the north side of the creek consist of surficial sand and gravel deposit containing interlayers of silty clay and sand, over gravel which is in turn underlain by clayey sand till.

Boreholes BH-24 and BH-25 were drilled along Hill Street between Jigs Hollow and Covered Bridge Drive along the north side of the existing pavement. In general, the subsurface conditions encountered in these boreholes consist of asphalt overlying sand and gravel fill overlying varying materials including silt containing organics, silty clay, and silty clay till.

Borehole BH-26 was drilled within the asphalt pavement on Covered Bridge Drive. The subsurface conditions encountered in this borehole consist of asphalt and granular and silty clay fill materials overlying sand and gravel.

Borehole BH-27 was drilled within the asphalt pavement on Tallwood Drive. The subsurface conditions encountered in this borehole consist of asphalt overlying sand and gravel to silty sand fill which in turn is underlain by silty clay and sandy silty clay till.

More detailed descriptions of the subsurface conditions encountered in the boreholes are provided in the following sections.

4.3 Trenched (Open Cut) Sections

4.3.1 Asphalt Pavement

Asphalt materials were encountered in all of the boreholes advanced through the roadway surface in boreholes GA11-1 to GA-11-5 and GA11-08 (2011 Investigation) and Boreholes BH-24 to BH-27. The asphalt thickness varied from approximately 50 mm to 220 mm.

4.3.2 Fill

Fill materials were encountered in all of the boreholes advanced on the road shoulders and through the roadway surface in Boreholes BH-1 to BH-9, GA11-1 to GA11-5, GA11-8 and BH-12 to BH-27. The fill extended to depths between about 0.6 m and 2.1 m below ground surface.

The fill material is variable in composition ranging from non-cohesive sand and gravel, gravelly sand, sand to silty sand and gravel, and silty sand to silty clay with some organics. The silty clay fill was brown to dark brown in colour.

Standard Penetration Test (SPT) "N"-values measured within the cohesive silty clay fill generally range from 17 blows to 39 blows per 0.3 m of penetration, suggesting that this fill has a very stiff to hard consistency. SPT "N"-values measured within the non-cohesive silty sand and sand and gravel fill range from 12 blows to 49 blows per 0.3 m of penetration. It should be noted that some of the "N"-values measured within the non-cohesive fill were in excess of 60 blows per 0.10 m of penetration; however, these materials were noted to be frozen at the time of the investigation. Based on the recorded "N" values, the non-cohesive fill is generally compact to dense with very dense zones.

The results of a grain size distribution test carried out on one sample of the non-cohesive fill are illustrated on Figure 6 in Appendix B. The natural water contents measured on samples of the non-cohesive fill materials range from about 4 percent to 10 percent expressed as a percentage of the dry weight of the soil.

The natural water contents measured on samples of the cohesive fill range from about 13 percent to 32 percent.

4.3.3 Clayey Silt/Silty Clay

A native clayey silt/silty clay deposit containing with varying amounts of sand and gravel was encountered in Boreholes BH-1, BH-2, BH-3 to BH-9, GA11-1 to GA11-3, BH-12 to BH-15, BH-18, BH-23, BH-24, BH-25 and BH-27 below the base/subbase fill material. This material extends to depths of between 0.8 m and 4.4 m below ground surface. The clayey silt deposit was brown in colour.

Standard Penetration Test (SPT) "N"-values measured within the cohesive silty clay deposit generally range from 3 blows to 61 blows per 0.3 m of penetration, suggesting a soft to hard consistency.

Grain size distribution tests were carried out on two selected samples of the silty clay deposit and the results are shown on Figure 7 in Appendix B. The natural water content measured on samples of the cohesive silty clay soil range from about 13 percent to 31 percent of the dry weight.

4.3.4 Stratified Sandy Silt/Sand to Sand and Gravel/Sandy Gravel

Stratified layers of silty sand / sand and gravel were encountered in boreholes BH-5, BH-6, BH-8, BH-9, GA11-1 to GA11-5, BH-14, BH-16 to BH-19, BH-22, BH-24 and BH-26 and extended to the borehole termination depths up to 5.2 m at some locations. The thickness of the stratified silty sand/sand and gravel varied from about 0.2 m to greater than 2.0 m.

Standard Penetration Test (SPT) "N"-values measured within the non-cohesive sandy silt to sand and sand and gravel deposit generally range from 2 blows to greater than 100 blows per 0.3 m of penetration, suggesting that these materials are typically very loose to very dense.

Natural water contents measured on samples of the non-cohesive sand and sand and gravel soils range from about 3 percent to 24 percent of the dry weight of the soil.

4.4 Grand River Crossing

Boreholes BH-10 and BH-11 were drilled at the location of the Grand River Crossing. Borehole BH-10 was drilled on the south side of the river and Borehole BH-11 was advanced on the north side of the river in the area

of the proposed crossing. In general, the subsurface conditions consist of surficial deposits of organic silt, with localized silty clay and silty sand layers which are in turn underlain by silty sand and gravel to gravelly silty sand to the borehole termination depths. More detailed descriptions of the subsurface conditions encountered in the boreholes are provided in the following sections.

4.4.1 Organic Silt

Organic silt was encountered in both boreholes at ground surface. The thickness of the organic silt was approximately 300 mm to 690 mm at the borehole locations. A second organic silt deposit was encountered at a depth of about 1.5 m to 2.4 m in Borehole BH-11.

4.4.2 Silty Clay Layer

A layer of silty clay was encountered underlying the surficial organic silt in both boreholes and extended to depths between of 0.8 m and 1.5 m below the existing ground surface. The silty clay was brown in colour and contained varying amounts of organic matter, sand and gravel.

SPT 'N' values within the silty clay deposit varied from 1 blow to 31 blows per 0.3 m of penetration. The SPT 'N' value of 31 blows per 0.3 m of penetration is a reflection of the frozen ground conditions at the time of drilling. Therefore, the silty clay should be considered as very soft to soft.

4.4.3 Silty Sand Layer

An approximately 0.6 m thick layer of silty sand was encountered below the silty clay in Borehole BH-10 and extends to a depth of about 1.4 m bgs. The deposit was brown in color and contains trace quantities of gravel. One SPT 'N' value of 18 blows per 0.3 m of penetration was measured within the silty sand layer indicating that the material is compact.

4.4.4 Sand and Gravel to Gravelly Silty Sand

Strata of sand and gravel to gravelly silty sand were encountered underlying the silty sand/sand and silt sand and gravel at the location of Boreholes BH-10 and BH-11. The sandy gravel to gravelly sand was brown to grey in colour and contained varying quantities of silt.

Cobbles and/or boulders are inferred to be present at various locations throughout these deposits based on hard augering/auger grinding noted at various depths.

SPT 'N' values within the sandy gravel to gravelly silty sand layer typically ranged from 21 blows per 0.3 m of penetration to greater than 50 blows per 0.05 m of penetration indicating that the material is generally compact to very dense.

Grain size distribution tests were carried out on selected samples of from these deposits and the results are presented on Figure 8 in Appendix B.

4.5 Canagagigue Creek Crossing

Boreholes BH-20 and BH-21 were drilled at the location of the Canagagigue Creek Crossing from within the road allowance. Borehole BH-20 was drilled on the south side of the creek and Borehole BH-21 was advanced on the north side of the creek in the area of the proposed crossing. The subsurface conditions on the south side of the creek (Borehole BH-20) consist of sand and gravel to sandy silty gravel over silt which is in turn underlain by sandy gravelly silt till. The subsurface conditions on the north side of the creek (Borehole BH-21) consist of sand

and gravel to sandy gravel containing pockets of silty clay and sand which is in turn underlain by gravelly clayey sand till.

More detailed descriptions of the subsurface conditions encountered in the boreholes are provided in the following sections.

4.5.1 Sand and Gravel to Sandy Silty Gravel

Strata of sand and gravel to sandy silty gravel containing interlayers of silty clay, sand and silt were encountered immediately below the ground surface at the location of both boreholes and extended to depths of 9.1 m and 10.7 m below ground surface, respectively. The sand and gravel was brown to grey in colour and contained varying quantities of silt.

SPT 'N' values within these granular deposits ranged from 10 blows to 149 blows per 0.3 m of penetration indicating these materials are compact to very dense (predominantly very dense).

The presence of cobbles and/or boulders within the deposit is inferred from hard augering/auger grinding noted at various depths in the boreholes.

Grain size distribution tests were carried out on selected samples of deposits and the results are presented on Figure 9 in Appendix B. The natural water content measured on samples of the non-cohesive silty sand to sand and gravel soils range from about 4 percent to 17 percent of the dry weight.

4.5.2 Silt

In BH-20, an approximately 1.5 m thick layer of silt containing some sand was encountered below the sand and gravel and extends to a depth of about 10.7 m. The deposit was brown with black staining in color and contains trace quantities of gravel and organics. A SPT 'N' value of 65 blows per 0.3 m of penetration was measured within the silt deposit indicating this material is very dense.

4.5.3 Cohesive Till

A cohesive deposit comprised of gravelly clayey sand to gravelly sandy silty clay till was encountered underlying the sand and gravel to sandy silty gravel deposit at the location of both boreholes and extended to the borehole termination depths of about 11.3 m and 12.8 m.

SPT 'N' values within the clayey sand till ranged from 92 blows per 0.3 m of penetration to greater than 50 blows per 0.1 m of penetration suggesting the till has a hard consistency.

An Atterberg limits test was carried out on a sample of the till and the results are plotted on the plasticity chart on Figure 10 in Appendix B. The results indicate that the fine portion of the material consists of silty clay of low plasticity. The Atterberg limits results are summarized below.

Liquid Limit:	20 %
Plastic Limit:	12 %
Plasticity Index:	8 %
Natural Water Content:	8 %

4.6 Groundwater Conditions

The unstabilized groundwater levels in the boreholes were measured during and upon completion of the drilling operations and this information is reported on the Record of Borehole sheets in Appendix A. Selected boreholes from the current and previous field investigations were also instrumented with a standpipe piezometer/well to permit long term monitoring of the groundwater levels.

Summarized below are the groundwater levels that were measured on separate visits after the completion of drilling:

Borehole No.	Ground Surface Elevation (m)	Date of Measurement	Groundwater Levels	
			Depth (m)	Elevation (m)
BH-3	339.67	March 17, 2015 April 25, 2015	3.40 1.18	336.27 338.49
BH-9	336.47	March 18, 2015 April 25, 2015	1.88 1.03	334.59 335.44
BH-10	316.98	March 26, 2015 March 29, 2015 April 25, 2015	5.61 5.71 5.52	311.37 311.27 311.46
BH-11	312.44	March 12, 2015 March 29, 2015 April 25, 2015	1.27 0.90 0.60	311.17 311.54 311.84
BH-16	331.57	March 27, 2015 April 25, 2015	2.78 2.39	328.79 329.18
BH-20	325.30	March 27, 2015 March 29 , 2015 April 25, 2015	3.66 3.70 3.54	321.64 321.60 321.76
BH-21	325.36	March 27, 2015 March 29, 2015 April 25, 2015	3.66 4.05 3.60	321.70 321.31 321.64
BH-22	333.52	March 26, 2015 April 25, 2015	3.35 2.20	330.17 331.32

It should be noted that the groundwater levels in the area are subject to seasonal fluctuations, precipitation events and fluctuations in the adjacent creek/river, and should be expected to be higher during the wet periods of the year. Perched groundwater conditions may also develop above the fine-grained glacial till soils, most notably during and following periods of sustained precipitation.

4.7 Hydraulic Conductivity of Overburden Soils

As part of the geotechnical investigation, in situ hydraulic conductivity tests (single well response tests) were carried out for the wells completed in BH-10 and BH-11, and for BH-20 and BH-21. The results of the single well response test results are discussed below.

Hydraulic Conductivity Estimates

Hydraulic conductivity was estimated using Hazen's method (d_{10}^2) and from the grain size distribution of selected soil samples and using the hydrostatic time-lag method of Hvorslev (1951) as described in Freeze and Cherry (1979). Hvorslev's method is described by the following equation:

$$K = \frac{r^2 \ln (L/R)}{2LT_0}$$

Where K = hydraulic conductivity of the tested material, r = radius of the well riser pipe, R = radius of the sand pack, L = length of screen and sand pack, and T_0 = time lag which is determined graphically as the time it takes for the water level to rise or fall 37 percent of the initial change.

Table 1 provides a summary of the estimated hydraulic conductivity values for selected wells and soil samples:

Table 1: Summary of Hydraulic Conductivity Estimates

Monitoring Well	Sample No.	Depth (m bgs)	Material Description	K (cm/s)	Method
BH10	N/A	6.0 – 9.0	Sand and gravel	5.6×10^{-2}	Hvorslev
BH11	N/A	3.1 – 6.1	Sand and gravel	1.3×10^{-3}	Hvorslev
BH20	N/A	7.5 – 10.5	Silty sand	3.2×10^{-5}	Hvorslev
BH21	N/A	6.0 – 9.0	Sand and gravel	1.9×10^{-5}	Hvorslev
BH-10	7	4.6 – 5.2	Sand and gravel	1.6×10^{-3}	Hazen
BH-10	11	9.15 – 9.75	Sand and gravel	7.2×10^{-4}	Hazen
BH-11	5	3.05 – 3.65	Sand and gravel	1.7×10^{-2}	Hazen
BH-11	7	6.1 – 6.3	Silty sand	1.8×10^{-5}	Hazen
BH-20	3	7.6 – 8.2	Silty sand	3.6×10^{-5}	Hazen
BH-20	5	10.7 – 11.3	Silty sand	6.2×10^{-6}	Hazen
BH-21	9	7.6 – 8.2	Silty sand	5.6×10^{-3}	Hazen

The hydraulic conductivities range from approximately 1.0×10^{-6} to 5.6×10^{-2} cm/s with mean values of 1.3×10^{-2} for the Grand River crossing and 1×10^{-3} cm/s for the Canagagigue Creek Crossing.

5.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report presents an interpretation of the factual geotechnical data and provides preliminary geotechnical design recommendations for the water supply line installations. These discussions and recommendations are based on our understanding of the project and our interpretation of the factual data obtained from the current and previous subsurface investigations.

Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions or operational constraints may be required in the Contract

Documents. Those requiring information on the aspects of construction should make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

This project involves a watermain installation along Sawmill Road from Arthur Street South (Hwy. 85) to the north side of the Grand River, along Northfield Drive East from Sawmill Road to Jigs Hollow Road, along Jigs Hollow Road from Northfield Drive East to Hill Street, along Hill Street from Jigs Hollow Road to Covered Bridge Drive, along Covered Bridge Drive from Hill Street to Tallwood Drive and on Tallwood Drive to the Westmontrose Pump Station. The details of the final location and vertical alignment of the watermain line including other pertinent design features are not known at this time. Outlined below is the information known at this time.

5.1.1 Watermain Extensions

The proposed watermain extensions include:

- Construction of about 2,900 m of 300 mm diameter watermain on Sawmill Road form Arthurs Street South (Highway 86) to Northfield Drive. The watermain will be installed at a typical 2.0 m depth of cover.
- Construction of about 1,400 m of 300 mm diameter watermain on Sawmill Road from Northfield Drive to Golf Course Road. The watermain will be installed at a typical 2.0 m depth of cover and it is anticipated that the crossing of the Grand River will be carried out using trenchless methods.
- Construction of about 7,200 m of 100 mm diameter watermain on Northfield Drive East from Sawmill Road to Jigs Hollow Road, along Jigs Hollow Road from Northfield Drive East to Hill Street, along Hill Street from Jigs Hollow Road to Covered Bridge Drive, along Covered Bridge Drive from Hill Street to Tallwood Drive and on Tallwood Drive to the Westmontrose Pump Station.

5.2 Installation Methods

We understand that the proposed watermain will be installed by a combination of open cut excavations and trenchless techniques along the proposed watermain route. The diameter and length of the water supply line, the anticipated subsurface conditions along the alignments and the depth of cover limit the available installation techniques that would be economically viable. Each method considered has advantages, disadvantages and limitations and these are discussed further below.

Ground behaviour will be, in part, dependent on the installation method adopted and this report provides guidance on the influence of ground behaviour on some possible installation methods. It should not be construed that the Contractor is restricted to the particular methods considered herein, and in the event of alternative methods, the Contractor must make his/her own interpretation of the anticipated ground behaviour, based on the factual information provided in the Geotechnical Investigation Report.

Trenchless installation methods were evaluated for the waterbody crossings and the recommendations for the selection of the preferred method took into consideration the relative construction costs, existing subsurface conditions, the presence of buried utilities and the risks and consequences of each alternative. Trenchless methods are generally more costly compared to open-cut excavations, and there is always a possibility that excavations may be required to retrieve tunnelling equipment if adverse subsurface conditions are encountered.

5.3 Open Cut Excavation

An open cut excavation involves trench excavation and excavation sidewall support, bedding and pipe installation, trench backfilling and pavement restoration. The open cut method offers the best control of gradient and alignment reduces the potential for delays resulting from encountering obstructions and provides the least risk of unanticipated damage to the active roadways.

The major disadvantages with an open cut installation include the requirement for proper construction staging to minimize traffic disruption and the potential for post construction settlement of the backfill materials especially if deep trenches are required.

Pipe installation should be undertaken in accordance with Ontario Provincial Standard Specification (OPSS) 441 (Water Supply Line Installation in Open Cut). The open cut excavations are feasible at the majority of the watermain locations with the exception of the River and Creek crossings.

5.3.1 Vertical Alignment

We understand that a typical depth of cover of 2 m will be maintained through the majority of the open cut sections of the watermain installations. In general the anticipated subsurface conditions at the trench bottom will be stable and excavations will be sufficiently dry during construction. However, although the subsurface conditions at the trench bottom are generally adequate for pipe support, localized soils that are soft/loose or contain organic matter or other deleterious materials may require partial sub-excavation and removal and some pumping from filtered sumps may be required to keep the excavations dry. Increased groundwater control measures may be required where excavations extend into granular soils below the water table (e.g. the silty sand soils encountered in Boreholes BH-8 and BH-9).

5.3.2 Excavation Methods

The soils encountered at this site are considered to be suitable for open cut excavation using trenching and excavating equipment, such as backhoes normally used by contractors for water supply line installations. Excavations should be undertaken in accordance with OPSS 401 and OPSS 402.

The existing soils inherently contain cobbles and boulders as encountered in the boreholes. Boulder frequency is unlikely to be high enough to prevent the use of conventional trenching and excavating equipment.

5.3.3 Pipe Bedding

The bedding for the watermain must conform to the requirements of OPSD as appropriate. Additional bedding requirements that may be imposed by the pipe supplier or the Region of Waterloo must also be followed.

Granular “A” material meeting OPSS 1010 should be used as pipe bedding. Prior to placing the pipe bedding, any accumulation of water at the base of the excavation should be removed and any soft/loose soils should be subexcavated and replaced with compacted granular fill or pipe bedding material. Placement of the pipe bedding must be carried out in the dry.

The bedding and cover material should be placed in 150 mm thick loose lifts and uniformly compacted to at least 95 per cent of the materials Standard Proctor Maximum Dry Density (SPMDD) using suitable vibratory compaction equipment.

5.3.4 Trench Backfill

The majority of the fill and native soils are generally considered suitable for reuse as trench backfill provided they are free of topsoil, organic material or other deleterious material and provided that these soils are approved for use by the geotechnical engineer. Trench backfill materials should be placed in maximum 300 mm loose lifts and be uniformly compacted in accordance with OPSS 501.

Where the alignments are located below, or crosses existing roadways, it is recommended that the trench be backfilled with OPSS Granular 'B' Type I materials compacted to 100 per cent of SPMDD in accordance with Region of Waterloo standards. Elsewhere the backfill may consist of the excavated soil compacted to 95 per cent SPMDD.

To achieve the specified compaction, soils must neither be too wet nor too dry of their optimum moisture content. Soils that are too wet cannot be used immediately because the material will have to be dried to about ± 2 % of the optimum moisture content. If the construction operations are time sensitive, the use of imported granular material may be considered. Soils that are dry of optimum can be used immediately provided that the material is moisture conditioned (i.e. water added) to achieve a moisture content of ± 2 % of optimum.

It should be noted that backfilling will be undertaken in the narrow confines of trenches and achieving adequate compaction may be difficult given the space constraints. Therefore, it is recommended that the placing and compacting of backfill materials be done under close supervision.

Normal post-construction settlement of the compacted backfill materials equivalent to about 1-2 % of the backfill height is anticipated to occur within about six months following the completion of the backfilling operations.

5.3.5 Trench Clay Plugs and Cut-off Collars

Where the invert of the trench is below the water table clay plugs or cutoff collars are usually installed in trenches to minimize the extent of groundwater lowering due to the "French Drain" effect of the granular bedding and backfill material.

Clay plugs should be placed in the trenches at 50 m intervals (or less) along the full length of the trench, where the invert of the trench is below the water table. The plug should be 1 m thick measured along the pipe, and should completely replace the granular bedding and sand backfill placed above the spring line and obvert of the sanitary sewer and water supply line pipes. The clay plugs should be compacted to at least 95 per cent SPMDD.

Material used for the clay plugs should contain not less than 15 % of particles finer than 2 microns and the compacted mass should have a coefficient of permeability less than 10^{-6} cm/s.

Alternatively, cut off collars consisting of unshrinkable fill can be installed around the pipe barrel to achieve the same effect. Collars should not be placed closer than 1 m to a pipe joint and precautions should be taken to ensure that at least 95 per cent SPMDD compaction is achieved on the soil backfill placed around the collars. Watertight connections should be made between the collar and the pipe wall.

5.4 Trenchless Installation Methods

This section of the report provides preliminary geotechnical input associated with the two waterbody crossings (one at the Grand River and the second at Canagagigue Creek Crossing). These recommendations are provided based on our interpretation of the available geotechnical information, our understanding of the project

requirements and the available preliminary design drawings and should be considered preliminary in nature. Further assessment and, if necessary, investigation will be required once additional information on the proposed alignments and river/creek bed topography are known.

The geotechnical recommendations are based on our interpretation of the factual data obtained from the boreholes advanced during the subsurface investigation at this site. The interpretation and recommendations provided are intended to provide the designers with initial information to assess the feasibility of the proposed HDD installation. Where comments are made on construction they are provided in order to highlight those aspects which could affect planning of the project. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

5.4.1 Impact of Subsurface Conditions on Selection of Installation Methods

It is understood that the water line crossings of the Grand River and Canagagigue Creek are proposed to be installed using trenchless installation methods.

The predominant soils at these sites consist of saturated, granular soil deposits typically varying in composition from gravelly sand to sandy gravel. Given the 35 mm inside diameter of the split spoon sampler (which is smaller than the upper limit of gravel size of about 75 mm), the actual gravel percentages that may be present at this site may be greater than the values measured during the laboratory testing and identified in this report. Based on grinding during drilling, and increased resistance to augering, these deposits are inferred to contain cobbles and potentially boulders.

The above noted deposits pose significant constraints to any trenchless installations due to the large water inflows that would occur into excavation/shaft areas, the potential for hole instability/loss of ground and the potential for encountering obstructions (e.g. cobbles/boulders). Trenchless methods that use open face excavation methods, such as jack and bore methods are not considered feasible due to these issues. In this regard, trenchless methods that provide for mechanisms to limit water inflows and minimize the potential for excavation/drillhole instability will need to be considered.

The use of closed-face, microtunnelling methods would be the lowest risk option for installation through these materials but such methods are generally not considered to be economical for the diameter and size of crossings considered.

The use of horizontal directional drilling (HDD) methods could also be considered for the proposed water line installations. However, the coarse granular nature and, in particular the presence of cobbles and large proportions of gravel, will pose significant difficulties and risks with HDD methods. Further discussion related to this installation method is provided in the following sections.

5.4.2 Description of Horizontal Direction Drilling

Horizontal Directional Drilling (HDD) involves boring a small diameter pilot hole from the “entry end” by a steerable, fluid-jet assisted, mechanical cutting tool, and pulling back of the utility pipe through the pilot borehole from the “exit end”. The pilot borehole is reamed to a diameter large enough to make the pulling back of the utility pipe possible. The reamed hole is typically about 1.5 times the diameter of the utility pipe. The hole is stabilized by circulation of a large volume of viscous fluid, generally a bentonite slurry. The drill cuttings are also

removed from the hole by circulation of the slurry. To avoid build-up of friction along the line of the utility pipe, and to minimize "standby" time of the drilling equipment, the pullback operation is carried out continuously, if possible. A large work area for pipe laying and the capacity to handle large volumes of fluid which may require controlled disposal are constraints of any pipe installation by directional drilling.

The main disadvantage of HDD is that the method can run into serious difficulties while boring through gravelly, cobbly, and bouldery soils such as those encountered at the proposed crossing sites. These coarse materials are difficult to be held in suspension and transported to the slurry pit at the entry/exit end. Inside the drilled hole, they can act as obstructions and reaming of the hole or pipe pullback can be problematic. Success in boring and in installation of pipes through gravelly soils has been achieved recently with sophisticated mud management; however, HDD through such materials is still considered risky and must be carried out by highly skilled contractors only.

A common method of dealing with near surface gravelly materials and/or soils containing cobbles is to use a "conductor casing". A conductor casing is a steel pipe with inside diameter slightly larger than the maximum size of the proposed HDD bore. The casing is driven or augered through the gravelly/cobbly surficial soils. Once the gravels/cobbles inside the casing are removed, the drill head enters the ground via the conductor casing.

Maintaining hole stability and avoiding inadvertent return of drilling fluid due to hydraulic fracturing of the overburden soil, called 'frac-outs', are also difficult to control during drilling of non-cohesive soils and require a high level of mud management and driller skill.

5.4.3 Works Area and Drill Entry/Exit Considerations

The typical documented HDD guideline size for works area at drill entry and exit sides are 2000 m^2 and 1500 m^2 respectively. In addition, a pipe laydown area of minimum 7 m width and length equivalent to the length of the pipeline plus about 40 m extending back from the exit side is typically required to fuse the pipe sections and laydown the pipe during pull back. The entry and exit pit locations are determined by the depth of the installations and entry and exit angles.

The Canagagigue Creek crossing is proposed to follow a straight alignment parallel to Jigs Hollow Road which is surrounded by trees in the area of the crossing. Development of the required work areas is likely to require tree removal at this site.

The preliminary water line alignment for the Grand River crossing includes a proposed western bend near the south bank of the river (i.e. on to Sawmill Road). Sawmill Road is located immediately south of the proposed crossing location and residential properties are located on the south side of Sawmill road along the extension of the proposed crossing alignment. Overhead hydro lines are also present in this area which could impact construction staging. There is likely insufficient space/distance available to develop an entry/exit pit at this location (i.e. between the river and Sawmill Road) taking into account the distance that the pit must be setback from the river in order to allow for the required depth of HDD alignment cover for frac-out at the river's edge. Development of the pit on the far side of the road would extend into private residential properties. In this regard, modifications to the alignment may be necessary and it is recommended that the review of the proposed HDD alignment be carried out in conjunction with consultation with an HDD contractor. Compound curves in the bore path (i.e. vertical and horizontal curves combined over the same section of borepath) should be avoided based on the subsurface conditions.

5.4.4 Ground Conditions and Mitigation Measures

The majority of the drill paths will extend through the sandy gravel to gravelly sand deposits. The results of grain size distribution tests completed on selected samples obtain from this deposit shows up to about 60% gravel-sized particles and there are likely zones with even higher proportions of gravel. Cobbles/boulders within the sand and gravel deposits can originate from the igneous and metamorphic rocks of the Canadian Shield and, these can materials have unconfined compressive strengths of up to 250 MPa or more. Further, it is noted that the borehole drilling method used during the current investigation program did not include coring and the random distribution of these materials does not permit estimation of the exact size of the cobbles and boulders nor an estimate of the quantity (overall volume) and frequency of these materials.

The presence of cobbles/boulders was inferred within this deposit and as described above, this may cause substantial problems for the HDD installation. The HDD installation within these deposits may have substantial problems as identified accordance with Table 1 of ASTM F1962-11; such problems could include but not be limited to obstructing the drilling process causing delay, increased wear-and-tear of tools, misalignment and possible additional need for multiple attempts or altering the drill path to avoid large obstructions.

As such, suitable/specialized equipment designed for drilling through gravel, cobbles and boulders will be needed to be used for these crossings to facilitate advancing through soils containing these materials.

The maintenance of hole stability and minimizing the potential of frac-out are also a significant concern for a hole drilled through non-cohesive, wet soils under the water table. These risks can often be mitigated using sophisticated mud management methods carried out by highly skilled HDD contractors.

The surficial sand and gravel deposits (anticipated to contain cobbles and potentially boulders) will likely require use of a section of steel surface casing at drill entry to maintain fluid circulation and hole stability in the unsaturated zone and to avoid frac-outs (inadvertent drill fluid release to ground surface) in the coarse granular soils. The steel surface casing is installed before pilot hole drilling is started, normally by using an air hammer to drive it in open ended but with a casing shoe. The casing can be inclined at 30 percent but cannot be curved. The casing diameter must be large enough to allow the pilot bore and reaming passes to be completed inside the casing. The wall thickness of the casing should be selected such that if the casing is installed by driving, it does not fail/ buckle and the casing can be driven along the specified bore path. The problem of grade control and failure during driving can also be managed by using telescoping casing. The responsibility for structural design of the casing including its size is best left to the contractor, because the design is dependent on its method of installation.

Given the anticipated installation difficulties, consideration should be given to a prequalification process for potential HDD contractors to limit tenderers to those contractors that can demonstrate they have successfully completed installations in similar subsurface conditions.

5.4.5 Hydraulic Fracturing / Drilling Fluid Pressures

The potential for hydraulic fracturing (frac-out) to occur during a directional drill is influenced by several factors including the depth of cover below ground surface, the ground conditions (including fractured or high permeability materials), the hydrostatic head acting in the drill hole and the dynamic drilling fluid pressures that occur during the drilling process. Once initiated, hydraulic fractures occurring in soil will lead to fluid loss and may continue to spread vertically causing fluid movement towards the surface (frac-out). Therefore, the mud pressure in the drillhole should be carefully monitored and controlled while drilling. The required depth of cover

beneath the river/creek beds to minimize the potential for frac-out will need to be finalized at detailed design stage by completing a hydrofracture analysis during future design stages.

The HDD contractor should also responsible for completing a hydraulic fracture analysis before finalizing the drill path. This evaluation should incorporate the specific equipment, materials, drill path geometry and drill plan that will be used. Deeper burial depths, shorter bore lengths, or a combination of these modifications may be considered to reduce frac-out potential.

The drilling fluid design should take into account the requirement for provision of long-term support of the final HDD annulus to minimize the potential for development of post-construction voids/settlements.

Drilling fluid and cutting return to the rig should be monitored as well as visually inspecting the condition of the ground surface for fluid release. In addition, a drilling fluid management plan assessing the properties of the drilling mud should be implemented to control loss of drilling fluid into higher permeable zones. A properly designed drill plan that minimizes excessive drilling pressure and stationary circulation within high permeable zones is also recommended to prevent scoured zones with an increased borehole annulus. The potential for formation of mud rings, poor cutting clearance and difficulty pulling the pipe should be monitored during the drilling process to ensure a clean, well-engineered bore is maintained. If reduced cutting returns or pressure spikes/drops are recorded at the rig occur, then drilling should be stopped and mitigative measures considered and incorporated.

Environmental monitoring of the crossing locations should be carried out during construction. In addition, contingency plans for drilling fluid containment should be implemented in the event of unexpected fluid release to the ground surface. Maintaining the minimum recommended depths of cover below the crossings should reduce the possibility of fluid release by confining the drill path within more consolidated materials due to the confining stress of the overlying soil and lower expected permeability of the clayey materials.

Uncontrolled build-up of downhole pressures could lead to hydraulic fracturing of the soil resulting in drilling fluid release at the surface. Corrective measures such as the use of drilling fluid additives capable of inhibiting the swelling potential of these materials, as well as minimizing the time between the completion of drilling and pulling of the pipe may be required. Prior to the initiation of the directional drill, a plan should be developed with the drilling contractor to establish alarm criteria in relation to downhole pressures and cutting and fluid return to the rig.

Since the HDD drill fluids will take the path of least resistance, there is potential for migration of the drill fluids through the existing boreholes. Therefore, the monitoring wells installed as part of this project should be decommissioned/sealed prior to commencing the HDD operations.

5.4.6 Construction Dewatering

Excavations for the HDD entry and exit points may penetrate below the groundwater table. At this stage in the assessment, the location, dimensions and depths of such excavations are not known but we have assumed, for preliminary purposes, an excavation measuring 15 m in length by 5 m in width and penetrating 3 m below the groundwater table.

The key factor in assessing dewatering for the pit excavation is the potential hydraulic conductivity of the soil that will be encountered below the water table. Based on the maximum hydraulic conductivity measured for the Grand River crossing (5.6×10^{-2} cm/s) the peak groundwater inflow will approximate the Darcy flux across a 3 m

effective face along a 40 m long perimeter. These assumptions yield a peak instantaneous pumping rate of approximately 4000 L/min (5800 m^3/day) neglecting the effect of influx through the excavation base. The same analysis for the Canagagigue Creek crossing yields values about one tenth of those for the Grand River site (400 L/min and 580 m^3/day). Both sites are therefore likely to exceed the 50 m^3/day threshold requiring a Permit to Take Water (PTTW) from the MOECC.

Sustained rates of influx will be substantially lower since the initial dewatering will reduce hydraulic gradients rapidly. During construction, it is expected that the majority of the pumped groundwater will be water removed from storage in close proximity to the works.

Applying Jacob's modified non-equilibrium equation, the dewatering rate (Q) required to adequately lower the groundwater elevation (to a maximum drawdown of 3 m), is estimated as follows:

$$Q = \frac{\pi K(H^2 - h^2)}{ln\, R_o/r_w} + 2\left[\frac{xK(H^2 - h^2)}{2L}\right]$$

Where K = interpreted hydraulic conductivity (48 m/day);

H = average saturated thickness of the aquifer before pumping (10 m);

h = height of dewatering above impermeable base (7 m);

x = excavation length (15 m);

L = line source distance (60 m);

R_o = radius of influence of the cone of depression (500 m); and

r_w = equivalent radius of dewatering area (10 m).

Based on this analysis, the steady state groundwater inflow rate to the proposed Grand River excavation is estimated to be approximately 1000 m^3/day.

Sustained pumping rates are likely to be lower for the Canagagigue Creek crossing given the lower hydraulic conductivities encountered at that location.

Given the small total drawdown, no adverse effects of dewatering are likely with respect to well interference or geotechnical stability however the pumped water will require filtration or settling before discharge.

5.5 Instrumentation and Monitoring

Below the Canagagigue Creek and the Grand River Bridge, the watermain may be installed by trenchless methods and settlement monitoring of settlement-sensitive features (e.g. bridges, roadways etc.) at these locations is recommended. The instrumentation and monitoring program is recommended to:

- Document the effects of the installation on the overlying roadway, utilities and bridge structures;
- Obtain prior warning of ground movements that could occur due to the construction methods and equipment or unforeseen ground condition; and

- Allow adjustments to be made to the installation methods such that the established settlement limits are not exceeded.

A precondition survey should be carried out by the Engineer prior to construction to document the existing conditions of the pavement, ground and structures for the purpose of determining any restoration that may be required due to construction impacts.

A Settlement Monitoring Plan should be prepared by the contractor and should illustrate the approximate locations of the monitoring instruments.

5.6 OHSA Soil Classification

Excavation works must be carried out in accordance with the guidelines outlined in the Occupational Health and Safety Act and Regulations for Construction Projects (OHSA). For the purposes of the OHSA the subsurface soils encountered at this site are classified as follows:

- Fill Material – Type 3 soils above the water table and Type 4 soils below the water table;
- Silty Clay to Clayey Silt – Type 2 (very stiff), 3 (firm to stiff) or 4 (very soft to soft) soils;
- Gravel and Sand to Silt – Type 2 soils above the water table and Type 4 soils below the water table; and
- Silty Sand to Sand and Silt (Till) – Type 1 or 2 soils above the water table and Type 3 soils below the water table.

Where space permits, and provided that proper groundwater control is in place, temporary open-cut excavations through Type 1, Type 2 and Type 3 soils should be made with side slopes formed no steeper than 1 Horizontal to 1 Vertical (1H:1V). The allowable side slopes for excavations made in submerged gravel and sand and silty sand soils or soft clayey soils should be at least 3H:1V or flatter. Alternatively, a temporary support system designed by a qualified professional engineer could be used to support excavation sideslopes.

5.7 Pavement Structure

We understand that as part of the watermain installation, there will be open cut excavations made through the existing pavement structures. The existing pavement structures vary for each roadway section with some sections having a granular surface and others containing hot mix asphalt surfaces. Therefore, the following preliminary pavement designs were recommended for a pavement that is required to last for approximately 10 years after which we assume they will be reconstructed.

The AADT values, annual growth rate and percent of commercial vehicles used for the temporary pavement design were not known at this time. The recommended temporary pavement structures are outlined below:

Recommended Pavement Structure Design for Trench Excavations

Material	Roadway Section Pavement Thickness		
	Sawmill Road and Northfield Drive	Jigs Hollow Road	Hill Street, Covered Bridge Road and Tallwood Drive
HL1 or SP 12.5.FCI (Surface Course)	50 mm	-	40 mm

HL8 or SP 19 (Binder Course)	100 mm	-	50 mm
Granular A Base Course	150 mm	150 mm – 200 mm	150 mm
Granular B Subbase	350 mm	400 mm – 600 mm	300 mm – 400 mm

In addition to the foregoing the following construction details should be taken into consideration:

- PG 64-28 asphalt is recommended for asphalt mixes used for the surface and binder courses;
- The finished pavement surface and layers of the pavement structure should be adequately sloped to provide positive drainage to the edge of the pavement;
- The final subgrade surface should be sloped at least 3% to provide positive drainage towards the side ditches;
- The existing pavement (if applicable) should be saw cut full depth and the asphalt joint between existing pavement and the temporary pavement should be in accordance with applicable Region of Waterloo standards; and
- Continuity of drainage through the granular road base and subbase layers should be maintained between the existing and new sections of pavements. Therefore, the recommended granular thickness of the temporary pavement may have to be increased in some areas to match the thickness of the adjacent granular fill.

During construction the layer thicknesses should be evaluated at each roadway section. The granular base and subbase layer thicknesses of new pavement should not be less than the existing adjacent pavement layers.

Pavement distress is also anticipated due to subsidence of the backfill material within the trenches after construction is complete.

5.8 Soil Analytical Chemistry

5.8.1 Soil Chemical Analyses

Selected soil samples were submitted to ALS for chemical characterization with respect to general inorganic parameters including metals, pH, sodium adsorption ratio (SAR) and electrical conductivity (EC) to assess options for reuse or disposal of excess soils that will be generated during construction. Based on visual and/or olfactory screening of soil samples, these nominal parameters are analysed when there are no indications of environmental impacts. However, additional sampling/testing will likely be required during construction to confirm disposal or re-use options.

The samples were collected during the geotechnical investigation and delivered under chain of custody protocol to an independent Standards Council of Canada (SCC) accredited laboratory (ALS Analytics Inc. in Mississauga, Ontario). Eight samples were submitted for analysis of metals as well as pH, electrical conductivity (EC) and sodium adsorption ratio (SAR). The Certificates of Analysis are included in Appendix C.

In order to characterize the material for potential transfer to another site requiring fill, the results were compared to the Table 1 standards ("Full Depth Background Site Condition Standards" for Residential/Parkland/Institutional/Industrial/Commercial property use) provided in the Ontario Ministry of the Environment (MOE) document entitled "Soil, Ground Water and Sediment Standards for the Use Under Part XV.1 of the Environmental Protection Act" dated April 15, 2011. These soil standards are considered background values derived from the Ontario Typical Range values for the specified land uses and are considered by the MOE to be representative of upper limits of typical province-wide background concentrations in soils. The analytical results were also compared to the Table 2 standards ("Full Depth Generic Site Condition Standards in a Potable Ground Water Condition" for Industrial/Commercial/Community Property Use with coarse textured soils.

Based on the results of chemical analysis, the concentrations of the pH and metal parameters meet the Table 1 standards. Three of eight soil samples exceeded the Table 1 standard for EC and SAR. All of the soil samples met the Table 2 standards for pH, metals, EC and SAR.

Debris or stained/odorous soils, that are encountered during excavation, should be segregated and re-evaluated for disposal or re-use as fill and may require additional chemical analysis.

5.8.2 Soil Aggressiveness to Concrete and Steel Members

Two selected soil samples were analyzed for measurement of water soluble sulphates, soil pH and resistivity. These analyses were carried out to evaluate the potential for the existing subsoil to adversely impact buried concrete or steel members over time. The following table presents the results of the chemical analyses carried out for each sample tested. A copy of the Certificates of Analysis from ALS is provided in Appendix C.

Borehole No. / Sample No.	Depth (m)	Material Description	Parameters Analysed/Results		
			Sulphates ug/g (%)	Resistivity (ohm-cm)	pH
BH-27	1.1	Silty Sand	22 (0.0022)	1580	7.97
BH-15	1.7	Silty Clay	<20 (<0.0020)	6430	7.98

The soluble sulphate concentrations of the two samples were also compared to the Canadian Standard CAN3/CSA A23.1-14 Table 3, Additional Requirements for Concrete Subjected to Sulphate Attack. Comparison of the results indicate that the water soluble sulphate concentrations of the tested soil samples ranges from < 0.002% to 0.002%; therefore, lower than 0.1%. Based on these results there is a negligible potential for sulphate attack on the concrete.

6.0 ADDITIONAL WORK INSPECTION AND TESTING

Prior to finalizing the design of the proposed works and prior to tendering, the geotechnical aspects of the final design drawings/specifications and proposed construction methodology should be reviewed by this office to confirm that the intent of this report has been met and to confirm if additional investigation is warranted.

During construction, Golder Associates Ltd. personnel should carry out periodic monitoring during excavations for the watermain construction to confirm that the subsurface conditions encountered at subgrade level are

consistent with those in the boreholes and to identify potential zones of weaker soils that would require remedial works. Golder Associates personnel should also carry out sufficient site visits and inspections during the water crossings construction to monitor conformance with the pertinent project specifications.

7.0 CONSTRUCTION CONCERNS

Potential construction concerns associated with the water supply installation include, but are not necessarily limited to:

- Encountering unforeseen subsurface conditions along the length of the proposed alignments such as more extensive fills, greater thicknesses of cohesionless soils over a longer portion of the alignment, etc.;
- Encountering obstructions such as cobbles and boulders;
- Disturbance to buried utilities and structures (high pressure gas) due to trenchless operations; and
- Groundwater levels that are higher at the time of construction than those recorded.

8.0 CLOSURE

This report is intended to summarize available data on subsurface soil and groundwater conditions for the subject site and to provide preliminary engineering comments and recommendations as input to the CLASS EA study of the proposed works. The data contained in this report was obtained from the current investigation and referenced other readily available subsurface data. The recommendations contained in this report should be reviewed during future design stages when additional details on the water supply line alignment and proposed construction methods are available.

We trust this report is sufficient for your immediate requirements. Should you have any comments or questions, please do not hesitate to contact us.

GOLDER ASSOCIATES LTD.

Joe M. Tavares, C.E.T.
Principal

Kevin Nelson, P.Eng.
Principal

JMT/MM/KN/CM/JCC/VM/ll

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use o f the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

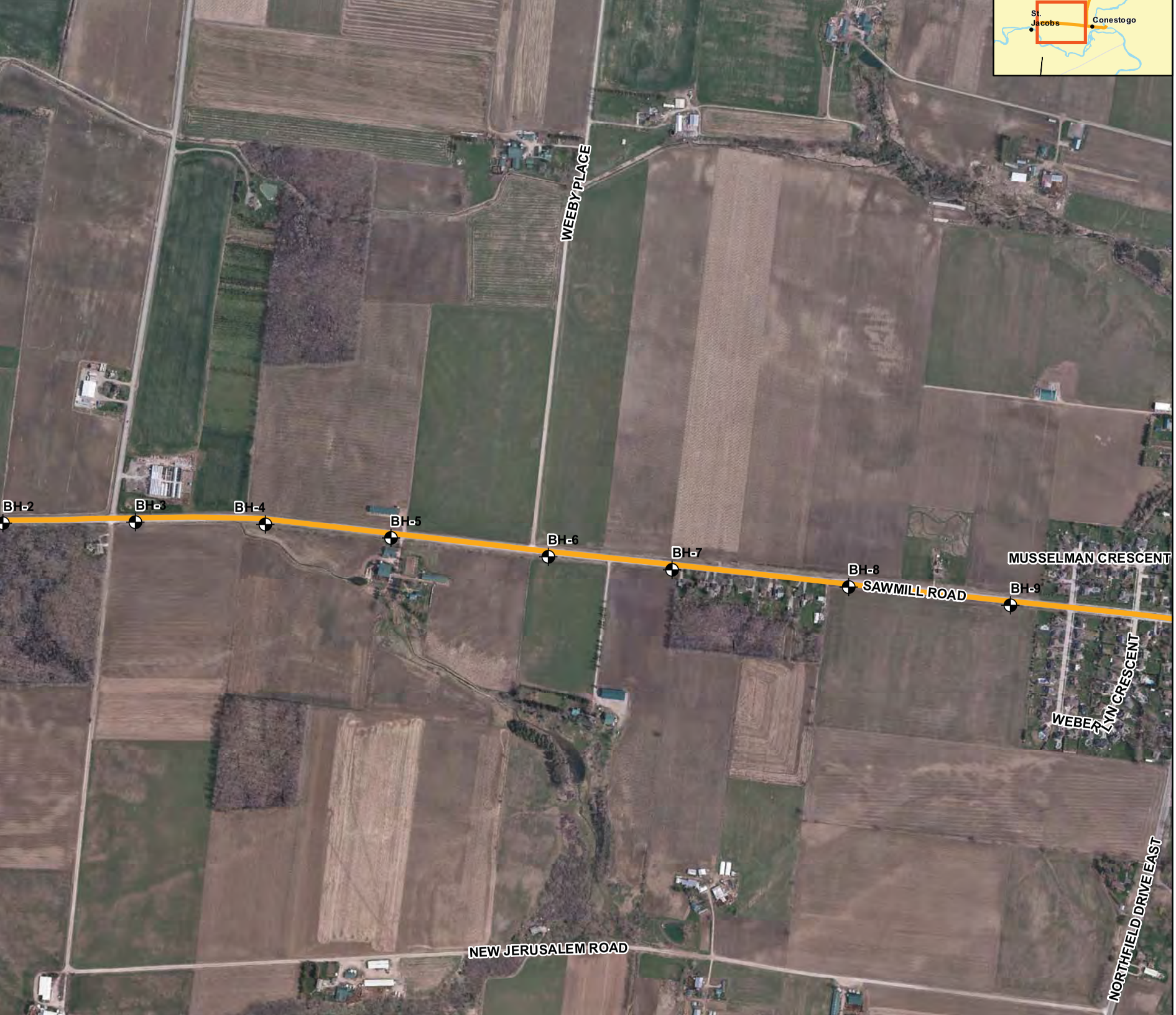
Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.



