Belfountain Dam & Headpond

Class Environmental Assessment

Technical Report 1 – Baseline Inventory

Prepared for:

Credit Valley Conservation
Mississauga, Ontario, Canada

Prepared by:

Amec Foster Wheeler
Environment & Infrastructure
3215 North Service Road
Burlington, ON L7N 3G2
Canada

(905) 335-2353

August 2015

Project No. TP114113

BELFOUNTAIN DAM & HEADPOND
CLASS ENVIRONMENTAL ASSESSMENT

TECHNICAL REPORT 1 – BASELINE INVENTORY

Submitted to:

Credit Valley Conservation

Submitted by:
Amec Foster Wheeler Environment & Infrastructure
A division of Amec Foster Wheeler Americas Limited
3215 North Service Road
Burlington, ON L7N 3G2

Tel: 905-335-2353
Fax: 905-335-1414

August 2015

TP114113

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

By Report Section:

Following the Report:

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Purpose

Amec Foster Wheeler has been retained by Credit Valley Conservation (CVC) to assess various alternatives and associated implementation options for future management of the Belfountain Dam and Headpond, under the guiding principles of the Conservation Ontario Class Environmental Assessment (Class EA) process. The Class EA will document baseline environmental conditions, establish a long-list of management alternatives, evaluate each alternative using appropriate physical, biological, cultural and socioeconomic criteria leading to the selection of the Preferred Alternative(s). Implementation options will then be developed for the Preferred Alternative, and a detailed impact and mitigation plan will be prepared. Significant public, agency and stakeholder consultation is planned for each stage of the project and input will be used to inform the process.

1.2 Project Team

The Amec Foster Wheeler Team includes four (4) consultants with specialists in thirteen (13) key study disciplines:

- Amec Foster Wheeler Environment & Infrastructure: Project Management, Public Consultation, Water Resources Engineering, Structural Engineering, Geotechnical Engineering, Cultural and Built Heritage, and Archaeology
- PARISH Aquatic Services, A Division of Matrix Solutions Inc.: Stream Morphology, Aquatic Ecology, Terrestrial Ecology and Sediment Quality
- Collins-Ferrara Engineering Inc: Mechanical Engineering
- Ameresco Inc.: Financial Analysis

1.3 Study Area

The formal Study Area is comprised of the Belfountain Dam and Headpond and the immediate surrounding area that may be impacted by implementation of management alternatives (ref. Figure 1 and 2). The Study Area contains several anthropogenic and natural features including the Belfountain Dam and Headpond, other historic structures including the ‘Yellowstone Cave’, retaining walls and building foundations, a pedestrian bridge over the dam, a large terrace recreational area, the West Credit River and significant mature forest land. Appendix B provides a photographic catalogue depicting the Study Area in its current and historic states.

The dam is located within the Belfountain Conservation Area (BCA), which, along with the Willoughby Property and the Cox Property comprise the larger Belfountain Complex (ref. Figure 3). The closest settlement is Belfountain, a village within the Town of Caledon and the Region of Peel.

The study must also consider the conduit of the dam within the West Credit River watershed. The area upstream of Belfountain Dam, influences the hydraulic, aquatic and riparian conditions through the Study Area, though no impacts to the upstream watershed are expected. Figure 4 illustrates the West Credit River watershed. The study will also consider the downstream West Credit River floodplain, as the presence and operation of the Belfountain Dam impacts flood risk in this area.

1.4 Background

The site of the Belfountain Dam originally contained a smaller water control structure associated with a historic mill operation. Charles Mack, a wealthy Toronto manufacturer, purchased the land in 1908 with the intention to create a public recreational area. The Belfountain Dam was built in an attempt to mimic Niagara Falls and create a feature for his park, which opened to the public in 1914. The dam served as an aesthetic feature and through the generation of a headpond, enabled recreation (swimming, boating and fishing). Pre-contact aboriginal and euro-Canadian artifacts have been found on the site and nearby sites. A detailed discussion on regional and park history and archeological resources can be found in *Section 3.7 Cultural & Built Heritage* and *Section 3.8 Archaeology*.

After Mack's death the park was sold. CVC acquired Mack's Park in 1959 and began to acquire additional parcels comprising part of what is now the Belfountain Complex. CVC has made some improvements to the dam over time, however the main spillway structure remains largely original and continues to serve the same aesthetic/recreational purpose for the BCA (the dam has never provided flood control or purposed flow augmentation). The engineering aspects of the dam (hydrology, hydraulics, structural and geotechnical) are well understood from recent and formative studies. Of particular note, a recent geotechnical investigation has determined that various components of the dam do not meet current Provincial guidelines for dam stability and as such the structure now presents a safety concern that must be mitigated. A detailed discussion on the dam, previous investigations and governing legislature can be found in *Section 3.1 Formative Studies.* Additional structural and geotechnical investigations have been completed in support of the current Class EA in order to address gaps identified in previous studies and are summarized in Sections 3.2 and 3.3.

As noted, the Belfountain Dam is located on the West Credit River. The watercourse and its associated valley lands represent some unique and valuable aquatic and terrestrial habitat, much of which has adjusted over time to the presence of the dam, at least locally, along with the species it supports. Of particular note, the dam now represents a barrier for fisheries, providing protection to upstream native brook trout from highly competitive downstream non-native species. Sections 3.5 and 3.6 provide characterization of *Aquatic Ecology* and *Terrestrial Ecology.* Similarly, the function of the watercourse itself has been impacted by the presence of the dam, most significantly in the impounded of sediment in the headpond, sediment that would have otherwise been transported downstream; *Section 3.4 Stream Morphology & Sediment* provides a discussion on these elements.

The Belfountain Dam & Headpond Class EA is being undertaken concurrently with the Belfountain Complex Management Plan (BCMP). The BCMP study area includes the three (3) properties comprising the Complex and will outline the future management plan for the Complex. Due to the complex engineering issues related to the Belfountain Dam, and given that some of the potential outcomes trigger a Conservation Ontario Class EA, it has been considered preferable and necessary to evaluate the management of the dam and headpond in a separate planning process (the current Class EA). Section 1.5 provides more information on the scope and progress of the BCMP.

1.5 Study Objectives

CVC has established seven (7) guiding objectives for the Class EA:

Objective #1: Maintain a Fisheries Barrier - Maintain a barrier between upstream brook trout and downstream non-native and invasive species.

Objective #2: Reduce/minimize risk to visitors, staff, affected property and downstream dams

Objective #3: Maintain or improve the visitor experience - Maintain the high quality visitor experience that the public expects when they visit Belfountain Conservation Area.

Objective #4: Conserve and enhance cultural heritage attributes - Maintain and improve the cultural heritage attributes that are representative of Belfountain Conservation Area's history as a rare example of an early 20th century park.

Objective #5: Promote natural stream function - Maintain and improve the natural function of the West Credit River and its ecosystem.

Objective #6: Strive for long-term sustainability including economic viability - Maintain or improve BCA's ability to function as an active conservation area within CVC's Core 10 Conservation Area System and as part of the Niagara Escarpment Parks and Open Space System with the resources currently available.

Objective #7: Conserve and enhance natural heritage attributes - Contribute to the form and function of the Study Area as well as nearby natural heritage features by maintaining or enhancing the cover of natural area.

These objectives will be considered in the development and evaluation of management alternatives. The Preferred Alternative will ultimately be required to meet the stated objectives.

1.6 Key Background Studies

1.6.1 Draft Belfountain Complex Management Plan (BCMP)

The BCMP is being prepared by CVC. The purpose of the study is to *establish conservation area goals and objectives, and provide the means and strategies for achieving them* (ref. BCMP Background Report, Draft, CVC, 2014).

Also excerpted from the BCMP Background Report (Draft, CVC, 2014)*:*

The ultimate goal of the Belfountain Complex Management Plan is to develop a vision that balances the protection of natural features and the functions they provide with the development of appreciation and recreation opportunities and the values of the local community and general public. The vision will also identify and delineate the function of the Complex in the context of its role as a Core 10 property within CVC's Conservation Areas System. The main outputs of the management plan include:

- *Classification and zoning based on existing natural features and functions as well as recreation and interpretive opportunities*
- *Management policies, processes, and practices will be reviewed and updated as necessary*
- *Guidelines and management policies that guide daily operational decisions and implement the long-term vision will be developed*
- *Options for appreciation and recreational programming opportunities will be identified, prioritized and scheduled*
- *Infrastructure and development projects for operational and visitor management purposes will be identified, prioritized and scheduled*
- *Projects related to habitat restoration and rehabilitation, stewardship and monitoring will be identified, prioritized and scheduled*
- *Site and/or business plans for all applicable, proposed infrastructure, development, programming and restoration projects will be developed*

The management planning process is separated into three (3) distinct phases:

1. *Background Report*: Synthesis of ecological, cultural, social and economic information that forms the foundation for science-based decision making (summarized in Section 1.5.1.1)

2. *Strategic Directions*: Development and refinement of recommendations through consultation with the Stakeholder Advisory Committee, public, agency partners and CVC staff

3. *Final Management Plan*: Describes the projects, programs and tasks that are required to meet the objectives for the Complex and contains a framework for evaluating success

CVC has completed the Background Report and is currently in the *Strategic Directions* phase. The Final Management Plan will ultimately incorporate the Preferred Alternative and implementation option advanced by the Belfountain Dam and Headpond Class EA.

1.6.1.1 Background Report

CVC completed extensive background research and field investigation in order to characterize the BCMP study area. The report provides a summary of the following disciplines:

- Natural heritage
- Cultural heritage
- Conservation area visitation
- Recreational and educational programming
- Infrastructure (including the Belfountain Dam and Headpond)
- Social and economic environments
- Strategies, policies and legislation

As noted, the study area for the BCMP includes the Belfountain Dam and Headpond, and as such, forms a comprehensive document with much of the information required to generate the Baseline Inventory for the current Class EA. Discipline specialists have populated the Baseline Inventory for the current Class EA (ref. Section 3.0) using relevant information from the BCMP Background Report and supplemented this information with reference to other key documents and additional field investigation, as required.

1.6.1.2 Visitor Survey and Experience

The fulsome characterization of the direct and indirect social benefits for the BCMP has been completed as part of the BCMP Background Report (CVC, 2014). The Belfountain Dam and Headpond comprise a small area within the Belfountain Complex, however the dam and headpond are considered two (2) of the key features that attract visitors to the BCA.

A comprehensive Visitor Information Survey was conducted at BCA in 2010 with the goal of gaining baseline information for visitor demographics, visitor attributes and site attributes. Ninety percent (90%) of respondents rated the dam and waterfall and bridge (used to view the dam) as *very high* or *high* importance to their visit. CVC staff understands that a large portion of visitors value the drama, noise and vistas created by the dam. Staff also believes that the park offers urban visitors, who may have little exposure to nature, an opportunity to experience nature in a safe and controlled setting. In other words, the park allows visitors to get close to the river and forest without having to undertake more adventurous activities like hiking.

CVC staff also notes that BCA provides a "unique" park experience because of the features it contains including, most notably, the Belfountain Dam, but also the other heritage aspects discussed in Section 3.7.

Maintaining or improving the visitor experience is an objective of the Class EA and will be a key consideration in developing alternatives for the management of the dam.

1.6.2 Dam Safety Review & Geotechnical Investigation

All dams in Ontario are required by the Province of Ontario to undergo periodic Dam Safety Reviews (DSR). A DSR reviews the engineering (hydrology, hydraulics, structural, geotechnical) and safety (public, operator) and operational aspects of a dam through site reconnaissance, background review and intrusive investigations and analysis, where required.

A DSR was undertaken for Belfountain Dam (ref. Dam Safety Review, Belfountain Dam, Klohn Crippen Consultants Ltd, March 2007) in accordance with the Ontario Dam Safety Guidelines (Ministry of Natural Resources, 1999). The following summarizes the key outcomes:

- The Inflow Design Flood (IDF) was determined to be the 100 year event;
- Seepage and rubble from a collapsed retaining wall was observed at the south abutment, monitoring was recommended;
- Some indication of slope movement was observed by way of leaning trees, monitoring was recommended;
- Signs of distress in the north retaining wall were observed and monitoring was recommended (monitoring is being undertaken by Amec Foster Wheeler and is ongoing, no evidence is movement has yet been observed);
- The Hazard Potential Classification (HPC) of the dam was determined to be *Low*;
- The spillway and control structure were determined to have sliding factors of safety below the required value of 1.5 for Usual, Flood and Earthquake conditions; and
- The factors of safety were determined using assumptions based on Regional geologic mapping, geotechnical investigation was recommended to confirm assumptions and update factors of safety as appropriate.

It is noted that the Ministry of Natural Resources and Forestry (MNRF) has updated the guidelines for dam design and safety review in the Lakes and Rivers Improvement Act (LRIA) *Technical Bulletins* (August 2011).

Based on the recommendations in the 2007 DSR, the *Geotechnical Investigation and Dam Safety Report, Belfountain Dam* (ref. Terraprobe, December 2013), was undertaken. This assessment was undertaken in accordance with the August 2011 Technical Bulletins. Intrusive investigations were undertaken to confirm structural and founding conditions and design, including boreholes, test pits and ground penetrating radar. Three (3) steel shear anchors were installed in the boreholes (2 in the spillway, 1 in the control structure). The following summarizes the key outcomes:

- The spillway was determined to have a sliding factor of safety below the required value of 2.0 for Usual Summer conditions (with consideration for 3 shear anchors installed as part of the investigation);
- Five (5) additional anchors would be required to achieve the required factor of safety;
- The spillway was determined to have a sliding factor of safety below the required value of 2.0 for Usual Winter conditions if ice were to form and apply load to the crest of the dam. This condition can be alleviated by lowering water levels below the silt level to eliminate the load. Otherwise, five (5) shear anchors, in addition to the five (5) required for summer conditions would be required;
- The control structure was determined to meet the guidelines;
- The north retaining wall was determined to be inadequate under flood (IDF) and flood combined with earthquake conditions; and,
- The HPC and IDF were not updated as part of this study.

1.6.3 Operation Maintenance & Surveillance Manual and Emergency Preparedness Plan

The *Belfountain Dam Maintenance, Operation and Surveillance Manual* (OMS) (CVC, October 2013) is intended to be a compilation of information used by CVC staff to operate (under normal conditions), maintain, and monitor the condition of the water-retaining structures associated with the Belfountain Dam. Dam safety is a significant focus of the OMS. The OMS outlines the following:

- The procedures required to operate, monitor the performance of, and maintain a facility to ensure that it meets regulatory and policy obligations, and functions in accordance with its design;
- The procedures required to fully document the performance of the facility;
- The roles and responsibilities of individuals assigned to the facility; and,
- Procedures to document essential information, and ensure that records are kept.

The *Belfountain Dam Emergency Preparedness Plan* (EPP) (CVC, revised March 2014) outlines an action plan in the event of a dam safety emergency. The normal operations of the dam are outlined in the OMS. The specific emergency responsibilities of all staff involved in the maintenance and operation of the dam are outlined. The plan describes how to identify an emergency, the actions for staff to take in an emergency, and provides contact information for CVC and agency contacts. In the event that evacuation is required, procedures and contact information for properties in the inundation zone are also provided. The EPP also indicates that it may be justified to increase the HPC for the Belfountain Dam (previously defined as *Low*, ref. Klohn Crippen, 2007) when the potential failure of the downstream Stonecutter's Dam is considered. A cascade failure may have the potential to inundate two (2) residential structures. Furthermore, the most recent dam safety guidelines (MNRF, 2011) now consider transient persons in the calculation of life safety, which is a component used in assigning the HPC. The trails within BCA downstream of the dam would have transient persons at various times.