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PROJECT
GEOTECHINICAL IN
WATER SUPPLY

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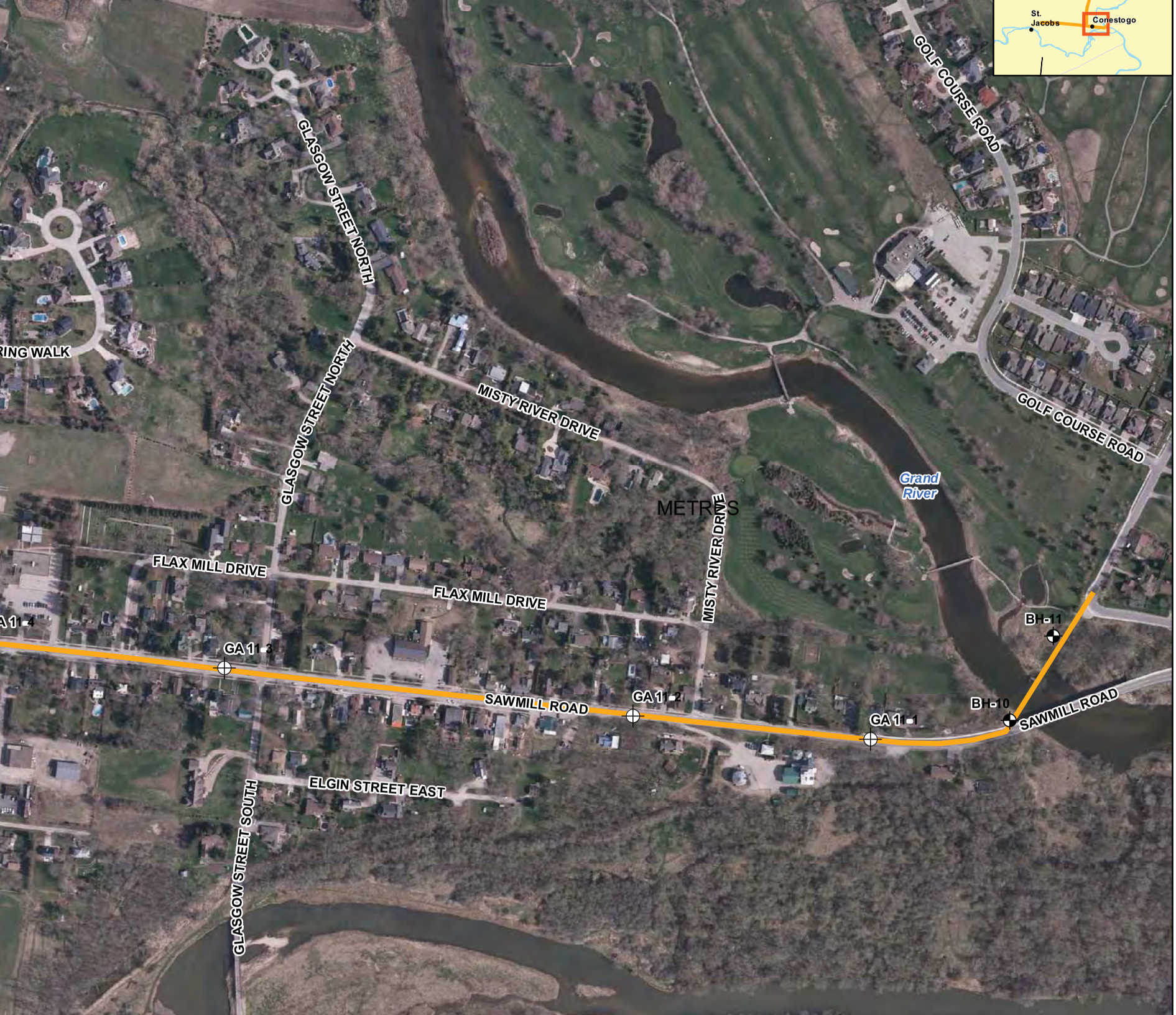
CONSULTANT



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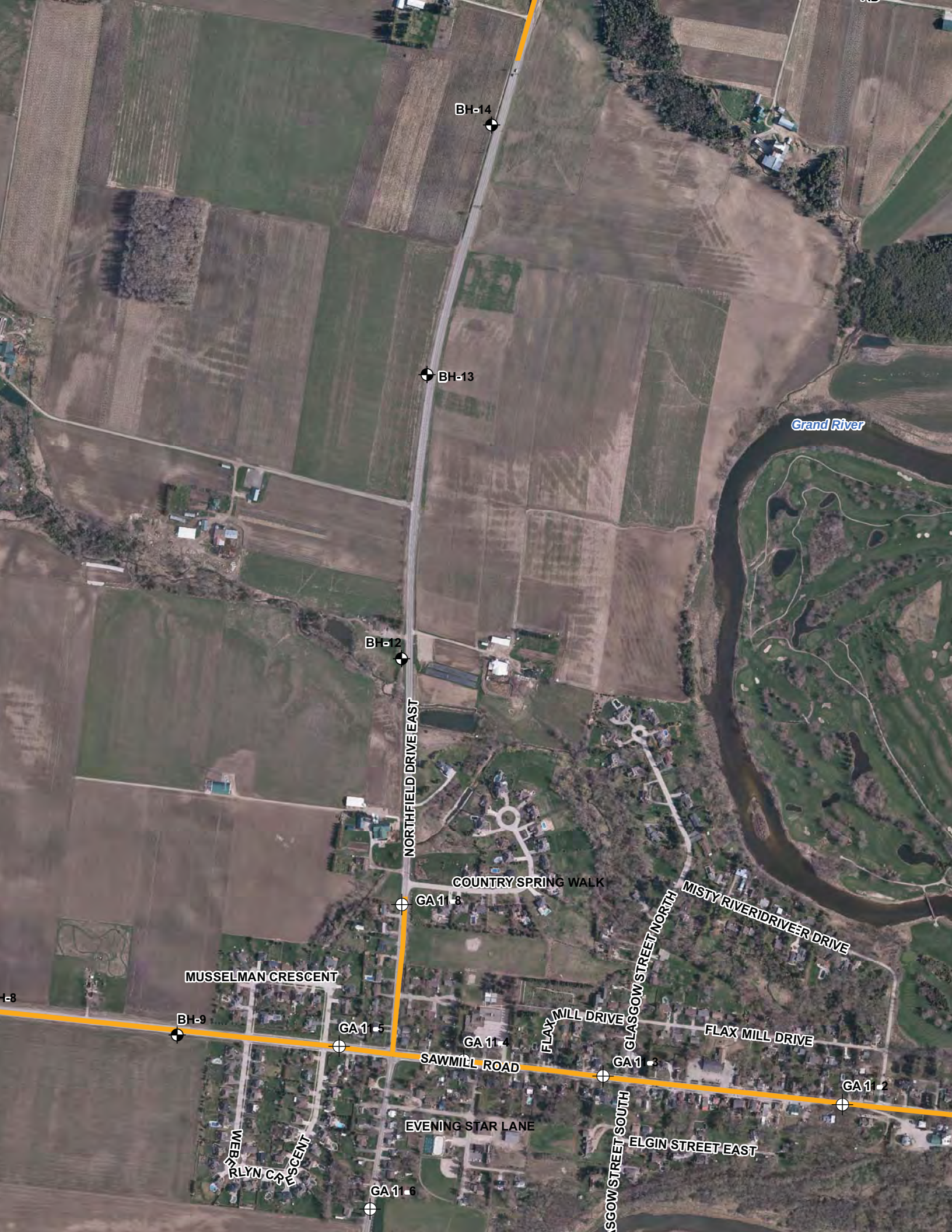
BH-14
BH-13
Grand River
BH-12
NORTHFIELD DRIVE EAST
COUNTRY SPRING WALK
GA 1-8
MISTY RIVERIDRIVE:R DRIVE
GLASGOW STREET NORTH
MUSSELMAN CRESCENT
BH-9
GA 1-5
GA 1-4
FLAX MILL DRIVE
FLAX MILL DRIVE
SAWMILL ROAD
GA 1-3
GA 1-2
EVENING STAR LANE
ELGIN STREET EAST
GLASGOW STREET SOUTH
GA 1-6

ROAD
BH-19
JIGS HOLLOW ROAD
TRY LANE
NORTHFIELD DRIVE EAST
BH-18
BH-17
PEEL STREET
BH-15
BH-16

HILL
BH-24
BH-25
DRIVE
RIVERS EDGE DRIVE
BH-23
LETSON DRIVE
JIGS HOLLOW ROAD
BH-22
LETSON DRIVE
Grand
River

APPENDIX A

Abbreviations and Terms used on Records of Boreholes and Test Pits
List of Symbols
Record of Borehole Sheets BH1 – BH27
Record of Borehole Sheets GA11-1 – GA11-8

September 2015
Report No. 1521180

Golder Associates

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 9	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLA	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)
> 12 to 35	rimary soil name prefixed with "gravelly, sandy, SILT , CLA E " as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (40 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
S	oil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
T	Thin-walled, open – note size
T	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
L , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
C E	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
	sieve analysis for particle size
	combined sieve and hydrometer ( ) analysis
C	Modified roctor compaction test
S C	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
(F)	field vane (LV-laboratory vane test)
γ	unit weight

. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
ery Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
ery Dense	>50

1. S T 'N' in accordance with AST D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on S T 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength kPa)	SPT 'N'[1] blows/0.3m)
ery Soft	<12	0 to 2
Soft	12 to 25	2 to 4
irm	25 to 50	4 to 8
Stiff	50 to 00	8 to 15
ery Stiff	100 to 200	15 to 30
ard	>200	>30

1. S T 'N' in accordance with AST D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < L	Material is estimated to be drier than the Plastic Limit.
w ~ L	Material is estimated to be close to the lastic Limit.
w > L	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 0
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ , σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress = $(\sigma + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties continued)

w	water content
w_l or LL	liquid limit
w_p or L	plastic limit
I_p or I	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
CR	over-consolidation ratio = σ'_p / σ'_{vo}

d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma + \sigma_3)/2$
p′	mean effective stress $(\sigma' + \sigma'_3)/2$
q	$(\sigma - \sigma_3)/2$ or $(\sigma' - \sigma'_3)/2$
q_u	compressive strength $(\sigma - \sigma_3)$
S_t	sensitivity

Notes: $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 1521180

LOCATION: N 4821291.86; E 536758.34

RECORD OF BOREHOLE: BH-1

SHEET 1 OF 1

BORING DATE: March 17, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		342.63							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SM/GP) SILTY SAND and GRAVEL; brown; non-cohesive, moist, compact		0.00	1	SS	16		○	M	
				341.87							
1		FILL - (CL) SILTY CLAY, some gravel, trace sand, some organics; black; cohesive, w<PL, hard		0.76	2	SS	37*		○		
				341.18							
2		(CL) SILTY CLAY, some sand, trace gravel; brown; cohesive, w~PL, soft to firm		1.45	3	SS	4		○		
				340.42							
3		(CI) SILTY CLAY, trace sand, trace gravel; brown (TILL); cohesive, w<PL, very stiff		2.21	4	SS	17		◐		
					5	SS	28		○		
4				338.52	6A				○		
		(SM) SILTY SAND, some gravel, trace clay; brown (TILL); non-cohesive, moist, very dense		4.11	6B	SS	71/ 0.25		○		
				4.22							
5		END OF BOREHOLE NOTE: 1. Open borehole dry upon completion of drilling. * STP N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

GTA-BHS 001 S:\CLIENTS\CIMA\CONESTOGO_PLAINS_WATER_SUPPLY_WATERLOO_ON\02_DATA\GINT\1521180.GPJ GAL-MIS.GDT 8/27/15

PROJECT: 1521180

LOCATION: N 4821294.51; E 537039.64

RECORD OF BOREHOLE: BH-2

BORING DATE: March 17, 2015

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp ○ W WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		341.40							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, trace to some silt; brown; non-cohesive, moist, compact to very dense		0.00	1	SS	22*		○		
					2	SS	60/ 0.15*		○		
1		(CI) SILTY CLAY, trace sand, trace gravel; brown (TILL); cohesive, w PL to w<PL, stiff to hard		340.33 1.07							
2					3	SS	15		○		
					4	SS	33		○		
3											
					5	SS	13		○		
4				336.98	6	SS	20		○		
		END OF BOREHOLE		4.42							
5		NOTE: 1. Open borehole dry upon completion of drilling. SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

GTA-BHS 001 S:\CLIENTS\CIMA\CONESTOGO_PLAINS_WATER_SUPPLY_WATERLOO_ON\02_DATA\GINT\1521180.GPJ GAL-MIS.GDT 8/27/15

PROJECT: 1521180

RECORD OF BOREHOLE: BH-3

SHEET 1 OF 1

LOCATION: N 4821298.49; E 537315.74

BORING DATE: March 17, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		339.67									
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP) SAND and GRAVEL, trace to some silt, trace organics; brown; non-cohesive, moist, compact		0.00	1	SS	25*				W		Concrete
1					2A								
		(CL) SILTY CLAY, some sand, trace gravel, some organics; black; cohesive, w PL, very stiff		338.60 1.07		SS	30						
					2B						W		Bentonite Seal Apr. 25, 2015
2		(CI) SILTY CLAY, trace to some sand, trace to some gravel; brown (TILL); cohesive, w<PL to w~PL, stiff to very stiff		338.15 1.52	3	SS	14				W		
					4	SS	17				W		
3		(CL) Sandy SILTY CLAY, trace gravel; brown (TILL); cohesive, w<PL to w PL, very stiff - 15 cm thick sand seam encountered at a depth of 3.2 m		336.70 2.97	5	SS	19				W		Silica Sand Filter
4					6	SS	25				W		
				335.25									
		END OF BOREHOLE		4.42									
5		NOTE: 1. Water level measurements in piezometer: Date / Depth (m) / Elevation (m) 3/17/15 / 3.40 / 336.27 4/25/15 / 1.18 / 338.89 SPT N-Value impacted by frost.											
6													
7													
8													
9													
10													

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: DD
CHECKED: JMT

GTA-BHS 001 S:\CLIENTS\CIMA\CONESTOGO_PLAINS_WATER_SUPPLY_WATERLOO_ON\02_DATA\GINT\1521180.GPJ GAL-MIS.GDT 8/27/15

PROJECT: 1521180

RECORD OF BOREHOLE: BH-4

SHEET 1 OF 1

LOCATION: N 4821297.28; E 537576.41

BORING DATE: March 17, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		338.89									
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, some silt; brown, containing cobbles; non-cohesive, moist, very dense		0.00 / 338.13	1	SS	60/ 0.15*				○		
1		(CL) Gravelly SILTY CLAY, some sand; brown; non-cohesive, w>PL, very stiff		0.76 / 337.37	2	SS	26*				○		
2		(CI) SILTY CLAY, trace sand, trace gravel; brown (TILL); cohesive, w<PL to w PL, stiff to very stiff		1.52	3	SS	9				○		
		- 8 cm thick silt seam encountered at a depth of 2.6 m			4	SS	23				○		
3					5	SS	24				○		
4					6	SS	26				○		▽ Mar. 17, 2015
		END OF BOREHOLE		334.57 / 4.32									
5		NOTE: 1. Water level in open borehole measured at a depth of 3.96 m below ground surface upon completion of drilling. SPT N-Value impacted by frost.											
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-5

SHEET 1 OF 1

LOCATION: N 4821261.20; E 537871.00

BORING DATE: March 17, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		339.28							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, trace to some silt; brown; non-cohesive, moist, compact to very dense		0.00	1	SS	25*		○		
				338.42	2	SS	50/ 0.10*		○		
1		(CL) Sandy SILTY CLAY, some gravel; brown, containing rootlets; cohesive, w>PL, firm		0.86							
2					3	SS	7		○		
				337.07							
		(CI) SILTY CLAY, trace sand; brown; cohesive, w<PL, very stiff		2.21	4	SS	26		○	MH	
				336.31							
3		(ML) Sandy SILT, trace plastic fines, trace gravel; brown; non-cohesive, moist, very dense		2.97	5	SS	52		○		
4		- 8 cm thick sand seam encountered at a depth of 4.0 m		335.04	6	SS	91/ 0.28		○		
		END OF BOREHOLE		4.24							
5		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		* SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-6

SHEET 1 OF 1

LOCATION: N 4821222.93; E 538207.91

BORING DATE: March 18, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○; 20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		340.00							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, trace silt; brown; non-cohesive, moist, compact to dense		0.00	1	SS	28*		○		
					2A				○		
1		FILL - (CL) SILTY CLAY, some sand, trace to some gravel, some organics; black, containing rootlets; cohesive, w~PL		338.93 1.07	2B	SS	42*				
		(CI) Sandy SILTY CLAY, some gravel; brown; cohesive, w>PL, firm to stiff		338.40	3A				○		
		- 15 cm thick sand seam encountered at a depth of 1.7 m		1.60	3B	SS	11				
2					4	SS	7		○		
3				336.75	5A						
		(CI) SILTY CLAY, trace sand, trace gravel; brown (TILL); cohesive, w<PL, very stiff		3.25	5B	SS	25		○		
				336.19							
4		(ML) Sandy SILT; brown; non-cohesive, moist, dense		3.81	6	SS	31		○		▽ Mar. 18, 2015
				335.58							
		END OF BOREHOLE		4.42							
5		NOTE:									
		1. Water level in open borehole measured at a depth of 4.37 m below ground surface upon completion of drilling.									
6		SPT N-Value impacted by frost.									
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: DD

CHECKED: JMT

Golder Associates

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PROJECT: 1521180

LOCATION: N 4821199.15; E 538470.10

RECORD OF BOREHOLE: BH-7

BORING DATE: March 18, 2015

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○; 20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		339.96							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, some silt, trace organics; brown; non-cohesive, moist, compact		0.00	1	SS	30*		○		
				339.35							
1		(CL) SILTY CLAY, trace sand, trace organics; brown to black, containing rootlets; cohesive, w~PL		0.61	2	SS	19*		○		
				338.39	3A						
		(CL) Sandy SILTY CLAY, trace to some gravel; brown; cohesive, w>PL, soft to stiff		1.57	3B	SS	3		○		
2					4	SS	4		○		
3					5	SS	9		○		
				336.23							
		(CI) SILTY CLAY, some sand; brown; cohesive, w<PL, hard		3.73							
4					6	SS	34		○		
		- 15 cm thick silt and sand seam encountered at a depth of 4.3 m		335.54							
		END OF BOREHOLE		4.42							
5		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-8

SHEET 1 OF 1

LOCATION: N 4821160.57; E 538824.60

BORING DATE: March 18, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		337.67							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, compact		0.00 / 337.47	1A				○		
		(CL) Sandy SILTY CLAY, trace gravel, trace organics; brown to black; cohesive, w<PL, stiff		0.20 / 336.98	1B	SS	12				
1		(SM) SILTY SAND, trace to some gravel, trace plastic fines; brown; non-cohesive, moist, very loose to compact		0.69	2	SS	27*		○		
2					3	SS	2		○		Mar. 18, 2015
		(CI) SILTY CLAY, trace to some sand, trace gravel; brown (TILL); cohesive, w<PL to w~PL; very stiff to hard		335.46 / 2.21	4	SS	22		○		
3		- 10 cm thick sand seam encountered at a depth of 3.1 m.			5	SS	36		○		
4					6	SS	22		○		
		END OF BOREHOLE		333.25 / 4.42							
5		NOTE: 1. Water level in open borehole measured at a depth of 1.83 m below ground surface upon completion of drilling. SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-9

SHEET 1 OF 1

LOCATION: N 4821131.13; E 539103.85

BORING DATE: March 18, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		336.47							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, trace silt; brown; non-cohesive, moist, compact		0.00 / 336.17	1A	SS	20				Concrete
		FILL - (CL) SILTY CLAY, trace sand, trace organics; black; cohesive, w PL, very stiff		0.30 / 335.86	1B						
		(SM) SILTY SAND, trace gravel, trace plastic fines; brown; non-cohesive, moist, compact		0.61 / 335.56	2A						Bentonite Seal
1		(CL) SILTY CLAY, some sand, trace organics; brown; w<PL, stiff		0.91 / 334.95	2B	SS	21				Apr. 25, 2015
2		(SM) SILTY SAND, trace to some gravel, trace plastic fines; brown; non-cohesive, moist, compact		1.52 / 332.96	3	SS	12				
					4	SS	15				
3					5A						Silica Sand Filter
		(CI) SILTY CLAY, trace to some sand, trace gravel; brown to grey (TILL); cohesive, w<PL, very stiff		3.51 / 332.05	5B	SS	21				
4					6	SS	22				
		END OF BOREHOLE		4.42							
5		NOTE:									
		1. Water level measurements in piezometer:									
		Date / Depth (m) / Elevation (m): 3/18/15 / 1.88 / 334.59; 4/25/15 / 1.03 / 335.44									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: DD

CHECKED: JMT

Golder Associates

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PROJECT: 1521180

LOCATION: N 4820986.74; E 540800.36

RECORD OF BOREHOLE: BH-10

BORING DATE: March 26, 2015

SHEET 1 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		316.98							
0	Power Auger, 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	(OL) ORGANIC SILT; black; cohesive		0.00 / 316.68	1A						Concrete
		(CL) Sandy SILTY CLAY, trace sand, trace gravel; brown; cohesive, hard		0.30 / 316.22	1B	SS	31*				
1		(SM) SILTY SAND, some gravel; brown; non-cohesive, moist, compact		0.76 / 315.61	2	SS	18				
		(SP/GP) SAND and GRAVEL, some silt to silty ; brown; non-cohesive, moist to wet, compact		1.37 / 314.77	3	SS	12				
2		(SM/GP) SILTY SAND and GRAVEL; brown; non-cohesive, moist, compact		2.21 / 313.17	4	SS	10				Bentonite Seal
3					5	SS	11				
4		(SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist to wet, compact		3.81 / 311.34	6	SS	13				
5					7	SS	11			M	▽
6		(SM/GP) SILTY SAND and GRAVEL to gravelly SILTY SAND; brown, contains cobbles and boulders; non-cohesive, wet, compact to very dense		5.64	8	SS	7				
7					9	SS	50/0.05				Silica Sand Filter
		Auger grinding below a depth of 7.8 m									
8		Refusal or piece of wood encountered at a depth of 8.2 m Re-augered borehole at 0.5 m offset to 8.2 m			10	SS	42				
9					11	SS	29			MH	
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-10

SHEET 2 OF 2

LOCATION: N 4820986.74; E 540800.36

BORING DATE: March 26, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROF LE: DESCR PTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAM C PENETRAT ON RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE NSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
				306.56	12	SS	50/ 0.05				
		END OF BOREHOLE		10.42							
11		NOTE:									
		1. Water level measurements in piezometer:									
		Date / Depth (m) / Elevation (m): 3/26/15 / 5.61 / 311.37; 3/29/15 / 5.71 / 311.27; 4/25/15 / 5.52 / 311.46									
12		* SPT N-Value impacted by frost.									
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-11

SHEET 1 OF 2

LOCATION: N 4821071.49; E 540838.04

BORING DATE: March 12, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		312.44							Stick Up 0.33 m
0	Power Auger, 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	(OL) ORGANIC SILT, trace sand; black, containing rootlets; non-cohesive, moist, very loose		0.00	1	SS	2				Concrete
				311.75							Apr. 25, 2015
1		(CL) Sandy SILTY CLAY, trace organics; brown; cohesive, w~PL, very soft		0.69	2	SS	1				Bentonite Seal
				310.99							
2		(OL) ORGANIC SILT, some sand; black, containing rootlets; non-cohesive, moist, very loose Auger grinding at a depth of 1.8 m		1.45	3	SS	2			86.7	
				310.00	4A 4B						
		(SP/GP) SAND and GRAVEL, some silt to Gravelly SILTY SAND; brown and grey, contains cobbles and/or boulders; non-cohesive, wet, compact to very dense Auger grinding throughout the deposit below a depth of 3.0 m		2.44	4C	SS	21				
3					5	SS	31			MH	
4											
5					6	SS	43				Silica Sand Filter
6					7	SS	50/ 0.05			MH	
7											
8					8	SS	61/ 0.15				
9				303.14	9	SS	72/ 0.15				
		END OF BOREHOLE		9.30							
		NOTE: 1. Water level measurements in									
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

LOGGED: AB

CHECKED: MCK

Golder Associates

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-11

SHEET 2 OF 2

LOCATION: N 4821071.49; E 540838.04

BORING DATE: March 12, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROF LE: DESCR PTION	SOIL PROF LE: STRATA PLOT	SOIL PROF LE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAM C PENETRAT ON RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE NSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
		piezometer: Date Depth (m) Elevation (m) 3/12/15 1.27 311.17 3/29/15 0.90 311.54 4/25/15 0.60 311.84									
11											
12											
13											
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16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

GTA-BHS 001 S:\CLIENTS\CIMA\CONESTOGO_PLAINS_WATER_SUPPLY_WATERLOO_ON\02_DATA\GINT\1521180.GPJ GAL-MIS.GDT 9/2/15

PROJECT: 1521180

RECORD OF BOREHOLE: BH-12

SHEET 1 OF 1

LOCATION: N 4821815.97; E 539603.62

BORING DATE: March 17, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		332.82							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, compact		0.00	1	SS	35*		○		
				332.21							
1		FILL - (CL) SILTY CLAY, some sand to sandy, trace to some gravel; brown, containing trace organics to a depth of 2.1 m; cohesive, w<PL to w~PL, very stiff		0.61	2	SS	39*		○		
					3	SS	17		○		
2		- 10 cm thick sand seam encountered at a depth of 2.0 m.			4	SS	16		○		
				329.85							
3		(CI) SILTY CLAY, trace sand, trace gravel; brown (TILL); cohesive, w<PL, very stiff		2.97	5	SS	24		○		
4					6	SS	22		○		
				328.40							
		END OF BOREHOLE		4.42							
5		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

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PROJECT: 1521180

LOCATION: N 4822264.33; E 539638.28

RECORD OF BOREHOLE: BH-13

BORING DATE: March 17, 2015

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		339.89							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, some silt; brown; moist, very dense		0.00	1	SS	74*				
				339.20							
1		FILL - (CL) SILTY CLAY, some sand, trace gravel, trace organics; brown to black, containing rootlets; cohesive, w~PL		0.69	2	SS	30*				
				338.44							
2		(CL) Sandy SILTY CLAY, some gravel; brown (TILL); cohesive, w<PL, very stiff		1.45	3	SS	16				
					4	SS	17				
				336.92							
3		(Cl) SILTY CLAY, trace sand, trace gravel; brown to grey (TILL); cohesive, w<PL, very stiff		2.97	5	SS	26				
4					6	SS	21				
				335.47							
		END OF BOREHOLE		4.42							
5		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-14

SHEET 1 OF 1

LOCATION: N 4822686.19; E 539743.62

BORING DATE: March 18, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		338.48									
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, trace silt; brown; non-cohesive, moist, compact		0.00 / 338.18	1A	SS	29*				○		
		(CL) SILTY CLAY, some sand to sandy; brown, containing organics to a depth of 0.61 m; cohesive, w PL, very stiff		0.30	1B								
1					2	SS	25				○		
		(SM) SILTY SAND, some gravel; brown; non-cohesive, moist, very loose		337.03 / 1.45									
2		- 10 cm thick sand seam encountered at a depth of 1.7 m.			3	SS	3				○		
		(CL) Sandy SILTY CLAY, some gravel; brown (TILL); cohesive, w PL, very stiff		336.27 / 2.21	4	SS	17				○		
3		(CI) SILTY CLAY, trace to some sand, trace gravel; brown to grey (TILL); cohesive, w<PL, very stiff		335.51 / 2.97	5	SS	23				○		
4					6	SS	26				○		
		END OF BOREHOLE		334.06 / 4.42									
5		NOTE: 1. Open borehole dry upon completion of drilling. SPT N-Value impacted by frost.											
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DD

CHECKED: JMT

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-15

SHEET 1 OF 1

LOCATION: N 4823085.21; E 539902.16

BORING DATE: March 27, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		331.76							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, compact		0.00	1A	SS	29*				
				331.40							
		FILL - (CI) SILTY CLAY, trace gravel; brown; cohesive, w<PL		0.36	1B						
				331.07							
		(CI) SILTY CLAY, trace to some gravel, trace sand; brown to grey; cohesive, w<PL to w PL, very stiff		0.69							
1					2	SS	28*				
2					3	SS	24				
3					4	SS	21				
					5	SS	15				
4					6	SS	24				
				327.34							
		END OF BOREHOLE		4.42							
5		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)

WATER CONTENT PERCENT — Wp ○ W I WI (10 20 30 40)

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-16

SHEET 1 OF 1

LOCATION: N 4823013.00; E 540409.92

BORING DATE: March 27, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		331.57									
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, compact		0.00	1A	SS	30						Concrete
				331.27									
		FILL - (CL) SILTY CLAY, some sand, some gravel; brown; cohesive, w~PL, very stiff		0.30	1B								
				330.88									
1		FILL - (SM) SILTY SAND, some gravel; brown, containing pockets of silty clay; non-cohesive, w<PL, compact		0.69	2	SS	23						Bentonite Seal
				330.12									
2		(GP) Sandy GRAVEL, some silt to silty; brown; non-cohesive, moist to wet, dense to very dense Cobbles encountered at a depth of 1.5 m		1.45	3	SS	44						Apr. 25, 2015
					4	SS	54						
3					5	SS	51						Silica Sand Filter
4					6	SS	54						
				327.15									
		END OF BOREHOLE		4.42									
5		NOTE: 1. Water level measurements in piezometer: Date / Depth (m) / Elevation (m) 3/27/15 / 2.78 / 328.79 3/25/15 / 2.39 / 329.18											
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

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PROJECT: 1521180

LOCATION: N 4823324.78; E 540537.58

RECORD OF BOREHOLE: BH-17

BORING DATE: March 17, 2015

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		332.49							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, dense		0.00 / 331.88	1	SS	35				
1		(SM) SILTY SAND, some gravel; brown; non-cohesive, moist, compact		0.61 / 330.28	2	SS	30		○		
2					3	SS	15				
		(SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, dense		2.21 / 329.52	4	SS	37		○		
3		(GP) Sandy GRAVEL, some silt; grey, cobbles inferred; non-cohesive, wet, very dense		2.97 / 328.76	5	SS	81/ 0.25		○		
		(CL) Sandy SILTY CLAY, some gravel; brown; cohesive, w>PL, very stiff		3.73 / 328.07	6	SS	26		○		▽ Mar. 17, 2015
		END OF BOREHOLE		4.42							
4		NOTE: 1. Water level in open borehole measured at a depth of 3.96 m below ground surface upon completion of drilling.									
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-18

SHEET 1 OF 1

LOCATION: N 4823801.56; E 540622.29

BORING DATE: March 26, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		341.84							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SW/GP) SAND and GRAVEL, trace silt; brown; non-cohesive, moist, dense		0.00	1	SS	39		○		
				341.15							
1		FILL - (CL) SILTY CLAY, some sand to sandy, trace gravel; black to brown containing organics to a depth of 1.4 m; cohesive, w~PL, firm to very stiff		0.69	2A	SS	24				
					2B						
					3A				○		
				340.01							
2		(SM) SILTY SAND, trace gravel; brown; non-cohesive, wet, loose to compact		1.83	3B	SS	7				
					4A						
				339.25							
3		(CI/CL) SILTY CLAY, trace to some sand, trace gravel; brown; cohesive, w PL, very stiff		2.59	4B	SS	21				
					5A				○		
				338.49							
		(SM/GP) SILTY SAND and GRAVEL; brown; non-cohesive, wet, compact		3.35	5B	SS	15				
				338.11							
4		(CI) SILTY CLAY, some sand, trace gravel; grey; cohesive, w~PL, stiff		3.73	6	SS	9				
				337.34							
		(SM) SILTY SAND, some gravel; grey (TILL); non-cohesive, moist, very dense		4.50	7	SS	63		○		
5				336.66							▽ Mar. 26, 2015
		END OF BOREHOLE		5.18							
		NOTE:									
		1. Water level in open borehole measured at a depth of 2.13 m below ground surface upon completion of drilling.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MC

CHECKED: MCK

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-19

SHEET 1 OF 1

LOCATION: N 4824335.25; E 540711.64

BORING DATE: March 26, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		336.00							
0	Direct Push, 83 mm Outer Diameter, 76 mm Inner Diameter Dual Tube	FILL - (SP/GP) Silty SAND and GRAVEL; brown; non-cohesive, moist, dense		0.00	1	SS	37*				
				335.24							
1		(SM) SILTY SAND, trace to some gravel, trace plastic fines; brown; non-cohesive, moist, very dense		0.76	2	SS	82*		○		
					3	SS	88*				
2					4	SS	178		○		
				333.10							
3		END OF BOREHOLE		2.90							
		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		SPT N-Value impacted by frost.									
4											
5											
6											
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10											

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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

PROJECT: 1521180

LOCATION: N 4824613.12; E 540761.02

RECORD OF BOREHOLE: BH-20

BORING DATE: March 27, 2015

SHEET 1 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		325.30							
0	Power Auger, 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	(SP/GP) SAND and GRAVEL, trace to some silt; brown; non-cohesive, moist to wet		0.00							Gravel; Concrete
1											
2											Bentonite Seal
3											
4				320.73							Apr. 25, 2015
5		(GM) Sandy SILTY GRAVEL; brown; non-cohesive, moist to wet, compact to very dense		4.57	1	SS	14		○		
6					2	SS	47		○		
7					3	SS	63		○	MH	
8											
9				316.16							Silica Sand Filter
		(ML) SILT, some sand, trace gravel, trace organics; brown with black staining; non-cohesive, moist, very dense		9.14	4	SS	65		○		
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

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PROJECT: 1521180

LOCATION: N 4824613.12; E 540761.02

RECORD OF BOREHOLE: BH-20

BORING DATE: March 27, 2015

SHEET 2 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
	Power Auger	(ML) SILT, some sand, trace gravel, trace organics; brown with black staining; non-cohesive, moist, very dense		314.63							Silica Sand Filter
11	Power Auger	(CL) Gravelly Sandy SILTY CLAY; grey (TILL); cohesive, w PL, very hard		10.67	5	SS	92		○	MH	
				314.02							
		END OF BOREHOLE		11.28							
12		NOTE:									
		1. Water level measurements in piezometer:									
		Date / Depth (m) / Elevation (m): 3/27/15 / 3.66 / 321.64; 3/29/15 / 3.70 / 321.60; 4/25/15 / 3.54 / 321.76									
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

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PROJECT: 1521180

LOCATION: N 4824701.54; E 540776.21

RECORD OF BOREHOLE: BH-21

SHEET 1 OF 2

BORING DATE: March 27, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s	WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		325.36									
0	Power Auger, 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	(SP) SAND and GRAVEL, trace silt; brown; moist, non-cohesive, compact to very dense		0.00	1	SS	28						Gravel
1					2	SS	72*						Concrete
					3A	SS	70						
2		(CL) SILTY CLAY, some sand, some gravel; black; cohesive, hard		323.38	3B								
		(SP) SAND, some silt, some gravel; brown with black staining; non-cohesive, moist, compact		1.98 2.11	4	SS	13						Bentonite Seal
3		(CL) SILTY CLAY, some sand, some gravel; brown and black; cohesive, stiff		322.31 3.05	5A								
		(SM/GP) SILTY SAND and GRAVEL; brown; non-cohesive, moist, compact		3.20	5B	SS	10						
		(SP/GP) SAND and GRAVEL to Sandy GRAVEL, some silt, some sand; brown, containing cobbles and boulders; non-cohesive, wet, dense to very dense Auger grinding throughout the deposit below a depth of 3.8 m		321.70 3.66									Apr. 25, 2015
4					6	SS	84						
5					7	SS	45						
6					8	SS	83						
7													
8					9	SS	58					MH	Silica Sand Filter
9													
10					10	SS	149						
		CONTINUED NEXT PAGE											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

GTA-BHS 001 S:\CLIENTS\CIMA\CONESTOGO_PLAINS_WATER_SUPPLY_WATERLOO_ON\02_DATA\GINT\1521180.GPJ GAL-MIS.GDT 9/2/15

PROJECT: 1521180

LOCATION: N 4824701.54; E 540776.21

RECORD OF BOREHOLE: BH-21

SHEET 2 OF 2

BORING DATE: March 27, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s	WATER CONTENT PERCENT (Wp, W, Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---											
10	Power Auger (210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers)	(SP/GP) SAND and GRAVEL to Sandy GRAVEL, some silt, some sand; brown, containing cobbles and boulders; non-cohesive, wet, dense to very dense		314.69									Silica Sand Filter
		(SC) Gravelly CLAYEY SAND, some gravel trace sand; grey (T LL); cohesive, moist, hard		10.67	11	SS	50/ 0.05				Wp, W, Wl	MH	
11													
12					12	SS	131/ 0.08				Wp, W, Wl		
				312.56									
		END OF BOREHOLE		12.80									
13		NOTE:											
		1. Water level measurements in piezometer:											
		Date / Depth (m) / Elevation (m): 3/27/15 / 3.66 / 321.70; 3/29/15 / 4.05 / 321.31; 4/25/15 / 3.60 / 321.64											
14		* SPT N-Value impacted by frost.											
15													
16													
17													
18													
19													
20													

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: AB

CHECKED: MCK

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-22

SHEET 1 OF 1

LOCATION: N 4825193.90; E 540862.10

BORING DATE: March 26, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		333.52							
0	Power Auger 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	FILL - (SW/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, dense		0.00 / 333.06	1A	SS	49*				Protective Casing
		(ML) SILT, some sand, some plastic fines; brown; non-cohesive, moist, dense		0.46 / 332.83	1B						
1		(SM/GP) SILTY SAND and GRAVEL; brown; non-cohesive, moist, dense		0.69 / 332.07	2	SS	31		○		Bentonite Seal
2		(ML) SILT, some sand, some gravel, some plastic fines; brown; non-cohesive, moist, compact		1.45 / 331.31	3	SS	13				Apr. 25, 2015
		(SM) SILTY SAND, some plastic fines, some gravel; brown; non-cohesive, wet, compact		2.21 / 330.93	4A	SS	10		○		
3		(CL) Sandy SILTY CLAY, some gravel; brown (TILL); cohesive, w<PL to w PL, stiff to very stiff		2.59	4B						
					5	SS	14		○		Silica Sand Filter
4				329.41	6	SS	16				
		(SM/GP) SILTY SAND and GRAVEL; brown; non-cohesive, wet, compact		4.11							
5				328.34	7	SS	14		○		
		END OF BOREHOLE		5.18							
6		NOTE: 1. Water level measurements in piezometer: Date / Depth (m) / Elevation (m): 3/26/15 / 3.35 / 330.17; 4/25/15 / 2.20 / 331.32. SPT N-Value impacted by frost.									
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MC

CHECKED: MCK

GTA-BHS 001 S:\CLIENTS\CIMA\CONESTOGO_PLAINS_WATER_SUPPLY_WATERLOO_ON\02_DATA\GINT\1521180.GPJ GAL-MIS.GDT 8/27/15

PROJECT: 1521180

RECORD OF BOREHOLE: BH-23

SHEET 1 OF 1

LOCATION: N 4825749.52; E 540979.83

BORING DATE: March 26, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○; 20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		339.68							
0	Power Auger 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	FILL - (SP/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, dense to very dense		0.00	1	SS	47		○		
					2A						
1				338.61		SS	60*				
		(CL) SILTY CLAY, some sand; dark brown; cohesive, w PL, hard		1.07	2B						
					3A	SS	10				
2				337.70					○		
		(Cl) SILTY CLAY, trace sand, trace gravel; brown; cohesive, w<PL, stiff to very stiff		1.98	3B						
					4	SS	24				
3				336.71					○		
		(Cl) SILTY CLAY, trace sand to sandy, trace gravel; brown; cohesive, w<PL, very stiff to hard		2.97	5	SS	19				
					6	SS	54				
4				335.26							
		END OF BOREHOLE		4.42							
5		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MC

CHECKED: MCK

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-24

SHEET 1 OF 1

LOCATION: N 4826214.40; E 541096.75

BORING DATE: March 26, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		345.10							
0	Power Auger 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	ASPHALT		0.00							
		FILL - (SW/GP) SAND and GRAVEL, trace to some silt; brown; non-cohesive, moist, very dense		0.05	1A	SS	58*		○		
					1B						
				344.19	2A						
1		(ML) SILT, some sand, trace gravel, trace plastic fines, trace organics; black to dark brown; non-cohesive, moist, compact		0.91	2B	SS	27				
				343.65							
		(CL) SILTY CLAY, some sand, some gravel; brown; cohesive, w<PL, firm		1.45	3	SS	6		○		
2				342.89							
		(CL/CI) Sandy SILTY CLAY, trace to some gravel; brown (TILL); cohesive, w<PL, very stiff		2.21	4	SS	22				
3					5	SS	30		○		
				341.37							
		(CI) SILTY CLAY, trace sand, trace gravel; grey; cohesive, w~PL, stiff to very stiff		3.73	6	SS	16				
4											
					7	SS	12		○		
5				339.92							
		END OF BOREHOLE		5.18							
		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MC

CHECKED: MCK

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PROJECT: 1521180

LOCATION: N 4826152.22; E 541525.93

RECORD OF BOREHOLE: BH-25

SHEET 1 OF 1

BORING DATE: March 26, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		342.82							
0	Power Auger 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	ASPHALT		0.00							
		FILL - (SW/GP) SAND and GRAVEL, trace to some silt; brown; non-cohesive, moist, very dense		0.05	1A	SS	62*				
				342.21	1B						
		(CI) SILTY CLAY, trace sand, trace gravel; brown (TILL); cohesive, w PL to w<PL, very stiff to hard		0.61							
1					2	SS	26				
2					3	SS	17				
					4	SS	32			MH	
3					5	SS	17				
				339.09							
		(CI) SILTY CLAY, trace sand, trace gravel; brown; cohesive, w~PL, stiff		3.73							
4					6	SS	15				
					7	SS	14				
5				337.64							
		END OF BOREHOLE		5.18							
		NOTE:									
		1. Open borehole dry upon completion of drilling.									
		SPT N-Value impacted by frost.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: MC

CHECKED: MCK

Golder Associates

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PROJECT: 1521180

RECORD OF BOREHOLE: BH-26

SHEET 1 OF 1

LOCATION: N 4826262.34; E 541841.10

BORING DATE: March 26, 2015

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE		334.08							
	Power Auger, 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	ASPHALT		0.00 / 0.05	1A				○		
		FILL - (SW/GP) SAND and GRAVEL, trace to some silt; brown; non-cohesive, moist, compact		333.47	1B	SS	20				
		FILL - (CL/CI) SILTY CLAY, trace to some sand, trace to some gravel; brown; cohesive, w PL, hard		0.61 / 333.17	2A						
1		(SP/GP) SAND and GRAVEL, some silt to silty; brown to grey; non-cohesive, dry, very dense		0.91	2B	SS	66				
		Cobbles inferred below a depth of 1.5 m			3	SS	50/ 0.13		○		
2					4	SS	64/ 0.20				
3				331.04							
		AUGER REFUSAL END OF BOREHOLE		3.04							
4		NOTE: 1. Encountered refusal at a depth of 2.6 m below ground surface. Re-augered borehole approximately 1.0 m away from original location and encountered auger refusal at a depth of 3.04 m below ground surface. 2. Open borehole dry upon completion of drilling.									
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MC

CHECKED: MCK

GTA-BHS 001 S:\CLIENTS\CIMA\CONESTOGO_PLAINS_WATER_SUPPLY_WATERLOO_ON\02_DATA\GINT\1521180.GPJ GAL-MIS.GDT 8/27/15

PROJECT: 1521180

LOCATION: N 4826206.35; E 542096.05

RECORD OF BOREHOLE: BH-27

BORING DATE: March 26, 2015

SHEET 1 OF 1

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 64kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		324.24							
0	Power Auger 210 mm Outer Diameter, 130 mm Inner Diameter Hollow Stem Augers	ASPHALT		0.00							
		FILL - (SW/GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, very dense		0.12	1A	SS	62*				
				323.54	1B						
1		FILL - (SM) SILTY SAND, some gravel; brown; non-cohesive, wet, very dense		0.70	2	SS	50/0.10				
				322.79							
2		(CL) Sandy SILTY CLAY, some gravel; brown; cohesive, w~PL, firm		1.45	3	SS	5				
					4	SS	17				
				321.27							
3		(CL) Sandy SILTY CLAY, some gravel; brown (TILL); cohesive, w>PL, hard		2.97	5	SS	61				
					6	SS	50/0.10				
4				320.18							
		SPLIT-SPOON REFUSAL END OF BOREHOLE		4.06							
		NOTE: 1. Open borehole dry upon completion of drilling. SPT N-Value impacted by frost.									
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MC

CHECKED: MCK

GTA-BHS 001 S:\CLIENTS\CIMA\CONESTOGO_PLAINS_WATER_SUPPLY_WATERLOO_ON\02_DATA\GINT\1521180.GPJ GAL-MIS.GDT 8/27/15

PRO ECT: - 1186-0205

RECORD OF BOREHOLE: GA11-1

S EET

LOCATION: SEE IGURE 2

BORING DATE: November 4, 2011

DATUM

SPT/DCPT HAM ER: ASS, 64kg; DROP, 760mm

DEPTH SCALE ETRES	BORING METHOD	SOIL PR ILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPT (m)	SAM LES: NUMBER	TY E	BLOWS/0.3m	D NAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGT Cu, kPa (nat . + Q - ●, rem V. ⊕ U - ○)	DRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl)	ADDITIONAL LAB. TESTING	PIEZO ETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	OWER AUGER 108 mm Solid Stem Auger	ASPHALT		0.00							
		oist brown sand and gravel, trace silt (Granular Base ILL)		0.18		AS	-		○		
		Compact moist brown sand and gravel, trace silt, contains cobbles (Granular Base ILL)		0.34	2	AS	-				
					3A						
		Compact moist brown with black staining CLAYEY SILT with GRAVEL, some sand		0.91	3B	50 DO	7		○		
		Compact to very dense moist brown SILTY SAND, some gravel, trace clay (TILL)		1.04	3C						
2					4	50 DO	49		○		
					5	50 DO	32				
3					6	50 DO	50/ .08		○		
		END BOREHOLE		3.38							Borehole was open and dry upon completion of drilling, Nov. 4, 2011
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

: 50

Golder Associates

LOGGED: MC

CHECKED:

GTA-BHS 001 1111860205.GPJ GAL-MIS.GDT 4/17/12 K Dec. 201

PRO ECT: - 1186-0205

RECORD OF BOREHOLE: GA11-2

S EET

LOCATION: SEE IGURE 2

BORING DATE: November 4, 2011

DATUM

SPT/DCPT HAM ER: ASS, 64kg; DROP, 760mm

DEPTH SCALE ETRES	BORING METHOD	SOIL PR ILE DESCRIPTION	STRATA PLOT	ELEV. DEPT (m)	SAM LES NUMBER	SAM LES TY E	SAM LES BLOWS/0.3m	D NAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGT Cu, kPa (20 40 60 80) nat . + Q - ● rem V. ⊕ U - ○	DRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (0 20 30 40)	ADDITIONAL LAB. TESTING	PIEZO ETER R STANDPIPE INSTALLATION
		GROUND SURFACE									
0	OWER AUGER 108 mm Solid Stem Auger	ASPHALT		0.00							
		oist brown sand and gravel, some silt (Granular Base ILL)		0.13		AS	-		○		
		oist brown sand and gravel, some silt (Granular Base ILL)		0.30	2	AS	-		○		Hole lug
		Compact moist dark brown to brown sand, some silt, trace clay (FILL)		0.76	3A 3B	50 DO	0		○		
		Compact moist brown SAND, trace silt, trace clay		1.27	3C						
2		Compact moist brown SAND and GRAVEL, trace silt		1.45	4	50 DO	20				Silica Sand ilter
					5	50 DO	26		○		
3					6A	50 DO	29				
		ery stiff moist brown CLA E SILT, trace sand (TILL)		3.20	6B				○		
		END BOREHOLE		3.66							Piezometer was dry, Dec 6, 20
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

: 50

Golder Associates

LOGGED: C

CHECKED:

GTA-BHS 001 1111860205.GPJ GAL-MIS.GDT 4/17/12 K Dec. 201

PRO ECT: - 1186-0205

RECORD OF BOREHOLE: GA11-3

S EET

LOCATION: SEE IGURE 2

BORING DATE: November 4, 2011

DATUM

SPT/DCPT HAM ER: ASS, 64kg; DROP, 760mm

DEPTH SCALE ETRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPT (m)	SAM LES NUMBER	SAM LES TY E	SAM LES BLOWS/0.3m	D NAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGT Cu, kPa (20 40 60 80) nat . + Q - ● rem V. ⊕ U - ○	DRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZO ETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	OWER AUGER 108 mm Solid Stem Auger	ASPHALT		0.00							
		opist brown sand and gravel, some silt (Granular Base ILL)		0.13		AS	-		○		
		Compact moist dark brown CLAYEY SILT with SAND, trace gravel		0.61	2	AS	-				
					3A	50 DO	0		○		
		Compact moist brown SILTY SAND, trace gravel, trace clay		1.07	3B						
					4A	50 DO	17				
2		Compact moist brown SAND, some gravel, trace silt		1.83	4B				○		
					5	50 DO	24				
3					6	50 DO	23				
		END BOREHOLE		3.66							Borehole caved at a depth of about 2.7 m below ground surface upon completion of drilling, Nov. 4, 2011 Borehole was dry upon completion of drilling, Nov. 4, 2011
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

: 50

Golder Associates

LOGGED: MC

CHECKED:

GTA-BHS 001 1111860205.GPJ GAL-MIS.GDT 4/17/12 K Dec. 201

PRO ECT: - 1186-0205

RECORD OF BOREHOLE: GA11-4

S EET

LOCATION: SEE IGURE 2

BORING DATE: November 4, 2011

DATUM

SPT/DCPT HAM ER: ASS, 64kg; DROP, 760mm

DEPTH SCALE ETRES	BORING METHOD	SOIL PR ILE DESCRIPTION	STRATA PLOT	ELEV. DEPT (m)	SAM LES NUMBER	SAM LES TY E	SAM LES BLOWS/0.3m	D NAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGT Cu, kPa nat . + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	DRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZO ETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	OWER AUGER 108 mm Solid Stem Auger	ASPHALT		0.00							
		oist brown sand and gravel, trace silt (Granular Base ILL)		0.12		AS	-		○		
		Compact moist brown sand and gravel to gravelly sand (Granular Subase FILL)		0.35	2	AS	-				
					3	AS	-				
					4	50 DO	21		○		
					5A	50 DO	7				
2		Compact to dense moist brown SAND, some gravel, trace silt		1.83	5B				○		
					6	50 DO	15				
3					7	50 DO	31		○		
		END BOREHOLE		3.66							Borehole was open and dry upon completion of drilling, Nov. 4, 2011
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

: 50

Golder Associates

LOGGED: MC

CHECKED:

GTA-BHS 001 1111860205.GPJ GAL-MIS.GDT 4/17/12 K Dec. 201

PRO ECT: - 1186-0205

RECORD OF BOREHOLE: GA11-5

S EET

LOCATION: SEE IGURE 2

BORING DATE: November 4, 2011

DATUM

SPT/DCPT HAM ER: ASS, 64kg; DROP, 760mm

DEPTH SCALE ETRES	BORING METHOD	SOIL PR ILE DESCRIPTION	STRATA PLOT	ELEV. DEPT (m)	SAM LES NUMBER	SAM LES TY E	SAM LES BLOWS/0.3m	D NAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGT Cu, kPa nat . + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	DRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (0 20 30 40)	ADDITIONAL LAB. TESTING	PIEZO ETER R STANDPIPE INSTALLATION
		GROUND SURFACE									
0	OWER AUGER 108 mm Solid Stem Auger	ASPHALT		0.00							
		oist brown sand and gravel, occasional cobble, trace silt (Granular Base FILL)		0.08		AS	-		○		
		Loose moist brown sand and gravel, trace silt (Granular Subbase FILL)		0.31	2	AS	-		○		Hole lug
					3A						
		Loose moist dark brown silty sand and gravel, trace clay (FILL)		0.86	3B	50 DO	7		○		
2		Compact moist brown SAND, trace silt		1.27	3C						
					4	50 DO	5		○		
		Dense moist brown SAND and GRAVEL to GRAVELLY SAND		2.21							Silica Sand ilter
					5	50 DO	33				
3					6	50 DO	39		○		
		END BOREHOLE		3.66							i ezometer was dry, Dec. 6, 2011
4											
5											
6											
7											
8											
9											
10											

GTA-BHS 001 1111860205.GPJ GAL-MIS.GDT 4/17/12 K Dec. 201

DEPTH SCALE

: 50

Golder Associates

LOGGED: C

CHECKED:

PRO ECT: - 1186-0205

RECORD OF BOREHOLE: GA11-8

S EET

LOCATION: SEE IGURE 2

BORING DATE: November 4, 2011

DATU

SPT/DCPT HAM ER: ASS, 64kg; DROP, 760mm

DEPTH SCALE ETRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPT (m)	NUMBER	TY E	BLOWS/0.3m
		GROUND SURFACE					
0	OWER AUGER 108 mm Solid Stem Auger	ASPHALT		0.00		AS	-
		oist brown sand and gravel, trace silt, some gravel (Granular Base FILL)		0.22	2	AS	-
		oist brown SILT SAND, trace clay		0.61	3	AS	-
		Compact moist brown SAND, some gravel, trace silt		0.76	4	50 DO	3
2					5	50 DO	16
					6	50 DO	4
3		Dense moist brown SAND and GRAVEL, trace silt		2.79	7	50 DO	33
		Dense moist brown SAND, some gravel, trace silt		3.73	8	50 DO	27
4		END BOREHOLE		4.42			
5							
6							
7							
8							
9							
10							