1.6.4 Belfountain Conservation Area Headpond Study

In 2005, CVC completed the *Belfountain Conservation Area Head Pond Study* (TSH, 2005). The primary objective of the study was to improve fisheries in the headpond. The study followed the principles of the Class EA process, however was not formally filed as such. The study looked at management alternatives for the dam and the headpond, similar to the current study. The study recommended partial dam removal (to allow passage of select fish species) and restoration of the watercourse, including removal of sediment in the headpond. The recommendations of the study were not supported by CVC's Board of Directors as the study was deemed to have not adequately considered visitor experience and the long-term economic viability of the park when selecting the preferred alternative. Other considerations were also the impact to the heritage resources. The Board elected to revisit the management of the Belfountain Dam and Headpond at a time in which the Belfountain Complex could be evaluated as a whole by way of Master Plan which is concurrently being undertaken by CVC (ref. Section 1.6.1).

2.0 CONSERVATION ONTARIO CLASS ENVIRONMENTAL ASSESSMENT PROCESS

2.1 Overview

This study is following the process outlined in the Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Projects (June 2002, Amended June 2013) which is approved under the Environmental Assessment Act (1990). The Conservation Ontario Class EA process outlines mandatory principles, details of project consultation and technical requirements. A Conservation Ontario Class EA document is considered a legal document which outlines project recommendations and next steps, based on a technical assessment, to the public and to technical practitioners and agencies, who have to review and implement the findings of the study. The Class EA approach is considered a suitable means for the planning of remedial flood and erosion control projects for Conservation Authorities, because such projects:

- have a common process of planning, design, approval, construction, operation and monitoring; and,
- have a generally predictable range of effects, which, though significant enough to require environmental assessment, are generally responsive to standard mitigation measures.

It is the responsibility of the Conservation Authority to ensure that the planning process, as set out in the Class EA document, is undertaken. The projects that will be assessed are those with predictable environmental effects and proposed mitigation measures will be identified and documented. The Class EA process provides a consistent, streamlined, easily understood process for planning and implementing flood and erosion control projects. The process provides a means for the identification of issues and concerns, and the preferred means of addressing them, with due regard to environmental management, protection, and mitigation measures. The process also provides the flexibility to be tailored to the activity, taking into account the environmental setting, *public* interest, and unique situation requirements.

2.2 Conservation Ontario Class EA Process

The Conservation Ontario Class EA Process applies to Remedial Flood and Erosion Control Projects, which are required to protect human life and property, in previously developed areas, from an impending *flood* or *erosion* problem. The Class EA document categorizes projects according to the following groupings:

- ***Riverine Flooding***: Two main causes of flooding in the riverine system are an increase in water level from a storm event or rapid snow melt, and a result of the formation of ice jams, frazil ice, or other debris in watercourses.
- ***Riverine and Valley Slope Erosion***: Riverine erosion is the result of fluvial processes which are determined by the watercourses flow and the sediment mixture of the watercourses bed and banks. Bluff/bank instability problems can also occur along river or stream banks as a result of weathering, internal drainage problems, or the removal of stabilizing vegetation and soil material from the surface of the slope.

- ***Shoreline Flooding:*** Shoreline flooding varies from a river system because an additional component, that of wave action, must be considered in addition to increases in water levels. The still water level plus the wave action (wave uprush/runup, overtopping, ice accumulation) result in a final storm elevation.
- ***Shoreline Erosion:*** The erosion processes along the shoreline differ from those in a riverine system. Erosion is predominantly brought about by waves, currents, shore geomorphology, ice and changes in water levels. Shoreline erosion can result in deterioration of bluffs/banks, dunes, berms and beaches.

The Planning and Design process as shown in Figure 2.2.1 outlines the step required to be undertaken by the proponent including how the Class EA process is initiated and the environmental planning and design principles that are to be employed in this process.

As part of the Class EA process the following key principles have been considered:

- *Establish a Problem and Opportunity Statement;*
- *Consult with affected parties early in and throughout the process, such that the planning process is a cooperative venture;*
- *Consider a reasonable range of alternatives, both functionally different "alternatives" and "alternative methods" of implementing the solution;*
- *Systematic evaluation of alternatives in terms of their advantages and disadvantages, to determine their net environmental effects; and,*
- *Provision of clear and complete documentation of the planning process followed, to allow "traceability" of decision-making with respect to the project.*

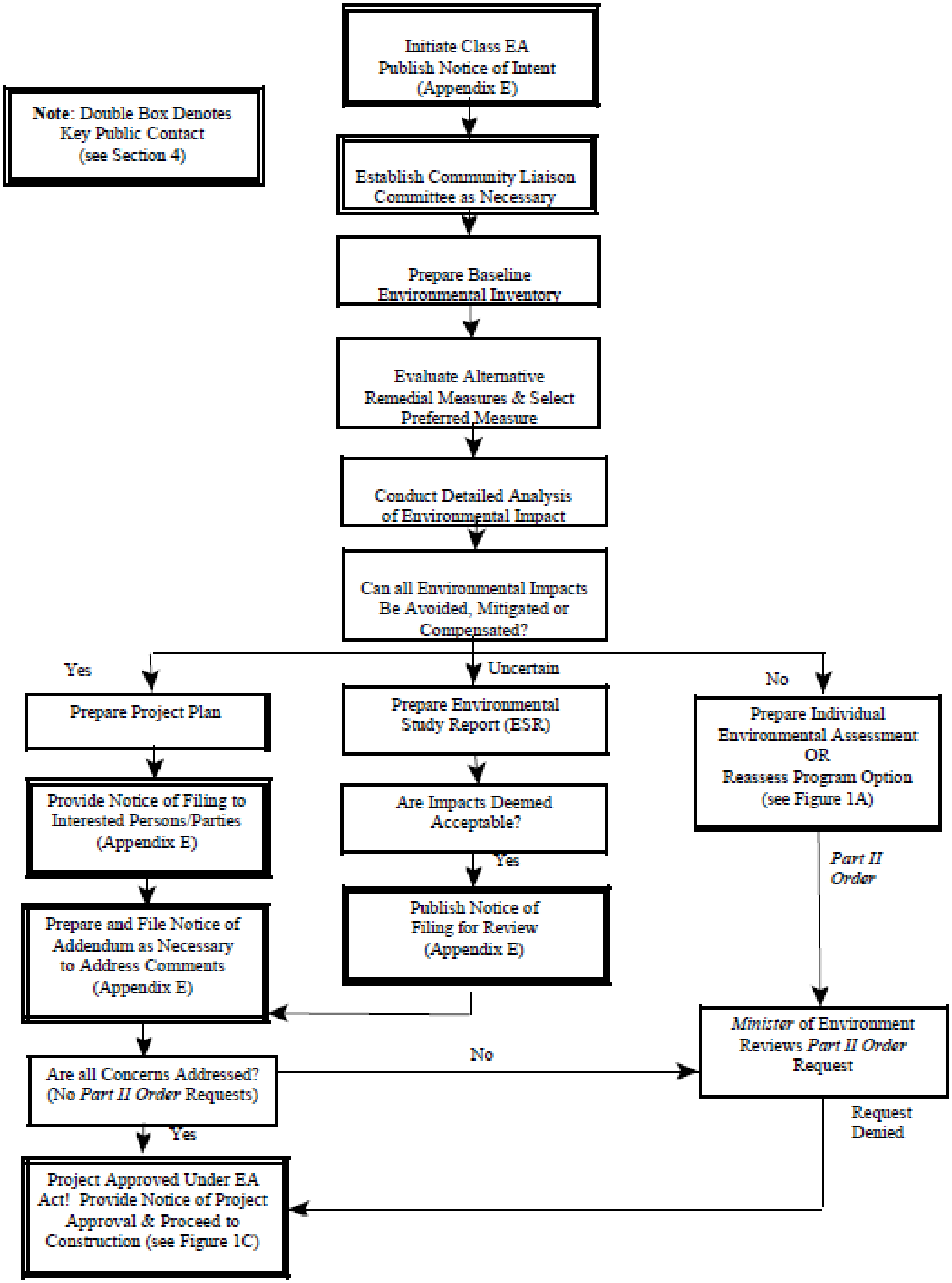


Figure 2.2.1: Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Projects (June 2002, Amended June 2013).

2.3 Consultation Plan Overview

A Consultation Plan (Plan) has been developed for this study to support the required EA consultation activities and identify opportunities to further enhance those engagement activities with the general public, interested persons, Aboriginal communities and government agencies. This Project will need to meet the regulatory requirements of the Conservation Ontario Class EA document. The Plan (May 2015) is presented in Appendix A and the following summarizes the proposed activities.

Notifications

The general public, interested persons, and Aboriginal communities will be informed and invited to participate in the planning and design aspects of the Project through the placement of notices in newspapers and through other means as outlined in the following.

- Notice of Intent to Undertake a Remedial Project – published in local newspapers and sent directly by mail to the project mailing list (including Aboriginal communities and contact groups) and Conservation Ontario (CO)/Ministry of the Environment and Climate Change (MOECC) Region offices. The Notice of Intent was published on May 7, 2015 in local newspapers (Caledon Enterprise, Orangeville Banner, Erin Advocate, Georgetown Independent), posted onto the website (http://www.creditvalleyca.ca/wp-content/uploads/2015/05/belf-dam-notice-of-intent.pdf) and issued to interested agencies and persons (ref. Appendix A).
- Notice of Public Information Session – published in local newspapers and sent directly by mail to the project mailing list (including Aboriginal communities and contact groups) and CO office.
- Notice of Filing of an Environmental Study Report – published in local newspapers and sent directly by mail to the project mailing list (including Aboriginal communities and contact groups) and CO/MOECC Region offices.
- Notice of Filing Addendum (if required) – published in local newspapers and sent directly by mail to the project mailing list (including Aboriginal communities and contact groups) and CO/MOECC Region offices
- Notice of Project Approval – sent directly by mail to the project mailing list and CO office.
- Notice of Project Completion – sent directly by mail to the project mailing list and CO/MOECC Region offices.

Notices will also be issued to individuals that have requested to be kept informed about the Project and whose names have been added to the Project Mailing List. This list will be updated as individuals identify an interest to be added or subsequently removed.

Community Liaison Committee

The guidelines identify that a Community Liaison Committee (CLC) is to be formed. In the case of this Project, a Stakeholder Advisory Committee (SAC) already exists, which will assume the function of the CLC. This committee will discuss the Environmental Study Report outcomes and recommendations prior to the Notice of Filing being issued to provide input and subsequently to address comments received. CVC will consider any requests from interested individuals who may wish to join and participate in this committee. The contact list for the CLC is provided in Appendix A, along with the agency contact list and CVC Core and Review Teams.

Methods of Participation

Individuals who have an interest in the Project can participate through a number of ways that CVC will make available, including:

- reviewing copies of reports and documents;
- providing oral and/or written comments;
- attending information sessions to obtain information and to have questions answered;
- meeting with CVC to discuss concerns;
- becoming a member of CVC's contact group by adding their names to the Project Mailing List to be directly notified of future updates to the undertaking; and
- requesting to be a member of the SAC.

Aboriginal Communities

CVC recognizes the value and requirement of engaging with potentially affected First Nations and Métis communities. The variety of perspectives that these Aboriginal communities can provide to a Project, add value to the process and results. Consultation is specific to each community and can only be determined subsequent to an introductory meeting (and in some cases correspondence) to introduce CVC and the Project. Efforts will be made to ensure that First Nations and Métis communities are made aware of the Project and are given opportunity to become informed and provide input on the Project.

CVC has contacted the Ministry of Aboriginal Affairs (MAA) and Aboriginal Affairs and Northern Development Canada (AANDC) for assistance in determining which Aboriginal communities may have an interest in the Project. Subsequent, to receiving direction from the government, introductory letters and follow-up calls will be made to each community. Based on the outcomes of this initial contact, consultation with each community may include meeting with Chief and Council, community and/or providing further documentation.

Consultation Activities

A variety of methods to inform and seek feedback from the general public, interested persons, Aboriginal communities and government agencies will be used. These methods include:

- Website: CVC will develop webpages to host information about the Project, including background, objectives, overview of safety and environmental concerns, and post Project-related documentation (such as fact sheets, presentations). The webpages can be accessed at: https://www.creditvalleyca.ca/enjoy-the-outdoors/conservation-areas/belfountain-conservation-area/belfountain-conservation-area-management-plan/class-environmental-assessment-for-belfountain-dam-and-headpond-area/

- Frequently Asked Questions (FAQs): to proactively address the anticipated questions that may arise, CVC will develop responses to these questions and make them available on the website and in hardcopy at the CA and public meetings. The FAQs can be accessed at: http://www.creditvalleyca.ca/wp-content/uploads/2015/05/belf-dam-faq.pdf
- Fact Sheets: CVC will prepare fact sheets to provide background information on the Project, its objectives and next steps. These fact sheets will be distributed to stakeholders and Aboriginal communities through email and posted to the website. The fact sheets will be made available in hard copy format at events (such as an open house, a focus group). The first fact sheet can be accessed at: http://www.creditvalleyca.ca/wp-content/uploads/2015/05/belf-dam-factsheet.pdf
- Multi-Stakeholder Committee: CVC has an established SAC that will provide a forum for in-depth discussions regarding Project issues, bring transparency to Project-related activities, and help to foster good community relations. Meeting minutes and presentations can be accessed at: http://www.creditvalleyca.ca/enjoy-the-outdoors/conservation-areas/belfountain-conservation-area/belfountain-conservation-area-management-plan/consultation/stakeholder-advisory-committee/
- Open Houses: CVC will host two community information sessions to communicate important Project information and seek feedback about attendees' Project-related priorities and interests.
- Feedback Forms: CVC will solicit feedback about the Project and the methods/activities used to involve the public through comment forms (hard copy and online). This feedback will be incorporated into the Project planning process. Where feedback is consistent from stakeholders, specific activities may be identified to address these concerns to ensure transparency of the process.
- Consultation Tracking: CVC will maintain a record of contacts with stakeholders and Aboriginal people. This record of contacts will include a summary of the event, parties involved, identify questions/concerns raised as well as responses given, commitments made and actions required.

3.0 BASELINE INVENTORY

Establishing a Baseline Inventory involves assessing the condition and performance of the existing environment and systems within the Study Area. The following systems, or disciplines of study have been characterized because they either influence the existing problem or are required to understand potential impacts or opportunities related to mitigation alternatives:

- structural engineering
- hydrology and hydraulics
- aquatic ecology
- cultural and built heritage
- finance
- geotechnical engineering
- stream morphology
- terrestrial ecology
- archaeology

Typically for a Class EA, all information required to characterize the Baseline Inventory must be collected by the Study Team through background review, field investigations and analysis completed specifically for the study. The current Class EA is unique in that a significant amount of recent study has been completed for the Study Area (ref. Section 1.6) and has been made available to prepare the Baseline Inventory. As part of the project scoping exercise, the Project Team reviewed these recent studies in order to identify any missing information which was considered important to completing the Class EA. Gap-filling studies were then scoped in consultation with CVC and have been completed in support of the Class EA. Information available in the background studies that is considered pertinent to the Baseline Inventory is summarized by study discipline in the following sections. Where gap-filling studies have been completed for a certain discipline, these are also summarized.