D NAMIC PENETRATION RESISTANCE, BLOWS/0.3m
20 40 60 80

SHEAR STRENGT Cu, kPa
nat . + Q - ●
rem V. ⊕ U - ○
20 40 60 80

DRAULIC CONDUCTIVITY, k, cm/s
0^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT
Wp W WI
0 20 30 40

ADDITIONAL LAB. TESTING

PIEZO ETER R STANDPIPE INSTALLATION

DEPTH SCALE
: 50

LOGGED: MC

CHECKED:

Golder Associates

GTA-BHS 001 1111860205.GPJ GAL-MIS.GDT 4/17/12 K Dec. 201

APPENDIX B

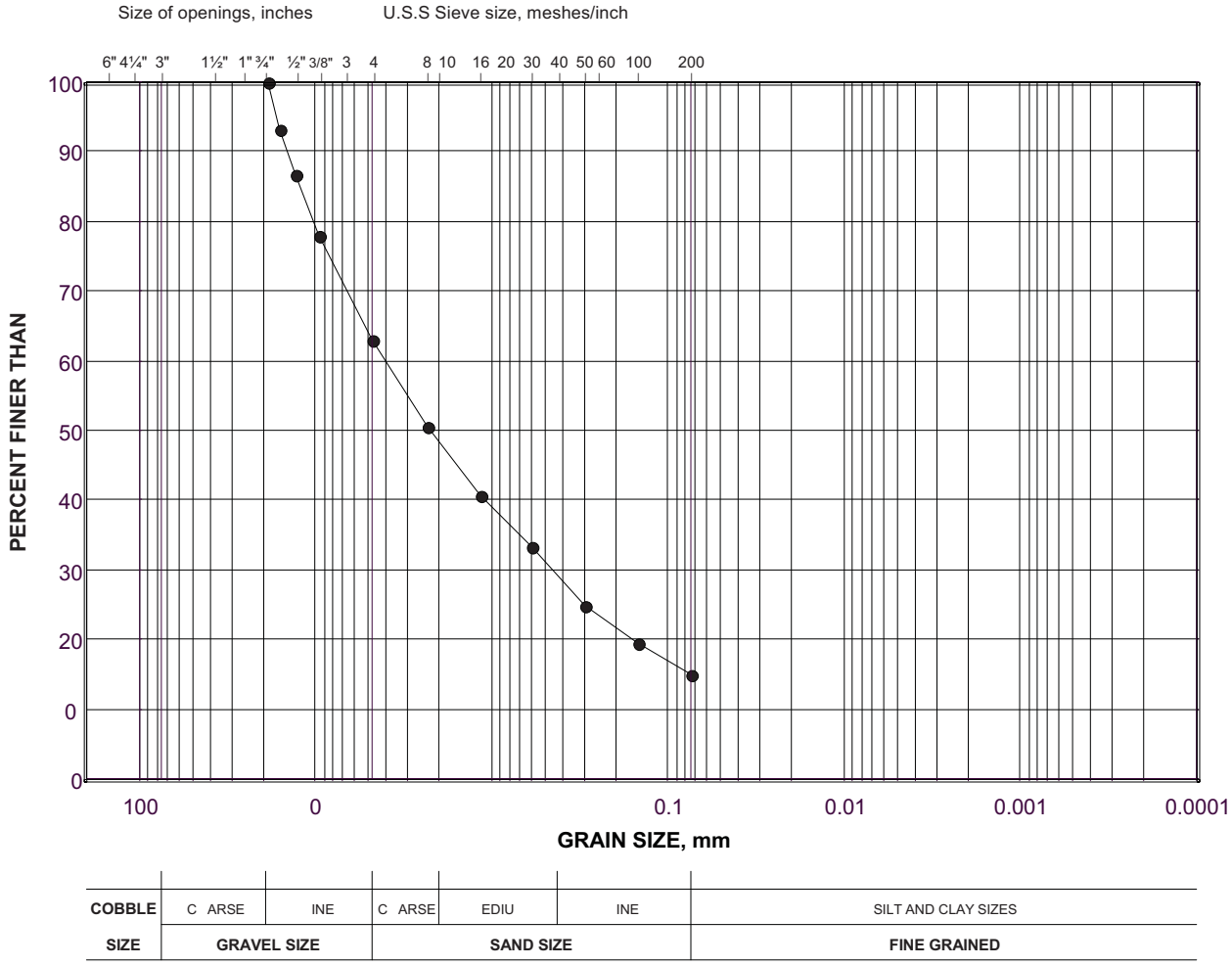
Laboratory Test Results

September 2015
Report No. 1521180

GRAIN SIZE DISTRIBUTION

Silty Sand and Gravel Fill

FIGURE 6



LEGEND

SY BOL	BOREHOLE	SAM LE	DEPTH(m)
●			0.0 - 0.46

Project Number: 521 80

Checked By: JR

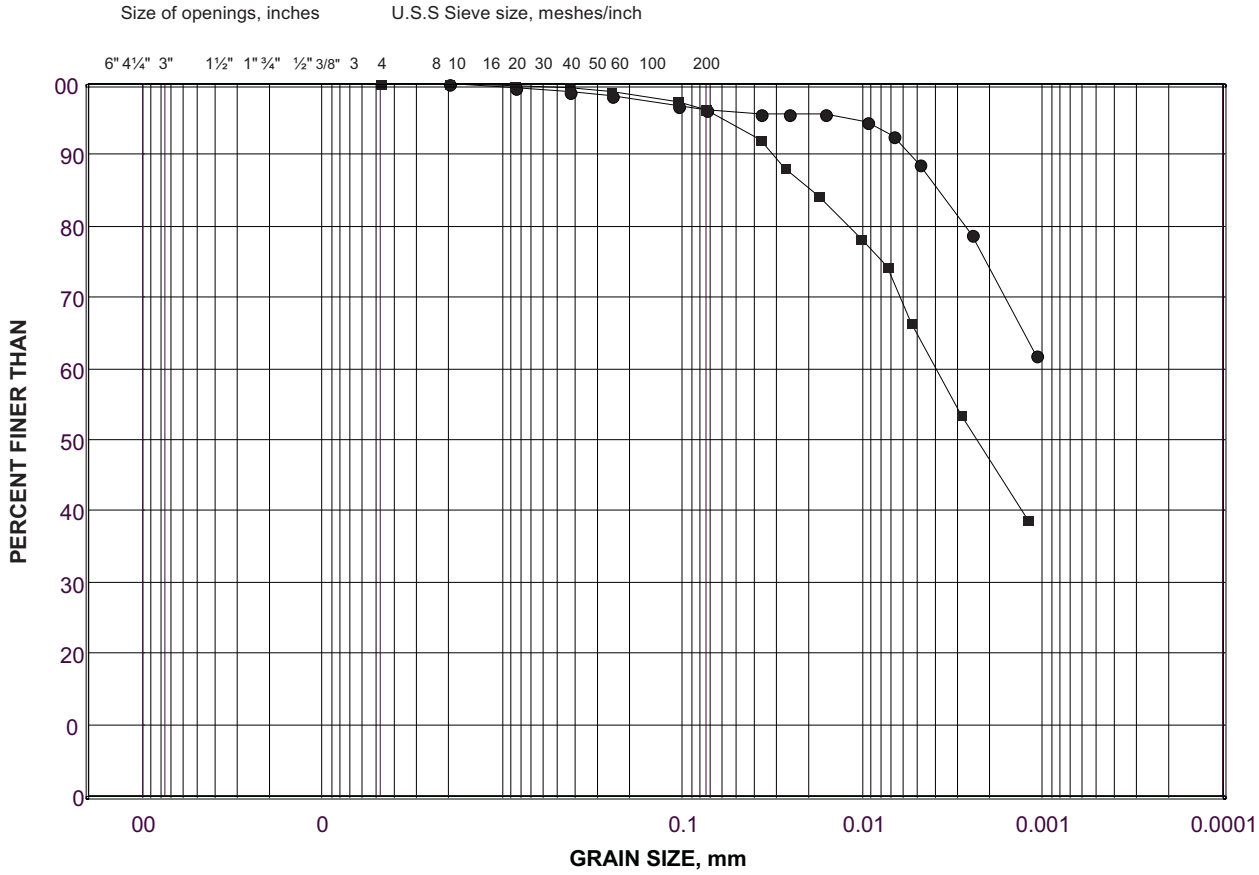
Golder Associates

Date: 28-Apr-15

GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE 7



LEGEND

SY BOL	BOREHOLE	SAM LE	DEPTH(m)
●	25	4	2.29 - 2.90
■	5	4	2.29 - 2.90

Project Number: 521 80

Checked By: JR

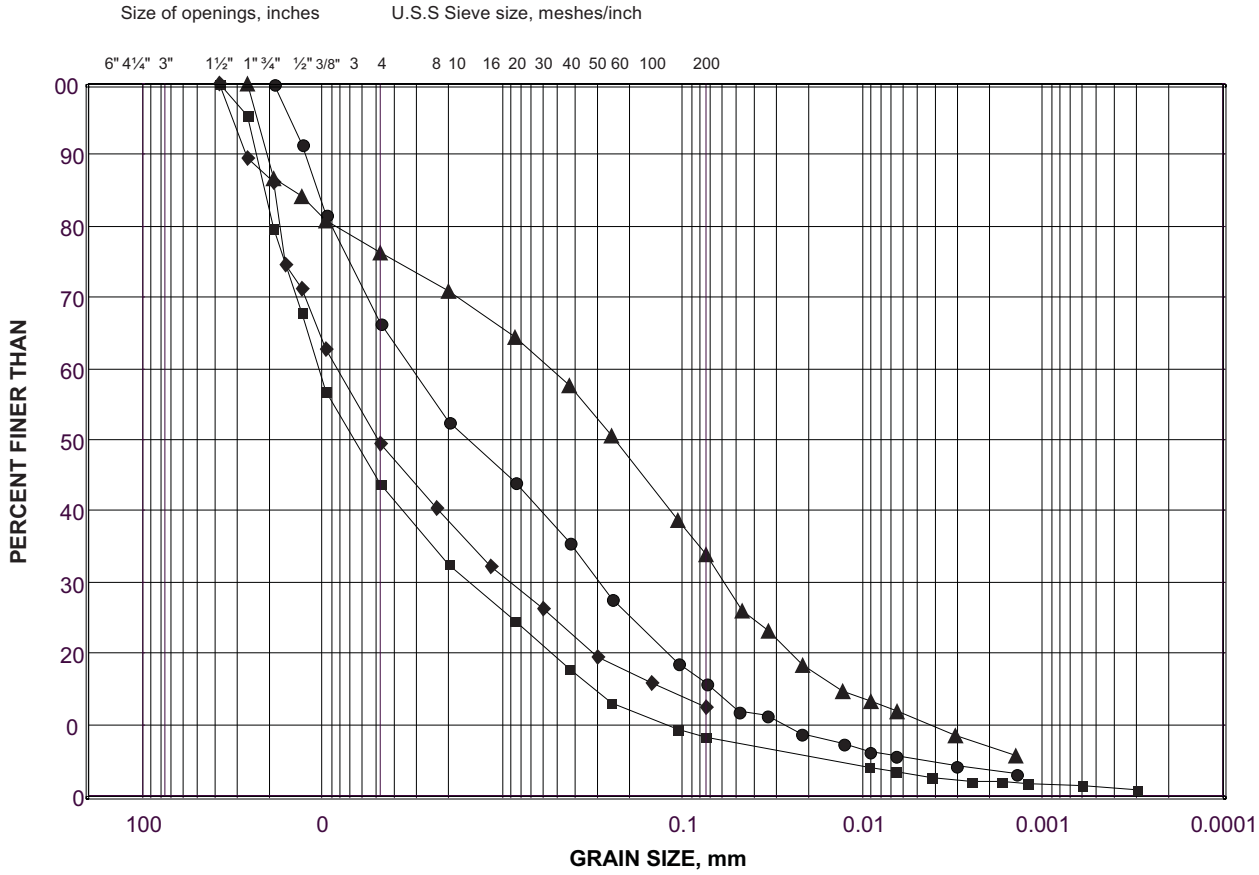
Golder Associates

Date: 28-Apr-15

GRAIN SIZE DISTRIBUTION

Sand and Gravel

FIGURE 8



LEGEND

SY BOL	BOREHOLE	SAM LE	DEPTH(m)
●	0		9.14 - 9.75
■		5	3.05 - 3.66
◆	0	7	6.10 - 6.27
▲		7	6. 0 - 6.27

Project Number: 521 80

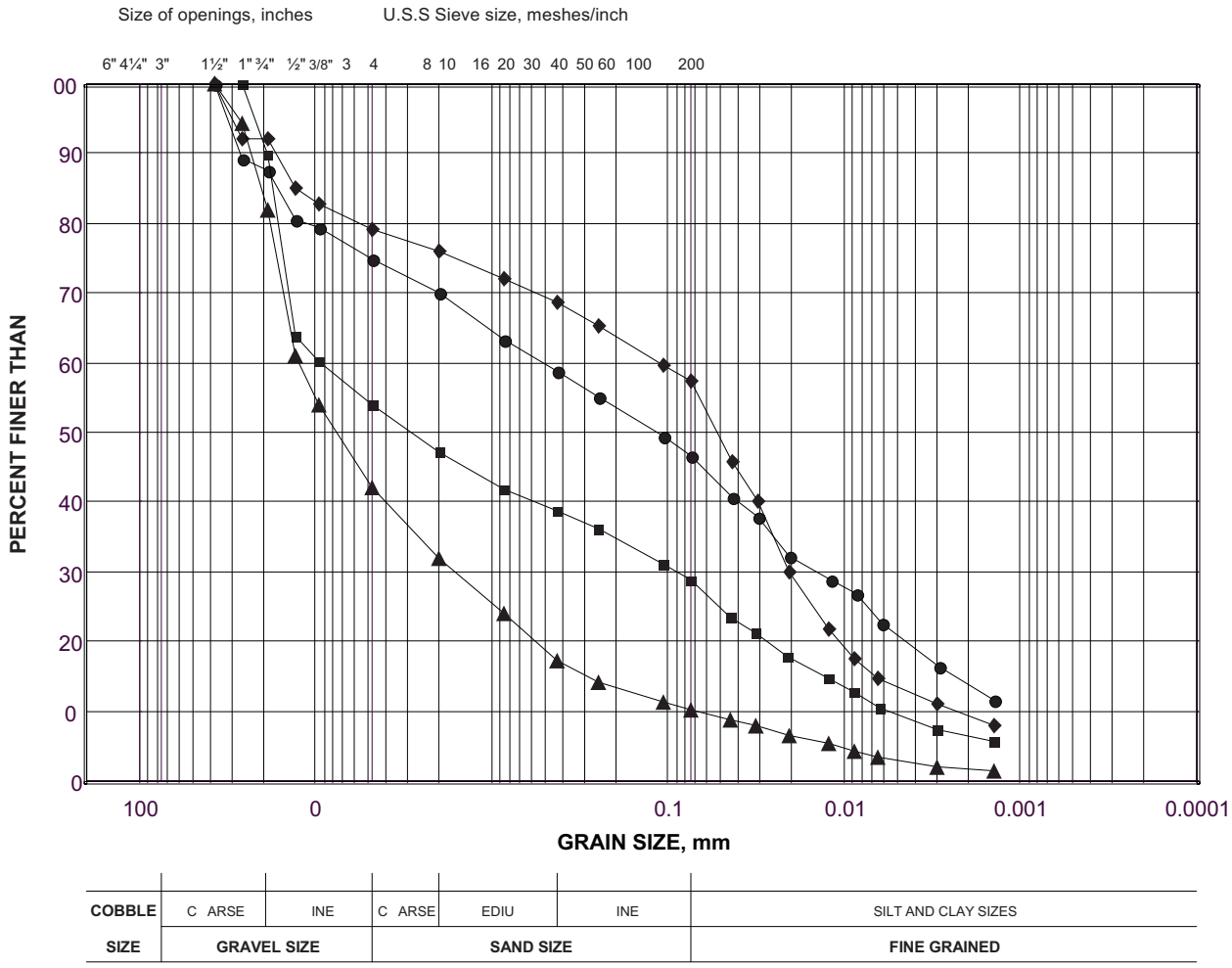
Checked By: JR

Golder Associates

Date: 28-Apr-15

GRAIN SIZE DISTRIBUTION

FIGURE 9



LEGEND

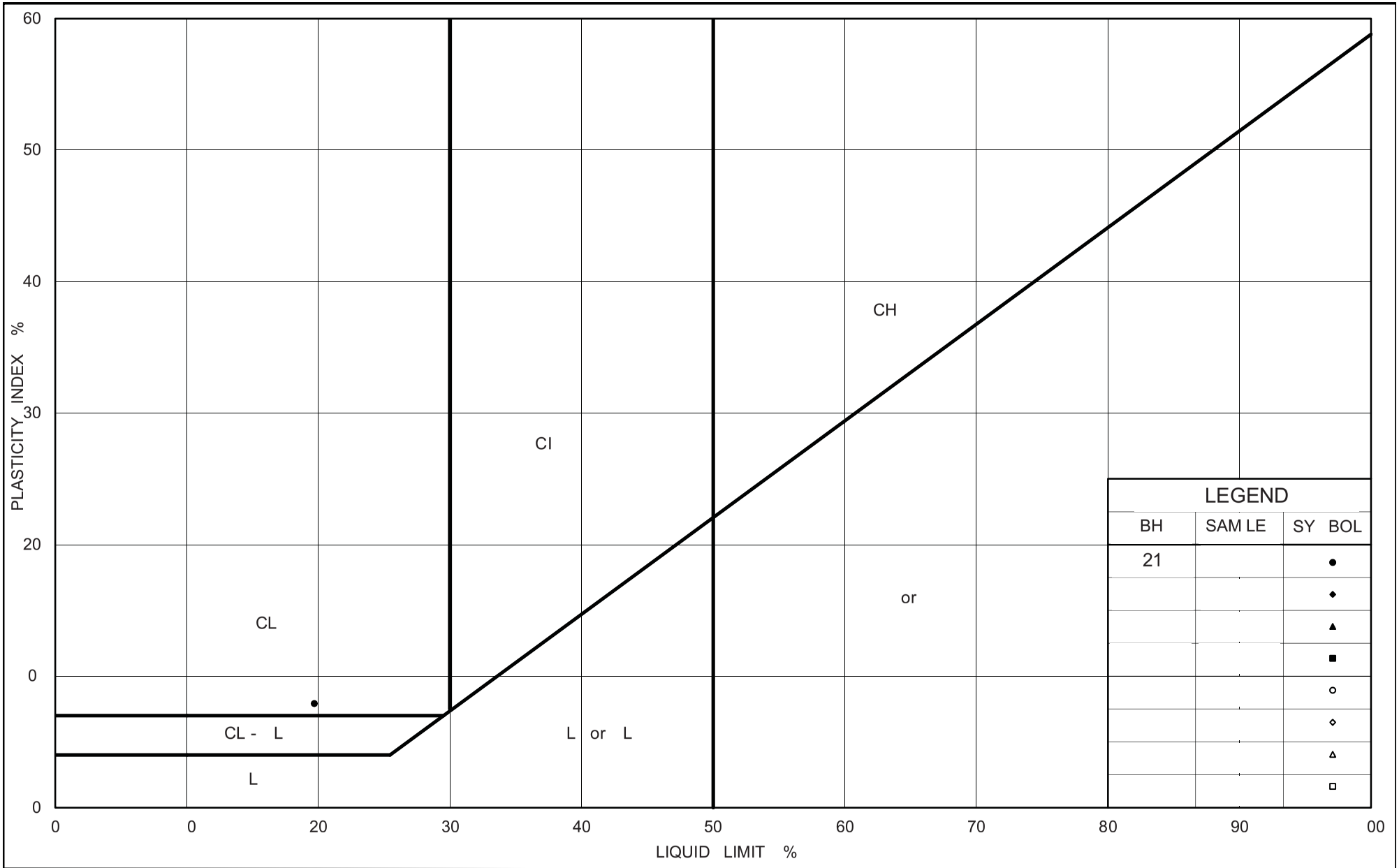
SY BOL	BOREHOLE	SAM LE	DEPTH(m)	DESCRIPTION
●	21		9.91 - 0.21	Gravelly Clayey Sand
■	20	3	7.62 - 8.23	Sandy Gravel
◆	20	5	10.67 - .28	Sandy Silt
▲	21	9	7.62 - 8.23	Sand and Gravel

Project Number: 521 80

Checked By: JR

Golder Associates

Date: 28-Apr-15



Golder Associates

PLASTICITY CHART
Gravelly Clayey Sand

Figure No. 10

Project No. 1521 80

Checked By JR

APPENDIX C

Certificates of Chemical Analysis (Soil)

September 2015
Report No. 1521180

Golder Associates

Golder Associates Ltd
ATTN: Joe Tavares
210 Sheldon, Suite 201
Cambridge N N1T A8

Date Received: 24-MAR-15
Report Date: 31-MAR-15 5:45 (MT)
ersion: INAL

Client hone: 519-620-1222

Certificate of Analysis

Lab Work Order #: L1591166

roject .O. #: NOT SUBMITTED
Job Reference: 5 21 80
C of C Numbers:
Legal Site Desc:

Emerson Omar Perez

Emerson erez
Account anager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1591 66- ES1-03/12/15-BH1 GR-DEPTH 2.5'-4.5'							
Sampled By: CLIENT on 2-MAR-15							
atrix: SOIL							
Miscellaneous Parameters							
% oisture	35.7		0.10	%	24-MAR-15	25-MAR-15	R3164158
Metals/Inorg-O. Reg 153/04 July 2011)							
Boron-HWE-O.Reg 153/04 July 2011)							
Boron (B), Hot Water Ext.	0.69		0.10	ug/g	26-MAR-15	26-MAR-15	R3164894
Conductivity-O.Reg 153/04 July 2011)							
Conductivity	0.343		0.0040	mS/cm	26-MAR-15	26-MAR-15	R3165148
Cyanide WAD)-O.Reg 153/04 July 2011)							
Cyanide, Weak Acid Diss	<0.050		0.050	ug/g	24-MAR-15	26-MAR-15	R3165537
Hex Chrom-O.Reg 153/04 July 2011)							
Chromium, Hexavalent	<0.20		0.20	ug/g	24-MAR-15	25-MAR-15	R3164297
Mercury in Soil by CVAAS							
ercury (Hg)	0.0277		0.0050	ug/g	26-MAR-15	26-MAR-15	R3165028
Metals in Soil by CRC ICPMS							
Antimony (Sb)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Arsenic (As)	2.4		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Barium (Ba)	41.6		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Beryllium (Be)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Boron (B)	8.5		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cadmium (Cd)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Chromium (Cr)	3.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cobalt (Co)	3.3		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Copper (Cu)	8.7		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Lead (Pb)	16.2		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
olybdenum (Mo)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Nickel (Ni)	7.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Selenium (Se)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Silver (Ag)	<0.20		0.20	ug/g	25-MAR-15	26-MAR-15	R3165583
Thallium (Tl)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Uranium (U)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
anadium (V)	21.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Zinc (Zn)	63.2		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	58.6		0.10	mg/L		26-MAR-15	R3164902
Sodium (Na)	3.76		0.50	mg/L		26-MAR-15	R3164902
agnesium (Mg)	4.95		0.10	mg/L		26-MAR-15	R3164902
SAR	0.13		0.10	SAR		26-MAR-15	R3164902
pH-O.Reg 153/04 July 2011)							
pH	7.34		0.10	pH units	25-MAR-15	25-MAR-15	R3164449
L1591 66-2 ES2-03/12/15-BH1 GR-DEPTH 5'-16'2"							
Sampled By: CLIENT on 2-MAR-15							
atrix: SOIL							
Miscellaneous Parameters							
% oisture	7.76		0.10	%	24-MAR-15	25-MAR-15	R3164158
Metals/Inorg-O. Reg 153/04 July 2011)							
Boron-HWE-O.Reg 153/04 July 2011)							
Boron (B), Hot Water Ext.	<0.10		0.10	ug/g	26-MAR-15	26-MAR-15	R3164894
Conductivity-O.Reg 153/04 July 2011)							
Conductivity	0.282		0.0040	mS/cm	26-MAR-15	26-MAR-15	R3165148
Cyanide WAD)-O.Reg 153/04 July 2011)							
Cyanide, Weak Acid Diss	<0.050		0.050	ug/g	24-MAR-15	26-MAR-15	R3165537
Hex Chrom-O.Reg 153/04 July 2011)							

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1591 66-2 ES2-03/12/15-BH1 GR-DEPTH 5'-16'2"							
Sampled By: CLIENT on 2-MAR-15							
atrix: SOIL							
Hex Chrom-O.Reg 153/04 July 2011)							
Chromium, Hexavalent	0.27		0.20	ug/g	24-MAR-15	25-MAR-15	R3164297
Mercury in Soil by CVAAS							
ercury (Hg)	<0.0050		0.0050	ug/g	26-MAR-15	26-MAR-15	R3165028
Metals in Soil by CRC ICPMS							
Antimony (Sb)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Arsenic (As)	3.7		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Barium (Ba)	24.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Beryllium (Be)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Boron (B)	6.5		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cadmium (Cd)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Chromium (Cr)	9.3		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cobalt (Co)	.8		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Copper (Cu)	4.8		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Lead (Pb)	9.8		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
olybdenum (Mo)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Nickel (Ni)	4.6		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Selenium (Se)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Silver (Ag)	<0.20		0.20	ug/g	25-MAR-15	26-MAR-15	R3165583
Thallium (Tl)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Uranium (U)	<1.0		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
anadium (V)	3.6		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Zinc (Zn)	38.4		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	9.9		0.10	mg/L		26-MAR-15	R3164902
Sodium (Na)	1.8		0.50	mg/L		26-MAR-15	R3164902
agnesium (Mg)	7.96		0.10	mg/L		26-MAR-15	R3164902
SAR	0.57		0.10	SAR		26-MAR-15	R3164902
pH-O.Reg 153/04 July 2011)							
pH	8.01		0.10	pH units	25-MAR-15	25-MAR-15	R3164449
L1591 66-3 ES3-03/17/15-BH2-DEPTH 7.5'-9.5'							
Sampled By: CLIENT on 7-MAR-15							
atrix: SOIL							
Miscellaneous Parameters							
% oisture	5.3		0.10	%	24-MAR-15	25-MAR-15	R3164158
Metals/Inorg-O. Reg 153/04 July 2011)							
Boron-HWE-O.Reg 153/04 July 2011)							
Boron (B), Hot Water Ext.	<0.10		0.10	ug/g	26-MAR-15	26-MAR-15	R3164894
Conductivity-O.Reg 153/04 July 2011)							
Conductivity	.01		0.0040	mS/cm	26-MAR-15	26-MAR-15	R3165148
Cyanide WAD)-O.Reg 153/04 July 2011)							
Cyanide, Weak Acid Diss	<0.050		0.050	ug/g	24-MAR-15	26-MAR-15	R3165537
Hex Chrom-O.Reg 153/04 July 2011)							
Chromium, Hexavalent	<0.20		0.20	ug/g	24-MAR-15	25-MAR-15	R3164297
Mercury in Soil by CVAAS							
ercury (Hg)	0.0097		0.0050	ug/g	26-MAR-15	26-MAR-15	R3165028
Metals in Soil by CRC ICPMS							
Antimony (Sb)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Arsenic (As)	3.9		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Barium (Ba)	06		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Beryllium (Be)	0.66		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Boron (B)	4.6		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1591 66-3 ES3-03/17/15-BH2-DEPTH 7.5'-9.5'							
Sampled By: CLIENT on 7-MAR-15							
atrix: SOIL							
Metals in Soil by CRC ICPMS							
Cadmium (Cd)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Chromium (Cr)	22.5		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cobalt (Co)	8.8		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Copper (Cu)	7.3		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Lead (Pb)	10.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
olybdenum (Mo)	<1.0		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Nickel (Ni)	9.2		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Selenium (Se)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Silver (Ag)	<0.20		0.20	ug/g	25-MAR-15	26-MAR-15	R3165583
Thallium (Tl)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Uranium (U)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
anadium (V)	33.8		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Zinc (Zn)	55.6		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	22.3		0.10	mg/L		26-MAR-15	R3164902
Sodium (Na)	187		0.50	mg/L		26-MAR-15	R3164902
agnesium (Mg)	.13		0.10	mg/L		26-MAR-15	R3164902
SAR	0.5		0.10	SAR		26-MAR-15	R3164902
pH-O.Reg 153/04 July 2011)							
pH	7.82		0.10	pH units	25-MAR-15	25-MAR-15	R3164449
L1591 66-4 ES4-03/18/15-BH08-DEPTH 0'-12'							
Sampled By: CLIENT on 8-MAR-15							
atrix: SOIL							
Miscellaneous Parameters							
% oisture	4.7		0.10	%	24-MAR-15	25-MAR-15	R3164158
Metals/Inorg-O. Reg 153/04 July 2011)							
Boron-HWE-O.Reg 153/04 July 2011)							
Boron (B), Hot Water Ext.	<0.10		0.10	ug/g	26-MAR-15	26-MAR-15	R3164894
Conductivity-O.Reg 153/04 July 2011)							
Conductivity	0.348		0.0040	mS/cm	26-MAR-15	26-MAR-15	R3165148
Cyanide WAD)-O.Reg 153/04 July 2011)							
Cyanide, Weak Acid Diss	<0.050		0.050	ug/g	24-MAR-15	26-MAR-15	R3165537
Hex Chrom-O.Reg 153/04 July 2011)							
Chromium, Hexavalent	<0.20		0.20	ug/g	24-MAR-15	25-MAR-15	R3164297
Mercury in Soil by CVAAS							
ercury (Hg)	0.0084		0.0050	ug/g	26-MAR-15	26-MAR-15	R3165028
Metals in Soil by CRC ICPMS							
Antimony (Sb)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Arsenic (As)	3.6		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Barium (Ba)	3		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Beryllium (Be)	0.62		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Boron (B)	3.2		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cadmium (Cd)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Chromium (Cr)	20.6		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cobalt (Co)	8.4		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Copper (Cu)	6.9		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Lead (Pb)	9.7		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
olybdenum (Mo)	<1.0		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Nickel (Ni)	8.1		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Selenium (Se)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Silver (Ag)	<0.20		0.20	ug/g	25-MAR-15	26-MAR-15	R3165583

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1591 66-4 ES4-03/18/15-BH08-DEPTH 0'-12'							
Sampled By: CLIENT on 8-MAR-15							
atrix: SOIL							
Metals in Soil by CRC ICPMS							
Thallium (Tl)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Uranium (U)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
anadium (V)	31.4		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Zinc (Zn)	57.4		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	8.1		0.10	mg/L		26-MAR-15	R3164902
Sodium (Na)	39.7		0.50	mg/L		26-MAR-15	R3164902
agnesium (Mg)	4.20		0.10	mg/L		26-MAR-15	R3164902
SAR	2.19		0.10	SAR		26-MAR-15	R3164902
pH-O.Reg 153/04 July 2011)							
pH	7.80		0.10	pH units	25-MAR-15	25-MAR-15	R3164449
L1591 66-5 ES5-03/19/15-BH13-DEPTH 0'-12'							
Sampled By: CLIENT on 9-MAR-15							
atrix: SOIL							
Miscellaneous Parameters							
% oisture	5.4		0.10	%	24-MAR-15	25-MAR-15	R3164158
Metals/Inorg-O. Reg 153/04 July 2011)							
Boron-HWE-O.Reg 153/04 July 2011)							
Boron (B), Hot Water Ext.	0.12		0.10	ug/g	26-MAR-15	26-MAR-15	R3164894
Conductivity-O.Reg 153/04 July 2011)							
Conductivity	.15		0.0040	mS/cm	26-MAR-15	26-MAR-15	R3165148
Cyanide WAD)-O.Reg 153/04 July 2011)							
Cyanide, Weak Acid Diss	<0.050		0.050	ug/g	24-MAR-15	26-MAR-15	R3165537
Hex Chrom-O.Reg 153/04 July 2011)							
Chromium, Hexavalent	<0.20		0.20	ug/g	24-MAR-15	25-MAR-15	R3164297
Mercury in Soil by CVAAS							
ercury (Hg)	0.0087		0.0050	ug/g	26-MAR-15	26-MAR-15	R3165028
Metals in Soil by CRC ICPMS							
Antimony (Sb)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Arsenic (As)	3.4		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Barium (Ba)	23		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Beryllium (Be)	0.62		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Boron (B)	3.8		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cadmium (Cd)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Chromium (Cr)	21.5		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Cobalt (Co)	8.4		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Copper (Cu)	6.3		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Lead (Pb)	10.1		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
olybdenum (Mo)	<1.0		1.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Nickel (Ni)	8.6		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Selenium (Se)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Silver (Ag)	<0.20		0.20	ug/g	25-MAR-15	26-MAR-15	R3165583
Thallium (Tl)	<0.50		0.50	ug/g	25-MAR-15	26-MAR-15	R3165583
Uranium (U)	<1.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
anadium (V)	33.0		.0	ug/g	25-MAR-15	26-MAR-15	R3165583
Zinc (Zn)	58.8		5.0	ug/g	25-MAR-15	26-MAR-15	R3165583
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	44.5		0.10	mg/L		26-MAR-15	R3164902
Sodium (Na)	134		0.50	mg/L		26-MAR-15	R3164902
agnesium (Mg)	.9		0.10	mg/L		26-MAR-15	R3164902
SAR	4.63		0.10	SAR		26-MAR-15	R3164902

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1591 66-5 ES5-03/19/15-BH13-DEPTH 0'-12'							
Sampled By: CLIENT on 9-MAR-15							
atrix: SOIL							
pH-O.Reg 153/04 July 2011)							
pH	7.70		0.10	pH units	25-MAR-15	25-MAR-15	R3164449

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
B-HWS-R51 -WT	Soil	Boron-HWE-O.Reg 53/04 (July 201)	HW EXTR, EPA 6010B

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

CN-WAD-R51 -WT	Soil	Cyanide (WAD)-O.Reg 53/04 (July 201)	E 3015/APHA 4500CN I-WAD

The sample is extracted with a strong base for 6 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

CR-CR6-IC-R51 -WT	Soil	Hex Chrom-O.Reg 53/04 (July 201)	SW846 3060A/7199 R51

Soil sample undergoes a alkaline digestion process where the sample is acidified and derivatized with ,5-diphenylcarbazide (DPC) using ion chromatography.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

EC-R51 -WT	Soil	Conductivity-O.Reg 53/04 (July 201)	OEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2: v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

HG-200.2-CVAA-WT	Soil	ercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

HG-200.2-CVAA-WT	Soil	ercury in Soil by CVAAS	EPA 7471

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

HG-200.2-CVAA-WT	Soil	ercury in Soil by CVAAS	SW846 3050B/7471

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

ET-200.2-CCMS-WT	Soil	etals in Soil by CRC ICP S	EPA 200.2/6020A

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICP S.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and .

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201), unless a subset of the Analytical Test Group (ATG) has been requested (the rotocol states that all analytes in an ATG must be reported).

ET-200.2-CCMS-WT	Soil	etals in Soil by CRC ICP S	EPA 200.2/6020A (mod)

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
		Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICP S.	
		Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and .	
		Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201), unless a subset of the Analytical Test Group (ATG) has been requested (the rotocol states that all analytes in an ATG must be reported).	
ISTURE-WT	Soil	% oisture	Gravimetric: ven Dried
PH-R51 -WT	Soil	pH-O.Reg 53/04 (July 201)	EE E3137A
		A minimum 0g portion of the sample is extracted with 20mL of 0.01 calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.	
		Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).	
SAR-R51 -WT	Soil	SAR-O.Reg 53/04 (July 201)	SW846 6010C
		A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES.	
		Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).	

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLO , NTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1591 66 Report Date: 31-MAR-15 age of 4

Client: Golder Associates Ltd
210 Sheldon, Suite 201
Cambridge N N1T A8

Contact: Joe Tavares

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
B-HWS-R511-WT	**Soil**							
Batch R3164894								
WG2060142-2 IRM		**SALINITY SOIL4**						
Boron (B), Hot Water Ext.			90.0		%		70-130	26-MAR-15
WG2060142-1 MB								
Boron (B), Hot Water Ext.			<0.10		ug/g		0.1	26-MAR-15
CN-WAD-R511-WT	**Soil**							
Batch R3165537								
WG2059421-3 DUP		**L1591166-1**						
Cyanide, Weak Acid Diss		<0.050	<0.050	RPD-NA	ug/g	N/A	35	26-MAR-15
WG2059421-2 LCS								
Cyanide, Weak Acid Diss			08.6		%		80-120	26-MAR-15
WG2059421-1 MB								
Cyanide, Weak Acid Diss			<0.050		ug/g		0.05	26-MAR-15
WG2059421-4 MS		**L1591166-1**						
Cyanide, Weak Acid Diss			0.1		%		70-130	26-MAR-15
CR-CR6-IC-R511-WT	**Soil**							
Batch R3164297								
WG2059396-4 CRM		**WT-SQC012**						
Chromium, Hexavalent			85.8		%		70-130	25-MAR-15
WG2059396-2 LCS								
Chromium, Hexavalent			95.8		%		80-120	25-MAR-15
WG2059396-1 MB								
Chromium, Hexavalent			<0.20		ug/g		0.2	25-MAR-15
EC-R511-WT	**Soil**							
Batch R3165148								
WG2060469-1 LCS								
Conductivity			00.1		%		90- 0	26-MAR-15
WG2060143-1 MB								
Conductivity			<0.0040		mS/cm		0.004	26-MAR-15
HG-200.2-CVAA-WT	**Soil**							
Batch R3165028								
WG2060145-2 CRM		**WT-SS-1**						
ercury (Hg)			86.0		%		70-130	26-MAR-15
WG2060145-4 LCS								
ercury (Hg)			99.5		%		80-120	26-MAR-15
WG2060145-1 MB								
ercury (Hg)			<0.0050		mg/kg		0.005	26-MAR-15
MET-200.2-CCMS-WT	**Soil**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WT	**Soil**							
Batch R3165583								
WG2060145-3 LCS								
Antimony (Sb)			01.1		%		80-120	26-MAR-15
Arsenic (As)			01.4		%		80-120	26-MAR-15
Barium (Ba)			104.5		%		80-120	26-MAR-15
Beryllium (Be)			92.4		%		80-120	26-MAR-15
Boron (B)			94.3		%		80-120	26-MAR-15
Cadmium (Cd)			105.7		%		80-120	26-MAR-15
Chromium (Cr)			99.4		%		80-120	26-MAR-15
Cobalt (Co)			96.4		%		80-120	26-MAR-15
Copper (Cu)			98.6		%		80-120	26-MAR-15
Lead (Pb)			101.6		%		80-120	26-MAR-15
Molybdenum (Mo)			98.7		%		80-120	26-MAR-15
Nickel (Ni)			99.7		%		80-120	26-MAR-15
Selenium (Se)			104.3		%		80-120	26-MAR-15
Silver (Ag)			97.7		%		80-120	26-MAR-15
Thallium (Tl)			99.8		%		80-120	26-MAR-15
Uranium (U)			99.7		%		80-120	26-MAR-15
Vanadium (V)			102.2		%		80-120	26-MAR-15
Zinc (Zn)			93.8		%		80-120	26-MAR-15
WG2060145-1 MB								
Antimony (Sb)			<0.10		mg/kg		0.1	26-MAR-15
Arsenic (As)			<0.10		mg/kg		0.1	26-MAR-15
Barium (Ba)			<0.50		mg/kg		0.5	26-MAR-15
Beryllium (Be)			<0.10		mg/kg		0.1	26-MAR-15
Boron (B)			<5.0		mg/kg		5	26-MAR-15
Cadmium (Cd)			<0.020		mg/kg		0.02	26-MAR-15
Chromium (Cr)			<0.50		mg/kg		0.5	26-MAR-15
Cobalt (Co)			<0.10		mg/kg		0.1	26-MAR-15
Copper (Cu)			<0.50		mg/kg		0.5	26-MAR-15
Lead (Pb)			<0.50		mg/kg		0.5	26-MAR-15
Molybdenum (Mo)			<0.10		mg/kg		0.1	26-MAR-15
Nickel (Ni)			<0.50		mg/kg		0.5	26-MAR-15
Selenium (Se)			<0.20		mg/kg		0.2	26-MAR-15
Silver (Ag)			<0.10		mg/kg		0.1	26-MAR-15
Thallium (Tl)			<0.050		mg/kg		0.05	26-MAR-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WT	**Soil**							
Batch R3165583								
WG2060145-1 MB								
Uranium (U)			<0.050		mg/kg		0.05	26-MAR-15
Vanadium (V)			<0.20		mg/kg		0.2	26-MAR-15
Zinc (Zn)			<2.0		mg/kg		2	26-MAR-15
MOISTURE-WT	**Soil**							
Batch R3164158								
WG2059439-2 LCS								
% oisture			96.3		%		70-130	25-MAR-15
WG2059439-1 MB								
% oisture			<0.10		%		0.1	25-MAR-15
PH-R511-WT	**Soil**							
Batch R3164449								
WG2059547-1 LCS								
pH			6.97		pH units		6.7-7.3	25-MAR-15
SAR-R511-WT	**Soil**							
Batch R3164902								
WG2060143-2 IRM		**WT SAR1**						
Calcium (Ca)			95.0		%		70-130	26-MAR-15
Sodium (Na)			91.5		%		70-130	26-MAR-15
Magnesium (Mg)			91.3		%		70-130	26-MAR-15
WG2060143-1 MB								
Calcium (Ca)			<0.10		mg/L		0.1	26-MAR-15
Sodium (Na)			<0.50		mg/L		0.5	26-MAR-15
Magnesium (Mg)			<0.10		mg/L		0.1	26-MAR-15

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality bjectives)
DUP	Duplicate
RPD	Relative ercent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference aterial
MS	atrix Spike
MSD	atrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	ethod Blank
IRM	Internal Reference aterial
CRM	Certified Reference aterial
CCV	Continuing Calibration erification
CVS	Calibration erification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative ercent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard ethods, or Environment Canada (where available). or more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and atrix Spikes that do not originate from this Work rder.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L1591166-COFC

COC Number: 14 -

Page 1 of 1

Report To		Report Format / Distribution		Turnaround Time (TAT) is not available for all tests
Company:	Golder Associates	Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)		R ☑ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Joe Tavares	Quality Control (QC) Report with Report ☐ Yes ☐ No		P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	210 Sheldon Drive, Cambridge, Ontario, N1T 1A8	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
		Select Distribution: ☑ EMAI ☐ MAI ☐ FAX		E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	519 620 1222	Email 1 or Fax Joe_Tavares@golder.com		Specify Date Required for E2,E or P:
		Email 2 Adam_Buck@golder.com		

Invoice To	Same as Report To ☑ Yes ☐ No	Invoice Distribution	
	Copy of Invoice with Report ☑ Yes ☐ No	Select Invoice Distribution: ☑ EMAI ☐ MAIL ☑ FAX	
Company:	Golder Associates	Email 1 or Fax 1 (519) 620 9878	
Contact:	Joe Tavares	Email 2	
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Quote #:		Approver ID:	Cost Center:
Job #:	15 21180	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:	MAR-24	Location:	
ALS Lab Work Order # (lab use only)	L1591166	ALS Contact:	Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	REG 153 METALS AND INORGANICS PACKAGE	ELECTRICAL CONDUCTIVITY	SAR	Number of Containers
1	ES1 - 03/12/15 - BH11GR - Depth 2.5' - 4.5'	12-Mar-15		Soil	✓			
2	ES2 - 03/12/15 - BH11GR - Depth 15' - 16'2"	12-Mar-15		Soil	✓			
3	ES3 - 03/17/15 - BH2 - Depth 7.5' - 9.5'	17-Mar-15		Soil	✓	✓	✓	
4	ES4 - 03/18/15 - BH09 - Depth 10' - 12'	18-Mar-15		Soil	✓	✓	✓	
5	ES5 - 03/19/15 - BH13 - Depth 10' - 12'	19-Mar-15		Soil	✓			

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	
Are samples for human drinking water use? ☐ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☑	No ☐		Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☑						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			5.0		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	03/24/15	6:55pm					Mar 24/15	18:55

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0356-v09-Front64-January-2014

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1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Golder Associates Ltd
ATTN: Joe Tavares
210 Sheldon, Suite 201
Cambridge N N1T A8

Date Received: 30-MAR-15
Report Date: 08-APR-15 4:54 (MT)
ersion: INAL

Client hone: 519-620-1222

Certificate of Analysis

Lab Work Order #: L1593150

roject .O. #: NOT SUBMITTED
Job Reference: 5 21 80 HASE 000
C of C Numbers:
Legal Site Desc:

Comments: 31-MAR-2015: Added Corrosivity test package to samples L1593150- and -5 as per client request.
EP/ALS S

Emerson erez
Account anager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1593150- ES6-03/26/15-BH27-DEPTH 3-5'							
Sampled By: CLIENT on 26-MAR-15							
atrix: SOIL							
Cl,pH,SO4,S2,Redox,resistivity,%moist.							
Chloride-O.Reg 153/04 July 2011)							
Chloride	414		5.0	ug/g	01-APR-15	02-APR-15	R3169381
Redox Potential							
Redox otential	219		-1000	mV	01-APR-15	01-APR-15	R3167510
Sulphide as S)							
Sulphide (as S)	<0.20		0.20	mg/kg	06-APR-15	07-APR-15	R3169562
Miscellaneous Parameters							
% oisture	7.50		0.10	%	30-MAR-15	31-MAR-15	R3166915
Sulphate	22		20	mg/kg	31-MAR-15	01-APR-15	R3168369
Conductivity	697		4.0	umhos/cm	07-APR-15	07-APR-15	R3170218
Resistivity	580		00	ohm cm	31-MAR-15	31-MAR-15	R3167209
pH	7.97		0.10	pH units	31-MAR-15	31-MAR-15	R3167234
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	.3		0.10	mg/L		01-APR-15	R3167765
Sodium (Na)	17		0.50	mg/L		01-APR-15	R3167765
agnesium (Mg)	4.42		0.10	mg/L		01-APR-15	R3167765
SAR	7.45		0.10	SAR		01-APR-15	R3167765
L1593150-2 ES7-03/26/15-BH23-DEPTH -4'							
Sampled By: CLIENT on 26-MAR-15							
atrix: SOIL							
Miscellaneous Parameters							
% oisture	0.3		0.10	%	30-MAR-15	31-MAR-15	R3166915
Metals/Inorg-O. Reg 153/04 July 2011)							
Boron-HWE-O.Reg 153/04 July 2011)							
Boron (B), Hot Water Ext.	0.22		0.10	ug/g	01-APR-15	01-APR-15	R3167769
Conductivity-O.Reg 153/04 July 2011)							
Conductivity	0.332		0.0040	mS/cm	01-APR-15	01-APR-15	R3167600
Cyanide WAD)-O.Reg 153/04 July 2011)							
Cyanide, Weak Acid Diss	<0.050		0.050	ug/g	31-MAR-15	01-APR-15	R3168404
Hex Chrom-O.Reg 153/04 July 2011)							
Chromium, Hexavalent	<0.20		0.20	ug/g	31-MAR-15	01-APR-15	R3167696
Mercury in Soil by CVAAS							
ercury (Hg)	0.0082		0.0050	ug/g	01-APR-15	01-APR-15	R3167762
Metals in Soil by CRC ICPMS							
Antimony (Sb)	<1.0		1.0	ug/g	01-APR-15	01-APR-15	R3168075
Arsenic (As)	.9		1.0	ug/g	01-APR-15	01-APR-15	R3168075
Barium (Ba)	7.3		.0	ug/g	01-APR-15	01-APR-15	R3168075
Beryllium (Be)	<0.50		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Boron (B)	5.2		5.0	ug/g	01-APR-15	01-APR-15	R3168075
Cadmium (Cd)	<0.50		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Chromium (Cr)	8.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Cobalt (Co)	2.4		.0	ug/g	01-APR-15	01-APR-15	R3168075
Copper (Cu)	7.7		.0	ug/g	01-APR-15	01-APR-15	R3168075
Lead (Pb)	9.6		.0	ug/g	01-APR-15	01-APR-15	R3168075
olybdenum (Mo)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Nickel (Ni)	5.1		.0	ug/g	01-APR-15	01-APR-15	R3168075
Selenium (Se)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Silver (Ag)	<0.20		0.20	ug/g	01-APR-15	01-APR-15	R3168075
Thallium (Tl)	<0.50		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Uranium (U)	<1.0		1.0	ug/g	01-APR-15	01-APR-15	R3168075
anadium (V)	4.6		.0	ug/g	01-APR-15	01-APR-15	R3168075