3.1 Hydrology & Hydraulics

3.1.1 Purpose

Surface water hydrology is a component of the science of hydrology which encompasses the occurrence, movement and properties of water on earth. Surface water hydrology examines the interactions of water on the surface including rainfall, runoff, infiltration and evapotranspiration. The study of hydraulics examines the mechanics and properties of fluids, herein specifically the conveyance of stormwater in the West Credit River and through the BCA.

The existing hydrologic and hydraulic conditions for the Study Area have been previously defined in the Belfountain Dam Safety Review (Klohn Crippen, 2007) and as such no hydrologic or hydraulic analyses have been completed for the Baseline Inventory. The purpose of this component of the study is to summarize the hydrology and hydraulics and how it relates to the design and classification of the dam, and provide input into the development and evaluation of alternatives, primarily related to impacts to flood conveyance and inundation within the Study Area and downstream. Potential flood related impacts to the Stonecutter's Dam and other properties within the downstream flood inundation areas are an important consideration.

3.1.2 Background Information

The Belfountain Dam is located on the West Credit River, 2 km upstream of the main branch of the Credit River (ref. Figure 4). The upstream drainage area is approximately 10.4 km^2 (ref. Klohn Crippen, 2007). The 2007 DSR applied return period flows developed by EWRG (no specific study is referenced) using the GAWSER hydrologic model. Table 3.1.1 summarizes the 5 to 100 year and Regional peak flows at Belfountain Dam.

Table 3.1.1: West Credit River Peak Flows at Belfountain Dam

Return Period (Years)	Peak Flow (m^3/s)
5	4.9
10	14.0
25	34.4
50	40.3
100	50.1
Regional	197.8

The HEC-2 hydraulic model developed for the *Credit River Flood Damage Reduction Study* (Philips Planning & Engineering, 1984) was applied to establish hydraulic conditions through the dam and headpond.

As discussed in Section 1.6.2 and 1.6.3, the current Hazard Potential Classification (HPC) for Belfountain Dam was established in the 2007 DSR as *Low* without consideration for the potential cascade failure of the downstream Stonecutter's Dam, and based on Provincial guidelines which have now been superseded by the *LRIA Technical Bulletins* (MNRF, August 2011). As such, should the Preferred Alternative selected as part of the Class EA involve the retention of the dam, the HPC will need to be updated. The *Belfountain Dam Emergency Preparedness Plan* (CVC, 2014) identifies two (2) residential structures that could be inundated should the Belfountain Dam and Stonecutter's Dam fail. Based on the *Technical Bulletins* (MNRF, August 2011), inundation of a residential structure implies a potential loss of life, which would likely increase the HPC to *High*. The Inflow Design Flood (IDF) is the flood for which the hydraulic and structural performance of the dam is tested and it is selected based on the HPC, as outlined in the *Technical Bulletins*. The IDF is therefore likely to increase from the 100 year (ref. Klohn Crippen, 2007) to between the 1000 year and probable maximum flood (PMF). Should the dam remain, additional hydrologic analyses will be required to determine these flows, and additional hydraulic analysis will be required to determine the conditions through the dam and headpond, and downstream.

3.2 Structural Engineering

3.2.1 Purpose

Structural engineering pertains to the assessment, analysis and design of buildings, bridges, dams and other structures with respect to their stability and safety. Much of the structural assessment necessary to assess the stability of the Belfountain Dam has been completed in previous studies and is summarized in Section 1.6.2. The purpose of the structural assessment is to summarize the physical characteristics of the dam, as well as previous structural studies. A condition assessment of the abutment retaining walls of the Belfountain Dam was identified as a gap in the background information and has been completed in support of the Class EA. The purpose of this condition assessment is to provide an evaluation of the structural condition of these structures in order to determine the potential need for any mitigative measures that may be required if the Belfountain Dam is to remain. The structural assessment will also provide input into the development and evaluation of alternatives.

3.2.2 Background Information

The Belfountain Dam consists of a 19.8 m +/- wide by 4.8 m +/- high concrete and masonry gravity overflow spillway structure (crest elevation 359.3 m) founded on dolostone bedrock (elevation 354.5 m) (ref. Terraprobe 2013). The original spillway structure was constructed between 1908 and 1914 and consists of a course aggregate core with a cobble masonry face on the downstream side. CVC has repaired the crest with modern fine aggregate concrete. The structure has two (2) sluices (invert 356.6 m +/-) adjacent to the north bank, one of which has a screw-stem operated butterfly valve and the other has wooden stop logs. A concrete pier separates the southern sluice gate from the spillway, and another concrete pier separates the two (2) sluice gates. Refer to Appendix D for plan, profile and cross sections of the dam and sluices.

A dam safety review (DSR) was conducted in 2007 by Klohn Crippen. The visual evaluation, which was limited to the structures above the water, determined that the concrete was in good condition with the exception of some surface cracks and reinforcement cover spalling. The 2007 DSR also noted the presence of seepage at the right (south) abutment, rubble associated with collapse of old masonry at the right abutment and cracking and bulging of the left (north) abutment retaining walls. Monitoring of the left abutment retaining walls was recommended.

The 2007 DSR included preliminary stability calculations of the concrete structures which were made in accordance with Section 7.0, “Concrete Structures”, of the ODSG – draft September 1999 – Dam Safety Guidelines (Ref. 6). Based on assumptions made regarding founding conditions at the site, the preliminary stability assessment concluded that the concrete control structure and the concrete/masonry spillway do not meet the current ODSG stability criteria. The 2007 DSR recommended that additional investigations be carried out to better assess the engineering parameters of the dam foundations. The report also states that the control and spillway structures may require stabilizing by installing rock anchors or other structural improvements.

As recommended by the 2007 DSR, additional investigations were carried out as part of the *Geotechnical Investigation and Dam Safety Report* (Terraprobe 2013). This report determined that the dam structure does not have the required sliding factor of safety under the usual summer and winter loading conditions according to the *LRIA Technical Bulletins* (MNRF, 2011). The report states that in order to meet the required factor of safety, the installation of five (5) and ten (10) rock anchors will be required for summer and winter loading conditions respectively. The report also indicates that the addition of ten (10) rock anchors for the usual winter loading sliding resistance may be waived by lowering the water level in the head pond below the silt line during the winter. The report indicated that the position of the resultant, which is an indication that the overturning performance of the dam, does not meet the required factor of safety for the usual winter loading. The addition of rock anchors is expected to resolve this condition and must be verified if the dam is to remain.

A reinforced concrete cantilever retaining wall is present along the north bank of the dam structure. The Terraprobe 2013 geotechnical investigation and dam safety report determined that the retaining wall may not remain stable during IDF conditions. The report recommends excavating the aggregate backfill from behind the retaining wall and replacing it with concrete fill over the footing width that could then be anchored to the rock substrate, in order to stabilize the structure. Amec Foster Wheeler is currently supporting CVC in the monitoring of this retaining wall.

3.2.3 Condition Inspection

The inspection of the downstream north retaining wall was conducted on April 28, 2015 and the inspection of the downstream south abutment was completed on June 29, 2015. The concrete surface of the north downstream retaining wall was sounded with a hammer to check for delaminations. Photographs were taken to document the condition of the structures at the time of the site visits, which are included in Appendix D. The weather during the site visits was sunny and slightly overcast with temperatures ranging from 15 to 20 degrees Celsius. Water was flowing atop of the spillway during both inspections.