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1593150-2 ES7-03/26/15-BH23-DEPTH -4'							
Sampled By: CLIENT on 26-MAR-15							
atrix: SOIL							
Metals in Soil by CRC ICPMS							
Zinc (Zn)	36.7		5.0	ug/g	01-APR-15	01-APR-15	R3168075
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	27.5		0.10	mg/L		01-APR-15	R3167765
Sodium (Na)	30.1		0.50	mg/L		01-APR-15	R3167765
agnesium (Mg)	3.63		0.10	mg/L		01-APR-15	R3167765
SAR	.44		0.10	SAR		01-APR-15	R3167765
pH-O.Reg 153/04 July 2011)							
pH	7.85		0.10	pH units	31-MAR-15	31-MAR-15	R3166983
L1593150-3 ES8-03/26/15-BH19-DEPTH 0-2'							
Sampled By: CLIENT on 26-MAR-15							
atrix: SOIL							
Miscellaneous Parameters							
% oisture	8.14		0.10	%	30-MAR-15	31-MAR-15	R3166915
Metals/Inorg-O. Reg 153/04 July 2011)							
Boron-HWE-O.Reg 153/04 July 2011)							
Boron (B), Hot Water Ext.	<0.10		0.10	ug/g	01-APR-15	01-APR-15	R3167769
Conductivity-O.Reg 153/04 July 2011)							
Conductivity	0.946		0.0040	mS/cm	01-APR-15	01-APR-15	R3167600
Cyanide WAD)-O.Reg 153/04 July 2011)							
Cyanide, Weak Acid Diss	0.067		0.050	ug/g	31-MAR-15	01-APR-15	R3168404
Hex Chrom-O.Reg 153/04 July 2011)							
Chromium, Hexavalent	<0.20		0.20	ug/g	31-MAR-15	01-APR-15	R3167696
Mercury in Soil by CVAAS							
ercury (Hg)	0.0052		0.0050	ug/g	01-APR-15	01-APR-15	R3167762
Metals in Soil by CRC ICPMS							
Antimony (Sb)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Arsenic (As)	2.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Barium (Ba)	32.4		.0	ug/g	01-APR-15	01-APR-15	R3168075
Beryllium (Be)	<0.50		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Boron (B)	7.0		5.0	ug/g	01-APR-15	01-APR-15	R3168075
Cadmium (Cd)	<0.50		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Chromium (Cr)	.2		.0	ug/g	01-APR-15	01-APR-15	R3168075
Cobalt (Co)	3.4		.0	ug/g	01-APR-15	01-APR-15	R3168075
Copper (Cu)	8.6		.0	ug/g	01-APR-15	01-APR-15	R3168075
Lead (Pb)	6.8		.0	ug/g	01-APR-15	01-APR-15	R3168075
olybdenum (Mo)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Nickel (Ni)	7.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Selenium (Se)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Silver (Ag)	<0.20		0.20	ug/g	01-APR-15	01-APR-15	R3168075
Thallium (Tl)	<0.50		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Uranium (U)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
anadium (V)	20.4		.0	ug/g	01-APR-15	01-APR-15	R3168075
Zinc (Zn)	33.8		5.0	ug/g	01-APR-15	01-APR-15	R3168075
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	66.4		0.10	mg/L		01-APR-15	R3167765
Sodium (Na)	88.0		0.50	mg/L		01-APR-15	R3167765
agnesium (Mg)	9.50		0.10	mg/L		01-APR-15	R3167765
SAR	2.67		0.10	SAR		01-APR-15	R3167765
pH-O.Reg 153/04 July 2011)							
pH	7.90		0.10	pH units	31-MAR-15	31-MAR-15	R3166983

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1593150-4 ES10-03/27/15-BH21CC-DEPTH 5-7'							
Sampled By: CLIENT on 27-MAR-15							
atrix: SOIL							
Miscellaneous Parameters							
% oisture	8.8		0.10	%	31-MAR-15	01-APR-15	R3167194
Metals/Inorg-O. Reg 153/04 July 2011)							
Boron-HWE-O.Reg 153/04 July 2011)							
Boron (B), Hot Water Ext.	<0.10		0.10	ug/g	01-APR-15	01-APR-15	R3167769
Conductivity-O.Reg 153/04 July 2011)							
Conductivity	0.452		0.0040	mS/cm	01-APR-15	01-APR-15	R3167600
Cyanide WAD)-O.Reg 153/04 July 2011)							
Cyanide, Weak Acid Diss	<0.050		0.050	ug/g	31-MAR-15	01-APR-15	R3168404
Hex Chrom-O.Reg 153/04 July 2011)							
Chromium, Hexavalent	0.28		0.20	ug/g	31-MAR-15	01-APR-15	R3167696
Mercury in Soil by CVAAS							
ercury (Hg)	0.01 8		0.0050	ug/g	01-APR-15	01-APR-15	R3167762
Metals in Soil by CRC ICPMS							
Antimony (Sb)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Arsenic (As)	6.4		1.0	ug/g	01-APR-15	01-APR-15	R3168075
Barium (Ba)	72		1.0	ug/g	01-APR-15	01-APR-15	R3168075
Beryllium (Be)	.13		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Boron (B)	25.8		5.0	ug/g	01-APR-15	01-APR-15	R3168075
Cadmium (Cd)	<0.50		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Chromium (Cr)	36.1		.0	ug/g	01-APR-15	01-APR-15	R3168075
Cobalt (Co)	4.9		.0	ug/g	01-APR-15	01-APR-15	R3168075
Copper (Cu)	27.4		1.0	ug/g	01-APR-15	01-APR-15	R3168075
Lead (Pb)	14.6		.0	ug/g	01-APR-15	01-APR-15	R3168075
olybdenum (Mo)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Nickel (Ni)	31.7		.0	ug/g	01-APR-15	01-APR-15	R3168075
Selenium (Se)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
Silver (Ag)	<0.20		0.20	ug/g	01-APR-15	01-APR-15	R3168075
Thallium (Tl)	<0.50		0.50	ug/g	01-APR-15	01-APR-15	R3168075
Uranium (U)	<1.0		.0	ug/g	01-APR-15	01-APR-15	R3168075
anadium (V)	52.6		.0	ug/g	01-APR-15	01-APR-15	R3168075
Zinc (Zn)	84.9		5.0	ug/g	01-APR-15	01-APR-15	R3168075
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	33.2		0.10	mg/L		01-APR-15	R3167765
Sodium (Na)	37.9		0.50	mg/L		01-APR-15	R3167765
agnesium (Mg)	8.15		0.10	mg/L		01-APR-15	R3167765
SAR	.53		0.10	SAR		01-APR-15	R3167765
pH-O.Reg 153/04 July 2011)							
pH	7.61		0.10	pH units	31-MAR-15	31-MAR-15	R3166983
L1593150-5 ES1 -03/27/15-BH15-DEPTH 5-7'							
Sampled By: CLIENT on 27-MAR-15							
atrix: SOIL							
Cl,pH,SO4,S2,Redox,resistivity,%moist.							
Chloride-O.Reg 153/04 July 2011)							
Chloride	41.0		5.0	ug/g	01-APR-15	02-APR-15	R3169381
Redox Potential							
Redox otential	229		-1000	mV	01-APR-15	01-APR-15	R3167510
Sulphide as S)							
Sulphide (as S)	<0.20		0.20	mg/kg	06-APR-15	07-APR-15	R3169562
Miscellaneous Parameters							
% oisture	3.03		0.10	%	31-MAR-15	01-APR-15	R3167194
Sulphate	<20		20	mg/kg	31-MAR-15	01-APR-15	R3168369

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1593150-5 ES1 -03/27/15-BH15-DEPTH 5-7'							
Sampled By: CLIENT on 27-MAR-15							
atrix: SOIL							
Conductivity	49		4.0	umhos/cm	07-APR-15	07-APR-15	R3170218
Resistivity	6430		00	ohm cm	31-MAR-15	31-MAR-15	R3167209
pH	7.98		0.10	pH units	31-MAR-15	31-MAR-15	R3167234
SAR-O.Reg 153/04 July 2011)							
Calcium (Ca)	20.3		0.10	mg/L		01-APR-15	R3167765
Sodium (Na)	9.78		0.50	mg/L		01-APR-15	R3167765
agnesium (Mg)	3.03		0.10	mg/L		01-APR-15	R3167765
SAR	0.54		0.10	SAR		01-APR-15	R3167765

* Refer to Referenced Information for Qualifiers (if any) and ethodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
B-HWS-R51 -WT	Soil	Boron-HWE-O.Reg 53/04 (July 201)	HW EXTR, EPA 6010B

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

CL-R51 -WT	Soil	Chloride-O.Reg 53/04 (July 201)	EPA 300.0

5 grams of dried soil is mixed with 0 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

CN-WAD-R51 -WT	Soil	Cyanide (WAD)-O.Reg 53/04 (July 201)	E 3015/APHA 4500CN I-WAD

The sample is extracted with a strong base for 6 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

CR-CR6-IC-R51 -WT	Soil	Hex Chrom-O.Reg 53/04 (July 201)	SW846 3060A/7199 R51

Soil sample undergoes a alkaline digestion process where the sample is acidified and derivatized with ,5-diphenylcarbazide (DPC) using ion chromatography.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

EC-R51 -WT	Soil	Conductivity-O.Reg 53/04 (July 201)	EE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2: v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

EC-WT	Soil	Conductivity (EC)	EPA 9050A

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2: v/w. After tumbling the sample is then analyzed by a conductivity meter.

HG-200.2-CVAA-WT	Soil	ercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

HG-200.2-CVAA-WT	Soil	ercury in Soil by CVAAS	EPA 7471

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

HG-200.2-CVAA-WT	Soil	ercury in Soil by CVAAS	SW846 3050B/7471

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

ET-200.2-CCMS-WT	Soil	etals in Soil by CRC ICP S	EPA 200.2/6020A

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICP S.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and .

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201), unless a subset of the Analytical Test Group (ATG) has been requested (the rotocol states that all analytes in an ATG must be reported).

ET-200.2-CCMS-WT	Soil	etals in Soil by CRC ICP S	EPA 200.2/6020A (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICP S.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and .

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201), unless a subset of the Analytical Test Group (ATG) has been requested (the rotocol states that all analytes in an ATG must be reported).

ISTURE-WT	Soil	% oisture	Gravimetric: ven Dried
PH-R51 -WT	Soil	pH-O.Reg 53/04 (July 201)	EE E3137A

A minimum 0g portion of the sample is extracted with 20mL of 0.01 calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

REDOX- TENTIAL-WT	Soil	Redox otential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction otential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-WT	Soil	Resistivity	EE E3137A

Resistivity on a soil is a 2: extraction of DI water to soil. Sample is tumbled for 30 min. Conductivity of the extraction is taken and the inverse is calculated for resistivity.

SAR-R51 -WT	Soil	SAR-O.Reg 53/04 (July 201)	SW846 6010C

A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES.

Analysis conducted in accordance with the rotocol for Analytical ethods Used in the Assessment of roperties under art XV.1 of the Environmental rotection Act (July , 201).

SO4-WT	Soil	Sulphate	EPA 300.0
SULPHIDE-WT	Soil	Sulphide (as S)	APHA 4500S2D

Sulphide in Soil analysis is based on APHA 4500 S2D. A sub-sample of the soil sample is distilled, sulphuric acid and sodium hydroxide are added to the distillate. The sample is then analyzed on a spectrophotometer.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLO , NTARIO, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1593150 Report Date: 08-APR-15 age of 6

Client: Golder Associates Ltd
210 Sheldon, Suite 201
Cambridge N N1T A8

Contact: Joe Tavares

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
B-HWS-R511-WT	**Soil**							
Batch R3167769								
WG2063117-2 IRM		**SALINITY SOIL4**						
Boron (B), Hot Water Ext.			83.9		%		70-130	01-APR-15
WG2063117-1 MB								
Boron (B), Hot Water Ext.			<0.10		ug/g		0.1	01-APR-15
CL-R511-WT	**Soil**							
Batch R3169381								
WG2063731-2 DUP		**L1593150-1**						
Chloride		414	416		ug/g	0.5	30	02-APR-15
WG2063731-3 LCS								
Chloride			01.1		%		70-130	02-APR-15
WG2063731-1 MB								
Chloride			<5.0		ug/g		5	02-APR-15
WG2063731-4 MS		**L1593150-1**						
Chloride			N/A	S-B	%		-	02-APR-15
CN-WAD-R511-WT	**Soil**							
Batch R3168404								
WG2062495-3 DUP		**L1593150-2**						
Cyanide, Weak Acid Diss		<0.050	<0.050	RPD-NA	ug/g	N/A	35	01-APR-15
WG2062495-2 LCS								
Cyanide, Weak Acid Diss			7.6		%		80-120	01-APR-15
WG2062495-1 MB								
Cyanide, Weak Acid Diss			<0.050		ug/g		0.05	01-APR-15
WG2062495-4 MS		**L1593150-2**						
Cyanide, Weak Acid Diss			2.0		%		70-130	01-APR-15
CR-CR6-IC-R511-WT	**Soil**							
Batch R3167696								
WG2062493-3 CRM		**WT-SQC012**						
Chromium, Hexavalent			02.0		%		70-130	01-APR-15
WG2062493-2 LCS								
Chromium, Hexavalent			96.7		%		80-120	01-APR-15
WG2062493-1 MB								
Chromium, Hexavalent			<0.20		ug/g		0.2	01-APR-15
EC-R511-WT	**Soil**							
Batch R3167600								
WG2063153-1 LCS								
Conductivity			00.1		%		90- 0	01-APR-15
WG2063153-2 LCS								

Quality Control Report

Workorder: L1593150 Report Date: 08-APR-15

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-R511-WT	**Soil**							
Batch R3167600								
WG2063153-2 LCS								
Conductivity			00.1		%		90- 0	01-APR-15
WG2063118-1 MB								
Conductivity			<0.0040		mS/cm		0.004	01-APR-15
EC-WT	**Soil**							
Batch R3170218								
WG2065694-3 CVS								
Conductivity			00.6		%		80-120	07-APR-15
WG2065565-1 DUP		**L1593150-1**						
Conductivity		697	696		umhos/cm	0.1	20	07-APR-15
WG2065694-1 MB								
Conductivity			<4.0		umhos/cm		4	07-APR-15
HG-200.2-CVAA-WT	**Soil**							
Batch R3167762								
WG2063122-2 CRM		**WT-SS-1**						
ercury (Hg)			101.8		%		70-130	01-APR-15
WG2063122-4 LCS								
ercury (Hg)			103.0		%		80-120	01-APR-15
WG2063122-1 MB								
ercury (Hg)			<0.0050		mg/kg		0.005	01-APR-15
MET-200.2-CCMS-WT	**Soil**							
Batch R3168075								
WG2063122-3 LCS								
Antimony (Sb)			07.6		%		80-120	01-APR-15
Arsenic (As)			0.0		%		80-120	01-APR-15
Barium (Ba)			08.4		%		80-120	01-APR-15
Beryllium (Be)			00.5		%		80-120	01-APR-15
Boron (B)			00.8		%		80-120	01-APR-15
Cadmium (Cd)			0.7		%		80-120	01-APR-15
Chromium (Cr)			08.1		%		80-120	01-APR-15
Cobalt (Co)			06.4		%		80-120	01-APR-15
Copper (Cu)			08.8		%		80-120	01-APR-15
Lead (Pb)			1.2		%		80-120	01-APR-15
olybdenum (Mo)			06.4		%		80-120	01-APR-15
Nickel (Ni)			08.4		%		80-120	01-APR-15
Selenium (Se)			107.2		%		80-120	01-APR-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WT	**Soil**							
Batch R3168075								
WG2063122-3 LCS								
Silver (Ag)			09.8		%		80-120	01-APR-15
Thallium (Tl)			109.1		%		80-120	01-APR-15
Uranium (U)			0.3		%		80-120	01-APR-15
Vanadium (V)			1.8		%		80-120	01-APR-15
Zinc (Zn)			105.2		%		80-120	01-APR-15
WG2063122-1 MB								
Antimony (Sb)			<0.10		mg/kg		0.1	01-APR-15
Arsenic (As)			<0.10		mg/kg		0.1	01-APR-15
Barium (Ba)			<0.50		mg/kg		0.5	01-APR-15
Beryllium (Be)			<0.10		mg/kg		0.1	01-APR-15
Boron (B)			<5.0		mg/kg		5	01-APR-15
Cadmium (Cd)			<0.020		mg/kg		0.02	01-APR-15
Chromium (Cr)			<0.50		mg/kg		0.5	01-APR-15
Cobalt (Co)			<0.10		mg/kg		0.1	01-APR-15
Copper (Cu)			<0.50		mg/kg		0.5	01-APR-15
Lead (Pb)			<0.50		mg/kg		0.5	01-APR-15
Molybdenum (Mo)			<0.10		mg/kg		0.1	01-APR-15
Nickel (Ni)			<0.50		mg/kg		0.5	01-APR-15
Selenium (Se)			<0.20		mg/kg		0.2	01-APR-15
Silver (Ag)			<0.10		mg/kg		0.1	01-APR-15
Thallium (Tl)			<0.050		mg/kg		0.05	01-APR-15
Uranium (U)			<0.050		mg/kg		0.05	01-APR-15
Vanadium (V)			<0.20		mg/kg		0.2	01-APR-15
Zinc (Zn)			<2.0		mg/kg		2	01-APR-15
MOISTURE-WT	**Soil**							
Batch R3166915								
WG2062394-2 LCS								
% oisture			103.0		%		70-130	31-MAR-15
WG2062394-1 MB								
% oisture			<0.10		%		0.1	31-MAR-15
Batch R3167194								
WG2062494-2 LCS								
% oisture			106.6		%		70-130	01-APR-15
WG2062494-1 MB								
% oisture			<0.10		%		0.1	01-APR-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-R511-WT	**Soil**							
Batch R3166983								
WG2062497-1 DUP		**L1593150-2**						
pH		7.85	8.01		pH units	0.16	0.3	31-MAR-15
WG2062522-1 LCS								
pH			6.98		pH units		6.7-7.3	31-MAR-15
Batch R3167234								
WG2062729-1 DUP		**L1593150-1**						
pH		7.97	7.99		pH units	0.02	0.3	31-MAR-15
WG2062828-1 LCS								
pH			6.98		pH units		6.7-7.3	31-MAR-15
REDOX-POTENTIAL-WT	**Soil**							
Batch R3167510								
WG2063068-1 DUP		**L1593150-1**						
Redox otential		219	217		mV	0.9	25	01-APR-15
RESISTIVITY-WT	**Soil**							
Batch R3167209								
WG2062545-1 DUP		**L1593150-5**						
Resistivity		6430	6290		ohm cm	2.1	25	31-MAR-15
SAR-R511-WT	**Soil**							
Batch R3167765								
WG2063118-2 IRM		**WT SAR1**						
Calcium (Ca)			95.9		%		70-130	01-APR-15
Sodium (Na)			97.4		%		70-130	01-APR-15
agnesium (Mg)			96.2		%		70-130	01-APR-15
WG2063118-1 MB								
Calcium (Ca)			<0.10		mg/L		0.1	01-APR-15
Sodium (Na)			<0.50		mg/L		0.5	01-APR-15
agnesium (Mg)			<0.10		mg/L		0.1	01-APR-15
SO4-WT	**Soil**							
Batch R3168369								
WG2062542-3 DUP		**L1593150-5**						
Sulphate		<20	<20	RPD-NA	mg/kg	N/A	30	01-APR-15
WG2062542-2 LCS								
Sulphate			00.8		%		70-130	01-APR-15
WG2062542-1 MB								
Sulphate			<20		mg/kg		20	01-APR-15

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SULPHIDE-WT	**Soil**							
Batch R3169562								
WG2065459-1 CVS								
Sulphide (as S)			91.9		%		50-120	07-APR-15
WG2065457-2 DUP		**L1593150-1**						
Sulphide (as S)		<0.20	<0.20	RPD-NA	mg/kg	N/A	20	07-APR-15
WG2065457-1 MB								
Sulphide (as S)			<0.20		mg/kg		0.2	07-APR-15

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality bjectives)
DUP	Duplicate
RPD	Relative ercent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference aterial
MS	atrix Spike
MSD	atrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	ethod Blank
IRM	Internal Reference aterial
CRM	Certified Reference aterial
CCV	Continuing Calibration erification
CVS	Calibration erification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	atrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative ercent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard ethods, or Environment Canada (where available). or more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and atrix Spikes that do not originate from this Work rder.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com
Canada Toll Free: 1 800 668 9878

L1593150-COFC

COC Number: 14 -
Page 1 of 1

Report To		Report Format / Distribution	Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	Golder Associates	Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)	R ☑ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Joe Tavares	Quality Control (QC) Report with Report ☑ Yes ☐ No	P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	210 Sheldon Drive , Cambridge, Ontario , N1T 1A8	☐ Criteria on Report - provide details below if box checked	E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
		Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	519 - 620 - 1222	Email 1 or Fax Joe_Tavares@golder.com	Specify Date Required for E2,E or P:
		Email 2 Adam_buck@golder.com	

Invoice To		Invoice Distribution	Analysis Request
	Same as Report To ☑ Yes ☐ No	Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
	Copy of Invoice with Report ☑ Yes ☐ No		
Company:		Email 1 or Fax	
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:		Approver ID:	Cost Center:
Job #:	15 21180 Phase 1000	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)	MAR-30B L1593150	ALS Contact:	Sampler:

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	RBCA 153 METALS AND INORGANICS PACKAGE	SAR	CaCl2 EXTRACT	RESISTIVITY OF SOIL	SULPHATE (2:1 EXTRACT)	CONDUCTIVITY	Number of Containers
1	ES6-03/26/15-BH27-DEPTH 3-5'	26/MAR/15		SOIL		✓	✓	✓	✓	✓	1
2	ES7-03/26/15-BH23-DEPTH 1-4'	26/MAR/15		SOIL	✓						1
3	ES8-03/26/15-BH19-DEPTH 0-2'	26/MAR/15		SOIL	✓						1
4	ES10-03/27/15-BH21CC-DEPTH 5-7'	27/MAR/15		SOIL	✓						1
5	ES11-03/27/15-BH15-DEPTH 5-7'	27/MAR/15		SOIL		✓	✓	✓	✓	✓	
	[illegible]										

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	
Are samples for human drinking water use? ☐ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐
Ice packs	Yes ☑	No ☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated	☑			

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			9.9		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Adam Buck	Date: 03/31/15	Time: 06:40	Received by:	Date:	Time:	Received by: MN	Date: Mar 30/15	Time: 18:35

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

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APPENDIX G

Stage 1 Archeological Assessment

ARCHEOWORKS INC.

Stage 1 Archaeological Assessment: Proposed Conestogo Plains Water Supply System Class EA In the Geographic Township of Woolwich Historical County of Waterloo Now in the Township of Woolwich Regional Municipality of Waterloo Ontario

Project #: 242-WA1357-15
Licensee (#): Alvina Tam (P1016)
PIF#: P1016-0057-2015

Original Report

April 18th, 2015

Presented to:
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150 Frederick Street
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T: 519.575.4095

Prepared by:
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EXECUTIVE SUMMARY

Archeoworks Inc. was retained by the *Region of Waterloo* to conduct a Stage 1 Archaeological Assessment (AA) as part of the Conestogo Water Supply Environmental Assessment (EA) – Water Supply Alternative Solution No. 2 project area. This area, herein referred to as the "study corridor", encompasses the road allowances of Sawmill Road, Northfield Drive East, Jigs Hollow Road, Hill Street, Covered Bridge Drive, and Tallwood Drive, as well as the West Montrose and Conestogo water supply plants.

The Stage 1 background research identified archaeological potential for the recovery of Aboriginal and Euro-Canadian archaeological remains within undisturbed portions of the study corridor due to its close proximity (within 300 metres) to: historic structures and historic villages, several historic transportation routes, designated and listed cultural heritage resources, the West Montrose Cultural Heritage Landscape, a commemorative plaque, previously registered archaeological sites, two historic pioneer cemeteries and primary water sources.

A property inspection has revealed that the study corridor is situated within a primarily rural setting, and traverses through the communities of West Montrose and Conestogo. Disturbances such as the existing Conestogo Plains and West Montrose water supply plants; paved/gravel roadways and driveways; paved sidewalks; gravel shoulders; roadside ditches and embankments; production wells, and underground utilities were identified. Areas of no or low archaeological potential include permanently wet areas consisting of the Canagagigue Creek, Conestogo River and steep slope. Undisturbed areas include (but are not limited to) ploughed agricultural fields, grassed margins, areas of overgrown grass, and manicured grass lawns.

Based on the results of the background research and property inspection, the following recommendations are presented:

1. As per *Section 1.4.1, Standard 1.f.* of the *2011 S&G,* areas that exhibit disturbed conditions, as described within **Section 3.1**, are recommended to be exempt from a Stage 2 AA.

2. As per *Section 2.1, Standard 1* of the *2011 S&G*, physiographic features of no or low archaeological potential as described within **Section 3.2** are recommended to be exempt from a Stage 2 AA.

3. All identified undisturbed segments which co ntain archaeological potential as described within **Section 3.3** must be subjected to a Stage 2 AA at five metre intervals. Given the study corridor is a narrow linear corridor (10 metres or less) for the most part, as per *Section 2.1.2, Standard 1.f* of the *2011 S&G*, in situations where there are planned impacts 10 metres or less beyond the previously impacted limits on both sides of the existing roadway, a test pit survey at five metre transects may be undertaken. However,

where at the time of fieldwork the lands within the linear corridor meet the standards of pedestrian survey land preparation, as per *Section 2.1.1, Standards 2 and 3* , a pedestrian survey at five metre transects must be carried out in accordance *Section 2.1.1* of the *2011 S&G*. Within areas of ploughed agricultural fields measuring wider than 10 metres, those fields must be ploughed and subjected to appropriate weathering requirements prior to field investigation, in accordance with *Section 2.1.1* of the *2011 S&G*. followed by pedestrian survey at five-metre transects.

4. Should construction activities associated w ith this development, including construction laydown areas, extend beyond the assessed limits of the study corridor, in order to minimize impacts to cultural heritage resources, further archaeological investigation will be required prior to construction activities.

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PROJECT PERSONNEL

Project Director.....Alvina Tam - MTCS licence P1016

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Report Review..... Nimal Nithiyanantham – MTCS licence P390

Historical Research.....Lee Templeton – MTCS licence R454

Graphics ..... Mike Lawson
Alvina Tam - MTCS licence P1016
Lee Templeton – MTCS licence R454

1.0 PROJECT CONTEXT

1.1 Objective

The objectives of a Stage 1 Archaeological Assessment (AA), as outlined by the 2011 *Standards and Guidelines for Consultant Archaeologists* (‘*2011 S&G’*) (2011), are as follows:

- To provide information about the property’s geography, history, previous archaeological fieldwork and current land condition;
- To evaluate in detail the property’s archaeological potential, which will support recommendations for Stage 2 survey for all parts of the property; and
- To recommend appropriate strategies for Stage 2 survey.

1.2 Development Context

Archeoworks Inc. was retained by the *Region of Waterloo* to conduct a Stage 1 AA as part of the Conestogo Water Supply Environmental Assessment (EA) – Water Supply Alternative Solution No. 2 project area, which encompasses the road allowances of Sawmill Road, Northfield Drive East, Jigs Hollow Road, Hill Street, Covered Bridge Drive, and Tallwood Drive, as well as the West Montrose and Conestogo water supply plants. This area will herein be referred to as the “study corridor”. The study corridor encompasses:

- Part of Lots 31, 33, 34, 35, 36, 41, 42, 69, 70, 71, 75;
- Part of Wallace Tract;
- Part of Lots 1-4, Concession 1;
- Part of Lots 1-3, Broken Concession; and,
- The road allowance between Concession 1 and Broken Concession

All in the Geographic Township of Woolwich, historical County of Waterloo, now in the Township of Woolwich, Regional Municipality of Waterloo, Ontario (***see Appendix A – Map 1***).

The project will involve the construction of approximately 11.5 kilometres of watermain, situated mostly within the existing road allowances, connecting the communities of Conestogo and West Montrose to St. Jacobs. The watermain will be crossing the Grand River in Conestogo and the Canagagigue Creek midway between Conestogo and West Montrose. Furthermore, some modifications will be made to the West Montrose treatment plant and the Conestogot Plains treatment plant, while the Conestoga Golf Course treatment plant (along Golf Course Road) will be removed.

This study is being undertaken as a Class Environmental Assessment (Class EA) under ‘Schedule B” at the time of project initiation. Furthermore, the Region of Waterloo’s *Archaeological Facilities Master Plan* which documents archaeological resources and evaluates archaeological

potential within the region (Region of Waterloo, 1989), identifies the majority of the study corridor to have archaeological potential (Tam, 2015) (***see Map 2***).

This Stage 1 AA was conducted through the EA process under the project direction of Ms. Alvina Tam, under the archaeological consultant licence number P1016, in accordance with the *Ontario Heritage Act* (2009). Permission to investigate the study corridor was granted by the *Region of Waterloo* on November 19th, 2014.

1.3 Historical Context

The *2011 S&G*, published by the *Ministry of Tourism, Culture, and Sport* (*MTCS*) considers areas of early Euro-Canadian settlement, including places of early military pioneer or pioneer settlement (e.g., pioneer homesteads, isolated cabins, and farmstead complexes), early wharf or dock complexes, and pioneer churches and early cemeteries, as having elevated archaeological potential. There may be commemorative markers of their history, such as local, provincial, or federal monuments or heritage parks. Early historical transportation routes (trails, passes, roads, railways, portage routes), properties listed in a municipal register or designated under the *Ontario Heritage Act* or a federal, provincial, or municipal historic landmark or site, and properties that local histories or informants have identified with possible archaeological sites, historical events, activities, or occupations are also considered to have elevated archaeological potential.

To establish the archaeological and historical significance of the study corridor, *Archeoworks Inc*. conducted a comprehensive review of the Aboriginal and Euro-Canadian settlement history, the designated and listed heritage properties, commemorative markers as well as consulted with available historical mapping. Furthermore, an examination of the Region of Waterloo's *Archaeological Facilities Master Plan,* registered archaeological sites, previous archaeological assessments within close proximity to its limits, and review of the physiography of the overall area and its correlation to locating archaeological remains was performed.

The results of this background research are documented below and summarized in **Appendix B – Summary of Background Research**.

1.3.1 Pre-Contact Period

1.3.1.1 The Paleoindian Period (ca. 11,500 to 7,500 B.C.)

The region where the study corridor is situated was first inhabited after the final retreat of the North American Laurentide ice sheet. As the ice sheet retreated, meltwater flooded the Erie Basin forming the first of several postglacial lakes (Karrow and Warner, 1990, p.10). To the north, the ice recession uncovered a large area creating what has been referred to as "'Ontario Island,' extending northeast from London, including all or large parts of Perth, Huron, Bruce, Grey, Wellington, Dufferin, Waterloo and Oxford Counties" (Karrow and Warner, 1990, p.10). This area, surrounded by glacial lakes on three sides, is characterized by till plains, drumlins,

eskers, and shallow depressions that trapped glacial material in meltwater ponds and was likely a hostile environment, initially incapable of supporting flora and fauna (Karrow and Warner, 1990, pp.10-11).

When the ice advanced, approximately 13,000 years ago (or 11,000 B.C.), most of Southern Ontario, west of the Niagara Escarpment, remained free of ice (Karrow and Warner, 1990, p. 12). Subsequently, lake levels in the Huron Basin and Erie Basin continually fluctuated, but the inland remained relatively ice-free. The sandy, well-drained soils were sought out as they were rich in natural foodstuff, such as nut-bearing trees (Karrow and Warner, 1990, p.14). The continuing retreat of the ice decreased barriers that prevented the entry of plants growth and animal habitation. By 12,000 years ago (10,000 B.C.), spruce trees were probably well established within the Grand River watershed (Karrow and Warner, 1990, p. 14).

As the average climatic temperature warmed, small groups of Paleoindians entered Southern Ontario (Karrow and Warner, 1990, p.22; Stewart, 2013, p.28). Paleoindians are thought to have been small groups of nomadic hunter-gathers who depended on naturally available foodstuffs such as game or wild plants (Ellis and Deller, 1990, p.38). For much of the year, Paleoindians "hunted in small family groups; these would periodically gather into a larger grouping or bands during a favourable period in their hunting cycle, such as the annual caribou migration" (Wright, 1994, p.25).

Paleoindian sites are extraordinarily rare and consist of "stone tools clustered in an area of less than 200-300 metres" (Ellis, 2013, p.35). These sites appear to have been campsites used during travel episodes and can be found on well-drained soils in elevated situations, which would have provided a more comfortable location in which to camp and view the surrounding territory (Ellis and Deller, 1990, p.50). Traditionally, Paleoindian sites have been located primarily along abandoned glacial lake strandlines or beaches. However, this view is biased as these are the only areas in which archaeologists have searched for sites, due to current understanding of the region's geological history (Ellis and Deller, 1990, p.50; Ellis, 2013, p.37). In areas where attention has been paid to non-strandline areas and to older strandlines, sites are much less concentrated and are more ephemeral (Ellis and Deller, 1990, p.51). The artifact assemblage from this period is characterized by fluted and lanceolate stone points, scrapers, and small projectile points produced from specific chert types (Ellis and Deller, 1990). Distinctive dart heads were used to kill game, and knives for butchering and other tasks (Wright, 1994, p.24). These items were created and transported over great distances while following migratory animals within an extensive territory.

1.3.1.2 The Archaic Period (ca. 7,800 to 500 B.C.)

As the climate steadily warmed, mixed deciduous and coniferous trees slowly began to permeate throughout Southern Ontario (Karrow and Warner, 1990, p.30). The "Archaic peoples are the direct descendants of Paleoindian ancestors" that have adapted to meet new environmental and social conditions (Ellis, 2013, p.41; Wright, 1994, p.25). The Archaic Period is divided chronologically and cultural groups are divided geographically and sequentially. Archaic Aboriginals lived in "hunter-gatherer bands whose social and economic organization was

probably characterized by openness and flexibility" (Ellis et al., 1990, p.123). This fluidity creates 'traditions' and 'phases' which encompass large groups of Archaic Aboriginals (Ellis et al., 1990, p.123).

Few Archaic sites have faunal and floral preservation, thus lithic scatters are often the most common Archaic Aboriginal site type (Ellis et al., 1990, p. 123). House structures have "left no trace" due to the high acidic content of Ontario soils (Wright, 1994, p.27). Burial, grave goods and ritual items appear very rarely. By the Late Archaic, multiple individuals were buried together suggesting semi-permanent communities were in existence (Ellis, 2013, p.46). Ceremonial and decorative items also appear on Archaic Aboriginal sites through widespread trade networks, such as conch shells from the Atlantic coast and galena from New York (Ellis, 2013, p.41). Through trade with the northern Archaic Aboriginals situated around Lake Superior, native copper was initially utilized to make hooks and knives but gradually became used for decorative and ritual items (Ellis, 2013, p.42).

During the Archaic period, artifact assemblages were characterized by a reliance on a wide range of lithic raw materials in order to make stone artifacts, the presence of stone tools shaped by grinding and polishing, and an increase in the use of polished stone axes and adzes as wood-working tools (Ellis et al., 1990, p. 65; Wright, 1994, p.26). Ground-stone tools were also produced from hard stones and reformed into tools and throwing weapons (Ellis, 2013, p.41). Stone points were reformed from the fluted and lanceolate points to stone points with notched bases to be attached to a wooden shaft (Ellis, 2013, p.41).The bow and arrow was first used during the Archaic period (Ellis, 2013, p.42).

1.3.1.3. The Early Woodland Period (ca. 800 B.C. to 0 B.C.)

The Early Woodland cultures evolved out of the Late Archaic period (Ferris and Spence, 1995, p. 89; Spence et al., 1990, p.168). The Early Woodland period is divided into two complexes: the Meadowood complex and the Middlesex complex. The Middlesex complex appears to be restricted to Eastern Ontario, particularly along the St. Lawrence River while Meadowood materials depict a broad extent of occupation in southwestern Ontario (Spence et al., 1990, p.134, 141). The distinguishing characteristic of the Early Woodland period is the introduction of pottery (ceramics). The earliest forms were coil-formed, "thick, friable and often under fired, and must have been only limited to utility usage" (Ferris and Spence, 1995, p.89; Williamson, 2014, p.48).

Cache Blades, a formal chipped stone technology, and side-notched Meadowood point type, were commonly employed tools that were often recycled into a number of other tool forms such as end scrapers (Spence et al, 1990, p.128; Ferris and Spence, 1995, p.93). These tools were primarily formed from Onondaga chert (Spence et al., 1990, p.128). Meadowood sites have produced a number of distinctive material cultures that function in both domestic and ritual spheres (Ferris and Spence, 1995, p.90; Spence et al., 1990, p. 128). This allows correlations to be made between habitations and mortuary sites to create a well-rounded view of Meadowood culture (Ferris and Spence, 1995, p.90; Spence et al., 1990, p. 128). However, the settlement-subsistence system is poorly understood as only a "few settlement types have

been adequately investigated, and not all of these are from the same physiographic regions" (Ferris and Spence, 1995, p.93; Spence et al., 1990, p. 136). Generally, Meadowood sites are in association with the Point Peninsula and Saugeen complexes and "then eventually changed or were absorbed into the Point Peninsula complex" (Wright, 1994, pp. 29-30).

1.3.1.4 The Middle Woodland Period (ca. 200 B.C. to A.D. 900)

During the Middle Woodland Period, three primary cultural complexes developed in Southern Ontario. The Couture complex was located in the southwestern most part of Ontario (Spence et al, 1990, p.143). The Point Peninsula complex was "distributed throughout south-central and eastern Southern Ontario, the southern margins of the Canadian Shield, the St. Lawrence River down river to Quebec City, most of southeastern Quebec, along the Richelieu River into Lake Champlain" (Spence et al, 1990, p.157; Wright, 1999, p.633). The Saugeen complex occupied "southwestern Southern Ontario from the Bruce Peninsula on Georgian Bay to the north shore of Lake Erie to the west of Toronto" (Wright, 1999, p.629; Wright, 1994, p.30), as well as present along the Nottawasaga, Thames and Grand Rivers. The Saugeen and Point Peninsula cultures appear to have shared Southern Ontario but the borders between cultures are not well defined, and many academics believe that the Niagara Escarpment formed a frontier between the Saugeen complex and the Point Peninsula complex (Spence et al, 1990, p.143; Wright, 1999, p.629; Ferris and Spence, 1995, p.98). Consequently, the dynamics of hunter-gatherer societies shifted territorial boundaries resulting in regional clusters throughout southwestern Southern Ontario that have been variously assigned to Saugeen, Point Peninsula, or independent complexes (Spence et al, 1990, p.148; Wright, 1999, p.649).

Middle Woodland pottery share a preference for stamped, scallop-edge or tooth-like decoration, but each cultural complex had distinct pottery forms, such as globular pots, finishes, and zones of decoration (Williamson, 2014, p.49; Ferris and Spence, 1995, p. 97; Spence et al, 1990, p.143). Major changes in settlement-subsistence systems occurred during the Middle Woodland period, particularly the introduction of large 'house' structures and substantial middens associated with these structures (Spence et al., 1990, p.167; Ferris and Spence, 1995, p. 99). The larger sites likely indicate a prolonged period of macroband settlement and a more consistent return to the same site, rather than an increase in band size (Spence et al., 1990, p. 168). Environmental constraints in different parts of Southern Ontario all produced a common implication of increased sedentism caused by the intensified exploitation of local resources (Ferris and Spence, 1995, p. 100). Burial offerings became more ornate and encompassed many material mediums, including antler, whetstones, copper, and pan pipes (Ferris and Spence, 1995, p. 99). Burials during this time were set away from occupation sites and remains were buried at time of death; secondary burials were not common (Ferris and Spence, 1995, p. 101). Small numbers of burial mounds are present, particularly around Rice Lake, and both exotic and utilitarian items were left as grave goods (Williamson, 2014, p.51; Ferris and Spence, 1995, p.102).

1.3.1.5 The Late Woodland Period (ca. 900 B.C. to A.D. 1600)

Three sub-stages and their respective complexes have been assigned to the Late Woodland Period. These sub-stages are divided spatially and chronologically, and gradually progress into

the historic Contact Period groups of the Late Ontario Iroquois Stage (Fox, 1990; Williamson, 1990; Dodd et al., 1990; Warrick, 2000). Several migration theories have been suggested explaining Iroquoian origins, and an "available date from Southern Ontario strongly suggests continuity (*in situ*) from the Middle-Late Woodland Transitional Princess Point complex and Late Woodland cultural groups" (Ferris and Spence, 1995, p. 105; Smith, 1990, p.283).

During the Late Ontario Iroquoian stage, the Iroquoian-speaking linguistic groups developed. Prior to European Contact, neighbouring Iroquois-speaking communities united to form several confederacies known as the Huron (Huron-Wendat), Neutral (called Attiewandaron by the Wendat), Petun (Tionnontaté or Khionontateronon) in Ontario, and the Five Nations of the Iroquois (Haudenosaunee) of upper New York State (Birch, 2010, p.31; Warrick, 2013, p.71). These groups are located primarily in south and central Ontario. Each group was distinct but shared a similar pattern of life already established by the 16th century (Trigger, 1994, p.42).

The geographic distribution of pre-contact Ontario Iroquoian sites describes two major groups east and west of the Niagara Escarpment: the ancestral Huron-Wendat to the east and the ancestral Attiewandaron to the west (Warrick, 2000, p. 446). Prior to European contact, discrete site clusters west of the Grand River in the area of Kitchener have been assigned to the Attiewandaron, and clearly date prior to the mid-16th century (Lennox and Fitzgerald, 1990, p. 437). These sites "suggest a migration of peoples from the west into Historic Neutralia" or the Niagara Peninsula (Lennox and Fitzgerald, 1990, p. 437). The movement into the Niagara Peninsula before European Contact was likely a consequence of creating a buffer between the Attiewandaron and the Algonquin-speaking Western Basin Tradition of the Toledo-Detroit-Chatham area (Lennox and Fitzgerald, 1990, p.438). These two groups became increasingly hostile towards one another as evidenced by the presence of fortified villages that pre-date European contact (Lennox and Fitzgerald, 1990, p.438). By European contact, the Attiewandaron had dispersed the Western Basin Tradition.

Attiewandaron settlement patterns consist of a varying range of settlement types. Of those settlements which were occupied year-round, five acre sites are categorized as towns, one to five acres sites are villages, one acre sites are hamlets, and smaller settlements of one to two houses are referred to as agricultural cabin sites (Lennox and Fitzgerald, 1990, p.439). Furthermore, isolated, small fishing and hunting camps are also present. Village clusters are generally found on sandy loam soils of high agricultural capability and "are rarely found along the banks of major rivers or lakeshores, except for smaller, seasonal hunting and fishing camps. Instead, larger settlements tend to be located along smaller creeks, at headwater springs and around marshlands (Lennox and Fitzgerald, 1990, .p. 440). Many villages are enclosed within some form of a palisade and longhouses are of varying configurations covered in bark (Lennox and Fitzgerald, 1990, p.441).

Subsistence patterns reflect a diet dependent on a combination of hunting, farming, fishing, and gathering as their territory provided a diverse and rich array of subsistence resources (Lennox and Fitzgerald, 1990, p.450). Horticulture gradually began to take on a more central importance in subsistence patterns, particularly the farming of maize, squash, and beans. The

Attiewandaron lived in an area particularly rich in game and appear to have depended more upon hunting than the Huron-Wendat (Trigger, 1994, p.43).

1.3.2 European Contact Period (ca. A.D. 1600 to 1650)

At the time of European contact, the Attiewandaron were primarily located around the Niagara River, but likely used lands west of the Niagara Escarpment as territorial hunting grounds. According to Samuel de Champlain, who first referred to the Attiewandaron as *la Nation neutre,* the Attiewandaron inhabited 40 villages and could field 4,000 warriors (Warrick, 2008, p.80; Jury, 1974, p.4; White, 1978, p.410). It is speculated that prior to the great epidemics of the 1630s, the Attiewandaron Confederacy, consisting of the amalgamated Attiragenrega, Ahondihrouon, Antouaronon, Onguiaronon, Kakauagoga and Wenro tribes, numbered approximately 35,000 to 40,000 individuals (White, 1978, p.409; Warrick, 2008, p.86). Suggestions have been made that the Attiewandaron had developed politically, economically and demographically beyond the confederacy level to a chiefdom united under a paramount chief, Tsouharissen, who united the tribes within the Attiewandaron Confederacy (Noble, 2012; Lennox and Fitzgerald, 1990, p.411). Their territory along the north shore of Lake Erie was favourably located for easy trade with the Erie, Haudenosaunee, Tionnontaté, and Huron-Wendat (Trigger, 1994, p.47).

The interior lands occupied by the Attiewandaron contained rapidly running streams, large rivers, and portages routes. A significant trail beginning at Lake Simcoe, following the Nottawasaga River to the Pine River to the source of the Irvine River into the Grand River, and into the banks of Lake Erie, formed a native portage route favoured for travel and trade between Huron-Wendat and Attiewandaron territorial lands (Bricker, 1934, p.58).

There were only two recorded visits of French missionaries to the Attiewandaron villages in the Niagara Peninsula area; the first in 1626 by Reverend Father Joseph de la Roche Daillon, a Recollet in 1626 and Jean de Brebeuf and Joseph Marie Chaumont, French missionary priests in 1640 (Bricker, 1934, p.59; Johnson, 1964, p.xxx). Roche Daillon journeyed from the Huron-Wendat to the Attiewandaron under the pretense of trade, and spent months studying the Attiewandaron language in an attempt to instruct them in the principals of Christian religion (Bricker, 1934, p.58; White, 1978, p.409; Gingras, 2000; Jury, 1974, p.3). The Huron-Wendat, however, who guarded their trade advantage, was alarmed and enraged with fear that trade pacts were being considered between the French and Attiewandaron (Jury, 1974, p.20). Consequently, the Huron-Wendat travelled from village to village warning the Attiewandaron of “misfortune and ruin if they received the French in their midst” (Jury, 1974, p.20). This action caused the dismissal of Roche Daillon from the Attiewandaron and no direct trade relationship was ever formed between the French and Attiewandaron, allowing the Wendat to continue acting as middle-men (White, 1978, p.407).

By 1645, having grown dependent on European goods and with their territory no longer yielding enough animal pelts, the Haudenosaunee became increasingly aggressive towards the Huron-Wendat Confederacy (Trigger, 1994, p.53). Armed with Dutch guns and ammunition, the Haudenosaunee engaged in warfare with the Huron-Wendat Confederacy and brutally attacked

and destroyed several Huron-Wendat villages throughout Southern Ontario (Trigger, 1994, p.53). After the massacres of 1649-50, the small groups that remained of the Huron-Wendat Confederacy became widely dispersed throughout the Great Lakes region (Schmalz, 1991, p.17). Many Huron-Wendat tribes, such as the Tahontaenrat, sought refuge and protection within the Attiewandaron, until the Haudenosaunee attacked in the 1650s (Warrick, 2008, p.208; Trigger, 1994, p.56). The Attiewandaron Confederacy was entirely dispersed. Many were captured and incorporated into the Haudenosaunee, or sought refuge within other tribes (Trigger, 1994, 57; Lennox and Fitzgerald, 1990, p.410). The last mention of the Attiewandaron in French writing was in 1671 (Noble, 2012).

1.3.3 Post Contact Period (ca. A.D. 1650 – 1800)

Although their homeland was located south of the Great Lakes, the Haudenosaunee controlled most of Southern Ontario in the 1660s, occupying at "least half a dozen villages along the north shore of Lake Ontario and into the interior" (Schmalz, 1991, p.17; Williamson, 2013, p.60). The Haudenosaunee established "settlements at strategic locations along the trade routes inland from the north shore of Lake Ontario. Their settlements were on canoe-and-portage routes that linked Lake Ontario to Georgian Bay and the upper Great Lakes" (Williamson, 2013, p.60). The Haudenosaunee used this acquired territory within Southern Ontario to hunt game and obtain furs for trade exclusively with the Dutch and English (Coyne, 1895, p.20).

The Anishinaabeg, an Algonquin-speaking linguistic and cultural group, wanted control of the land between Lake Huron and Lake Ontario in order to further their role in the fur trade and began to challenge the Haudenosaunee dominance in the region (Johnston, 2004, pp.9-10; Gibson, 2006, p.36). Before contact with the Europeans, the Ojibwa territorial homeland was situated inland from the north shore of Lake Huron (MNCFN, ND, p.3). The English referred to those Algonquin-speaking linguistic and cultural groups that settled in the area bounded by Lakes Ontario, Lake Erie, and Lake Huron as Chippewas or Ojibwas (Smith, 2002, p.107). In 1640, the Jesuit fathers had recorded the name "*oumisagai*, or Mississaugas, as the name of an Algonquin band near the Mississagi River on the northwestern shore of Lake Huron. The French, and later English, applied this same designation to all Algonquian [-speaking groups] settling on the north shore of Lake Ontario" (Smith, 2002, p. 107; Smith, 2013, pp.19-20).

After a major smallpox epidemic in 1662, the capture of New Netherland by the English in 1664, and a series of successful attacks against the Haudenosaunee by the Ojibwa from 1653 to 1662, the Haudenosaunee dominance in Southern Ontario began to fail (Warrick, 2008, p.242; Schmalz, 1991, p.20). Prior to 1680, the Ojibwa had begun to settle just north of the evacuated Huron-Wendat territory and with the English entering the fur-trading market, the Ojibwa began to expand further into Southern Ontario (Gibson, 2006, p. 36; Schmalz, 1991, p.18). By the 1690s, Haudenosaunee settlements along the northern shores of Lake Ontario were abandoned (Williamson, 2013, p.60). By 1701, after a series of successful battles on the Bruce Peninsula, at the mouth of the Humber River and along Burlington Bay, the Haudenosaunee were defeated and expelled from Ontario (Gibson, 2006, p. 37; Schmalz, 1991, p.27; Coyne, 1895, p.28). After these battles, the Ojibwa replaced the Haudenosaunee in Southern Ontario (Schmalz, 1991, p.29).

In 1701, representatives of several bands within the Ojibwa Nation and the Haudenosaunee assembled in Montreal to participate in Great Peace negotiations, sponsored by the French (Johnston, 2004, p.10; Trigger, 2004, p.58). The Mississaugas were granted sole possession of the territory to the north of Lake Ontario and Lake Erie (Hathaway, 1930, p.433). From 1701 to the fall of New France in 1759, the Ojibwa experienced a "golden age" of trade, holding no conclusive alliance with either the British or the French while maintaining their middle-man position between native groups to the north and in southwestern Ontario (Schmalz, 1991, p. 35).

Canada was still under the jurisdiction of the French up until the Seven Years' War (1756-1763) between France and Great Britain. Conflicts continually arose between the French and British against the independent tribes within the Haudenosaunee Confederacy until 1754. The Haudenosaunee Confederacy attempted to remain neutral during the Seven Years' War, but when the French surrendered New France to the British in 1763, several attempts were made to expel the British as British sovereignty removed the Haudenosaunee as critical middle men in the fur trade (Trigger and Day, 1994, p.90).

1.3.4 Euro-Canadian Settlement Period (A.D. 1780s to Present)

By 1775, the Haudenosaunee Confederation, or Six Nations, was divided in their support during the American War of Independence. Some wished to side with the British, others with the revolutionaries, but most wished to remain neutral (Trigger and Day, 1994, p.90). By 1779, the American army had burned many tribal villages in the Haudenosaunee homeland south of Lake Ontario, forcing many of the Haudenosaunee Confederacy to seek refuge in Upper Canada (Trigger and Day, 1994, p.91). For their aid in the British effort against the Americans, the Haudenosaunee were awarded land along the Grand River by Sir Frederick Haldimald, Governor and Commander-in-Chief of the British forces in North America on behalf of the British Crown (Trigger and Day, 1994, p.91; Nelson and O'Neill, 1989, p.87).

However, before the Haudenosaunee refugees could settle in the Grand River region, Governor Haldimald had to purchase the land from the Mississauga who had settled in the region before the Seven Years War (Johnston, 1964, p.xxxviii). The British Government regarded the Mississaugas "as the aboriginal inhabitants of the territory in which the Grand River tract was located" (Bourgeois, 1986, p.p.4). The Mississauga at the western end of Lake Ontario ceded a large tract of land that extended from the Niagara Peninsula to lands close to the head of Lake Ontario and north to the shore of Lake Erie and as far west as Cat Fish Creek for £1,180 worth of trade goods, known as the Between the Lakes Purchase (Surtees, 1994, p.103; Johnston, 1964, p.xxxviii). The tract included over one million hectares of land for Euro-Canadian settlement, and approximately 675,000 acres of land nearly 12 miles wide along the course of the Grand River (six miles on either side of the river) awarded to the Haudenosaunee, or Six Nations; a document from 1792 confirmed the transaction and the limits of the land grant (Johnston, 1964, p.xxxviii; Surtees, 1994, p.104). However, the precise limits were uncertain "since no qualified surveyors actually went over the ground in 1784, it was described in the most misleading terms" (Johnston, 1964, p.xxxix). Eventually, the survey of this tract commenced under the instruction of Augustus Jones, an experienced professional surveyor,

and was completed in late January of 1791, prior to the cession of land by the Mississauga (Bourgeois, 1986, p.8). This survey did not include the mouth of the Grand River (Johnston, 1964, p.xl). A second survey of the Grand River tract was commissioned by the Haudenosaunee in 1796 (Bourgeois, 1986, p.11).

Joseph Brant, a Mohawk war chief, interpreter and Indian Department officer, regarded the territory as his own to manage on behalf of the Haudenosaunee. Furthermore, Joseph Brant regarded the Haudenosaunee as the allies of the British Crown, not its subjects. Brant realized the land grant exceeded the needs of the Haudenosaunee and Brant began to sell parcels along the Grand River to Euro-Canadians as he believed he owned the right to sell the land. However, by 1791, Lieutenant Governor John Graves Simcoe refused the Haudenosaunee the right to sell land or lease any part of their reserve. Brant argued the Haudenosaunee could not survive on hunting alone, and required experienced farmers to lay the foundations of a stable community. In 1796, Joseph Brant obtained the Power of Attorney from the other chiefs of the Haudenosaunee, allowing him the right to sell and lease Haudenosaunee lands within the Grand River tract (Graymont, 2014; Bourgeois, 1986, p.9; Johnston, 1964, pp.xlii-liv).

The Township of Woolwich, originally named 'Block No.3,' was comprised of 86,078 acres and was sold by Joseph Brant on behalf of the Haudenosaunee to William Wallace for £16,364 (Devitt, 1948, p.38; Parsell &Co, 1881, p.9). This purchase included all of the Township of Woolwich. However, William Wallace was unable to honor terms of the contract and was forced to relinquish all but 7,000 acres of the 86,078 acre tract (Johnston, 1964, p.lxi; Hayes, 1997, p.7). 15,000 acres were reserved for Joseph Brant and Ann Claus and an additional 15,000 acres were sold by William Wallace to Captain Robert Pilkington, a transaction confirmed by the Haudenosaunee, to establish a settlement in the north part of the Township (Johnston, 1964, p.lxi; Hayes, 1997, p.7). In 1807, Benjamin Eby and Henry Brubacher arrived from Pennsylvania to inspect the Beasley Tract in Waterloo Township, to which Benjamin Eby's father was heir to (Devitt, 1948, p.39; Leibbrandt, 1980, p.10). Unbeknownst to them, they had stumbled into the William Wallace Tract of Woolwich Township and shortly afterwards purchased 45,185 acres within the Township of Woolwich with the "whole amount [given] to the trustees of the Indians on May 1st, 1807" (Devitt, 1948, p.39).

The remaining 7,000 acres of William Wallace's Tract east of the Grand River, were still owned by William Wallace up until the War of 1812. Wallace is believed to have disappeared from Upper Canada to side with the Americans. After the War of 1812, the British Government passed into law that persons claiming to be Canadian but sided with the Americans, were declared outlaws and their lands were seized. William Wallace had his lands escheated by the Commissioner of Forfeited Estates. All 7,000 acres east of the Grand River was sold by the Commissioner of Forfeited Estates to William Crooks, and renamed Crooks Tract. Crooks Tract was sold off in large parcels to numerous settlers arriving from Pennsylvania (Uttley, 1933, p.13).

Mennonite settles arrived in Woolwich Township in 1808, traveling from Pennsylvania in their large conestogas, drawn by horses or oxen (Devitt, 1948, p.39; Bricker, 1935, p.123). Only the

War of 1812 slowed the arrival of Mennonites to Waterloo County and by 1825, 84 individuals resided within Woolwich Township, primarily of Pennsylvania German extraction (Leibbrandt, 1980, pp.12-13). By 1841, the population of Woolwich Township was 1,009 individuals where 32,327 acres were taken up and 9,100 acres were under cultivation (Smith, 1946, pp.223-224). The German Revolution of 1848, or the March Revolution, brought 15,000 individuals to the counties of Waterloo, Perth, Bruce and Grey many of which were poverty-stricken as a result of the famine and economic crisis overseas (Leibbrandt, 1980, p.29). By 1851, the number of individuals residing in Woolwich Township increased to 3,501 individuals (Smith, 1851, p.116). Upon arrival, settlers were tasked to clear the land of timber resources. The trees were of large size and of the finest quality timber and lumber (Snider, 1918, p.14). Once the land was cleared, houses were erected, and surplus timber was in abundance. The majority of the Township remained agriculturally focused as the soil was rich and fertile (Sutherland, 1864, p.2). Small communities began to develop within Woolwich Township as the community began to prosper.

Conestogo (also spelled Conestoga), is located on the confluence of the Spring Creek, Conestogo River and Grand River. It was founded by David Musselman after he purchased 700 acres of forest in the vicinity. In 1830, he bought a parcel of land where the village is currently located and established a sawmill on Spring Creek. Several years later, he built a dam across the Conestogo River and constructed a flour mill and another sawmill. A hamlet soon developed around this milling complex which included a cooper shop, blacksmith shop, general store, hotel, and post office. A brickyard, school, and church were added later and the hamlet was named Musselman's Mills. In 1852, the hamlet was renamed to Conestogo after the Conestoga Creek in Pennsylvania. In 1856, David Musselman sold the milling complex to Henry Snider who, along with his descendants, operated the mills until 1916. By 1881, the population increased to 300 individuals and was noted as being very picturesque (Uttley, 1933, p.16; Rayburn, 1997, p.78; Millar, 1995, p.41; Parsell, 1881, p.9).

St. Jacobs is located along King Street and Conestogo River and was not established until 1851 when Jacob Syder (also spelled Snider) built a saw and gristmill on the Conestogo River. Several settlers were in the area prior to this time, including John E. Bowman, and George Eby who had established a small mill and store, respectively. The establishment of Jacob Snider's milling complex brought mechanics and stores to the hamlet, and the hamlet was named Jacobstettel, or St. Jacobs. This milling complex was purchased by the E.W.B. Snider and incorporated into the Snider Flour Milling Company, the same company who owned the Conestogo milling complex until 1916 (Uttley, 1933, p.20; Rayburn, 1997, p.302; Parsell, 1881, p.9).

West Montrose, located along the west bank of the Grand River, and was settled by English and Scottish immigrants. A.L. Anderson arrived in the vicinity in the 1850s and was a native of Montrose, Scotland. In 1866, the hamlet was known as Montrose, but when the post office arrived, the name Montrose was already in use as a village in Welland County, and thus 'West' was added as a designator (Uttley, 1933, p.19; Rayburn, 1997, pp.369-370).

1.3.5 Past Land Use

To further assess the study corridor's potential for the recovery of historic Euro-Canadian pre-1900 remains, several documents were reviewed in order to gain an understanding of the land use history. A review of the 1861 *Tremaine's Map of the County of Waterloo* and the 1881 *Illustrated Historical Atlas of the County of Waterloo* (***see Map 3-4***) revealed the study corridor falls along original road allowances established during the survey of the Township of Woolwich. Where the study corridor extends outside open road allowances, it falls within several properties of different owners (***see Table 1***). Additionally, the study corridor traverses the villages of St. Jacobs, Conestogo, and West Montrose (***see Table 1***).

Table 1: Historic Structures within the Study Corridor

Con.	Lot	Occupant/Owner	Structure(s)
1861 *Tremaine's Map of the County of Waterloo*			
-	Wallace Tract	Eliot Hewitt	No structure(s)
-	31	Village of Conestogo	Village lots of Conestogo
-	33	D.M. Geo. Secollick	No structure(s)
-	34	Ludwig Koch	No structure(s)
-	35	Jacob Webber	No structure(s)
-	36		No structure(s)
-	41	David Musselman	No structure(s)
-	42	Peter M. Mussellman	Church
-	69	Isaac Swope	School House
-	70	Snider Mitchell	No structure(s)
-	71	Jacob Benner	No structure(s)
		Village of West Montrose	Village lots of West Montrose
1	1	Unlisted	No structure(s)
1	2	Unlisted	No structure(s)
1	3	Unlisted	No structure(s)
1	4	Robt Smith	No structure(s)
Broken Con.	1	Unlisted	No structure(s)
Broken Con.	2	Unlisted	No structure(s)
Broken Con.	3	Unlisted	No structure(s)
1881 *Illustrated Historical Atlas of the County of Waterloo*			
-	Wallace Tract	Chalmers Lot	No structure(s)
-	31	Village of Conestogo	Village lots of Conestogo
-	33	Unlisted	No structure(s)
-	34	Unlisted	No structure(s)
-	35	D.W.D. Dell-Robinson/I.E. Bowman	No structure(s)
-	36	Jacob Weber	No structure(s)
-	41	Unlisted	No structure(s)
-	42	Enoch Bauman	No structure(s)
-	69	Unlisted	No structure(s)
-	70	Unlisted	No structure(s)
-	71	Village of West Montrose	Village lots of West Montrose
1	1	Unlisted	No structure(s)
1	2	Jas. Adamson	No structure(s)
1	3	Jas. Adamson	No structure(s)

Con.	Lot	Occupant/Owner	Structure(s)
1	4	Jas. Adamson	No structure(s)
Broken Con.	1	Unlisted	No structure(s)
Broken Con.	2	Unlisted	No structure(s)
Broken Con.	3	Unlisted	No structure(s)

The 1861 Tremaine's Map depicts the study corridor traversing the village lots of Conestogo and West Montrose. Six historic homesteads and a flax mill were depicted within 300 metres of the study corridor. The 1881 Illustrated Atlas depicts the study corridor traversing the village lots of Conestogo and West Montrose. Two churches and their respective cemeteries were depicted within 300 metres of the study corridor.

In addition to the study corridor's documented proximity to, and the presence of Euro-Canadian historic structures, the study corridor traverses five historic settlement roads, present-day Sawmill Road, Northfield Drive, Jigs Hollow Road, Hill Street, and Covered Bridge Drive, which were originally laid out during the survey of the Township of Woolwich and the Village of West Montrose. In Southern Ontario, the *2011 S&G* considers undisturbed lands within 300 metres of early Euro-Canadian settlements and 100 metres of early historic transportation routes (e.g., trails, passes, roads, railways, portage routes) to be of elevated archaeological potential. Therefore, it is established that undisturbed lands within the study corridor that fall within 300 metres of these features have elevated archaeological potential.

1.3.6 Present Land Use

The primary present land use of the study corridor can be categorized as transportation/rural/municipal.

1.4 Archaeological Context

1.4.1 Designated and Listed Cultural Heritage Resources

Consultation of the Ontario Heritage Properties Database which records heritage resources that have been designated for their cultural value or interest under the *Ontario Heritage Act*, confirmed the presence of one provincially designated heritage property within 300 metres of the study corridor[1] (***see Table 2***).

Table 2: Provincially Designated Heritage Property within 300 metres of the Study Corridor

Description	Status
West Montrose Covered Bridge (ca.1881)	Provincial Plaque; Ontario Heritage Bridge List

Additional consultation of the online inventory entitled, "Township of Woolwich Municipal Register Heritage Designated Properties" (Township of Woolwich, 2015) which records

[1] **Clarification:** As of 2005, the Ontario Heritage Properties Database is no longer being updated. The Ministry of Tourism, Culture and Sport is currently updating a new system which will provide much greater detail to users and will become publicly accessible in the future. (http://www.hpd.mcl.gov.on.ca)

municipally designated and listed heritage properties within the Township of Woolwich has revealed four designated heritage properties, which includes the West Montrose Covered Bridge, located within 300 metres of the study corridor. Six listed heritage properties were also located within 300 metres of the study corridor (***see Table 3***).

Table 3: Municipally Identified Heritage Resources within 300 metres of the Study Corridor

Address	Description	Status
1790 Sawmill Road, Conestogo	Conestogo United Church	Designated Part IV
1924 Sawmill Road, Conestogo	Old Township Hall	Designated Part IV
52 Hill Street, West Montrose	Albright House	Designated Part IV
Along Bridge Road over the Grand River	West Montrose Covered Bridge (ca.1881)	Designated Part IV
1238 Rivers Edge Drive, West Montrose	19th Century Stone Cottage	Listed
1239 Rivers Edge Drive, West Montrose	Storage Sheds	Listed
1242 Rivers Edge Drive, West Montrose	19th Century Stone Cottage	Listed
5 Covered Bridge Drive, West Montrose	Former Blacksmith shop, gas station and 19th century Victorian house	Listed
12 Covered Bridge Drive, West Montrose	General Store	Listed
42 Covered Bridge Drive, West Montrose	West Montrose United Church and Cemetery ca. 1907	Listed

According to *Section 1.3.1* of the *2011 S&G,* undisturbed lands within 300 metres of properties inventoried in a municipal register or designated under the *Ontario Heritage Act*, or a federal, provincial, or municipal historic landmark or site, are considered to have elevated archaeological potential. Therefore, it has been determined that the undisturbed portions of the study corridor within 300 metres of these features have elevated archaeological potential.

1.4.2 Heritage Conservation Districts

A Heritage Conservation District (HCD) includes areas that have been protected under Part V of the *Ontario Heritage Act*. An HCD can be found in both urban and rural environments and may include residential, commercial, and industrial areas, rural landscapes or entire villages or hamlets with features or land patterns that contribute to a cohesive sense of time or place and to an understanding and appreciation of the cultural identity of a local community, region, province, or nation. An HCD may comprise an area with a group or complex of buildings, or a large area with many buildings and properties. They often extend beyond their built heritage, structures, streets, landscapes, and other physical and spatial elements, to include important vistas and views between and towards buildings and spaces within the district (MTCS, 2006, p.5). HCDs are a valuable cultural heritage and must be taken into consideration during municipal planning to ensure that they are conserved.

According to *Section 1.3.1* of the *2011 S&G,* undisturbed lands within 300 metres of heritage resources listed on a municipal register or designated under the *Ontario Heritage Act*, or a federal, provincial, or municipal historic landmark or site, are considered to have elevated archaeological potential. To determine if the study corridor is located within or in close proximity to an HCD, the Senior Planner at the Township of Woolwich was contacted and confirmed that a portion of the study corridor is located within the West Montrose Cultural

Heritage Landscape. The West Montrose Cultural Heritage Landscape is designated in the Official Plan of the Township of Woolwich (Templeton, 2015).

Therefore, it is established that undisturbed properties of the study corridor, within 300 metres of the West Montrose Cultural Heritage Landscape, have elevated archaeological potential.

1.4.3 Commemorative Plaques or Monuments

According to *Section 1.3.1* of the *2011 S&G,* undisturbed lands within 300 metres of Aboriginal and Euro-Canadian settlements where commemorative markers of their history, such as local, provincial, or federal monuments, cairns or plaques, or heritage parks, are considered to have elevated archaeological potential. To determine if any historical plaques are present, the Ontario Historical Plaques inventory, which contains a catalogue of federal Historic Sites and Monuments Board of Canada plaques, the provincial Ontario Heritage Trust plaques, plaques identified by various historical societies, and other published plaques located in Ontario were reviewed. This review confirmed the presence of one commemorative plaque marking the West Montrose Covered Bridge, within 300 metres of the study corridor. Therefore, based on the presence of the West Montrose Covered Bridge, as stated in discussed in **Section 1.4.1**, which the plaque commemorates, undisturbed lands within the study corridor that fall within 300 metres of this feature have elevated archaeological potential.

1.4.4 Pioneer/ Historic Cemetery

Background research has revealed that two pioneer/historic cemeteries, the West Montrose United Church Cemetery and St. Matthew's Evangelical Lutheran Cemetery, are located within 100 metres of the study corridor.

The West Montrose United Church cemetery is located at 42 Covered Bridge Drive and is maintained by the West Montrose United Church. The church is one of two present in the community of West Montrose, where the local congregation has existed since 1862. The congregation initially met at Crow's foot in Ebeneezer Church, and later met at Jacob Benner's blacksmith shop until a property was purchased for a new church. The present day United Church was built on said property in 1906-1907, and the foundation stones originated from the Rhodes Letson farm, which was built in 1862-1863 (Building Stories, 2015). The cemetery however, has existed for many years, even prior to the construction of the existing church, and is identified within the 1881 *Illustrated Historical Atlas of the County of Waterloo* (***see Map 4***).

The St. Matthew's Evangelical Lutheran Cemetery is located at 131 Flax Mill Drive. The earliest recorded death date on a legible marker dates from November 1st, 1856. The burials nearest the church are the oldest and there are several rows of burials with no markers present (CanadaGenWeb's Cemetery Project, 2015). This is a common feature of 19th century historic cemeteries, as they were not highly regulated; and burials often employed markers of little substance that have since disappeared. This cemetery and associated church are depicted within the 1881 *Illustrated Historical Atlas of the County of Waterloo (**see Map 4***).

As per *Section 1.3.1* of the *2011 S&G*, the presence of these historic and sensitive cultural heritage resources further elevates the potential to encounter archaeological remains within portions of the study corridor (***see Map 4***). Therefore, given the close proximity of the above mentioned cemeteries and respective churches (within 300 metres) to the study corridor, undisturbed lands within the study corridor which lie within 300 metres of these features have elevated archaeological potential.

1.4.5 Registered Archaeological Sites

In order provide a summary of registered or known archaeological sites within a minimum one kilometre distance from the project limits, as per *Section 7.5.8, Standard 1* of the *2011 S&G*, the *Ontario Archaeological Sites Database* (OASD) maintained by the *MTCS* was consulted (MTCS, 2014). Every archaeological site is registered according to the Borden System, which is a numbering system used throughout Canada to track archaeological sites and their artifacts. The study corridor is located within Borden blocks AjHc and AjHd.

The *2011 S&G* considers undisturbed lands within 300 metres of a registered archaeological site to be of elevated archaeological potential. According to the *MTCS* (2014), four archaeological sites have been registered within one kilometre of the study corridor. Archaeological site AjHd-17 lies within 50 metres and site AjHd-28 lies within 300 metres of the study corridor (***see Table 4***).

The *2011 S&G* considers undisturbed lands within 300 metres of a registered archaeological site to be of elevated archaeological potential. Given two archaeological sites fall within 300 metres of the study corridor, elevated archaeological potential can be established for undisturbed lands falling within proximity to these registered archaeological sites.

Table 4: Registered Archaeological Sites within One Kilometre of the Study Corridor

Borden #	Name	Cultural Affiliation	Type
Sites within 50 metres of Study Corridor			
AjHd-17	Solomon	Historic	School
Sites within 300 metres of Study Corridor			
AjHd-28	Conestoga Burials	Woodland, Late	Ossuary?
Sites within one kilometre of the Study Corridor			
AjHd-4	-	Undetermined	Findspot
AjHd-26	-	Meadowood, Woodland, early	Findspot

'-' denotes no information provided in OASD

Having noted the presence of archaeological resources within proximity to the study corridor, it is useful to provide the cultural history of occupation in Southern Ontario (***see Table 5***). This data provides a further understanding of the potential cultural activity that may have occurred within the study corridor (Ferris, 2013, p.13).

Table 5: History of Occupation in Southern Ontario

Period	Archaeological Culture	Date Range	Attributes
PALEO-INDIAN			
Early	Gainey, Barnes, Crowfield	≥11500-8500 BC	Big game hunters. Fluted projectile points
Late	Holcombe, Hi-Lo, Lanceolate	8500-7500 BC	Small nomadic hunter-gatherer bands. Lanceolate projectile points
ARCHAIC			
Early	Side-notched, corner notched, bifurcate-base	7800-6000 BC	Small nomadic hunter-gatherer bands; first notched and stemmed points, and ground stone celts.
Middle	Otter Creek, Brewerton	6000-2000 BC	Transition to territorial settlements
Late	Narrow, Broad and Small Points Normanskill, Lamoka, Genesee, Adder Orchard etc.	2500-500 BC	More numerous territorial hunter-gatherer bands; increasing use of exotic materials and artistic items for grave offerings; regional trade networks
WOODLAND			
Early	Meadowood, Middlesex	800BC-0BC	Introduction of pottery, burial ceremonialism; panregional trade networks
Middle	Point Peninsula, Saugeen, Couture: Jack's Reef Corner Notched	200 BC-AD 900	Cultural and ideological influences from Ohio Valley complex societies; incipient horticulture
Late	Algonquian, Iroquoian, Western Basin	AD 900-1250	Transition to village life and agriculture
	Algonquian, Iroquoian, Western Basin	AD 1250-1400	Establishment of large palisaded villages
	Algonquian, Iroquoian	AD 1400-1600	Tribal differentiation and warfare
HISTORIC			
Early	Huron, Neutral, Petun, Odawa, Ojibwa, Five Nations Iroquois	AD 1600 – 1650	Tribal displacements
Late	Six Nations Iroquois, Ojibwa, Mississauga	AD 1650 – 1800s	Migrations and resettlement
	Euro-Canadian	AD 1780 - present	European immigrant settlements

1.4.6 Previous Archaeological Assessments

In order to further establish the archaeological context of the study corridor, reports documenting previous archaeological fieldwork carried out within the limits of, or immediately adjacent to (i.e., within 50 metres) the study corridor were consulted. Four reports were identified:

1. Assessment Report, RMW - Licensed to Scarlett E. Janusas 1989-143C Researched by Archaeology Division, Regional documenting the discovery of AjHd-17

In an attempt to adhere to *Section 7.5.8, Standard 4* of the *2011 S&G*, the *MTCS* was contacted on February 5th, 2015 and on April 17, 2015 in order to obtain a copy of the report above (Templeton, 2015a; Templeton, 2015d). A site form for AjHd-17 was provided, which notes that the site was discovered in a ploughed field. The site was subjected to a controlled surface

collection and the mapped artifacts were collected. A scatter of bricks and brick fragments, ceramic ink wells, glass bottle fragments, granite ware sherds, a white earthenware sherd and a white clay pipe stem was encountered, as well as a possible cultural feature related to a historic school house. The site dates to approximately the early 19th century to mid-20th century, based on its depiction within the Tremaine's 1861 map, verbal testimony and the artifact collection. The site was found to have cultural heritage significance, and further archaeological assessment was recommended.

2. Stage 3 Archaeological Assessment of the Solomon Site (AjHd-17), Conestogo Turkey Farms, Weber Subdivision, Phase 11, Part of Lot 32, German Company Track (30T-89005), Village of Conestogo, Township of Woolwich, Regional Municipality of Waterloo, Ontario (Elizabeth Alder, 1994)

In 1994, *Elizabeth Alder* undertook a Stage 3 AA of the Solomon Site (AjHd-17) in advance of a subdivision development. This site is located within 50 metres of the current study corridor. The Stage 3 AA consisted of topsoil stripping to delineate the locations of cultural features and structural remains, and artifacts on the surface were collected prior to and after topsoil stripping. A cobblestone foundation was uncovered, as well as a scattering of red brick and mortar, determined to be from the demolished walls above. An additional feature, possibly an outhouse, was discovered south of the foundations. A title drain was also uncovered. Archival research concluded the foundations located during the Stage 3 AA were those of the third school house constructed in 1864 and consisted of a two-room red brick building. This school house was used over a period of 40 years and does not represent a significant discrete cultural horizon. No further archaeological research is required on the Solomon Site (AjHd-17).

3. Hwy86ByPass WP32-85-00 (Ministry of Transportation, 1990)

In an attempt to adhere to *Section 7.5.8, Standard 4* of the *2011 S&G*, the *MTCS* was contacted on February 5th, 2015 and on April 17th, 2015 in order to obtain a copy of the report above (Templeton, 2015a; Templeton, 2015d). A copy had not yet been received at the time of report completion.

4. Summary Report on Activates Conducted on the Conestoga Burials (AjHd-28) RM of Waterloo, Archaeological Division" held at RMW & MCTR, non-licence report (AjHd-28= found within 100m) (Tom Arnold, 1991)

In an attempt to adhere to *Section 7.5.8, Standard 4* of the *2011 S&G*, the consultant was contacted on February 5th, 2015 in order to obtain a copy of the report listed above. However, no copy was available (Templeton, 2015b). Subsequently, the *MTCS* and *Planning Department of the Region of Waterloo* were contacted to obtain a copy of the report (Templeton, 2015a; Templeton, 2015d). The Region of Waterloo suggested the *Waterloo Archives* be contacted to obtain a copy of this report (Templeton, 2015c). No response was received from the *Waterloo Archives* or from the *MTCS* at the time of report completion.

1.4.7 Physical Features

An investigation of the study corridor's physical features was conducted to aid in the development of an argument for archaeological potential based on the environmental conditions of the study corridor. Environmental factors such as close proximity to water, soil type, and nature of the terrain, can be used as predictors to determine where human occupation may have occurred in the past.

The portion of the study corridor encompassing Sawmill Road, Northfield Drive East, and parts of Jigs Hollow Road are situated within the Oxford Till Plain physiographic region, while the remainder of the study corridor is situated within the Guelph Drumlin Field.

The Oxford Till Plain resides with the centre of the peninsula of southwestern Ontario. The surface is drumlinized, oriented in a northwesterly direction and the till is composed of pale brown calcareous loam with Middle Devonian limestone being the predominate material. The dominant soil type is Guelph loam, a Grey Brown luvisol that is gently sloping with good drainage, medium textured, neutral and has a lack of stoniness. The early settlement period of the Oxford till plain saw many small farms, and over time, crops moved away from oats and hay to focus on grain corn production. Farm sizes rapidly increased and the Woodstock area in particular became known for its dairy farming with purebred Holstein cattle and dairy products.

The Guelph drumlin field covers 320 square miles that includes parts of the Regional Municipalities of Hamilton-Wentworth, Waterloo, and Halton, and a part of Wellington County. This area includes approximately 300 drumlins of varying sizes and is referable to the ice thrust that radiated from the western end of the basin of Lake Ontario. These drumlins are not as close as other areas; therefore more intervening low ground is present, which holds fluvial materials. The till in the drumlins are loamy, calcareous and quite stony, becoming sandier traveling to the northeast (Chapman and Putnam, 1984).

Agriculture within the Guelph drumlin field was traditional and generalized, with a growing specialization in the production of beef cattle, hogs, and poultry. "Natural pasture" land was poorly drained land that was improved through drainage and seeding. The Guelph countryside was accidentally laid out by early surveyors by the grain of the land. This allowed easier arrangement and carry out systems of contour elevation. Although there is a great amount of gravel in the vicinity of Guelph, these have provided useful building aggregates, and farmsteads and homes are well built on stone foundations. Abandoned farms are less frequent compared to nearby areas (Chapman & Putnam, 1984).

Several soil types are found within the study corridor, including: Burford-Fox, Freeport-Woolwich, Grand-Kirkland, Guelph, and Huron-St.Clements. A description of their characteristics may be found in **Table 6** (Ontario Agricultural College, 1971). The great variety in soil types further highlights the mixed landscape that the study corridor encompasses and supports the mixed nature of past subsistence practices and changing industries of early settlers in these areas. Soils more conducive to agriculture, such as good drainage and

stonefree, has the potential for past settlement, support greater population density and subsequently elevated archaeological potential.

Table 6: Study Corridor Soil Types

Soil Association	Description
Burford-Fox	Coarse and medium textured soils formed on outwash and shallow lacustrine deposits
Freeport-Woolwich	Coarse and medium textured soils, 1 to 3 feet deep, overlying medium textured till deposits
Grand-Kirkland	Coarse and medium textured soils formed on recent alluvial deposits
Guelph	Medium-textured soils formed on till deposits
Huron-St. Clements	Fine-textured soils formed on till or lacustrine deposits

In terms of archaeological potential, potable water is a highly important resource necessary for any extended human occupation or settlement. As water sources have remained relatively stable in Southern Ontario since post-glacial times, proximity to water can be regarded as a useful index for the evaluation of archaeological site potential. Distance from water has been one of the most commonly used variables for predictive modeling of site location. A watershed is an area drained by a river and its tributaries. As surface water collects and joins a collective water body, it picks up nutrients, sediment and pollutants, which may altogether, affect ecological processes along the way. Hydrological features such as primary water sources (i.e. lakes, rivers, creeks, streams) and secondary water sources (i.e. intermittent streams and creeks, springs, marshes, swamps) would have helped supply plant and food resources to the surrounding area and are indicators of archaeological potential (per Section 1.3.1 of the 2011 S&G).

The study corridor is situated within the Grand River watershed, and located within the confluence of the Conestogo and Grand Rivers, and crossed by the Canagagigue Creek. These primary water sources would have helped supply plant and food resources to their surrounding areas, and consequently support elevated potential for locating archaeological resources within undistributed portions of the study corridor that fall within 300 metres of their limits.

1.4.8 Current Land Conditions

The study corridor is currently situated within a mainly rural setting within the Township of Woolwich. It encompasses the road allowances of Sawmill Road, Northfield Drive East, Jigs Hollow Road, Hill Street, Covered Bridge Drive and Tallwood Drive and their associated right-of-way (ROW), as well as the West Montrose and Conestego Plains water supply systems. The topography within the study corridor is varied, measuring approximately 340 metres above sea level.

A detailed review of aerial photographs taken from 1978 (***see Maps 5-11***) and satellite imagery taken from 2013 (***see Maps 12-17***), reveals that the study corridor has remained relatively unchanged during this period of time. The most extensive changes to the study corridor are within the villages of Conestogo and West Montrose, where more residential homes were established alongside the study corridor as the towns expanded.

1.4.9 Date(s) of Fieldwork

A property inspection of the study corridor was undertaken on April 9th, 2015, to systematically review the archaeological potential of the study corridor.

1.5 Confirmation of Archaeological Potential

Based on the information gathered from background research documented in the preceding sections, elevated potential for the recovery of archaeological resources within the study corridor limits has been established. Features contributing to archaeological potential are summarized in **Appendix B**.

2.0 PROPERTY INSPECTION

This property inspection was conducted in compliance with the standards set forth in *Section 1.2* of the *2011 S&G*, published by the *MTCS*. The weather at the time of inspection (overcast with light fog) permitted good visibility (approximately 100 metres) of the study corridor

The inspection was carried out systematically at reduced 25 metre intervals to mitigate any visibility concerns due to the light fog, reviewing the entire extent of the study corridor to identify the presence or absence of archaeological potential. Photographic images of the study corridor are presented within **Appendix C**. Location and orientation information associated with all photographs taken in the field is provided within **Maps 18-40.** An inventory of the documented record generated in the field can be found within **Appendix D**.

2.1 Confirmation of Previously Identified Features of Archaeological Potential

During the Stage 1 property inspection it was confirmed that the Canagagigue Creek, and the Grand and Conestogo Rivers flow through sections of the study corridor or in proximity. In addition, it was confirmed that the study corridor traverses several historic settlement roads. As well, the study corridor was confirmed to be within 300 metres of the West Montrose Covered Bridge and its associated plaque, the West Montrose United Church and cemetery, and the St. Matthew's Evangelical Lutheran church and cemetery.

2.2 Identification and Documentation of Additional Features of Archaeological Potential

During the Stage 1 property inspection no additional features of archaeological potential were identified.

2.3 Identification and Documentation of Features that will affect Assessment Strategies

The Stage 1 property inspection resulted in several features that will impact the assessment strategies. These features are outlined in **Sections 3.1** and **3.2** and illustrated on **Maps 18-40** and documented in **Images 1-44**.

2.4 Identification and Documentation of Structures and Built Features that will Affect Assessment Strategies

During the Stage 1 property inspection no structures or built features were identified that will affect the assessment strategies

The results of this property inspection are detailed below.

3.0 Analysis and Conclusions

3.1 Identified Deep and Extensive Disturbances

The study corridor was evaluated for extensive disturbances that have removed archaeological potential. Disturbances may include but are not limited to: grading below topsoil, quarrying, building footprints, or sewage and infrastructure development. *Section 1.3.2* of the *2011 S&G's* counts infrastructure development among those "features indicating that archaeological potential has been removed."

The existing Conestogo Plains and West Montrose water supply systems; paved/gravel roadways and driveways; paved sidewalks; gravel shoulders; roadside ditches and embankments; production wells and underground utilities exhibit disturbed conditions. These land and infrastructure developments, the construction of which often entail soil-grading operations and the installation of utilities essential to service the areas (i.e., hydro, cable, sewer, water, etc.), would have caused extensive and deep disturbance to any archaeological resources that may have been present in the ground, thus resulting in the removal of archaeological potential within their footprints (***see Maps 18-40; Appendix C - Images 1-5, 7-17, 19-20, 23, 25-33, 35-44***). Therefore, it is recommended, as per *Section 1.4.1, Standard 1.f.,* of the *2011 S&G*, that these areas which exhibit disturbed conditions be exempt from a Stage 2 AA.

3.2 Physiographic Features of No or Low Archaeological Potential

The study corridor was also evaluated for physical features of no or low archaeological potential. These usually include but are not limited to: permanently wet areas, exposed bedrock, and steep slopes (greater than 20°) except in locations likely to contain pictographs or petroglyphs, as per *Section 2.1, Standard 2.a.* of the 2011 *S&G.*

Physiographic features of no or low archaeological potential encountered within the study corridor include permanently wet areas (consisting of the Grand River and Canagagigue Creek) (***see Maps 18-40; Images 6, 18, 24, 34***) (and steeply sloping terrain (***see Maps 18-40; Images 16, 20, 22, 32, 35***).

3.3 Identified Undisturbed Areas

Portions of the study corridor that exhibit neither extensively disturbed conditions nor contain physical features of no or low archaeological potential are considered to have archaeological potential. These areas include ploughed agricultural fields, grassed margins, areas of overgrown grass, and manicured grass lawns (***see Maps 18-40***; ***Images 1, 5, 7, 10, 14-15, 18, 21, 23, 24, 28-32, 37, 39-41, 43***).

Given the established potential to recover archaeological resources within these identified areas, a Stage 2 AA will be required. Given the study corridor is a narrow linear corridor (10 metres or less) for the most part, as per *Section 2.1.2, Standard 1.f* of the *2011 S&G*, in situations where there are planned impacts 10 metres or less beyond the previously impacted limits on both sides of the existing roadway, a test pit survey at five metre transects may be undertaken. However, where at the time of fieldwork the lands within the linear corridor meet the standards of pedestrian survey land preparation, as per *Section 2.1.1, Standards 2 and 3*, a pedestrian survey at five metre transects must be carried out in accordance *Section 2.1.1* of the *2011 S&G*. Within areas of ploughed agricultural fields measuring wider than 10 metres, those fields must be ploughed and subjected to appropriate weathering requirements prior to field investigation, in accordance with *Section 2.1.1* of the *2011 S&G*. followed by pedestrian survey at five-metre transects.

4.0 RECOMMENDATIONS

Based on the results of the background research and property inspection, the following recommendations are presented:

1. As per *Section 1.4.1, Standard 1.f.* of the *2011 S&G,* areas that exhibit disturbed conditions, as described within **Section 3.1**, are recommended to be exempt from a Stage 2 AA.

2. As per *Section 2.1, Standard 1* of the *2011 S&G*, physiographic features of no or low archaeological potential as described within **Section 3.2** are recommended to be exempt from a Stage 2 AA.

3. All identified undisturbed segments which co ntain archaeological potential as described within **Section 3.3** must be subjected to a Stage 2 AA at five metre intervals. Given the study corridor is a narrow linear corridor (10 metres or less) for the most part, as per *Section 2.1.2, Standard 1.f* of the *2011 S&G*, in situations where there are planned impacts 10 metres or less beyond the previously impacted limits on both sides of the existing roadway, a test pit survey at five metre transects may be undertaken. However, where at the time of fieldwork the lands within the linear corridor meet the standards of pedestrian survey land preparation, as per *Section 2.1.1, Standards 2 and 3* , a pedestrian survey at five metre transects must be carried out in accordance *Section 2.1.1* of the *2011 S&G*. Within areas of ploughed agricultural fields measuring wider than 10 metres, those fields must be ploughed and subjected to appropriate weathering requirements prior to field investigation, in accordance with *Section 2.1.1* of the *2011 S&G*. followed by pedestrian survey at five-metre transects.

4. Should construction activities associated w ith this development, including construction laydown areas, extend beyond the assessed limits of the study corridor, in order to minimize impacts to cultural heritage resources, further archaeological investigation will be required prior to construction activities.

5.0 ADVICE ON COMPLIANCE WITH LEGISLATION

1. This report is submitted to the MTCS as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the MTCS, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.

2. It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.

3. Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.

4. The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the *Ministry of Consumer Services*.

5. No construction activities shall take place within the study corridor prior to the *MTCS* (Archaeology Program Unit) confirming in writing that all archaeological licensing and technical review requirements have been satisfied.

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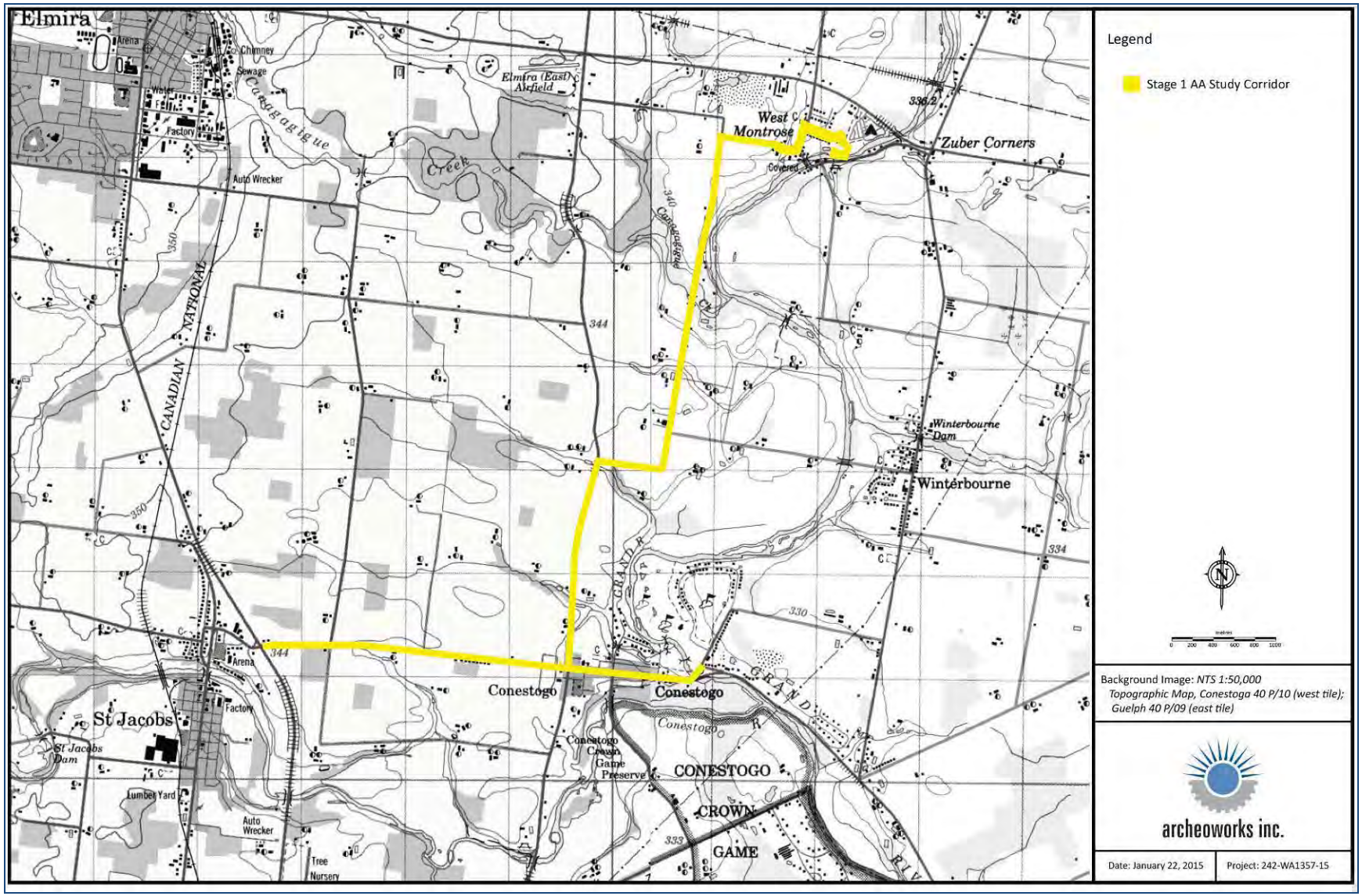
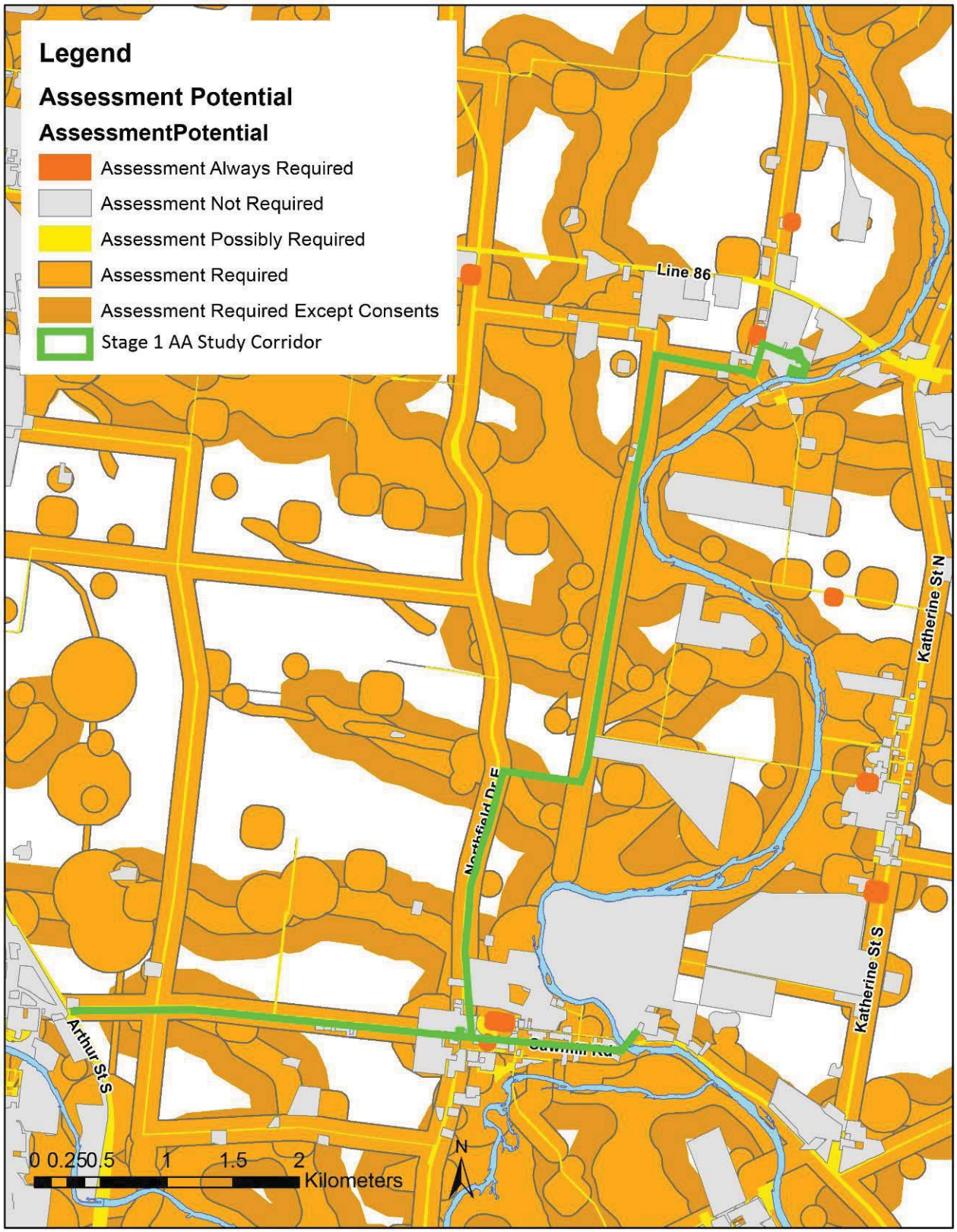
APPENDICES

APPENDIX A: MAPS

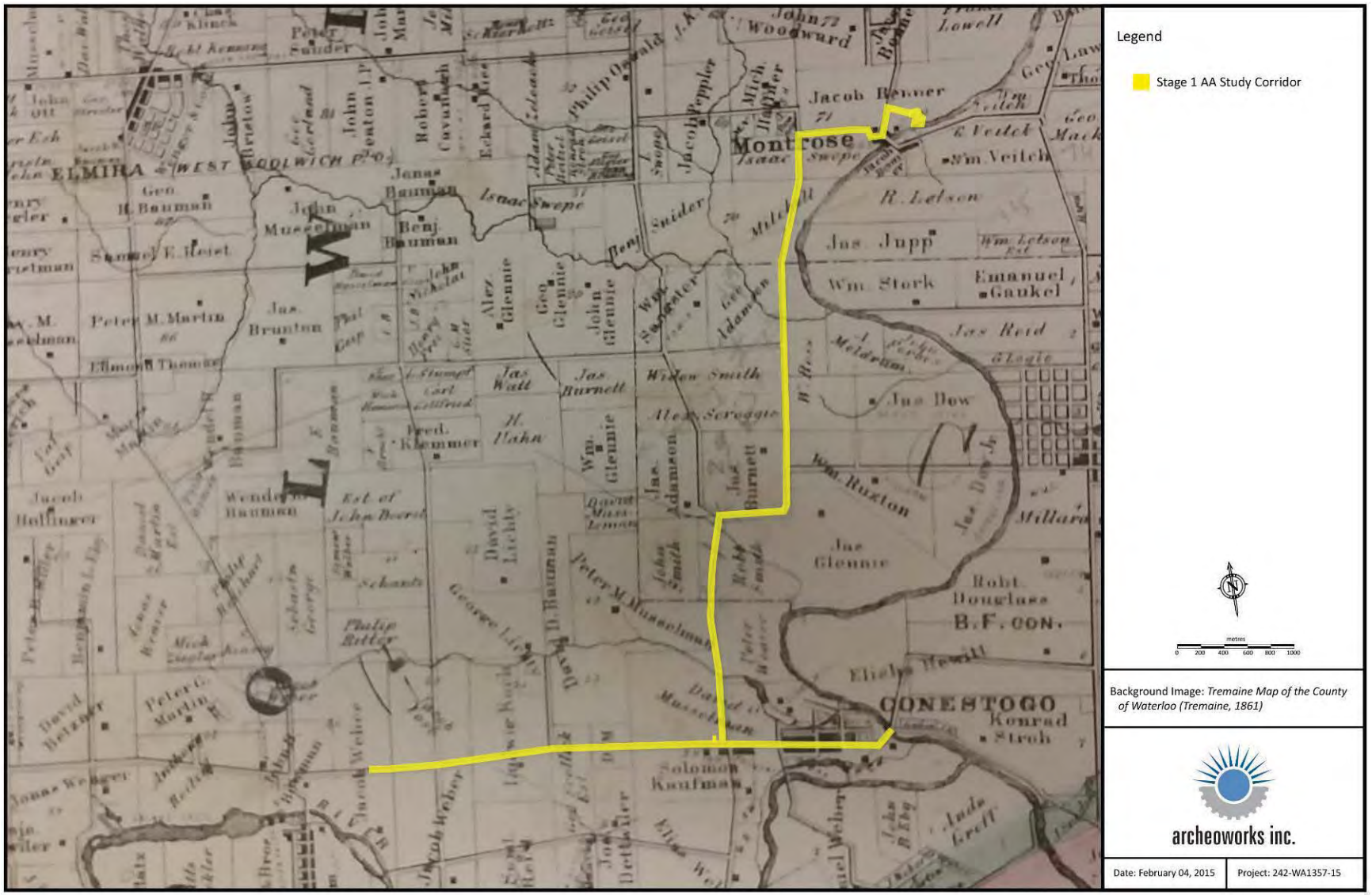


MAP 1 National Topographical System Map (Natural Resources Canada, 1998) identifying the Stage 1 AA study corridor.