The inspection was limited to visible areas only. Due to the water behind and spilling over the dam, the upstream and downstream faces of the spillway were not visible and could not be inspected. Only the top and a small segment of the exposed face of the downstream north retaining wall and the top and outward face of the downstream north retaining wall were visible and could be inspected. The south masonry abutment above and downstream of the spillway were visible and could be inspected. The north abutment slab and the downstream and upstream sides of the concrete piers above the waterline were visible and could be inspected. The remaining surfaces of the structures were either buried or below water and could not be inspected. Observations during the inspections are noted below:

General

- Few public warning signs to indicate the presence of the various structures and associated dangers to the public were observed.

Spillway

- The visible top face of the concrete spillway is in an overall good condition, with two localized areas of concrete spalling (Photo 1).
- The upstream and downstream faces of the spillway were under water and could not be inspected (Photo 2).
- Sediment behind the upstream face of the dam was measured to be 1.9 m below top of the spillway at the north abutment.

North Abutment

- The concrete slab above the piers is in good condition with a few narrow to medium cracks. A localized area of potential delaminated concrete was observed around a corner guard rail post (Photos 3 & 4).
- The piers are in generally good condition, with areas of light scaling, localized areas of severe erosion at the water level on the downstream side and narrow to medium cracks with efflorescence on the upstream side above the water level (Photos 5 & 6).
- The concrete wall around the sluice gate is in generally good condition with a few narrow cracks (Photo 7).
- The wooden stop logs are in poor condition and are heavily leaking. Leaking water has resulted in localized severe erosion of the footing of the downstream north retaining wall (Photo 8).
- The steel tube guard rail is in poor condition due to severe corrosion at the base of some of the posts (Photo 9).
- The signs at the north abutment are in good condition (Photo 10).

South Abutment

- The masonry abutment is in a fair to good condition overall with some loss of mortar (Photo 11).
- The south earth embankment downstream of the masonry abutment is very steep and is experiencing severe erosion which may jeopardize the stability of the structure over time. Surface runoff water at the south earth embankment was observed (Photo 12).
- A number of fallen trees and tilted trees were observed. Many trees have a sizable portion of their roots exposed. Further erosion of the embankment could lead to more trees falling which may pose a safety hazard to the public (Photo 13).
- The steel tube guard rail is in a good condition overall with localized areas of loss of protective coating (Photo 14).
- The signs at the south abutment are in good condition, however the sign facing the upstream side of the dam is covered by vegetation and would not be visible from the upstream side of the dam (Photo 15).
- Seepage was observed immediately downstream of the south masonry abutment. Regular visual monitoring of the seepage is recommended (Photo 16).
- Rubble associated with the collapse of old masonry walls was observed on the right abutment immediately downstream of the dam (Photos 16).
- The wooden walkway was observed to be tilted towards the watercourse. This may have been a result or original construction or due to movement of the earth embankment overtime. Monitoring of the walkway structure is recommended (Photo 17).

Upstream North Retaining Wall

- Outward movement and bulging of the wall was observed (Photo 18).
- Medium to wide cracks were observed approximately every 2 metres along the structure. The cracks extended across the full width of the structure and are believed to extend along the vertical faces of the wall no each side, below the ground and the water (Photo 19).
- Light scaling was visible throughout the top of the wall (Photo 20).

- Local areas of concrete spalling were observed at the top of the wall (Photo 21).
- The guard rail along on top of the wall is discontinuous which poses a threat to the public. Placement of new guard rail to close this gap is recommended (Photo 22).

Downstream North Retaining Wall

- The wall was observed to be in an overall good condition with localized areas of medium scaling, narrow to medium wet cracks with efflorescence, localized areas of delamination and localized concrete spalling around attached steel angles (Photos 23 & 24).
- The footing of the wall is in an overall good condition with localized severe erosion due to water leaking from stop logs and localized loss of founding material underneath (Photos 25 & 26).
- The steel tube guard rail and protective coating are in a good condition (Photo 27).
- The masonry facing at the wall is in good condition (Photo 28).

3.2.4 Recommendations

Based on the available background studies and the condition inspection of the dam abutments and retaining walls, the following work is recommended if the dam is to remain:

1. Stabilization of the north abutment retaining wall by anchoring into the bed rock and concrete infilling of the undermining under the wall's downstream footing;
2. Rehabilitation of concrete defects in north retaining wall;
3. Installation of erosion protection at the south abutment;

3.3 Geotechnical Engineering

3.3.1 Purpose

Geotechnical engineering pertains to soil and rock characteristics and behaviour. With respect to the Belfountain Dam, geotechnical engineering relates to how the structure interfaces with the founding geology, as well as the stability of the abutments including the south valley slope and the existing north retaining walls. Much of the geotechnical assessment necessary to assess the stability of the Belfountain Dam has been completed in previous studies and is summarized in Section 1.6.2. The scope of the geotechnical assessment for the Class EA is limited to summarizing regional geologic conditions and filling gaps from previous studies, specifically, to assess the stability of the left abutment retaining walls (North retaining wall) and the right abutment slopes (South abutment slopes) under existing conditions and assess possible alternatives to support the overall Class EA.

3.3.2 Background Information

The geological mapping information published by Ontario Division of Mines for the Orangeville area indicates that the Belfountain Dam site comprises interbedded sandstone, dolostone and shale of the Cataract Group underlain by red shale of Queenston formation. These sedimentary rocks, in general, have a low southwesterly dip and may contain low shear strength interfaces. The published maps also indicates the overburden at the site consists of glaciofluvial outwash deposits, ice-contact stratified drifts and alluvium. The *Belfountain Dam Geotechnical Investigation and Dam Safety Report* (Terraprobe, 2013) provides site specific information related to the subsurface geological and geotechnical conditions at the site. Terraprobe's investigation identified thickly laminated dolostone bedrock formation with nominally flat bedding planes and less frequent sub-vertical joints. The Rock Quality Designation (RQD) of the bedrock was found to be low (RQD = 13 to 25) at shallow depth and was increasing with depth.

The south abutment of the dam and valley sides immediately downstream of the dam are steeply sloping with exposed bedrock in places. The north abutment (upstream and downstream) of the dam consists of a reinforced concrete retaining wall with a hand railing fixed to the top of the retaining wall. Beyond the left abutment of the dam is a flat grassed public viewing area containing a fountain.

In 2007, Klohn Crippen carried out Dam Safety Review of the Belfountain Dam and recommended to monitor the movements of the left abutment downstream retaining wall. In 2010, Terraprobe carried out a geotechnical investigation program and installed an inclinometer to monitor the left abutment downstream retaining wall. Amec Foster Wheeler has been monitoring the movements of this retaining wall since December 2013 which indicated no notable movements or any signs of specific plane(s) of shear.

3.3.3 Field Investigation

North Abutment Retaining Wall

In order to assess alternatives for the North retaining wall, information on the retailing wall backfill is required. This information is to be obtained by completing test pits behind the retaining wall and laboratory testing of representative soil samples. Test pits are scheduled to be carried out in July 2015 by CVC's contractor currently on-site rehabilitating the terrace area. The test pits will be supervised by Amec Foster Wheeler. This section of the report will be updated with the results of the investigation in the Final Project File.