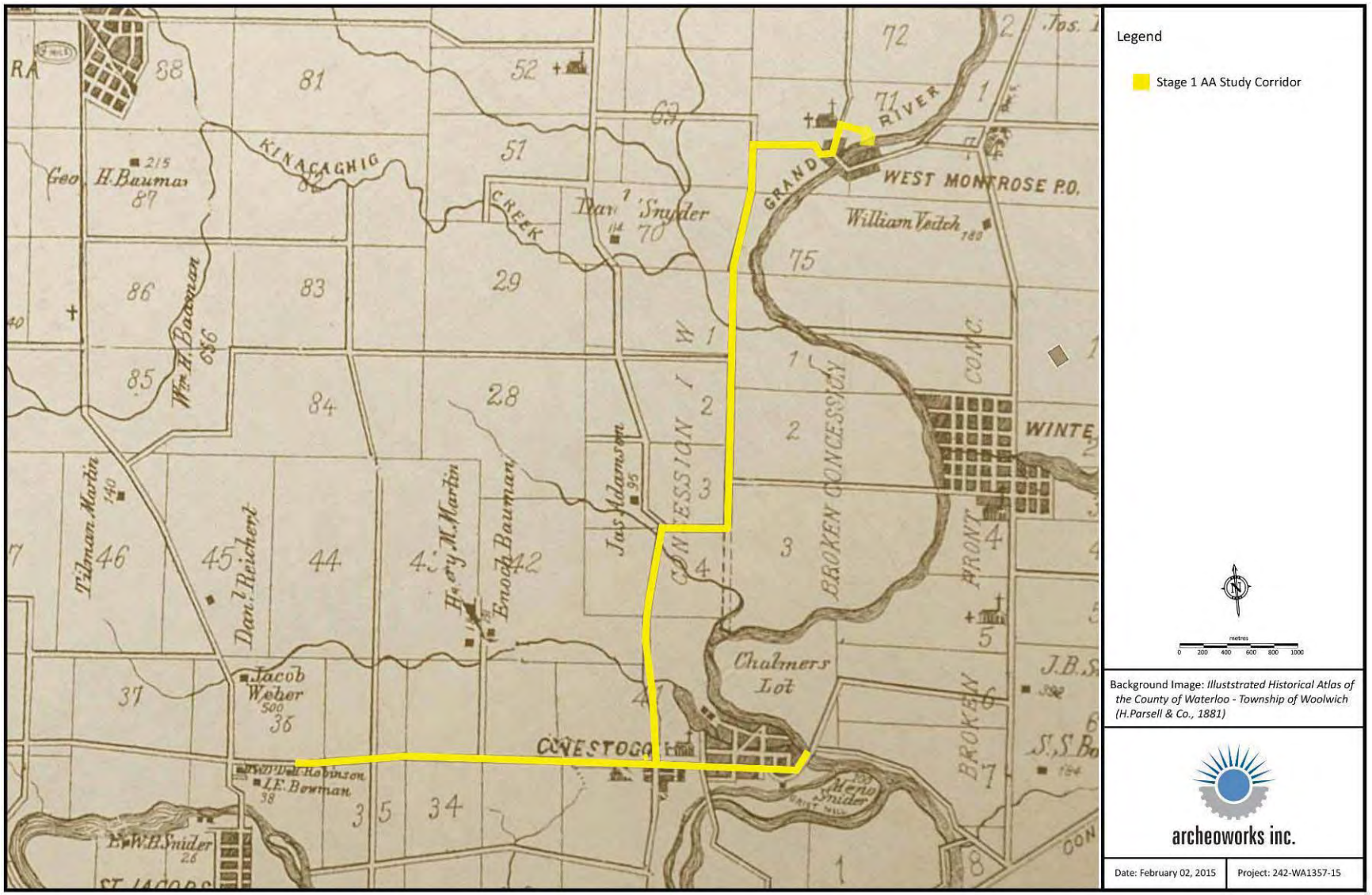
Archeological Potential



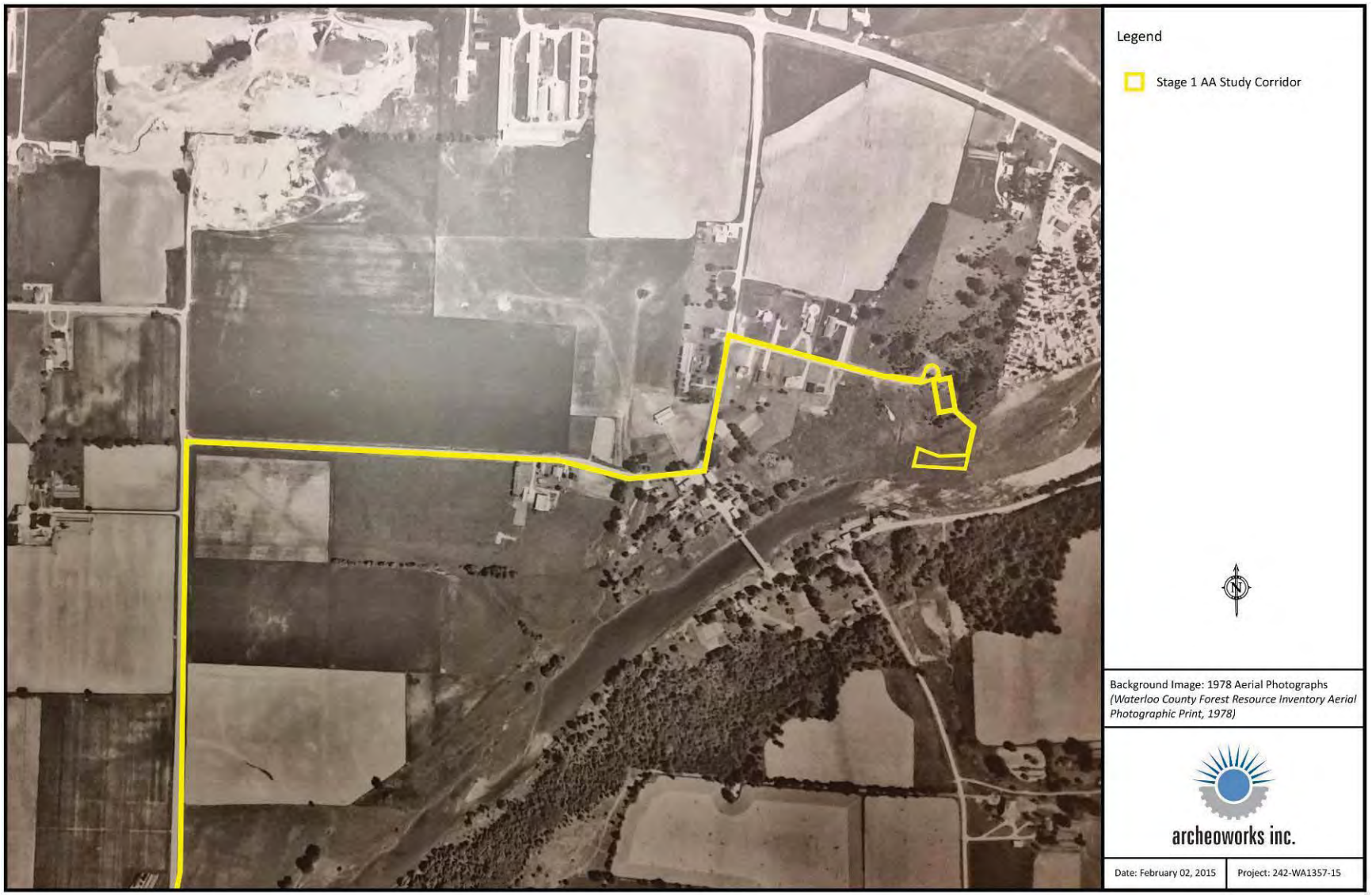
MAP 2 Archaeological potential within the Stage 1 AA study corridor according to the Archaeological Facilities Master Plan (Tam, 2015).



MAP 3 Tremaine Map of the County of Waterloo (Tremaine, 1861) identifying the Stage 1 AA study corridor.



MAP 4 Illustrated Historical Atlas of the County of Waterloo – Township of Woolwich (H. Parsell & Co., 1881) identifying the Stage 1 AA study corridor.



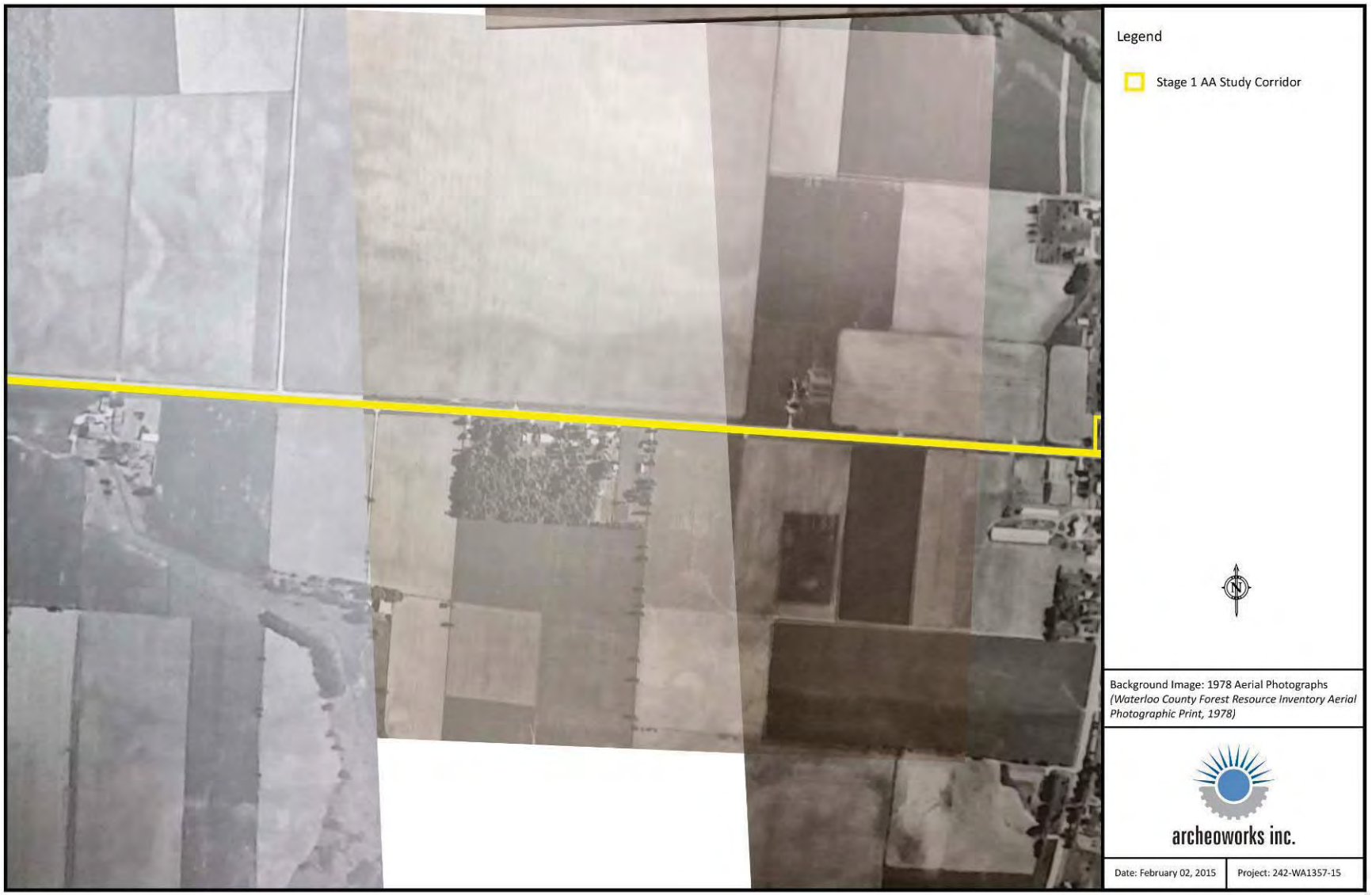
MAP 5 Stage 1 AA study corridor within a 1978 aerial photograph (Waterloo County Forest Resource Inventory Aerial Photographic Print, 1978).

MAP 6 Stage 1 AA study corridor within a 1978 aerial photograph (Waterloo County Forest Resource Inventory Aerial Photographic Print, 1978).

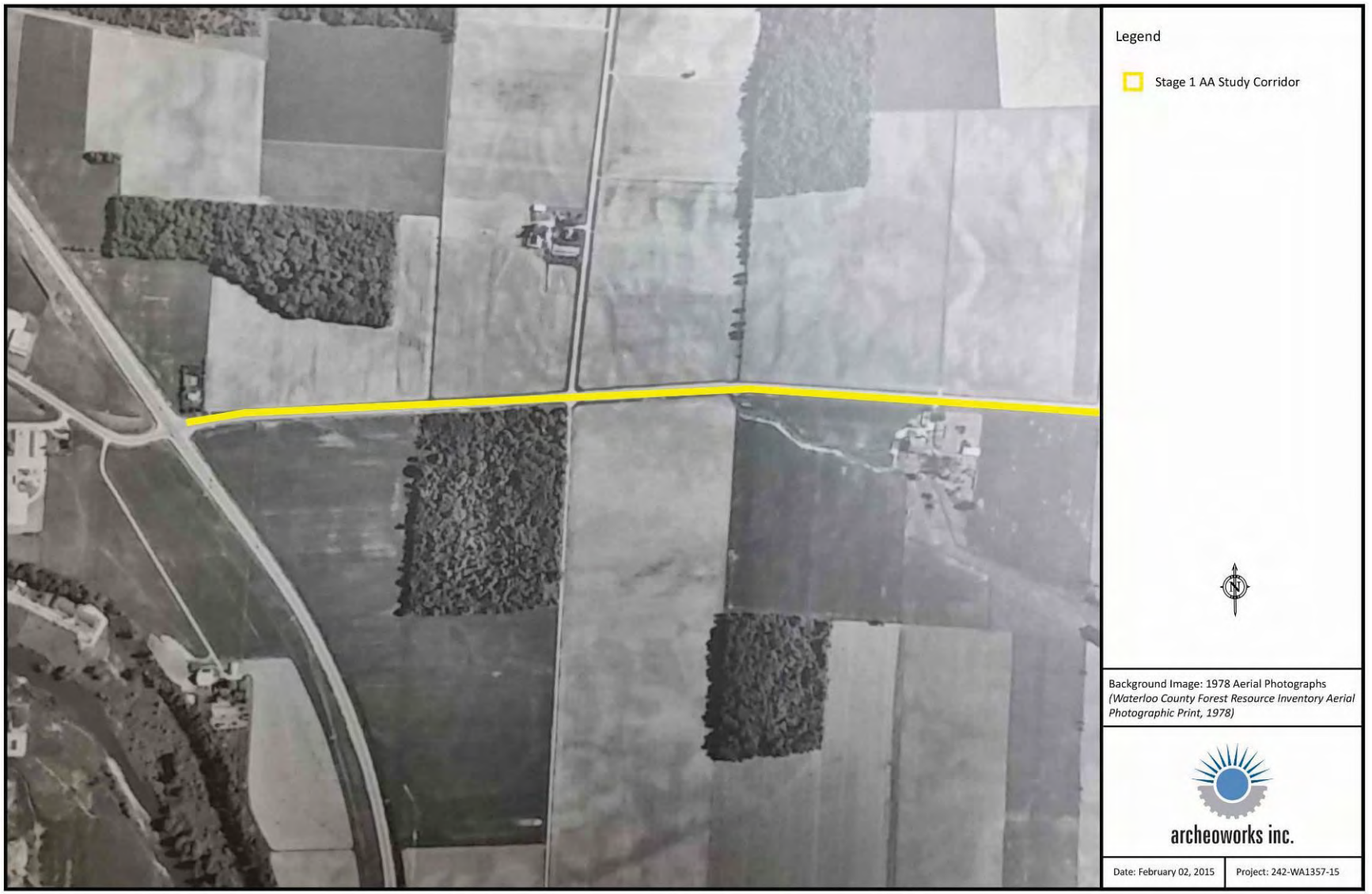
MAP 7 Stage 1 AA study corridor within a 1978 aerial photograph (Waterloo County Forest Resource Inventory Aerial Photographic Print, 1978).

MAP 8 Stage 1 AA study corridor within a 1978 aerial photograph (Waterloo County Forest Resource Inventory Aerial Photographic Print, 1978).

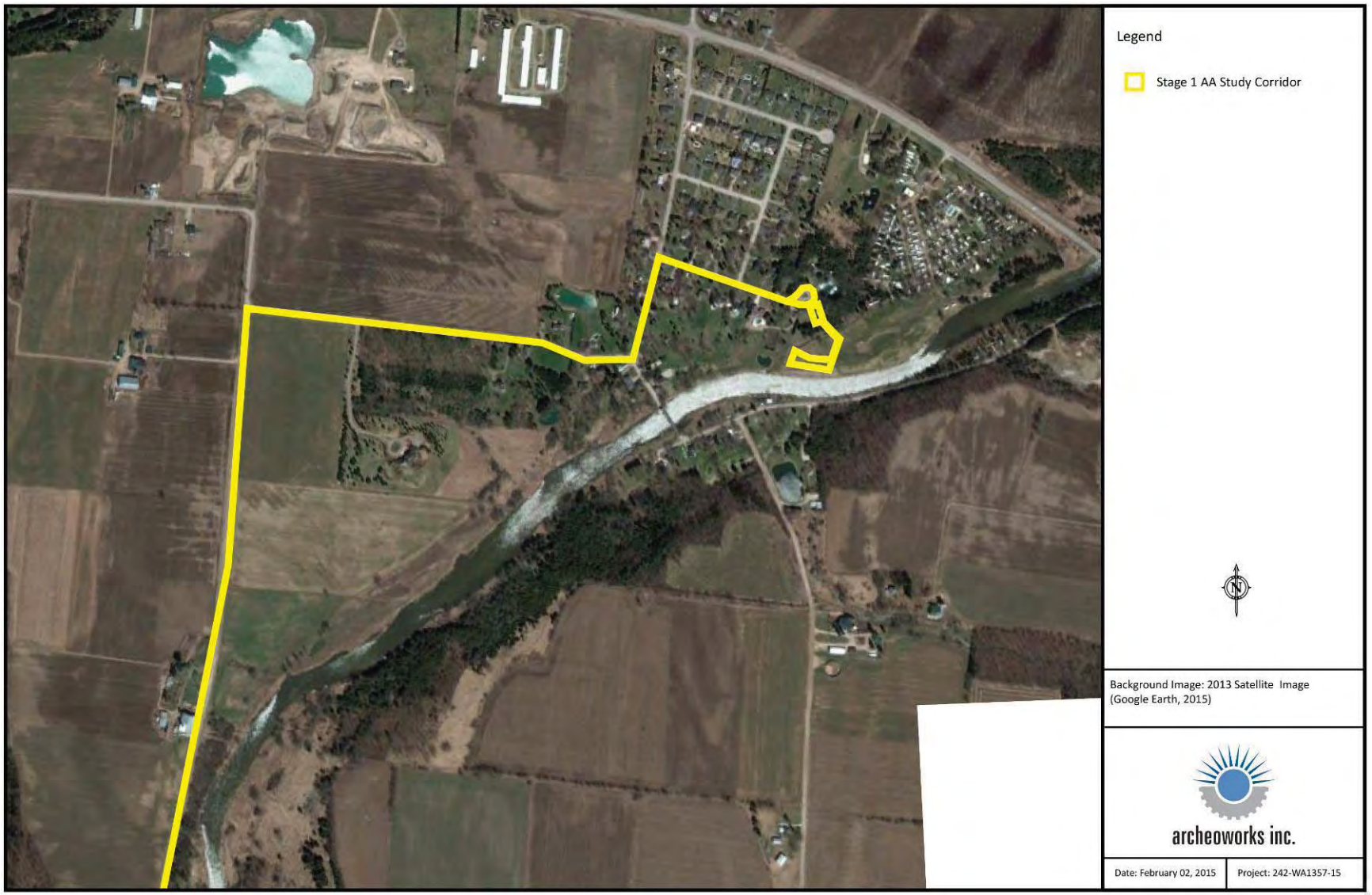
MAP 9 Stage 1 AA study corridor within a 1978 aerial photograph (Waterloo County Forest Resource Inventory Aerial Photographic Print, 1978).



MAP 10 Stage 1 AA study corridor within a 1978 aerial photograph (Waterloo County Forest Resource Inventory Aerial Photographic Print, 1978).



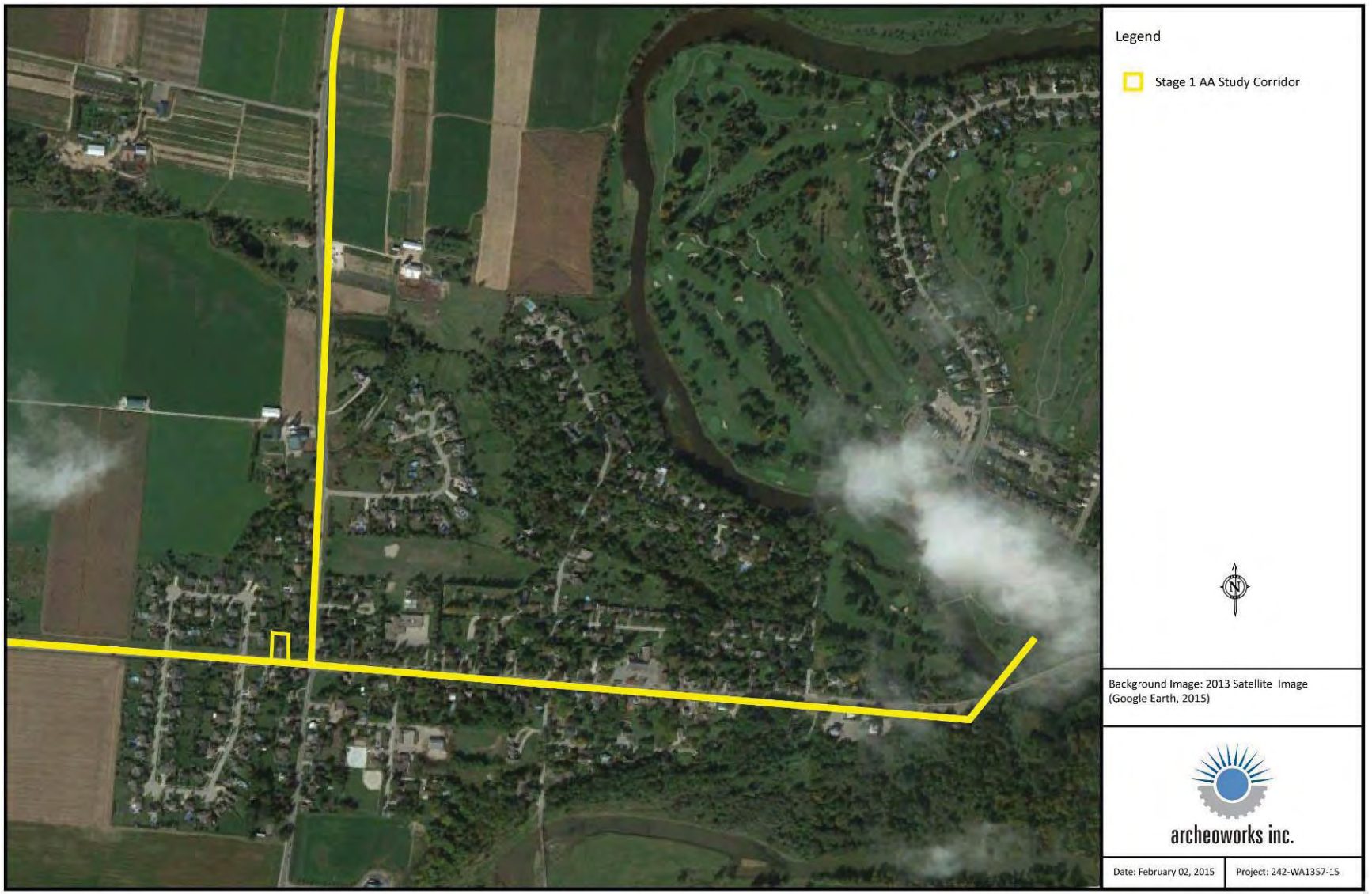
MAP 11 Stage 1 AA study corridor within a 1978 aerial photograph (Waterloo County Forest Resource Inventory Aerial Photographic Print, 1978).



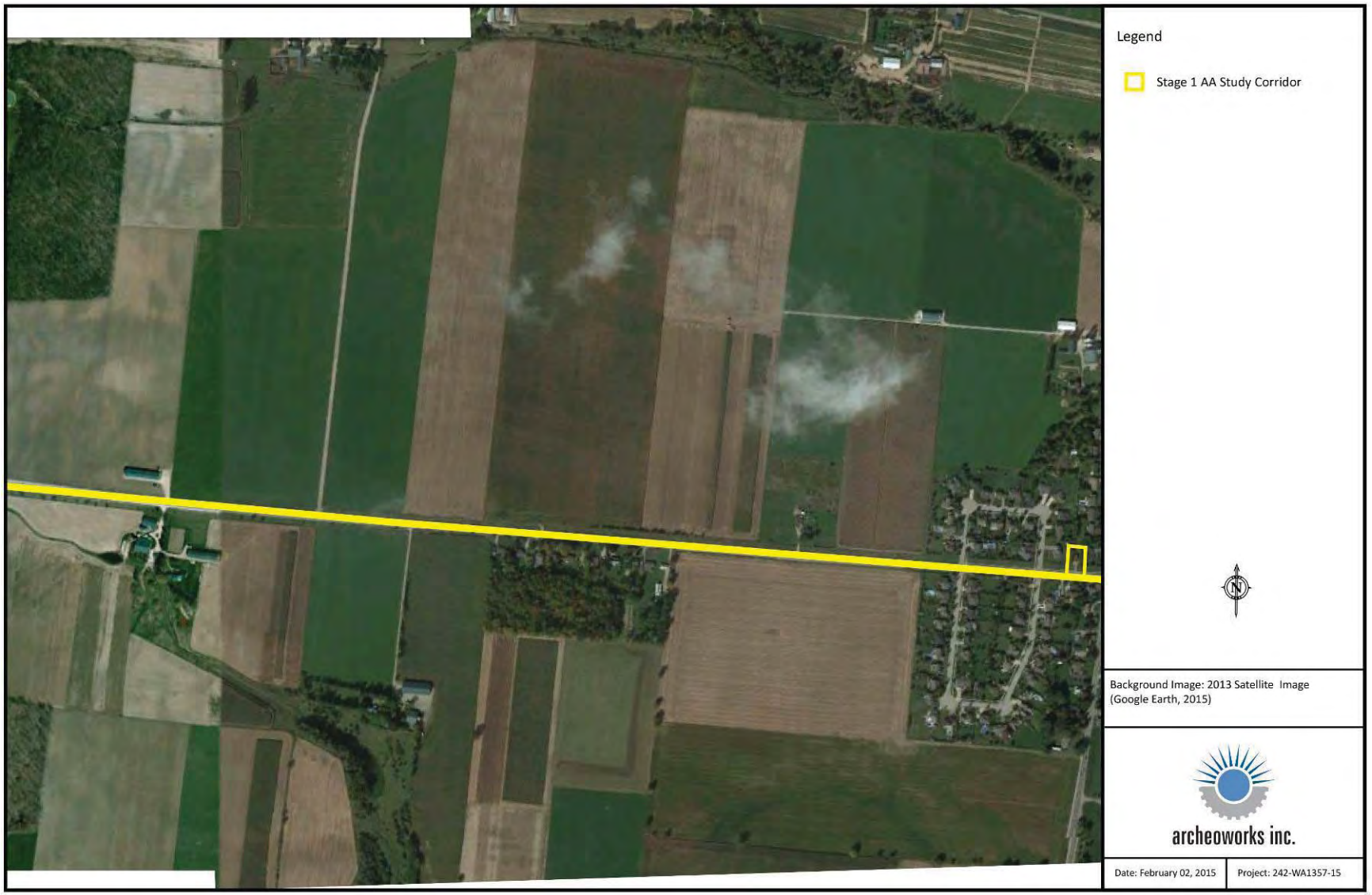
MAP 12 Stage 1 AA study corridor within a 2013 satellite image (Google Earth, 2015).

MAP 13 Stage 1 AA study corridor within a 2013 satellite image (Google Earth, 2015).

MAP 14 Stage 1 AA study corridor within a 2013 satellite image (Google Earth, 2015).



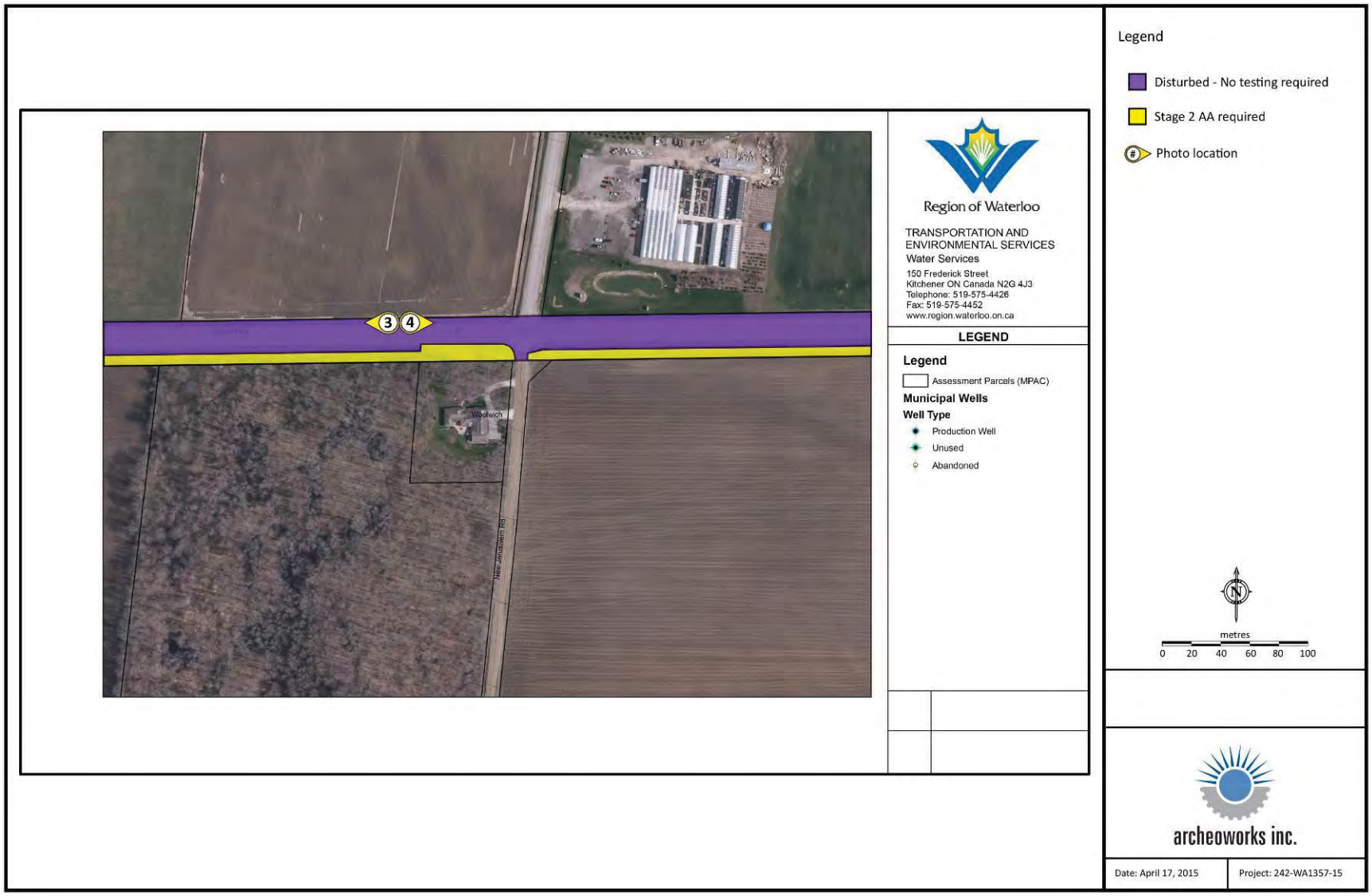
MAP 15 Stage 1 AA study corridor within a 2013 satellite image (Google Earth, 2015).



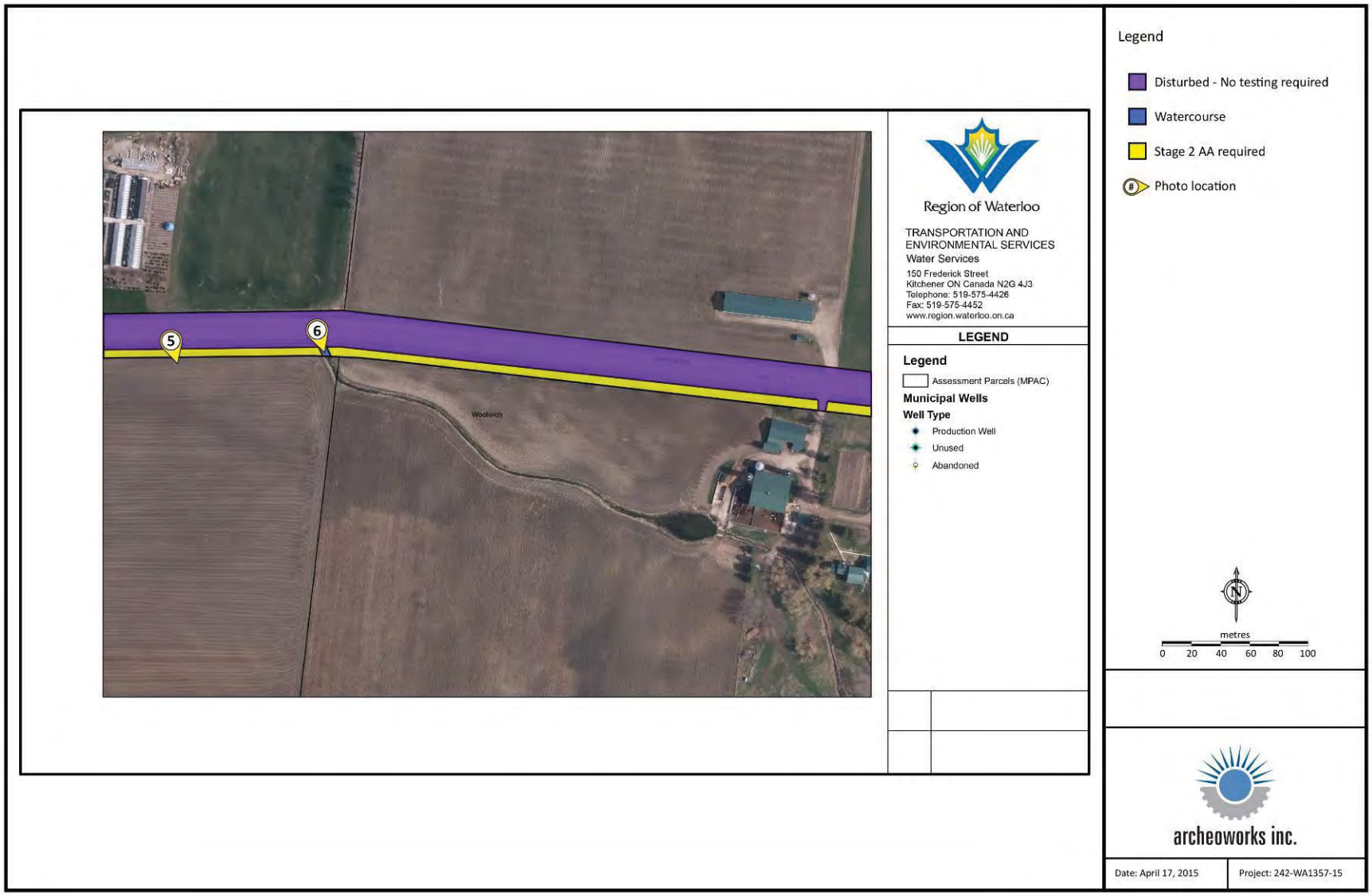
MAP 16 Stage 1 AA study corridor within a 2013 satellite image (Google Earth, 2015).

MAP 17 Stage 1 AA study corridor within a 2013 satellite image (Google Earth, 2015).

MAP 18 Stage 1 AA study corridor with photo locations indicated.

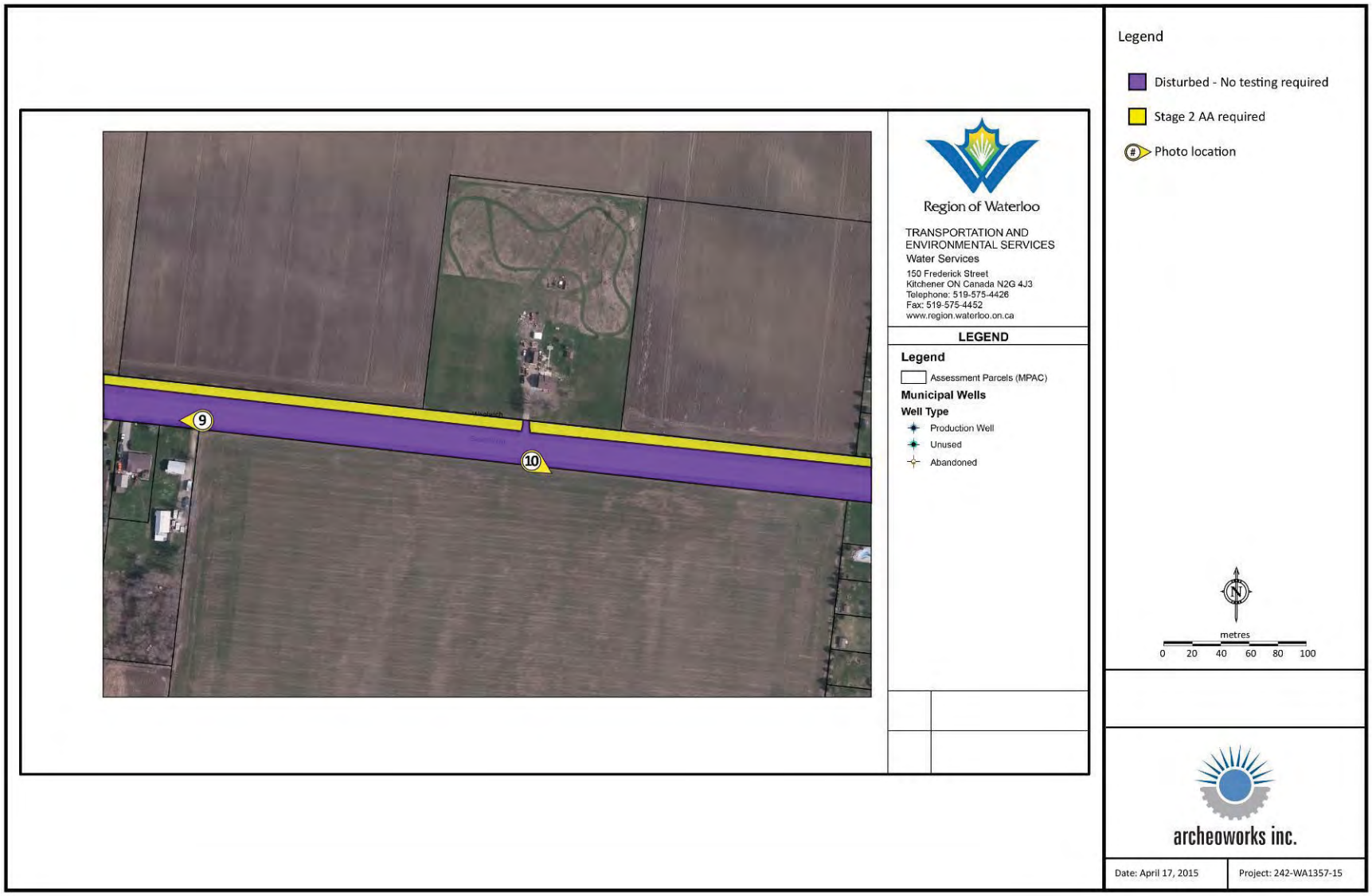


MAP 19 Stage 1 AA study corridor with photo locations indicated.

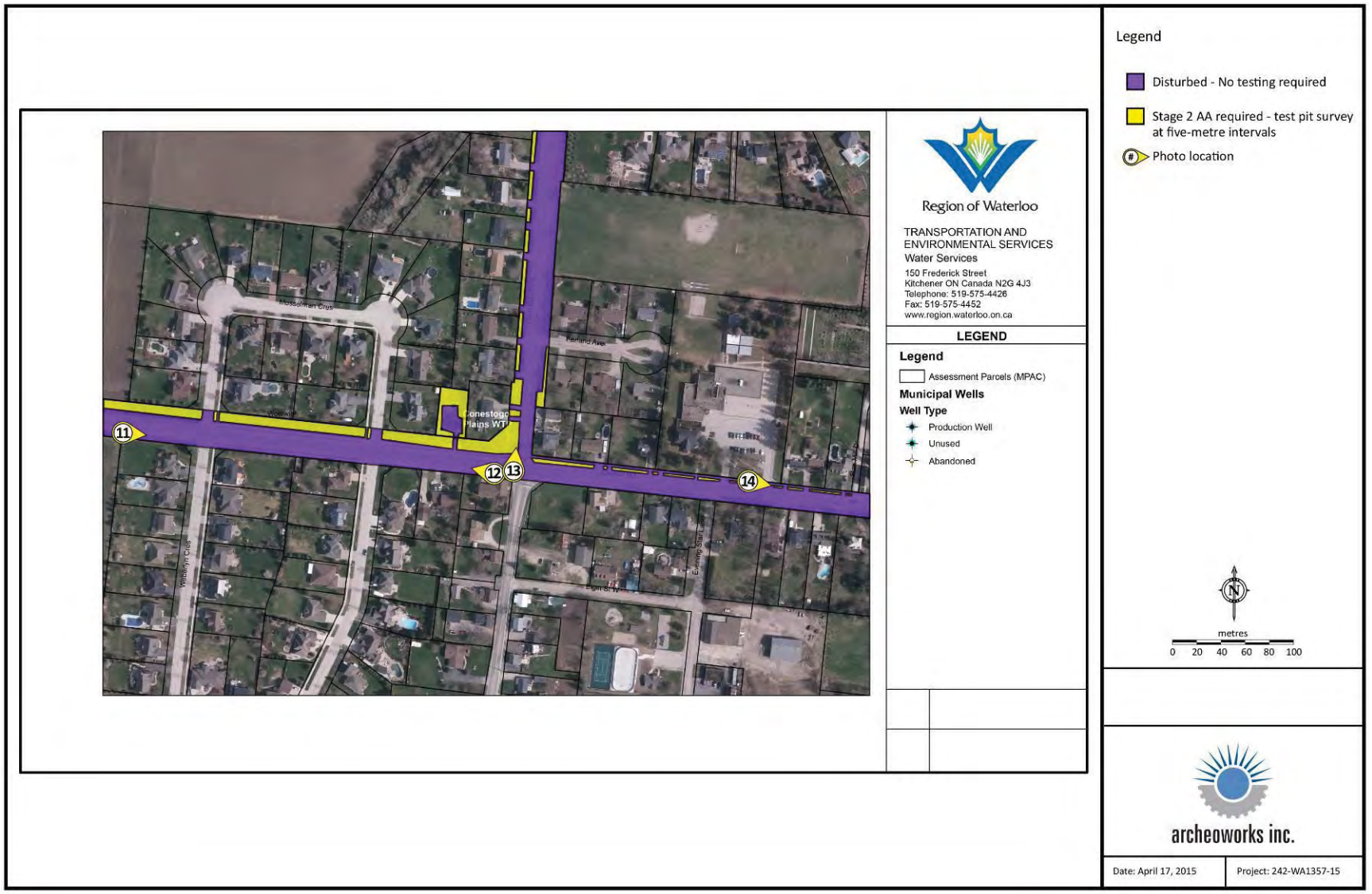


MAP 20 Stage 1 AA study corridor with photo locations indicated.

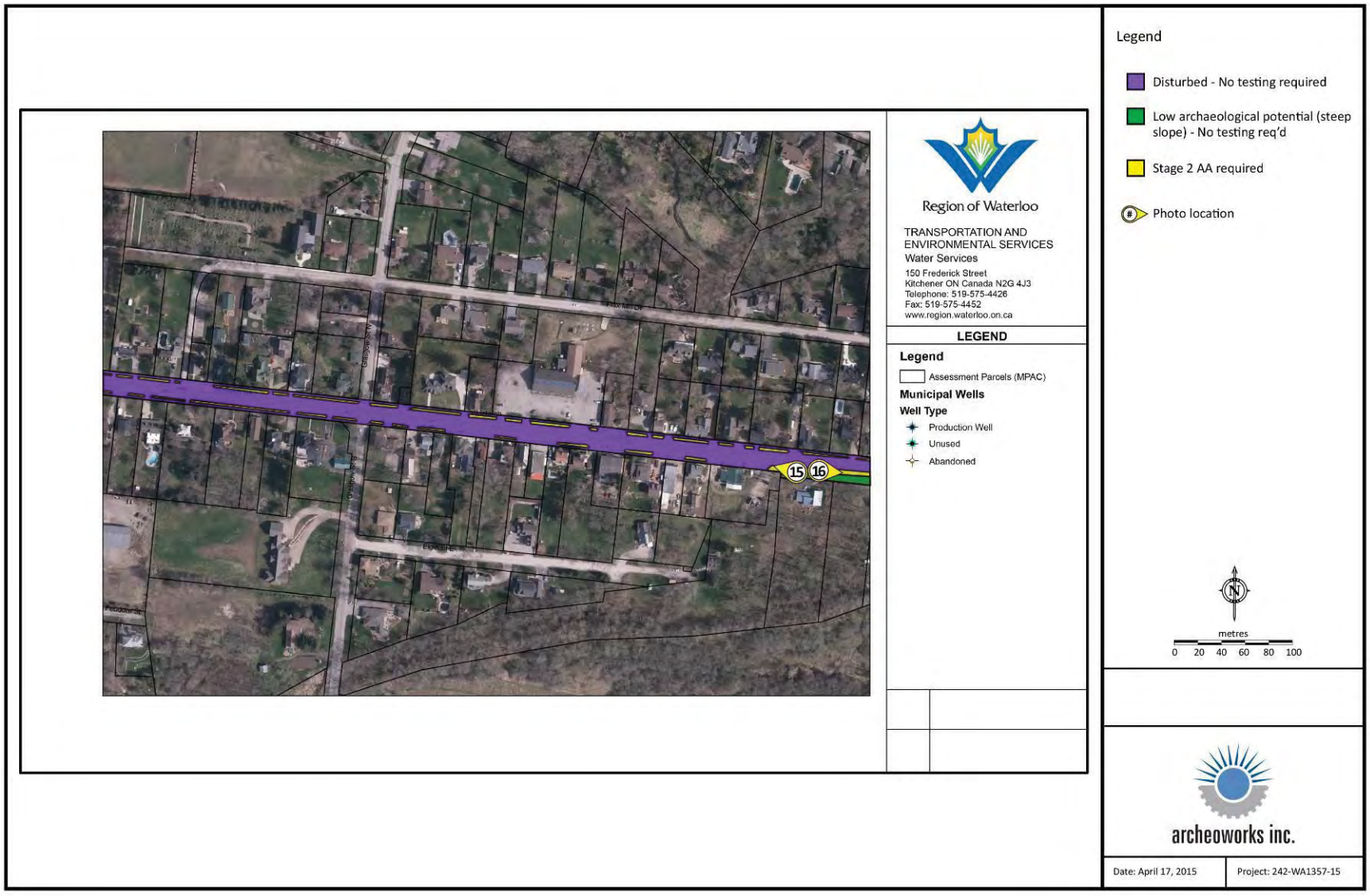
MAP 21 Stage 1 AA study corridor with photo locations indicated.



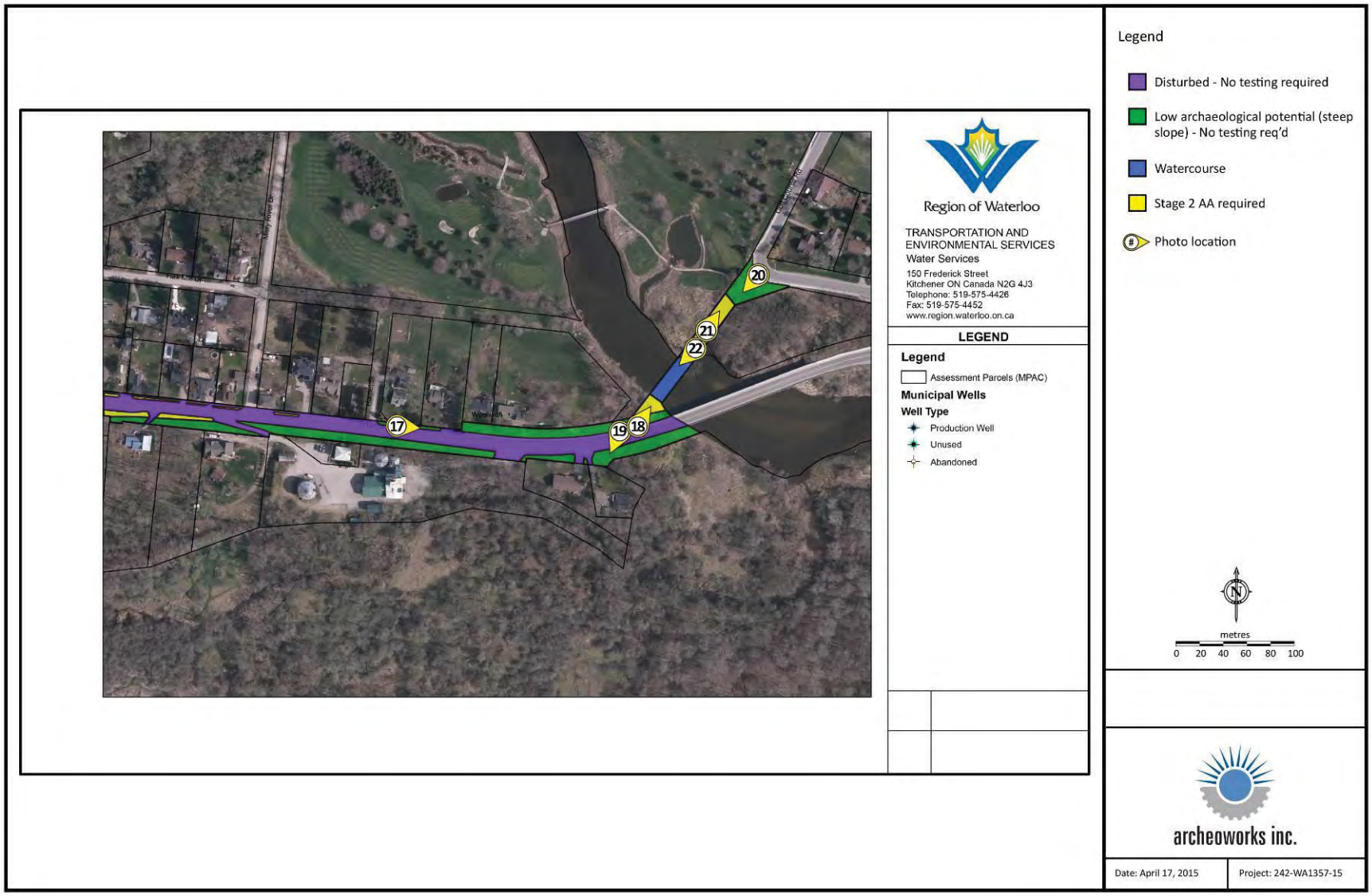
MAP 22 Stage 1 AA study corridor with photo locations indicated.



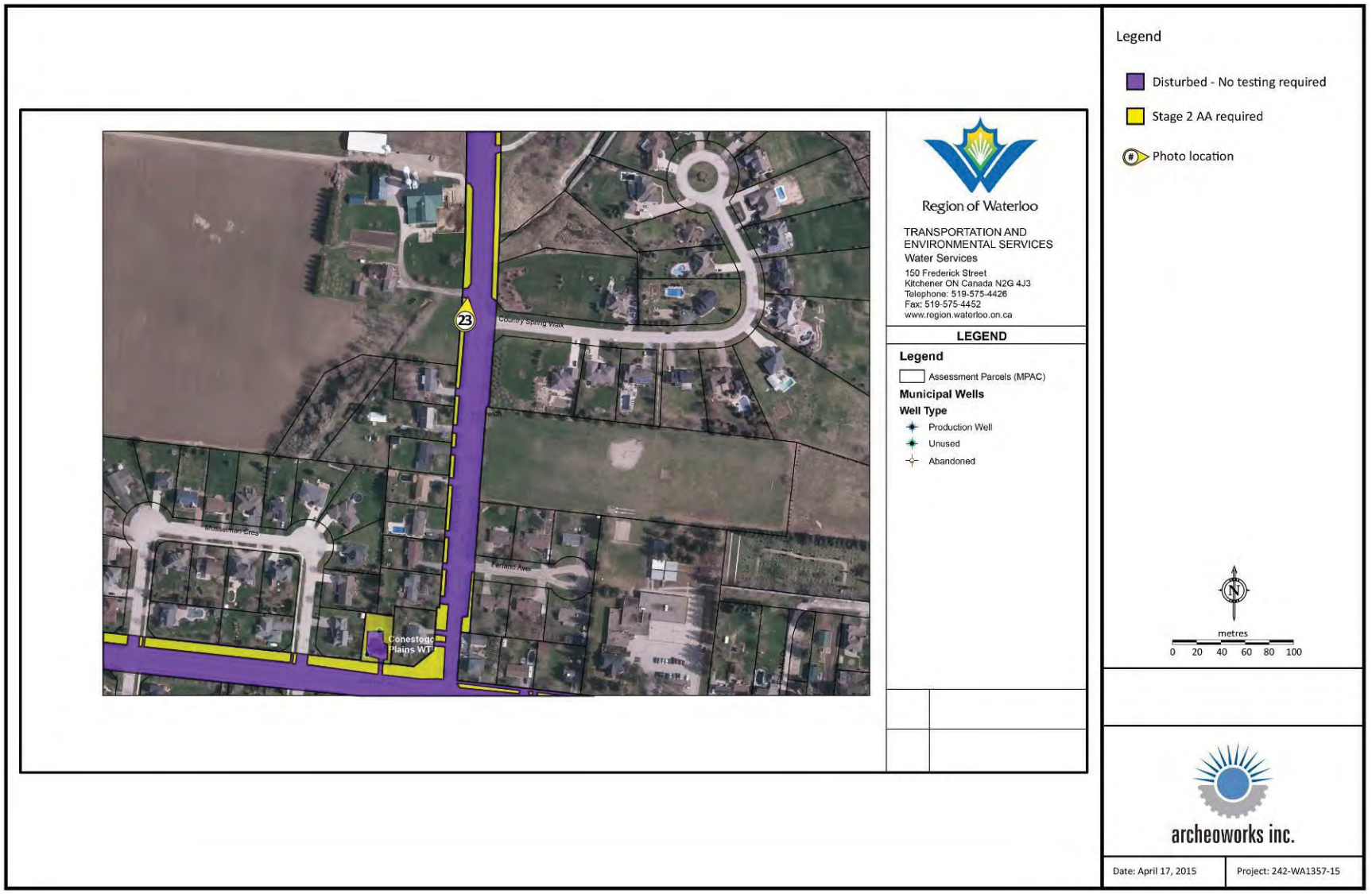
MAP 23 Stage 1 AA study corridor with photo locations indicated.



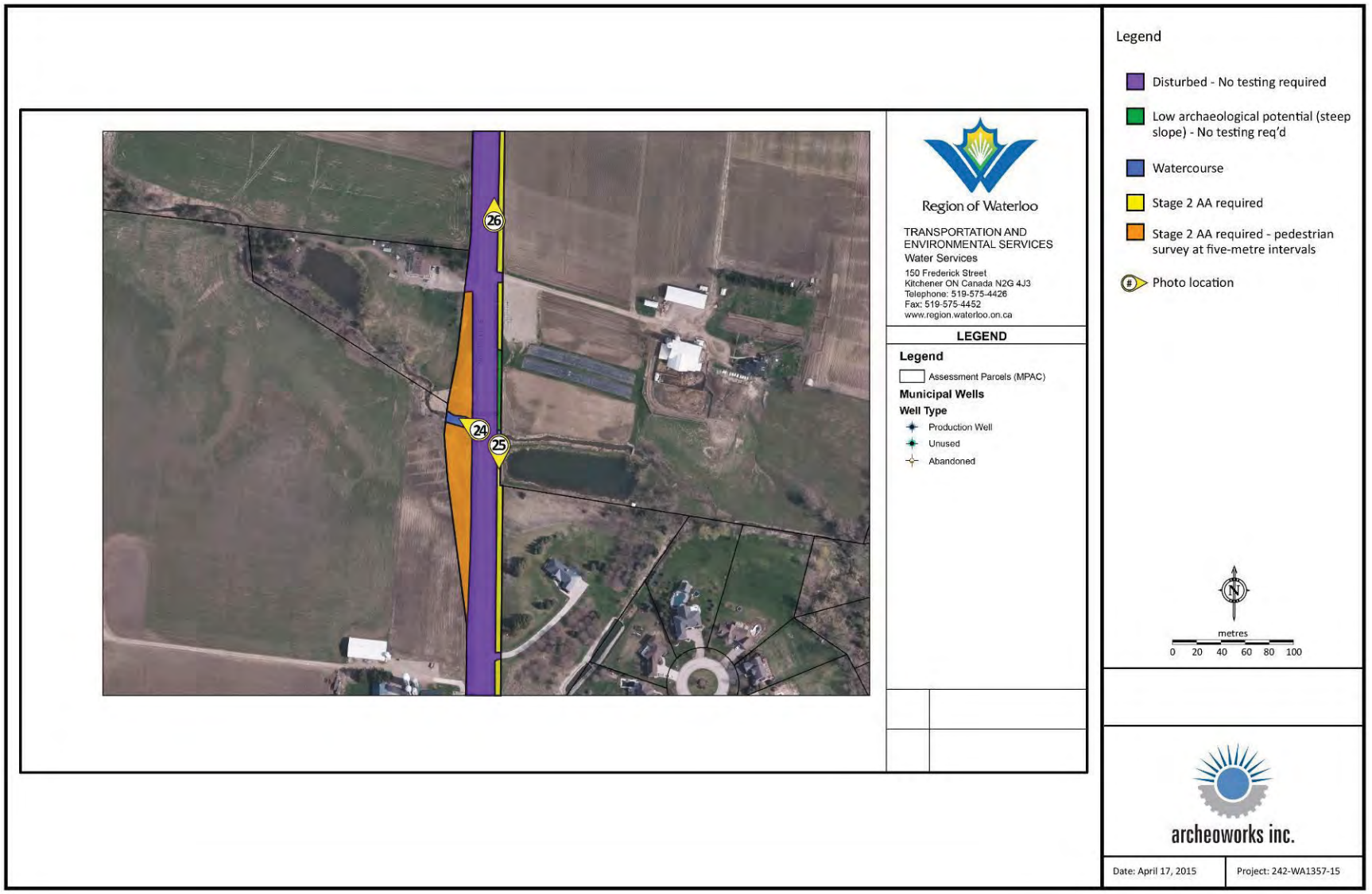
MAP 24 Stage 1 AA study corridor with photo locations indicated.



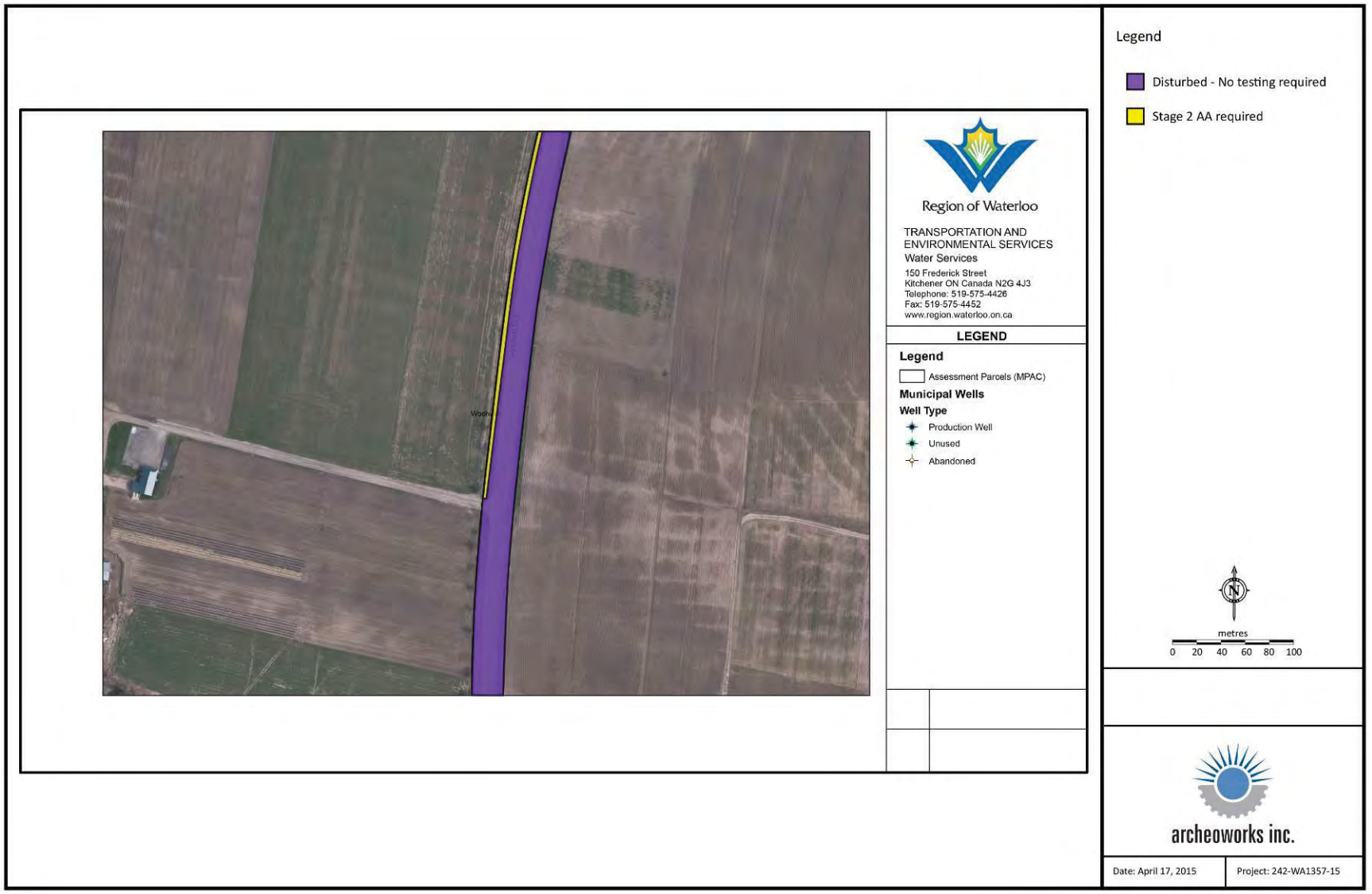
MAP 25 Stage 1 AA study corridor with photo locations indicated.



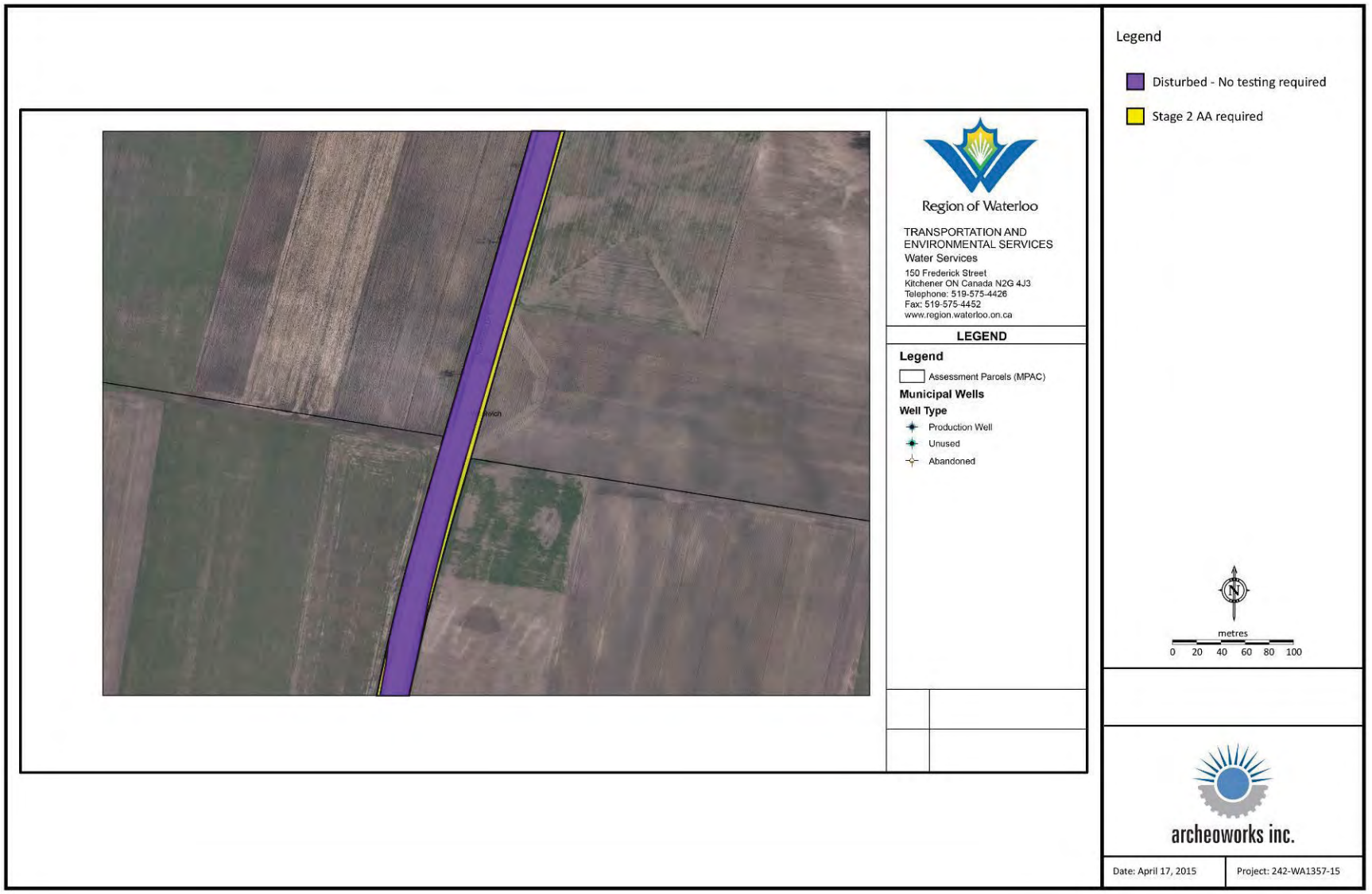
MAP 26 Stage 1 AA study corridor with photo locations indicated.



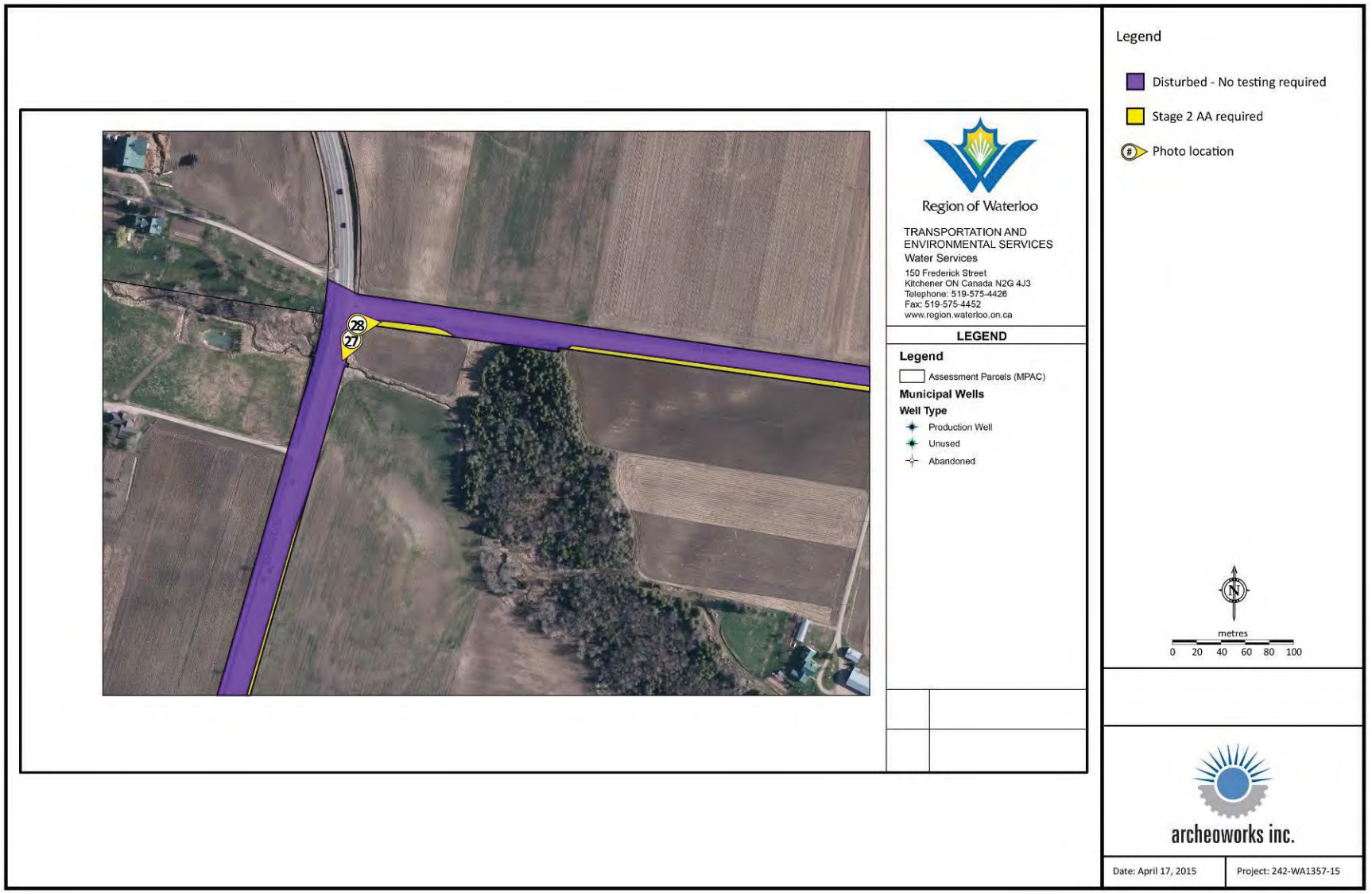
MAP 27 Stage 1 AA study corridor with photo locations indicated.



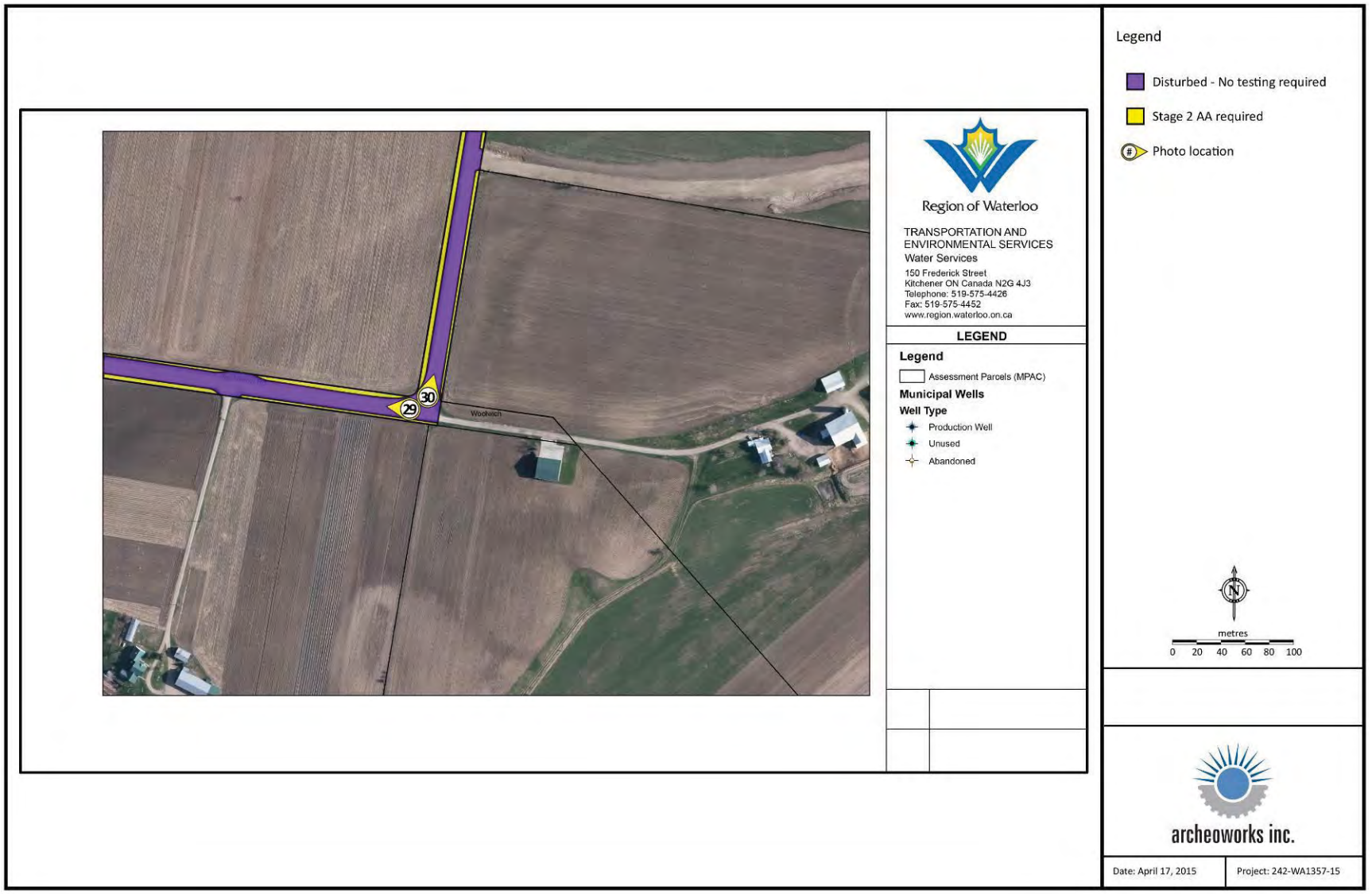
MAP 28 Stage 1 AA study corridor with photo locations indicated.



MAP 29 Stage 1 AA study corridor with photo locations indicated.

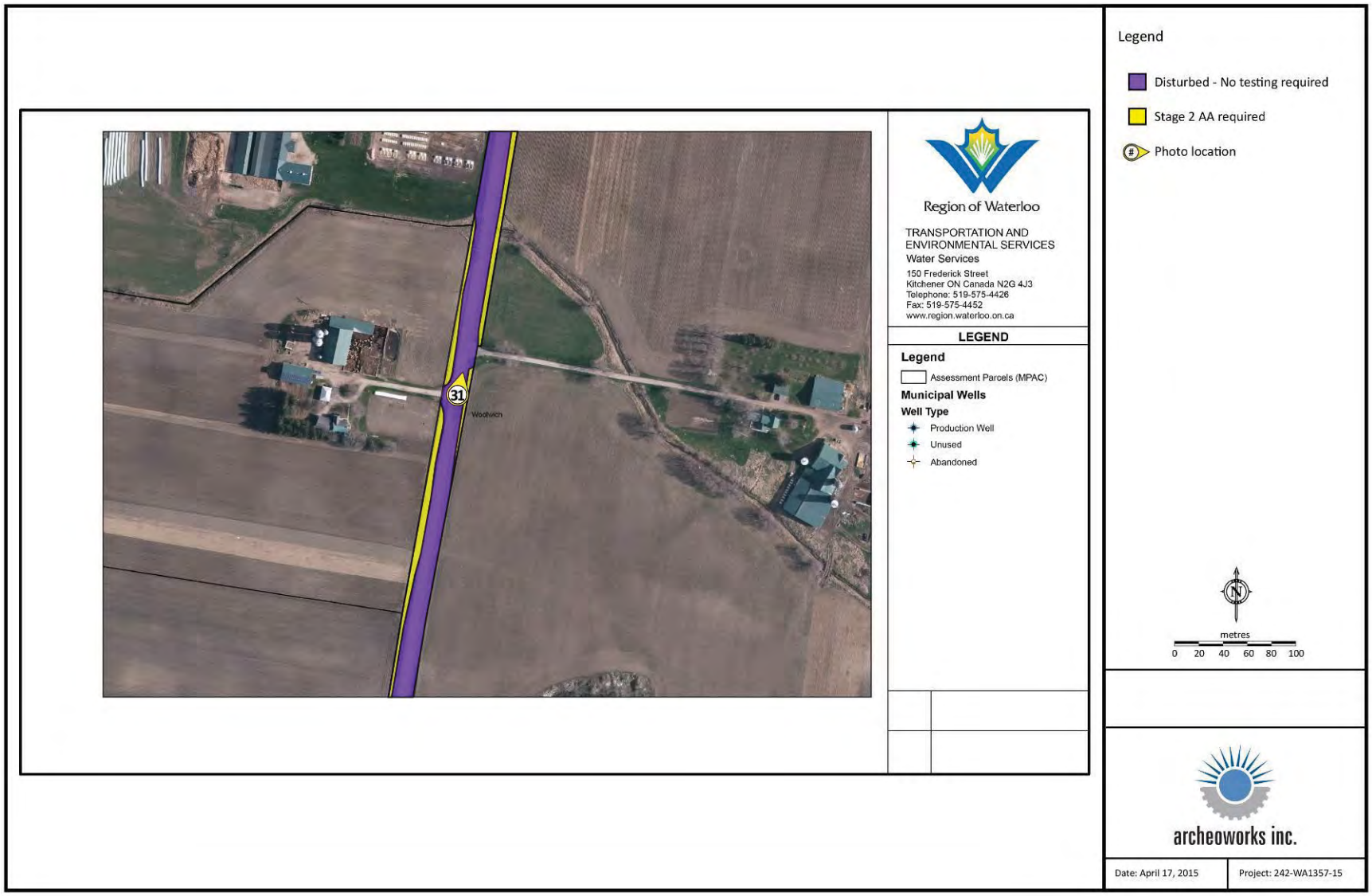


MAP 30 Stage 1 AA study corridor with photo locations indicated.

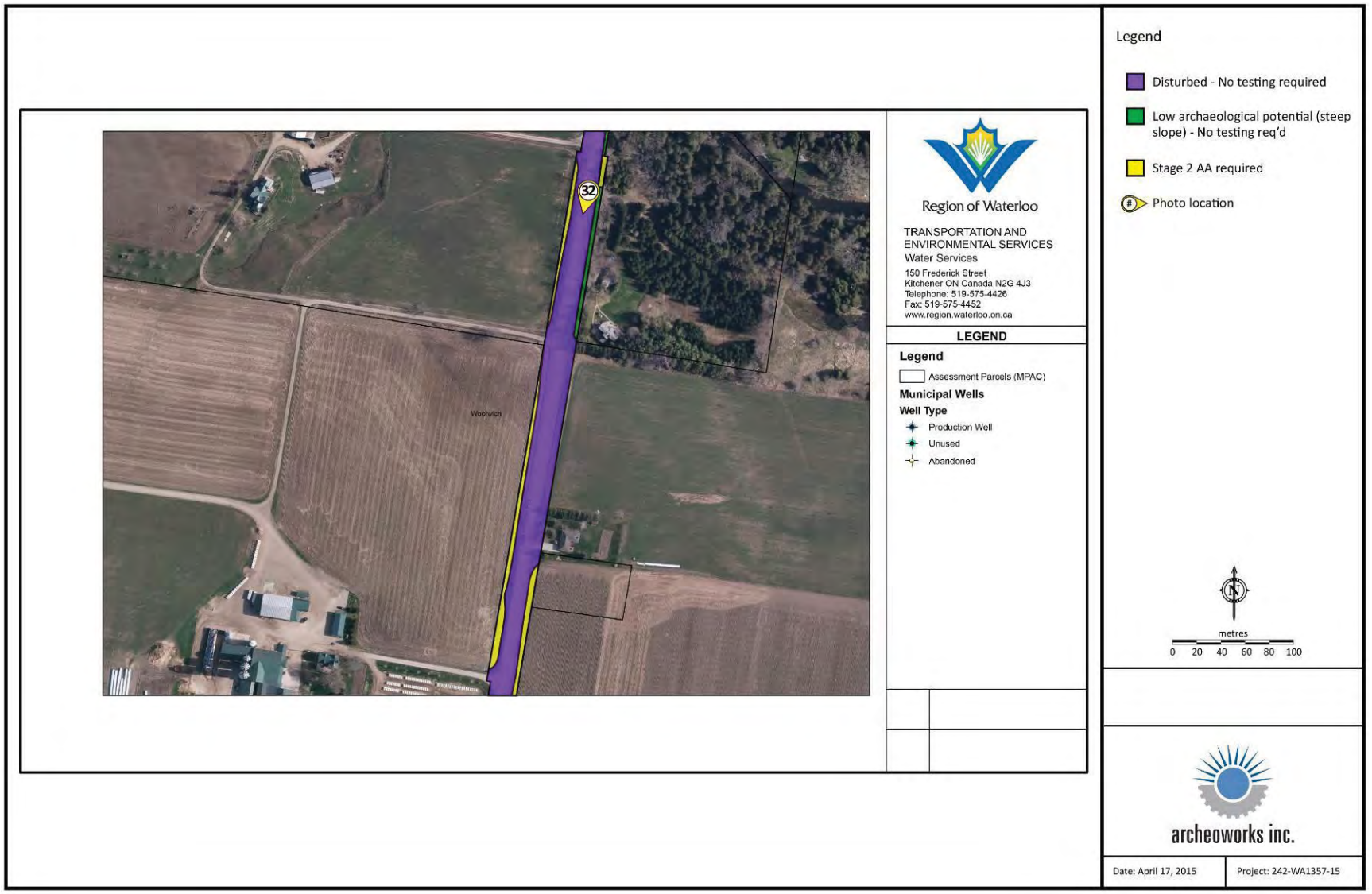


MAP 31 Stage 1 AA study corridor with photo locations indicated.

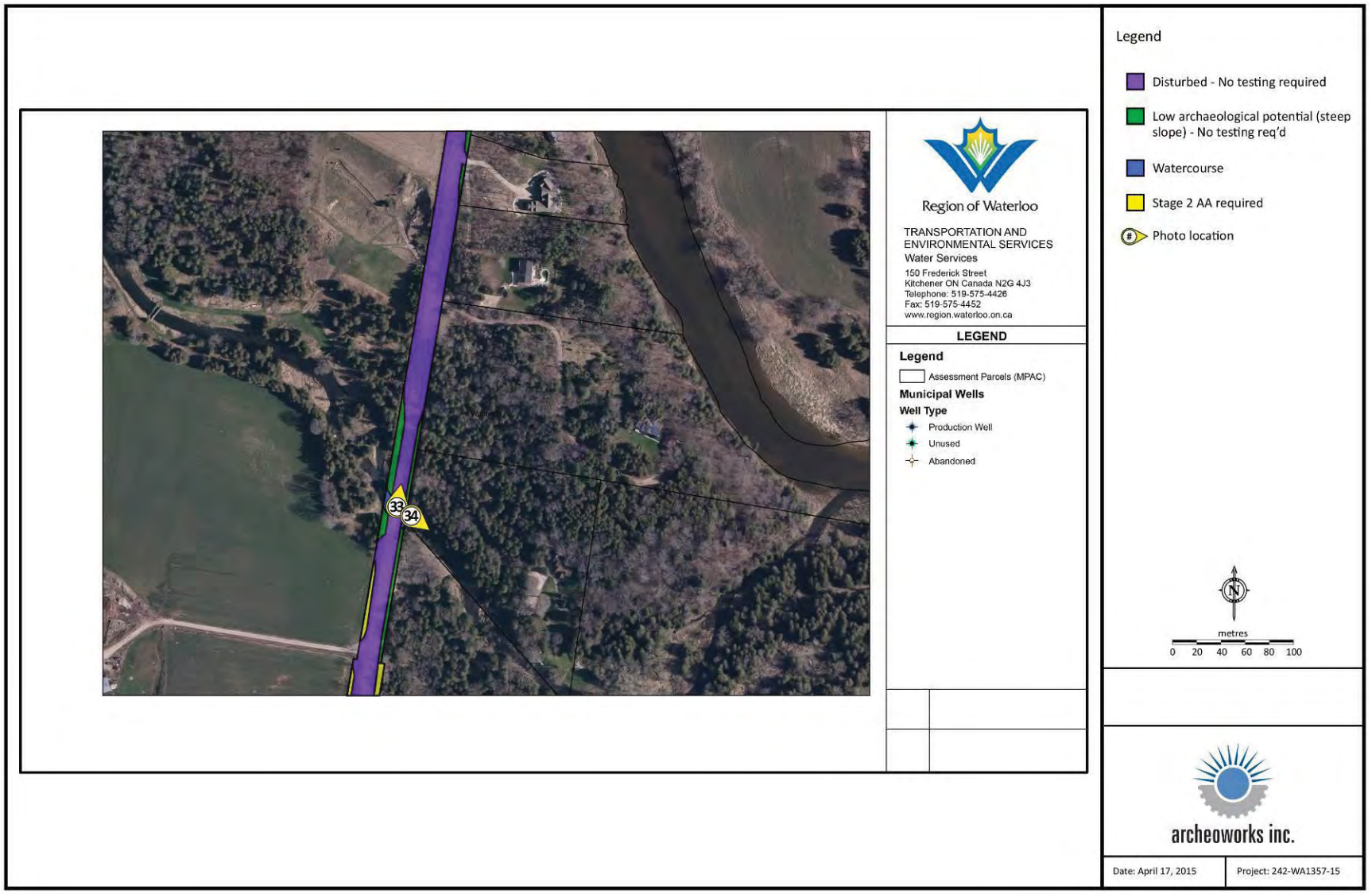
MAP 32 Stage 1 AA study corridor with photo locations indicated.



MAP 33 Stage 1 AA study corridor with photo locations indicated.

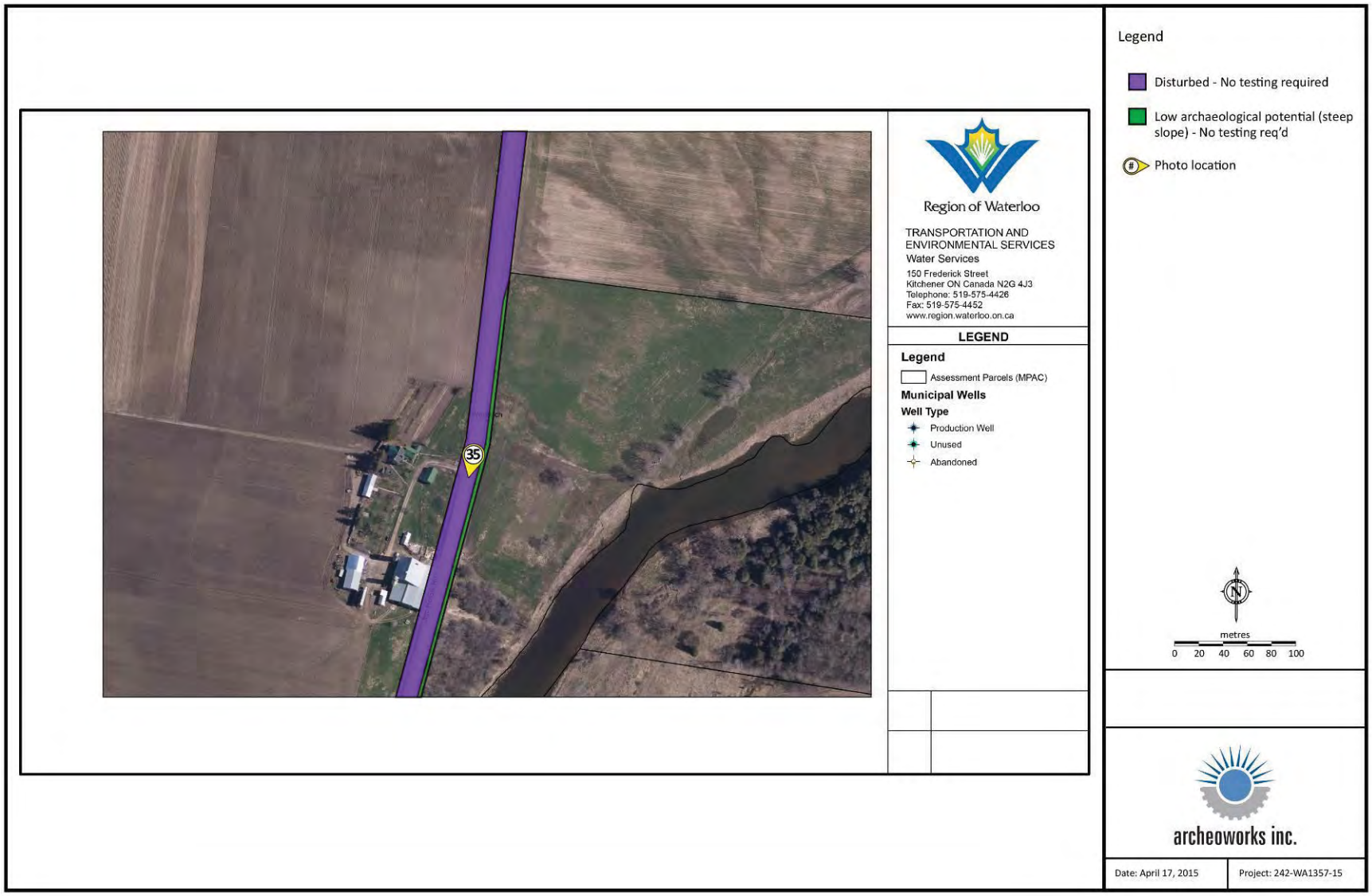


MAP 34 Stage 1 AA study corridor with photo locations indicated.

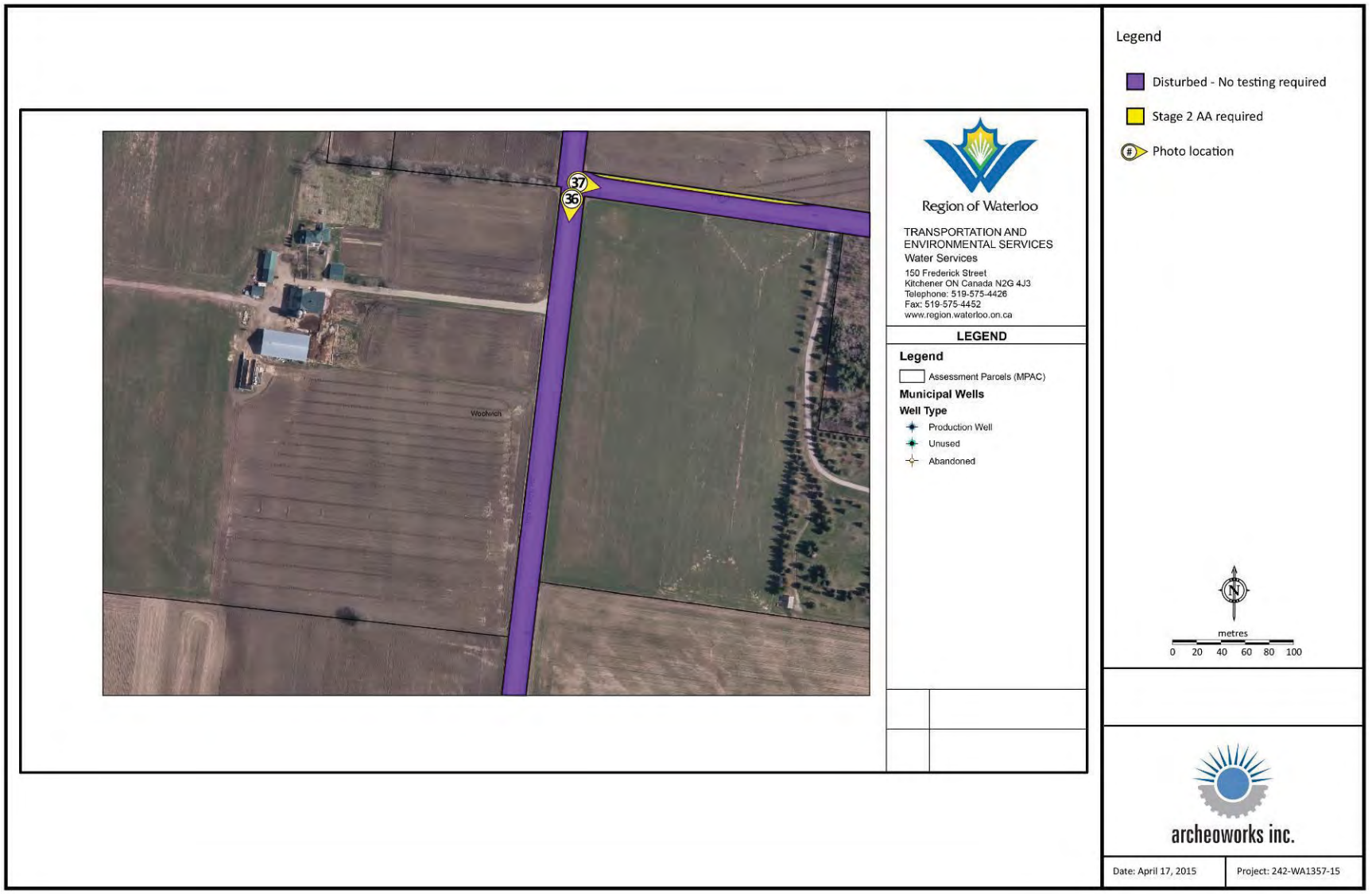


MAP 35 Stage 1 AA study corridor with photo locations indicated.

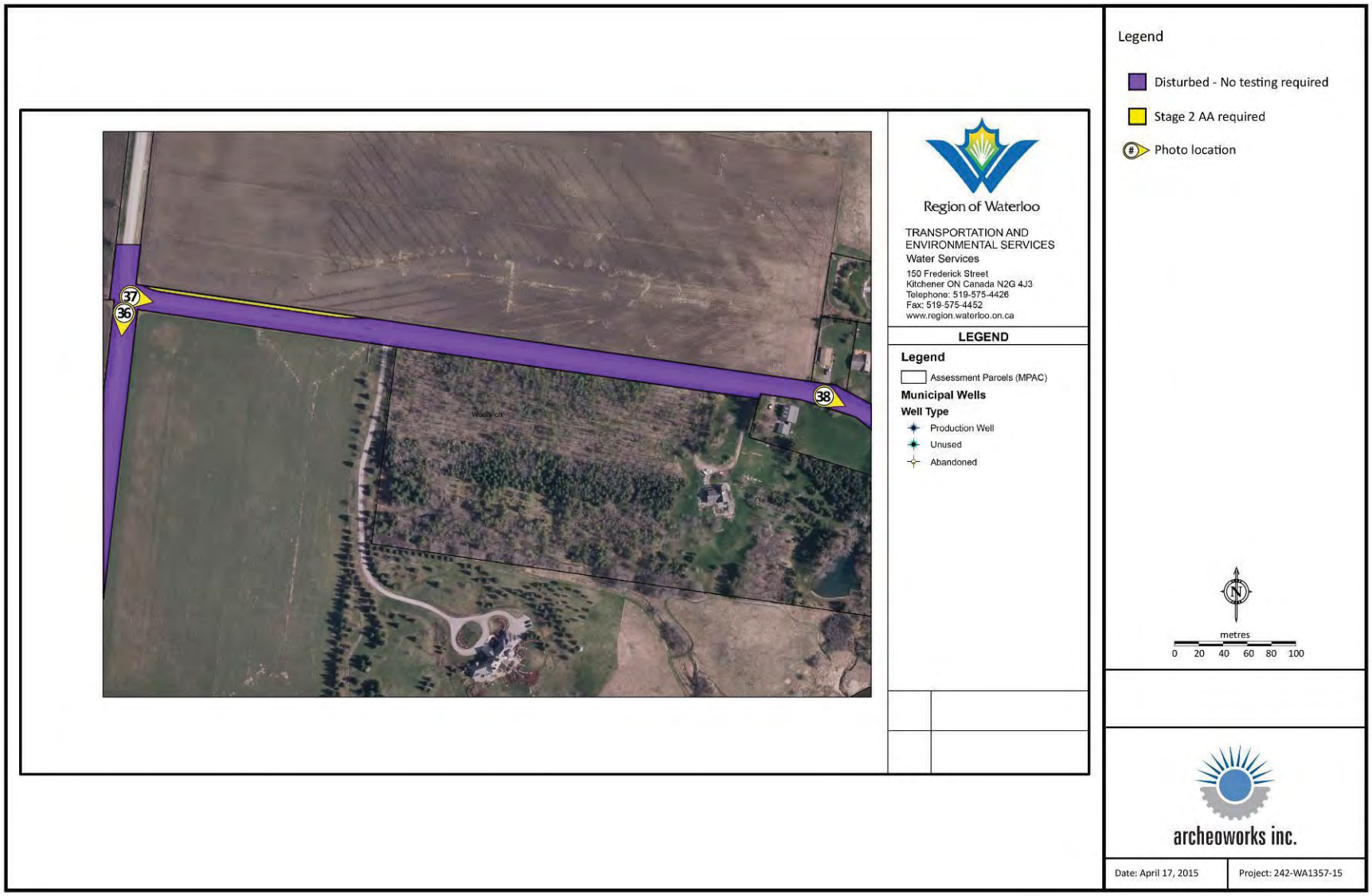
MAP 36 Stage 1 AA study corridor with photo locations indicated.



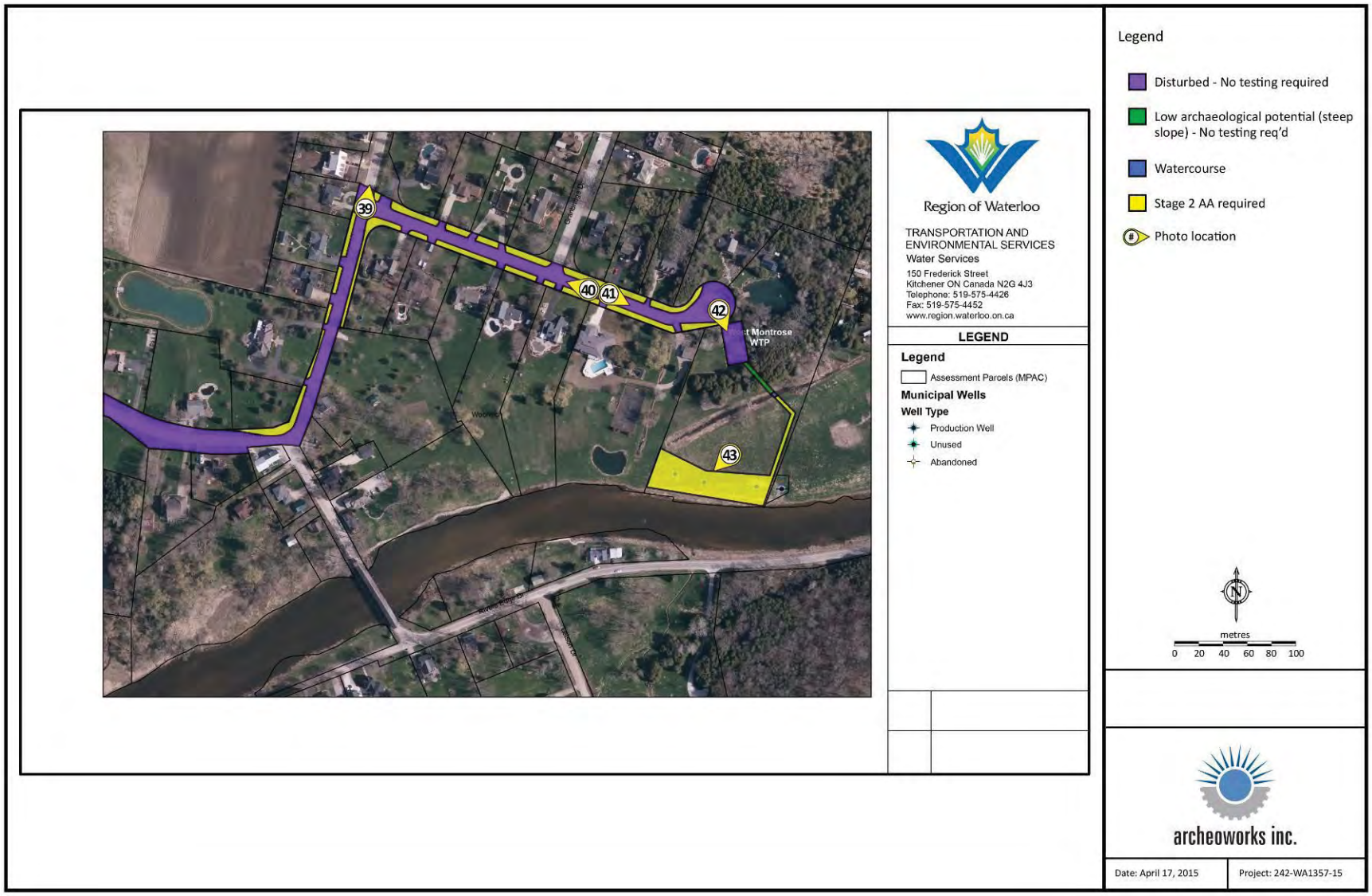
MAP 37 Stage 1 AA study corridor with photo locations indicated.