South Abutment Valley Slope

Stability of the steeply sloping right abutment was not assessed in the previous studies. Visual inspection of the right abutment slope indicated shallow peat and soil cover over this slope. Trees on the right abutment mid-slope and above are generally upright which indicates stable overall slope condition. However, some of the trees over the lower slope and near the toe area are leaning towards downslope indicating possible slope movement or surface erosion at the toe area and lower slope. The leaning / tilting trees may have been the result of surface erosion of the thin overburden or erosion of the toe area. Detailed notes with observation of the toe area is presented earlier in Section 3.2.3. The thickness of the soil and peat cover will be assessed (by means of long steel bar or hand auger) during the proposed test pitting program at the left abutment. This information, along with available contour data, will be used to assess the stability of the right abutment and identify any potential need for mitigation.

3.4 Stream Morphology & Sediment

3.4.1 Purpose

Stream morphology, also referred to as fluvial geomorphology, is the study of the form and function of stream channels through the interaction between water and sediment transport. The morphology of a specific stream is determined by the underlying characteristics of streamflow and sediment supply that are linked to geology and physiography. The objective of the stream morphology and sediment assessment is to develop a baseline geomorphic inventory of the West Credit River in the vicinity of Belfountain Dam which will be used to identify opportunities to improve stream stability and to provide input to the development of alternatives to management the Belfountain Dam.

3.4.2 Background Information

Numerous reports have been prepared for the Belfountain Complex, however information on the fluvial geomorphology and existing conditions of the area is generally lacking.

The Belfountain Complex Background Report (2014) summarizes general characteristics of the West Credit River, describing it as a single thread meandering channel with few observed areas of multiple thread development. The channel has an average gradient of 2.5% that is influenced by natural river processes as well as the Belfountain Dam and Stonecutter's Dam. The Background Report provides specifics of area geology and physiography which can aid in the characterising of channel reaches, as well as understanding underlying fluvial forms and processes.

The Belfountain Headpond Study (2005) contains useful observations documented in 2000 regarding bankfull dimensions and channel substrate. Upstream from the sediment accumulation, the bed substrate tends to be coarse with bedrock representing the dominant material. Stream banks are composed of shale and weathered to clay, with some areas of fine-textured alluvial deposits. Downstream of the dam, median bed material is reported to be 2 cm (D_{50}). With regards to the headpond sediment, five sediment samples were taken for quality analysis as part of the 2005 study. The samples were analysed and compared with the Guidelines for Use at Contaminated Sites in Ontario (MOE, 1997) which provides criteria to assess soil quality in terms of land use potential. Based on this assessment, there were no identified constraints to using the headpond sediment for residential or parkland landscaping or filling. The sediment may also be suitable for agricultural land or industrial land applications.

3.4.3 Methodology

3.4.3.1 Reach Delineation

The amount and size of sediment inputs, valley shape, land use or vegetation cover, and other parameters that influence channel form often change in a downstream direction along a waterway. In order to account for these changes, channels are often separated into "reaches". Reaches can be defined as stretches of channel that flow through a nearly constant valley setting and incorporate similar physical characteristics along their lengths. Thus, reaches experience similar controlling and modifying influences, which are reflected in similar geomorphological form, function, and process. The delineation of a reach considers sinuosity, gradient, hydrology, local geology, degree of valley confinement, and vegetative control using methods outlined in Parish Geomorphic Ltd. (2001).

Two (2) channel reaches were identified for the West Credit River within the study area of the Belfountain Dam and Headpond. WC-1 located upstream from the dam, extending within the study area from Forks of the Credit Road to the headpond, and WC-2 extending from the dam to the pedestrian bridge crossing located approximately 230 m downstream. These reach breaks have been determined by field truthing characteristics observed during the background review process.

3.4.3.2 Field Reconnaissance

In order to provide insight regarding existing geomorphic conditions and document any evidence of active erosion, a site visit was conducted on May 14, 2015. During the visit, channel conditions along the West Credit River study reaches were evaluated using two established synoptic surveys: the Rapid *Geomorphic Assessment* and the *Rapid Stream Assessment Technique*.

Rapid Geomorphic Assessment

The Rapid Geomorphic Assessment (RGA) was established by the Ontario Ministry of Environment (1999) to assess urban stream channels. It is a qualitative technique based on the presence and (or) absence of key indicators of channel instability such as exposed tree roots, bank failure, excessive deposition, etc. The various indicators are grouped into four categories representing specific geomorphic process: 1) Aggradation, 2) Degradation, 3) Channel Widening, and 4) Planimetric Form Adjustment. Over the course of the survey, the existing geomorphic conditions of each reach are noted and the presence or absence of the specific geomorphic indicators is documented. Upon completion of the field inspection, the indicators are tallied within each category and the subsequent results are used to calculate an overall reach stability index. This index value corresponds to one of three stability classes representing the relative degree of channel adjustment and (or) sensitivity to altered sediment and flow regimes (Table 3.4.1).

Table 3.4.1: RGA Classification

Index	Classification	Interpretation
≤0.20	In Regime or Stable (Least Sensitive)	The channel morphology is within a range of variance for streams of similar hydrographic characteristics – evidence of instability is isolated or associated with normal river meander propagation processes
0.21-0.40	Transitional/Stressed (Moderately Sensitive)	Channel morphology is within the range of variance for streams of similar hydrographic characteristics but the evidence of instability is frequent
≥0.41	In Adjustment (Most Sensitive)	Channel morphology is not within the range of variance and evidence of instability is wide spread

Rapid Stream Assessment Technique

The Rapid Stream Assessment Technique (RSAT; Galli, 1996) provides a purely qualitative assessment of the overall health and function of a reach in order to provide a quick assessment of local stream conditions and to identify and prioritize restoration needs on a watershed scale. This system integrates visual estimates of channel conditions and numerical scoring of stream parameters using six categories:

1. Channel Stability
2. Erosion and Deposition
3. Instream Habitat
4. Water Quality
5. Riparian Conditions
6. Biological Indicators

Once each condition has been assigned a score, values are totaled to produce an overall stream stability score, or health rating, based on a 50 point total. The final value is then categorized into one of three classes: low (poor health), moderate (moderate health), and high (good health).

Low (Poor Health)	<20
Moderate	=20-35
High (Good Health)	>35

Although the RSAT grades streams from a more biological and water quality perspective than the RGA, this information is still relevant within a geomorphic context. In general, the types of physical features that generate good habitat for aquatic organisms tend to represent healthy geomorphic systems as well (e.g., native fish may prefer a well-established riffle-pool sequence with little fine material on the riffles, quality riparian conditions provide food and shade to streams, woody debris and overhanging banks provide habitat structure, etc.).

3.4.3.3 Monitoring

Four (4) monitoring cross-sections (two upstream and two downstream of Belfountain Dam) were established to provide the opportunity to build upon baseline information and create a temporal dataset to allow for long-term understanding of the function and stability of the West Credit River (Figure 3.4.1). To establish a monitoring cross-section two pins are placed on each side of the channel on its respective top of bank. A survey is conducted between the two bank pins with approximately 40-50 individual recordings that are easily repeatable for future monitoring. Downstream of the dam both monitoring cross-sections were established in a transitional zone between a riffle and pool, while upstream of the dam the monitoring cross-sections are located in a transitional bedform type and a riffle.

Figure 3.4.1: Cross-Section Locations for Geomorphic Channel Survey of the West Credit River at Belfountain Dam.

In addition to monitoring cross-sections, a Modified Wolman Pebble Count was conducted to analyze the substrate sizing. This protocol involves measuring the median axis of 40 individual particles within the channel cross-sections that result in the D_{10}, D_{50}, and D_{90} percentiles.

3.4.3.4 Headpond Sediment Analysis

An additional bathymetric survey was completed for the headpond upstream of the dam to gain an understanding of the quantitative characteristics of the pond, including the volume of sediment within the pond. A combination of surveying and depth probing was completed in a grid pattern throughout the pond, as well as a perimeter survey. Two measurements were recorded whilst conducting the in-water portion of the survey; the original bed depth of the pond below the sediment build up which was determined by pushing the survey rod into the sediment until resistance was reached, and the top of the sediment surface. This method allows the difference in these two elevations to determine the thickness of sediment in that location, and over the whole site to determine the total volume of accumulated sediment in the pond.