MAP 38 Stage 1 AA study corridor with photo locations indicated.



MAP 39 Stage 1 AA study corridor with photo locations indicated.



MAP 40 Stage 1 AA study corridor with photo locations indicated.

APPENDIX B: SUMMARY OF BACKGROUND RESEARCH

Feature of Archaeological Potential		Yes	No	Unknown	Comment
1	Known archaeological sites within 300 m?	X			If Yes, potential confirmed
Physical Features		**Yes**	**No**	**Unknown**	**Comment**
2	Is there water on or near the property?	X			If Yes, potential confirmed
2a	Presence of primary water source within 300 metres of the study corridor (lakes, rivers, streams, creeks)	X			If Yes, potential confirmed
2b	Presence of secondary water source within 300 metres of the study corridor (intermittent creeks and streams, springs, marshes, swamps)		X		If Yes, potential confirmed
2c	Features indicating past presence of water source within 300 metres (former shorelines, relic water channels, beach ridges)		X		If Yes, potential confirmed
2d	Accessible or inaccessible shoreline (high bluffs, swamp or marsh fields by the edge of a lake, sandbars stretching into marsh)		X		If Yes, potential confirmed
3	Elevated topography (knolls, drumlins, eskers, plateaus, etc.)		X		If Yes to two or more of 3-5 or 7-10, potential confirmed
4	Pockets of well-drained sandy soil, especially near areas of heavy soil or rocky ground		X		If Yes to two or more of 3-5 or 7-10, potential confirmed
5	Distinctive land formations (mounds, caverns, waterfalls, peninsulas, etc.)		X		If Yes to two or more of 3-5 or 7-10, potential confirmed
Cultural Features		**Yes**	**No**	**Unknown**	**Comment**
6	Is there a known burial site or cemetery that is registered with the Cemeteries Regulation Unit on or directly adjacent to the property?		X		If Yes, potential confirmed
7	Associated with food or scarce resource harvest areas (traditional fishing locations, food extraction areas, raw material outcrops, etc.)		X		If Yes to two or more of 3-5 or 7-10, potential confirmed
8	Indications of early Euro-Canadian settlement (monuments, cemeteries, structures, etc.) within 300 metres	X			If Yes to two or more of 3-5 or 7-10, potential confirmed
9	Associated with historic transportation route (historic road, trail, portage, rail corridor, etc.) within 100 metres of the property	X			If Yes to two or more of 3-5 or 7-10, potential confirmed
Property-specific Information		**Yes**	**No**	**Unknown**	**Comment**
10	Contains property designated under the Ontario Heritage Act	X			If Yes to two or more of 3-5 or 7-10, potential confirmed
11	Local knowledge (aboriginal communities, heritage organizations, municipal heritage committees, etc.)		X		If Yes, potential confirmed
12	Recent ground disturbance, not including agricultural cultivation (post-1960, extensive and deep land alterations)	Only parts of the study corridor exhibit recent ground disturbance.			If Yes, low archaeological potential is determined

APPENDIX C: IMAGES

IMAGE 1: View of disturbances associated with paved road, gravel shoulder roadside ditch, and utilities. In addition, a view of overgrown grass with archaeological potential.

IMAGE 2: View of disturbances associated with paved road, gravel shoulder roadside ditch, and utilities.

IMAGE 3: View of disturbances associated with paved road, gravel shoulder roadside ditch, and utilities.

IMAGE 4: View of disturbances associated with paved road, gravel shoulder roadside ditch, and utilities.

IMAGE 5: View of disturbances associated with ditching and utilities. Also a view of ploughed agricultural field with archaeological potential.

IMAGE 6: View of watercourse traversing the study corridor.

IMAGE 7: View of disturbances associated with paved road, gravel shoulder, ditching and utilities. Also a view of ploughed agricultural field with archaeological potential.

IMAGE 8: View of disturbances associated paved road, gravel shoulder, ditching and utilities.

Image 9 View of disturbances associated with paved road, gravel shoulder and utilities.

Image 10 View of disturbances associated with paved road, gravel shoulder, ditching and utilities. Also a view of ploughed agricultural field with archaeological potential.

Image 11 View of disturbances associated with paved road, gravel shoulder, and ditching

Image 10 View of disturbances associated with paved roads and sidewalks, extant structures, and utilities.

Image 13 View of disturbances associated with paved road, sidewalks and driveways, extant structures, and utilities.

Image 14 View of disturbances associated with paved road, sidewalks and driveways, extant structures, and utilities. Also a view of manicured grass frontages with archaeological potential.

Image 15 View of disturbances associated with paved road and shoulder, extant structures, and utilities. Also a view of grassed margin with archaeological potential.

Image 16 View of disturbances associated with paved roads, sidewalks and driveways, extant structures, and utilities. Also a view of steep slope with low archaeological potential

Image 17 View of disturbances associated with paved road and shoulder, extant structures, and utilities. Also a view of steep slope with low archaeological potential.

Image 18 View of area of over grown gras with archaeological potential, as well as areas of low archaeological potential consisting of steep slope and a water course.

Image 19 View of disturbances associated with paved road/shoulder and driveways, and utilities. Also a view of steep slope with low archaeological potential.

Image 20 View of disturbances associated with gravel parking areand utilities. Also a view of steep slope with low archaeological potential

Image 21 View of dirt path and area of lightly treed, overgrown grass and with archaeological potential

Image 22 View of watercourse and remnants of bridge foundation.

Image 23 View of disturbances associated with paved road, gravel shoulder ditching and utilities. In addition, a view of grassed margin with archaeological potential.

Image 24 View of watercourse traversing the study corridor.

Image 25 View of disturbances associated with paved road, gravel shoulder embankment, and utilities. In addition, a view of grassed margin with archaeological potential.

Image 26 View of disturbances associated with paved road, gravel shoulder embankment, and utilities.

Image 27 View of disturbances associated with paved road, gravel shoulder embankment, and utilities.

Image 28 View of disturbances associated with dirt road, gravel shoulder and embankment. In addition, a view of ploughed agricultural field with archaeological potential.

Image 29 View of disturbances associated with dirt road. In addition, a view of ploughed agricultural fields with archaeological potential.

Image 30 View of disturbances associated with dirt road. In addition, a view of ploughed agricultural fields with archaeological potential.

Image 31 View of disturbances associated with dirt roads. In addition, a view of ploughed agricultural field with archaeological potential.

Image 32 View of disturbances associated with dirt road. Also a view of steep slope (leading to agricultural field) and treed area with archaeological potential.

Image 33 View of disturbances associated with dirt road and bridge.

Image 34 View of large watercourse traversing the study corridor.

Image 35 View of disturbances associated with dirt roads. In addition, a view of steep slope with low archaeological potential.

Image 36 View of disturbances associated with paved road, gravel shoulder, and ditching.

Image 37 View of disturbances associated with paved road, gravel shoulder, and ditching. In addition, a view of ploughed agricultural field with archaeological potential.

Image 38 View of disturbances associated with paved road, ditching and grading.

Image 39 View of disturbances associated with paved roads/driveway and utilities. Also a view of manicured lawns with archaeological potential.

Image 40 View of disturbances associated with paved road; and manicured lawns with archaeological potential.

Image 41 View of disturbances associated with paved road; and manicured lawns with archaeological potential.

Image 42 View of disturbances associated with the West Montrose water treatment plant.

Image 43 View of disturbance associated with a production well. In addition, a view of manicured grass field with archaeological potential.

Image 44 View of disturbances associated with the Conestogo Plains water treatment plant.

APPENDIX D: INVENTORY OF DOCUMENTARY AND MATERIAL RECORD

Project Information:				
Project Number:	242-WA1357-15			
Licensee:	Alvina Tam (P1016)			
MTCS PIF:	P1016-0057-2015			
Document/ Material			**Location**	**Comments**
1.	Research/ Analysis/ Reporting Material	Digital files stored in: /2015/242-WA1357-15 - Conestogo Plains Water Supply System Class EA	Archeoworks Inc., 16715-12 Yonge Street, Suite 1029, Newmarket, ON, Canada, L3X 1X4	Stored on Archeoworks network servers
2.	Written Field Notes/ Annotated Field Maps/ Images	Field Notes: One (1) Page Field Map: 25 Maps Digital Images: 12 digital photos	Archeoworks Inc., 16715-12 Yonge Street, Suite 1029, Newmarket, ON, Canada, L3X 1X4	Stored on Archeoworks network servers

Under Section 6 of Regulation 881 of the *Ontario Heritage Act*, *Archeoworks Inc*. will, "keep in safekeeping all objects of archaeological significance that are found under the authority of the licence and all field records that are made in the course of the work authorized by the licence, except where the objects and records are donated to Her Majesty the Queen in right of Ontario or are directed to be deposited in a public institution under subsection 66 (1) of the Act."

APPENDIX E: CHANGES SINCE PIF SUBMISSION

Study Corridor

The study corridor changed slightly following the PIF submission as more accurate mapping was provided by the client.

APPENDIX H

Cultural Heritage Evaluation

Region of Waterloo

Planning, Development & Legislative Services

Cultural Services

Date: January 8, 2015

Memorandum

To: Pam Law, Senior Project Engineer, Water Services

Cc: Lucille Bish, Director, Cultural Services

From: Lindsay Benjamin, Cultural Heritage Planner

Subject: Conestogo Water Supply EA – Cultural Heritage Evaluation of Water Supply Alternative Solution No.2

This is a response to a request for an evaluation of the cultural heritage value or interest of the resources located within the Conestogo Water Supply EA - Water Supply Alternative Solution No.2 project area, which encompasses the road allowances of Sawmill Road, Northfield Drive East, Jigs Hollow Road, Hill Street, Covered Bridge Drive and Tallwood Drive in the Township of Woolwich.

The proposed work will include the installation of three watermains that will be located within the road allowances of the above mentioned roads. The installation of a watermain through Conestogo will be done in conjunction with the Sawmill Road rehabilitation project planned for 2017, which has undergone a separate Environmental Assessment process. This same watermain will also cross the Grand River near Bridge #1702. In addition to the watermain work, some modifications will be made to the West Montrose treatment plant, and the Conestogo Plains treatment plant. The Conestogo Golf Course treatment plant, located along Golf Course Road, will be removed.

Modifications to the treatment plants are not anticipated to impact any cultural heritage resources.

To help identify and evaluate the cultural heritage resources located in the project area, a Preliminary Design Report was completed to inventory existing structures and landscapes. The report can be found in Appendix A of this memo.

A number of significant cultural heritage resources were identified adjacent to the project area, notably in the villages of Conestogo and West Montrose. From the description of work proposed, Cultural Heritage staff have determined that there will be no long-term negative impacts to any of the identified resources, and as such the completion of a Heritage Impact Assessment (HIA) for the project is not required.

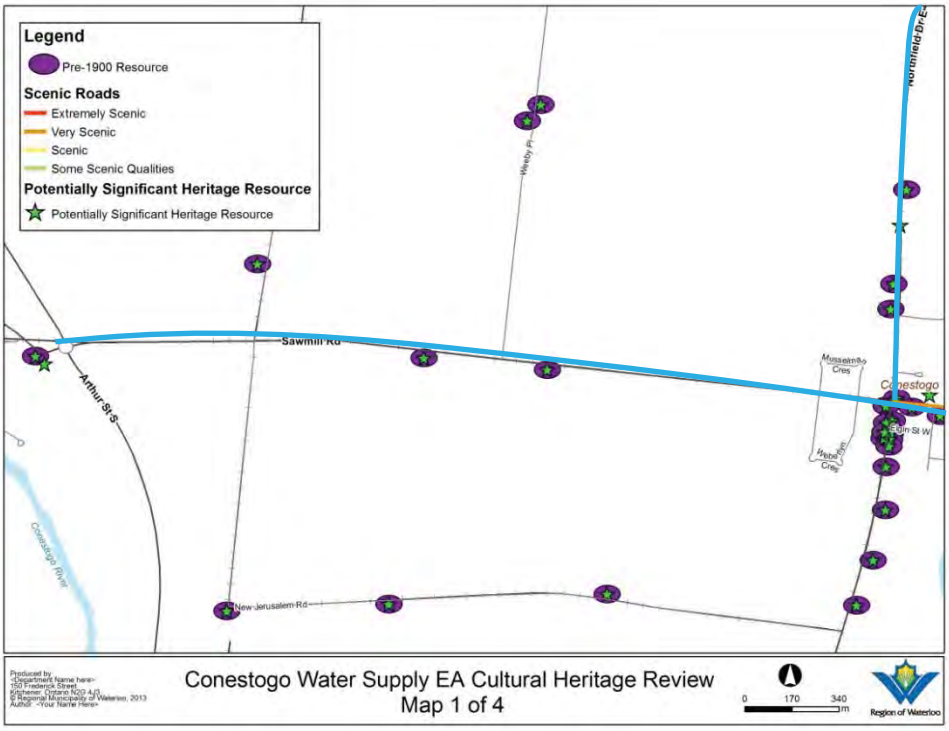
Any temporary impacts to identified cultural heritage resources during construction should be mitigated. In discussion with the Project Team, it has been confirmed that vibration monitoring will be undertaken during construction in an effort to mitigate impacts to the surrounding structures. Many of the buildings inventoried, notably those in Conestogo, as well as 52 Hill St. (Albright House) and 17 Covered Bridge Dr. in West Montrose, have very limited set backs from the road right of way. Care should be taken during construction to monitor and mitigate any potential impacts to these resources.

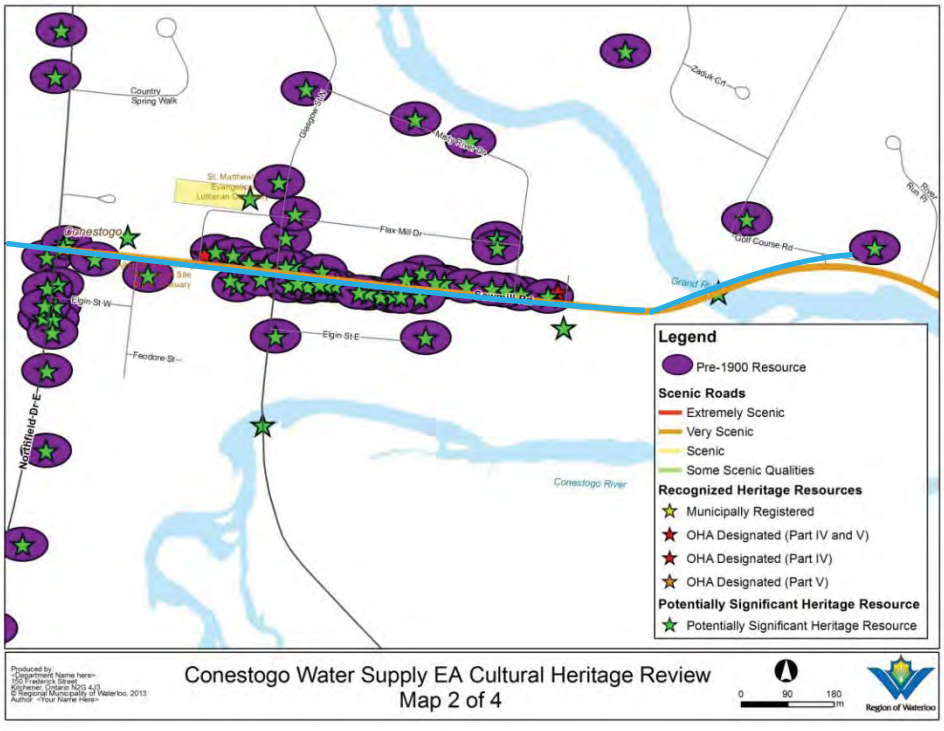
Should the proposed project plans change in nature or scope, such that there would be potential impacts to the identified cultural heritage resources, Cultural Heritage staff should be informed and further evaluation would need to be undertaken.

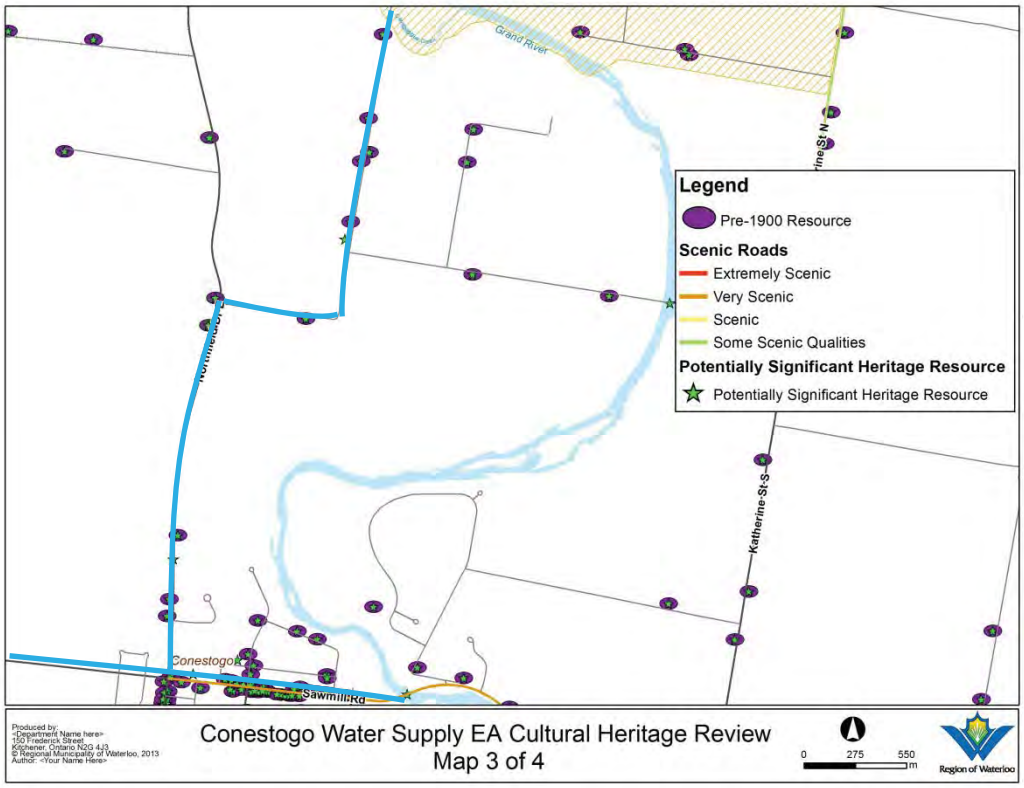
APPENDIX A

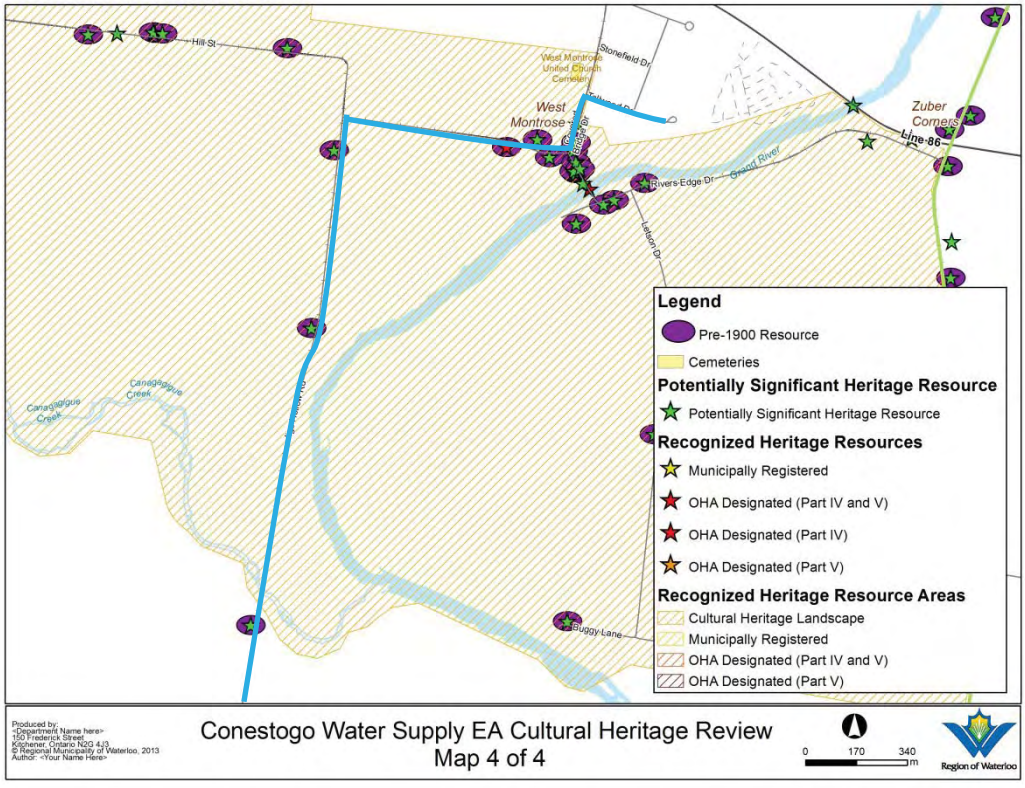
Cultural Heritage Comments - Current as of January 8, 2015

Project: Conestogo Water Supply EA






Grand River
Legend
Pre-1900 Resource
Scenic Roads
Extremely Scenic
Very Scenic
Scenic
Some Scenic Qualities
Potentially Significant Heritage Resource
Potentially Significant Heritage Resource
Katherine St S
Conestogo
Sawmill Rd
Produced by:
<Department Name here>
150 Frederick Street
Kitchener, Ontario N2G 4J3
© Regional Municipality of Waterloo, 2013
Author: <Your Name Here>
Conestogo Water Supply EA Cultural Heritage Review
Map 3 of 4
0 275 550 m
Region of Waterloo


Hill St
West Montrose United Church Cemetery
Stonefield Dr
West Montrose
Zuber Corners
Line 86
Rivers Edge Dr
Grand River
Legend
Pre-1900 Resource
Cemeteries
Potentially Significant Heritage Resource
Potentially Significant Heritage Resource
Recognized Heritage Resources
Municipally Registered
OHA Designated (Part IV and V)
OHA Designated (Part IV)
OHA Designated (Part V)
Recognized Heritage Resource Areas
Cultural Heritage Landscape
Municipally Registered
OHA Designated (Part IV and V)
OHA Designated (Part V)
Canagagigue Creek
Buggy Lane
Produced by:
<Department Name here>
150 Frederick Street
Kitchener, Ontario N2G 4J3
© Regional Municipality of Waterloo, 2013
Author: <Your Name Here>
Conestogo Water Supply EA Cultural Heritage Review
Map 4 of 4
0 170 340 m
Region of Waterloo

Summary

There are three designated properties, no municipally registered properties, 59 unofficially listed properties, and a total of 52 pre-1900 residential properties adjacent to the road corridor, along with two bridges. Many of the structures inventoried, notably those in Conestogo, as well as 52 Hill St. (Albright House) and 17 Covered Bridge Dr. in West Montrose, have very limited set backs from the road right of way. As such, care should be taken during construction to monitor and mitigate any potential impacts to these resources. A portion of road in this project area, Sawmill Rd., is considered scenic or of special character. An archaeological assessment is not required. There is one cemetery adjacent to the project area in West Montrose. The settlement of West Montrose is designated as a Cultural Heritage Landscape (CHL).

The area municipal heritage contact for this project is Jeremy Vink, Senior Planner, Township of Woolwich, jvink@woolwich.ca, 519-669-6038.

Please keep Cultural Heritage staff at the Region involved in this project as it progresses. The study area contains a high concentration of significant cultural heritage resources.

The following information is compiled from an inventory of cultural heritage resources that is maintained by the Region. The inventory is updated regularly with data that is provided by the area municipalities. To ensure the accuracy of the information it should be verified with the area municipality. For more information please contact the Cultural Heritage Specialist at 519-575-4094.

This information is intended to provide a general overview of the cultural heritage resources in the project area. A Heritage Impact Assessment and/or Archaeological Assessment must be completed if identified as a requirement in the Class Environmental Assessment.

Inventory of Heritage Features

	Pre-1900 Date Built	Designated Properties	Municipally Registered	Unofficially Listed
3015 Sawmill Rd.	1870			X
3011 Sawmill Rd. (Picard Peanuts)				X
2269 Sawmill Rd.	1870			X
2195 Sawmill Rd.	1895			X
1030 Northfield Dr. E.	1850			X
1966 Sawmill Rd.	1870			X
1955 Sawmill Rd.	1858			X
1948 Sawmill Rd. (Conestogo Public School)	1904			X
1939 Sawmill Rd.	1859			X
1911 Sawmill Rd.	1894			X
1915 Sawmill Rd.	1916			X
1892 Sawmill Rd. (specifically the garage next to this property)	1880			X
1887 Sawmill Rd.	1890			X

1895 Sawmill Rd.	1880			X
1842 Sawmill Rd. (1842 Bed & Breakfast)	1840			X
1830 Sawmill Rd.	1850			X
1857 Sawmill Rd.				X
1861 Sawmill Rd.	1850			X
1908 Sawmill Rd.	1900			X
1900 Sawmill Rd.	1880			X
1850 Sawmill Rd.	1840			X
1836 Sawmill Rd.	1895			X
1826 Sawmill Rd.	1850			X
1808 Sawmill Rd.	1860			X
1843 Sawmill Rd.	1850			X
1853 Sawmill Rd.	1870			X
1851 Sawmill Rd.	1870			X
1875 Sawmill Rd.	1870			X
1907 Sawmill Rd.	1870			X
1896 Sawmill Rd.	1900			X
1880 Sawmill Rd.	1890			X
1814 Sawmill Rd.	1870			X
1879 Sawmill Rd.	1870			X
1883 Sawmill Rd.	1880			X
1891 Sawmill Rd.	1880			X
1818 Sawmill Rd.	1870			X
1796 Sawmill Rd.	1850			X
1865 Sawmill Rd.	1855			X
1805 Sawmill Rd. (W&S Feed Supplies Mill)				X
1790 Sawmill Rd. (Conestogo United Church)	1878	X		
1924 Sawmill Rd. (Township Hall)		X		
3 Golf Course Rd.	1850			X
1904 Northfield Dr. E.	1885			X
1110 Northfield Dr. E.	1885			X
1183 Northfield Dr. E.	1870			X
1430 Northfield Dr. E.	1850			X
1444 Northfield Dr. E.	1880			X
1095 Jigs Hallow Rd.	1870			X
1210 Jigs Hallow Rd. (one-room school house)	1900			X
1230 Jigs Hallow Rd.	1857			X
1300 Jigs Hallow Rd.	1870			X
1313 Jigs Hallow Rd.	1870			X
1350 Jigs Hallow Rd.	1870			X
1440 Jigs Hallow Rd.	1870			X
1642 Jigs Hallow Rd.	1870	CHL		X
1764 Jigs Hallow Rd.	1880	CHL		X

52 Hill St. (Albright House)	c.1850	X/CHL		
31 Hill St.	1850	CHL		X
28 Hill St.	1897	CHL		X
12 Covered Bridge Dr. (Lost Acres Variety)	1902	CHL		X
15 Covered Bridge Dr.	1900	CHL		X
17 Covered Bridge Dr.	1870	CHL		X

Scenic Road

A section of Sawmill Road, from Northfield Dr. E. to the Conestogo village limits, is classified as a "Rural Village Main Street" and has been ranked as Very Scenic due to the presence of diverse and mature vegetation, views to the Grand River, and the built cultural heritage context. Further information can be found in the Scenic Roads Resource Document (DOCs 675554).

Heritage Bridge

Two bridges are located in the project area:

1) Bridge #1702 carries Sawmill Rd. across the Grand River. It is a continuous steel girder bridge on wall piers with solid concrete parapet walls. Constructed in 1963, the bridge has four spans and carries two-lanes of traffic, with a deck length of 123.5 metres and a total width of 12.3 metres. This type of bridge construction is typical of the era. Bridge #1702 exhibits a utilitarian design with simple solid concrete parapet walls.

   It was not included in *Spanning the Generations*, an inventory of heritage bridges in the Region of Waterloo, or other Grand River watershed-wide heritage bridge inventories. However, a remnant concrete pier from a pervious bridge remains in the Grand River just north of Bridge #1702. Care should be taken during construction not to impact this structure.

2) Bridge #2251 carries Northfield Dr. E. over a creek (name unknown). It is a single-span concrete box culvert constructed in 1950 with a length of 3.1 metres and width of 22.2 metres. This type of culvert construction is typical of the era.

   Bridge #2251 was included on page 6.13 of "Spanning the Generations: Phase 1," an inventory of heritage bridges in the Region of Waterloo. It was not included in other Regional or Grand River watershed-wide heritage bridge inventories.

Cultural Heritage Landscape

The Village of West Montrose has been designated as Cultural Heritage Landscape (CHL) under the Planning Act through an Official Plan Amendment. To see the CHL boundaries as they relate to the project area, please refer to Map 4 above.

The recognition and conservation of significant cultural heritage landscapes takes place in accordance with the Provincial Policy Statement and the Regional Official Policies Plan.

The West Montrose CHL is a defined geographical area of heritage significance that has been modified by human activities and is valued by the community. It is made up of a grouping of individual heritage features that together form a significant type of heritage form, distinctive from that of its constituent attributes or parts. Many of these heritage features have been inventoried in the list above.

More detailed information on the CHL designation and the policies that govern it can be found in the following PDF: http://www.woolwich.ca/en/townshipServices/resources/OP-CHAPTER_12.pdf

Cultural Heritage Definitions

Designated Properties – Protected from demolition and other adverse impacts
A designation confers a legal status on a property by a specific municipal by-law under the Ontario Heritage Act. Designation may fall under one of two categories under the Ontario Heritage Act: Part IV (individual designation) or Part V (district designation). Designation is an Area Municipal responsibility. The Area Municipal Council has the legal authority to refuse an application that will adversely affect the property's heritage attributes.

Municipally Registered/Listed Properties – Interim protection from demolition
The municipal register is the official list or record of cultural heritage properties that have been identified as being important to the community. The register includes all properties in the municipality that are designated under Part IV (individual designation) and Part V (district designation) of the Ontario Heritage Act. In addition, the municipal register may include properties of cultural heritage value or interest that have not been designated under the Ontario Heritage Act. This is commonly known as "listing." The Area Municipal Council must be given at least 60 days notice of intention to demolish or remove a building or structure on the property. This allows time for the municipality to decide whether to begin the designation process to give long term protection to the property.

The Process for Protected (Listed or Designated) Heritage Properties
If there are protected heritage properties located within the project boundaries of a Schedule B or C project a Heritage Impact Assessment (HIA) must be completed and Heritage Planning Staff at the Region and Area Municipality should be notified. The first phase of the HIA will provide an inventory of the heritage resources that are located within the project area. This inventory will provide more detail about the resources that have been identified in the PDR and may identify additional resources. The inventory should be used to identify and evaluate the impacts that the alternative solutions and design concepts will have on the heritage properties. Impacts to protected (listed/designated) heritage properties within the project boundaries should be avoided whenever possible.

Unofficially Identified Cultural Heritage Resources – No legal protection
Cultural Heritage Staff maintain a broad inventory of cultural heritage resources in the Region. These resources have been identified using a variety of sources including walking tours, local inventories, local histories, planning documents, heritage research projects, etc. Although these properties do not have any official heritage status or protection they may be potential candidates for designation or listing on a municipal register. If a historically significant property is threatened, a community may recognize its value and attempt to acquire some sort of heritage protection for the resource.

Cultural Heritage Landscapes
Cultural Heritage Landscapes are a defined geographical area that may have been modified by human activity and are identified as having cultural heritage value or interest by a community, including an Aboriginal community. The area may involve features such as structures, spaces, archaeological sites or natural elements that are valued together for their interrelationship, meaning or association. Examples may include, but are not limited to, heritage conservation districts designated under the Ontario Heritage Act; villages, parks, gardens, battlefields, mainstreets and neighbourhoods, cemeteries,

trailways, viewsheds, natural areas and industrial complexes of heritage significance; and areas recognized by federal or international designation authorities (e.g. a National Historic Site or District designation, or a UNESCO World Heritage Site).

Pre -1900 Residential Properties – For information
Residential structures in the project area that were built prior to 1900 have been identified. These identified historic structures have no formal heritage protection. However, historic buildings that have maintained their heritage value could be candidates for further heritage protection. Property data is taken from the Municipal Property Assessment Corporation (MPAC). The date that is assigned to a property represents the oldest structure on the lot.

Scenic Roads – Identified as possessing cultural value and require additional design consideration
Certain transportation corridors are characterized by natural, cultural heritage and recreational features that contribute to their scenic value or special character. Area municipalities are responsible for the designation of those municipal roads that possess scenic or cultural value. Likewise, the Region has identified sections of Regional road corridors that are considered scenic. The Special Character Streets and Scenic Roads Resource Document is a supplement to the Implementation Guidelines for Regional Transportation Corridor Design. It identifies and provides recommendations for the treatment of Scenic Roads and Special Character Streets that are part of the Regional road system within the Region of Waterloo. These recommendations should be considered before undertaking any work on a road that has been identified as possessing scenic value.

For conservation recommendations please consult the Scenic Road Resource Document (DOCs # 675554).

Additional Definitions

Heritage Bridges
The Region's Heritage Planning Advisory Committee has produced "Spanning the Generations: a Study of Old Bridges in Waterloo Region." Phase I is an inventory and ranking of more than 100 bridges based on their heritage attributes. Phase 2 documents the 10 most historically significant bridges. Phase 3 focuses on steel truss bridges. The document also contains protection and maintenance strategies for historic bridges in the Region. Any road work on an identified historic bridge should be done in conjunction with this document. For a hard copy of this document please contact the Cultural Heritage Planner at 519-575-4094.

A supplemental Regional Bridge Inventory was compiled in July 2012 by Cultural Heritage Planning Staff. The inventory provides a general overview of Regionally owned bridges built post-1930 and contains information and photos on each structure. The inventory was compiled as a resource to help assess the heritage value of the bridge structures. The study does not include Regionally owned culverts. Because the data contained in this report is reviewed and evaluated on a continual basis, it is only accurate as of July 2012. For the most accurate and up-to-date data on Regional bridges please contact Shawn Buckley sbuckley@regionofwaterloo.ca.

For ease, the Regional Bridge Inventory is sorted both by date of construction (DOCs # 1329552) and by Structure ID No. (DOCs # 1329856).

Cemeteries

If a cemetery is located adjacent to the road corridor the area municipality should be informed of any potential impacts to the cemetery. If land acquisition is required then the Cemeteries Regulation Unit at the Ministry of Consumer Services should be contacted.

Screening for Impacts to Built Heritage and Cultural Heritage Landscapes

This checklist is intended to help proponents determine whether their project could affect known or potential cultural heritage resources. The completed checklist should be returned to the appropriate Heritage Planner or Heritage Advisor at the Ministry of Tourism and Culture.

Step 1 – Screening for Recognized Cultural Heritage Value

YES	NO	Unknown	
☒	☐	☐	1. Is the subject property designated or adjacent* to a property designated under the *Ontario Heritage Act*?
☐	☒	☐	2. Is the subject property listed on the municipal heritage register or a provincial register/list? (e.g. Ontario Heritage Bridge List)
☐	☒	☐	3. Is the subject property within or adjacent to a Heritage Conservation District?
☐	☒	☐	4. Does the subject property have an Ontario Heritage Trust easement or is it adjacent to such a property?
☐	☒	☐	5. Is there a provincial or federal plaque on or near the subject property?
☐	☒	☐	6. Is the subject property a National Historic Site?
☐	☒	☐	7. Is the subject property recognized or valued by an Aboriginal community?

Step 2 – Screening Potential Resources

YES	NO	Unknown	
			Built heritage resources
			1. Does the subject property or an adjacent property contain any buildings or structures **over forty years old**† that are:
☒	☐	☐	▪ Residential structures (e.g. house, apartment building, shanty or trap line shelter)
☒	☐	☐	▪ Farm buildings (e.g. barns, outbuildings, silos, windmills)
☒	☐	☐	▪ Industrial, commercial or institutional buildings (e.g. a factory, school, etc.)
☒	☐	☐	▪ Engineering works (e.g. bridges, water or communications towers, roads, water/sewer systems, dams, earthworks, etc.)
☐	☒	☐	▪ Monuments or Landmark Features (e.g. cairns, statues, obelisks, fountains, reflecting pools, retaining walls, boundary or claim markers, etc.)
☐	☒	☐	2. Is the subject property or an adjacent property associated with a known architect or builder?
☐	☒	☐	3. Is the subject property or an adjacent property associated with a person or event of historic interest?
☐	☒	☐	4. When the municipal heritage planner was contacted regarding potential cultural heritage value of the subject property, did they express interest or concern?
YES	**NO**	**Unknown**	**Cultural heritage landscapes**
			5. Does the subject property contain landscape features such as:
☐	☒	☐	▪ Burial sites and/or cemeteries
☐	☒	☐	▪ Parks or gardens
☐	☒	☐	▪ Quarries, mining, industrial or farming operations
☐	☒	☐	▪ Canals
☐	☒	☐	▪ Prominent natural features that could have special value to people (such as waterfalls, rocky outcrops, large specimen trees, caves, etc.)
☐	☒	☐	▪ Evidence of other human-made alterations to the natural landscape (such as trails, boundary or way-finding markers, mounds, earthworks, cultivation, non-native species, etc.)
☒	☐	☐	6. Is the subject property within a Canadian Heritage River watershed?
☐	☒	☐	7. Is the subject property near the Rideau Canal Corridor UNESCO World Heritage Site?
☐	☒	☐	8. Is there any evidence from documentary sources (e.g., local histories, a local recognition program, research studies, previous heritage impact assessment reports, etc.) or local knowledge or Aboriginal oral history, associating the subject property/ area with historic events, activities or persons?

Note:

If the answer is "yes" to any question in Step 1, proceed to Step 3.

The following resources can assist in answering questions in Step 1:

Municipal Clerk or Planning Department – Information on properties designated under the Ontario Heritage Act (individual properties or Heritage Conservation Districts) and properties listed on a Municipal Heritage register.

Ontario Heritage Trust – Contact the OHT directly regarding easement properties. A list of OHT plaques can be found on the website: Ontario Heritage Trust

Parks Canada – A list of National Historic Sites can be found on the website: Parks Canada

Ministry of Tourism and Culture – The Ontario Heritage Properties Database includes close to 8000 identified heritage properties. Note while this database is a valuable resource, it has not been updated since 2005, and therefore is not comprehensive or exhaustive. Ontario Heritage Properties Database

Local or Provincial archives

Local heritage organizations*, such as the municipal heritage committee, historical society, local branch of the Architectural Conservancy of Ontario, etc.*

Consideration should also be given to obtaining oral evidence of CHRs. For example, in many Aboriginal communities, an important means of maintaining knowledge of cultural heritage resources is through oral tradition.

If the answer is "yes" to any question in Step 2, an evaluation of cultural heritage value is required. If cultural heritage resources are identified, proceed to Step 3.

If the answer to any question in Step 1 or to questions 2-4, 6-8 in Step 2, is “unknown”, further research is required.

If the answer is "yes" to any of the questions in Step 3, a heritage impact assessment is required.

If uncertainty exists at any point, the services of a qualified person should be retained to assist in completing this checklist. All cultural heritage evaluation reports and heritage impact assessment reports must be prepared by a qualified person. Qualified persons means individuals (professional engineers, architects, archaeologists, etc.) having relevant, recent experience in the identification and conservation of cultural heritage resources. Appropriate evaluation involves gathering and recording information about the property sufficient to understand and substantiate its heritage value; determining cultural heritage value or interest based on the advice of qualified persons and with appropriate community input. If the property meets the criteria in Ontario Regulation 9/06 under the Ontario Heritage Act, it is a cultural heritage resource.

† The 40 year old threshold is an indicator of potential when conducting a preliminary survey for identification of cultural heritage resources. While the presence of a built feature that is 40 or more years old does not automatically signify cultural heritage value, it does make it more likely that the property could have cultural heritage value or interest. Similarly, if all the built features on a property are less than 40 years old, this does not automatically mean the property has no cultural heritage value. Note that age is not a criterion for designation under the *Ontario Heritage Act*.

Step 3 – Screening for Potential Impacts

YES	NO	Will the proposed undertaking/project involve or result in any of the following potential impacts to the subject property or an adjacent* property?
❑	☒	**Destruction, removal or relocation** of any, or part of any, heritage attribute or feature.
❑	☒	**Alteration** (which means a change in any manner and includes restoration, renovation, repair or disturbance).
❑	☒	**Shadows** created that alter the appearance of a heritage attribute or change the exposure or visibility of a natural feature or plantings, such as a garden.
❑	☒	**Isolation** of a heritage attribute from its surrounding environment, context or a significant relationship.
❑	☒	**Direct or indirect obstruction** of significant views or vistas from, within, or to a built or natural heritage feature.
❑	☒	**A change in land use** such as rezoning a battlefield from open space to residential use, allowing new development or site alteration to fill in the formerly open spaces.
❑	☒	**Soil disturbance** such as a change in grade, or an alteration of the drainage pattern, or excavation, etc.

* For the purposes of evaluating potential impacts of development and site alteration “adjacent” means: contiguous properties as well as properties that are separated from a heritage property by narrow strip of land used as a public or private road, highway, street, lane, trail, right-of way, walkway, green space, park, and/or easement or as otherwise defined in the municipal official plan.

APPENDIX I

Watermain Support from Bridge Memorandum

MEMO

TO	:	Eric Tuson, P.Eng.
COPY TO	:	T000134A Project File
FROM	:	Ken Bontius, P.Eng.
DATE	:	**July 8, 2015**
SUBJECT	:	Water Main Support From Bridges Conestoga Plains Water Supply (Rev.1)

The following discussion has been prepared to address the Region of Waterloo's request for advice concerning the installation and support of a water main from the Sawmill Road Grand River Bridge and Jigs Hollow Bridge.

1. Background

The Region of Waterloo is undertaking a Municipal Class Environmental Assessment and related preliminary design planning for the installation of a new water main for the Conestoga Plains water supply. The proposed alignment for this water main includes routing of the alignment within the Sawmill Road and Jigs Hollow Road right of ways and includes existing water crossings in both cases.

The typical practice at bridge crossings would involve constructing the water mains offset away from the structures and installed by trenchless methods below the watercourse. However, based on the geotechnical investigation, trenchless crossing methods are not viable due to the ground conditions. An alternate to trenchless methods is to install the watermains by open cut across the watercourses. An open cut crossing approach is not preferred, given the extent of the crossing at the Grand River location and the overall grades and environmental impacts associated with both locations. There would also be additional schedule and significant construction costs associated with the extent and nature of an open

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cut approach. The schedule and cost impacts for each bridge site are discussed in the individual sections below.

Where such utilities can readily be kept separate and buried in the right of way below the crossing adjacent to the structure, then it has been preferred to maintain a separation to avoid any current or future coordination impact or liability. However, there is also no significant disadvantage or technical reason not to support utilities, including water mains, from bridge structures. It is fairly common practice within jurisdictions in Ontario and throughout the world to suspend water mains and other utilities in the manner and approach proposed. There are many examples of both existing structures and new bridge projects in Ontario where mains are being suspended from bridge infrastructure and utility support products, couplings and related details for this application are common. Where buried utility crossings are not reasonable due to complexity, environmentally sensitive areas, significant costs or property constraints then supporting the utilities across and suspended from the bridge structure is usually undertaken. Thus, utility crossings suspended on structures are common at high level and/or long crossings, complex or constrained urban locations and environmentally sensitive areas.

While straightforward and having minimal impact, the presence of suspended utilities on a superstructure and penetration through the substructure does add a separate element of work during construction and potentially during future repair or rehabilitation works on the structure. Measures to prevent bird nesting or public climbing onto the pipes may also be required. From the perspective of the utility owner too, the water main would also require insulation and potentially the cost of heat tracing to maintain the exposed pipes.

In consideration of the above, an alternative to suspend the water main from the identified bridges is being considered for the Conestoga Plains water main project. The water main would be supported on utility hangars suspended from the deck soffit between the girders. Standard pressure main expansion joints would be provided where the mains pass through the deck ends and penetrate the abutment ballast walls. This approach would be relatively straightforward and offer significant cost savings and schedule improvements while negating any property easement or

permitting requirements. The resulting horizontal and vertical alignments of the mains and minimal depth of valve chambers would also be preferable with this approach.

The following sections provide a discussion of the specific issues relating to each bridge site.

2. Sawmill Road over Grand River Bridge

The Sawmill Road – Grand River Bridge is a four-span structure with a superstructure consisting of a reinforced concrete deck on five lines of structural steel girders. Expansion joints are provided at each abutment end. Horizontal K-bracing is provided at the pier locations and at intermediate points of each span and solid steel end diaphragms are provided at the abutment ends. Suspended utilities can easily pass through the central opening in the lateral bracing between girders and can shift below the solid end diaphragms, above the abutment stem surface and between the bearing pedestals.

Based upon a review of the available bridge drawings and biennial inspection report for this bridge, the additional water main loads are considered to be negligible; accordingly, structural capacity issues are not anticipated to be an issue.

There is an existing set of utilities suspended from the deck soffit between the exterior girder and first interior girder on the north side of the bridge. These ducts pass through the bracing sections and below the solid end diaphragm and pass through sleeves in the abutment ballast walls. The remaining space between the girders at this location is quite limited particularly in the space between the bearing seats at the abutments but the water main could be accommodated in the same manner between the exterior girder and first interior girder on the south side of the bridge.

The bridge deck cantilevers are short resulting in only a negligible space between the web of the exterior girder and the inside face of the wingwalls. Accordingly, the water main would not be able to pass through the abutment if suspended on the exterior of the bridge. Suspension of the water main from the exterior edge of the deck is only feasible if the water mains are continued externally on the outside of

the wingwalls and approaches to the bridge. However, the abrupt change in the horizontal alignment of the water main to accommodate this approach is not preferred with regards to the water main design.

The work to install a water main through the ballast wall will involve partial removal of the asphalt, approach slabs and backfill at each abutment to facilitate access for coring of the ballast wall and installation of the water main section through the wall. For this work, the extent of removals at each location will be approximately 6m in length and 4m in width to enable proper access and space for the work while using cut slopes to avoid costly roadway protection. The granular backfill, approach slab and asphalt wearing surface would have to be reinstated in kind upon completion of the water main installation behind the abutments. A single lane closure, with temporary traffic signals to maintain traffic across the two lane structure, would be required for the duration of the work, and is estimated to require 5 to 7 working days. Future rehabilitation work on the bridge in the vicinity of the water main will require the protection and consideration of the water main in the proposed works. Since the structure has existing suspended utilities passing through the abutment wall, the additional provisions for the water main would not add any additional complexity or constraints on future work.

The cost to install the water main across and suspended from the Sawmill Road bridge is anticipated to be in the range of $ 600,000 with an overall completion schedule of 2 weeks. Alternatively, the cost for an open cut installation below the Grand River is estimated at a minimum of $ 1,000,000 and with an overall schedule of at least 6 weeks. Furthermore, there is essentially no direct environmental impact associated with the support of the water main from the bridge, whereas open cut installations through the Grand River would have significant impacts and may not even be permitted by the GRCA.

3. Jigs Hollow Bridge

The Jigs Hollow Bridge is a single span structure with a reinforced concrete deck supported on six lines of precast prestressed concrete girders bearing on a conventional concrete abutment and articulated with expansion joints at each end.

There are solid concrete transverse diaphragms between the girders at the abutment ends and at the mid-span. The water main can be suspended between the girders although sleeves through the concrete diaphragms would be required in addition to the sleeves required through the abutment ballast walls. The Jigs Hollow bridge also has insufficient space between the exterior face of the exterior girder web and the inside face of the wingwalls to permit a water main suspended below the deck cantilever from passing through the abutment. Again, the water main could be supported from the exterior cantilever only if it is continued externally on the outside of the wingwalls and approaches to the bridge.

Based upon a review of the biennial inspection report for this bridge, the additional water main loads are considered to be negligible for this bridge; accordingly, structural capacity issues are not anticipated to be an issue.

The construction methodology would be the same as for the Sawmill Road Bridge with the additional requirement to core and sleeve through concrete diaphragms. However, due to the unpaved approaches to the bridge, the schedule to complete the works may be reduced to 3 to 5 working days. While no imminent work is planned on the existing structure, the previous OSIM report for this structure recommended converting the expansion joints to a semi-integral abutment. If this work is contemplated and carried out in the future, the presence of the suspended water main should not adversely affect the work. The water main would need to be protected during the adjacent surrounding concrete removals, temporarily supported during reconstruction work and included within the design provisions for the integral abutment end diaphragm. The expansion coupling device for the water main would also need to be relocated as part of that future work. If the water main is installed in the existing structure and the Township does opt to carry out a semi-integral abutment conversion thereafter, the cost premium of installing it in advance versus installing the water main as part of the semi-integral deck conversion work is estimated at $15,000, with the understanding that work to protect the existing water main during the semi-integral conversion would be incidental to the overall work. It should also be noted that the Ministry of Transportation (MTO) Bridge Office has recently updated the warrants for semi-integral abutment conversions and under

the revised protocol, the Jigs Hollow Bridge would not be a candidate for such work.

The cost to install the water main across and suspended from the Jigs Hollow Road bridge is anticipated to be in the range of $ 100,000 with an overall completion schedule of 2 weeks. Alternatively, the cost for an open cut installation below the water course is estimated at $ 445,000 and with an overall schedule of at least 4 weeks. There is also essentially no direct environmental impact associated with the support of the water main from the bridge, whereas open cut installations through the environmentally sensitive embankments and water course would have significant impacts and may not even be permitted by the GRCA.

4. Closing

In consideration of the above discussion, supporting the water main from the bridge structures is straightforward and would be the preferred solution based on cost, schedule, environmental impact and preferred pipe profile/valve chamber access.

Based on our review of the structures, we would agree with the recommendation to support the water main from the bridge soffits and located between an exterior girder and first interior girder of each bridge. Furthermore, this work should be straightforward to accommodate at the detailed design stage without further investigations or effort to the preliminary design at this time.