In order to determine the water and soil quality of the headpond, three sediment core samples were taken. A Wildco 20-inch Stainless Steel Hand Corer was used to collect the sediment cores by inserting it perpendicular to the sediment until resistance was reached. Once the core was removed, it was capped at both ends and a measured sediment depth was recorded. This depth is recorded because the sediment is likely to settle in the core tube and does not accurately represent the accumulated sediment depth. A chemical analysis has been run on these three collected cores to determine the pond's substrate quality. The results are vital to developing and evaluation various management alternatives with respect to the accumulated sediment.

3.4.4 Results

3.4.4.1 Rapid Assessment

The following Section provides the results of the rapid assessments for the West Credit River within the study Reaches of WC-1 and WC-2. A summary of channel characteristics describing the reaches is provided in Table 3.4.2. The RGA scores are summarized in Table 3.4.3, and the RSAT scores are presented in Table 3.4.4. Additionally, a photographic record of each cross section at the time of the field evaluation is included at the end of the section.

Table 3.4.2: General Channel Characteristics as Described by Visual Observations During Rapid Assessments

Channel Characteristic	WC-1	WC-2
Bankfull Width (m)*	15-18	15-20
Bankfull Depth (m)	0.75 – 1.0	0.85 – 1.0
Entrenchment Ratio**	1.25	1.4
Gradient	Moderate	High
Sinuosity	Sinuous	Sinuous
Bank Height (m)	0.2-0.5	0.3-0.75
Bank Angle (degrees)	75 -85	80-90

*Bankfull widths were measured with 30m tape and range finder.
**Entrenchment Ratio is equal to the Flood Prone Width (i.e. The width associated with 2x bankfull depth) divided by the bankfull width.

Table 3.4.3: Summary of the 2015 RGA Scores for the West Credit River through the Belfountain Dam Complex

Reach	Factor Value				Stability Index	Condition
	Aggradation	Degradation	Widening	Planimetric Adjustment		
WC-1	0.14	0.10	0.30	0.29	0.21	Transitional
WC-2	0.29	0.25	0.43	0.14	0.28	Transitional

Table 3.4.4: Summary of the 2015 RSAT Scores for the West Credit River through the Belfountain Dam Complex

Reach	Factor Value						Overall Score	Condition
	Channel stability	Scour / deposition	Instream Habitat	Water Quality	Riparian Condition	Biological Indicators		
Max. Score	**11**	**8**	**8**	**8**	**7**	**8**	**50**	
WC-1	6	5	5	5	4	5	30	Moderate
WC-2	5	6	4	5	6	5	31	Moderate

Reach WC-1: Upstream of Belfountain Dam

Along Reach WC-1 of the West Credit River, the channel flows under Forks of the Credit Road through a single span bridge before continuing a wide single meander towards the east before entering the Belfountain Dam Headpond. The length of channel within this reach is approximately 180 m. The channel passes through maintained parklands with open cut lawn to the west and mature forested parkland to the east. Within the reach there are relatively consistent channel dimensions, with deviations observed in stable island development along the inner meander bend and backwater effects from the headpond continuing for approximately 20 m upstream from the pedestrian bridge crossing located at the upstream end of the headpond. Bankfull widths for WC-1 range from 15 to 20m, increasing in size with closer proximity to the headpond. Bankfull depths range from 0.5 m to 0.75m. Banks are primarily fine to medium sands with some silts and gravels, the channel bed is comprised of coarse sand, pebbles, cobbles and boulders.

The RGA score for WC-1, 0.21, signifies that the channel is predominately stable regime with some transitional tendencies. The dominant geomorphic process appears to be channel widening with fallen and leaning trees, exposed tree roots, and bed scour on both channel banks through the riffle. Channel widening is also exacerbated by backwatering effects form the headpond. Evidence of Planimetric form adjustment was observed through stable island development and the presence of a cut-off channel. The RSAT score for WC-1 is 30, suggesting that the channel is in moderate health. The majority of the bank network within the reach was observed to be stable, with little evidence of bank slumping or failure. Exposed tree roots are associated with larger, old trees and the bottom of banks area moderately armoured with the natural placement of cobbles. Riffle features were not embedded, and significant sand deposits were only observed as backwatering effects were encountered. Instream habitat was in good condition with diverse velocity flows between riffle, runs, and pools. Riparian conditions offer 50-60% shading over the channel, and a high number of benthics (mayflies and caddisflies only) were observed.

Reach WC-2: Downstream from Belfountain Dam

Reach WC-2 was assessed from immediately downstream from the Belfountain Dam up to a pedestrian bridge crossing connecting hiking trails within the study area. The total length of channel assessed is approximately 250 m. This section of channel reach is located within a steep walled valley that confines the channel and limits the ability of the channel to migrate horizontally along a floodplain. Valley confinement also impacts the bankfull width of the channel in some locations. Bankfull widths along the reach range from 10-20 m wide, and bankfull depths range from 0.75 – 0.85 m deep. Valley wall contacts are located along each channel bank. Bedrock outcroppings are observed high-up along the valley walls, some bedrock slabs have become detached and fallen into the channel.

The RGA stability index of 0.28 indicates the channel is in “transition” or stressed state. The main mode of adjustment is channel widening, as evidenced by bare banks, slumping blocks of sand and bedrock, leaning and fallen trees, and steep bank angles, especially along the outside of bends. The reach also exhibited evidence of aggradation, such as sand bar formation and the deposition of fines around structures and poor sorting of bed materials due to the inputs from the valley wall.

3.4.4.2 Detailed Channel Characterization

A geomorphic survey was conducted within WC-1 and WC-2 of the BCA in order to gain an understanding of the existing channel function and stability. Approximately 100m of channel was surveyed between Forks of the Credit Road and the headpond immediately upstream of Belfountain Dam, and approximately 70m of channel was surveyed between Belfountain Dam and Stonecutter's Dam.

The collection of more complete field data to also aids in defining current channel geometry and hydraulics. Detailed field data collection included the following tasks:

- Measurement of bankfull channel geometries via cross-section surveys at 4 locations.
- Characterization of bank parameters, such as height, angle, sediment composition, degree of vegetative cover, and other metrics.
- Identification of the median sediment size along the bed and a description of clast size distributions at the 4 cross-section survey sites.
- Determination of local energy gradients through a survey of channel bottom and bankfull elevations, including top-of-riffle and bottom-of-riffle (where applicable), maximum depth, and any obstructions to flow.

Table 3.4.5 summarizes the key geomorphic characteristics determined from the field survey. A detailed discussion on the full characterization, including figures can be found in the *Stream Morphology and Sediment Analysis: Belfountain Dam and Headpond Class EA* (Parish Aquatic Services, July 16, 2015, Appendix F).

Table 3.4.5: Average Channel Geometry Data Collected within the Study Area Reaches

Cross-section Name:	WC-1 Average	WC-2 Average
Bankfull Width (m)	17.11	16.96
Average Bankfull Depth (m)	0.30	0.59
Maximum Bankfull Depth (m)	0.53	1.00
Bankfull Width:Depth	58.00	28.62
Cross-sectional Area (m^2)	5.44	9.44
Wetted Perimeter (m)	17.23	17.40
Hydraulic Radius (m)	0.32	0.54
Channel Slope (m/m)	0.013	0.028

3.4.4.3 In-Channel Sediment Distribution

Results from the Modified Wolman Pebble Count, conducted at each cross section to analyze the substrate sizing, are presented in Appendix F for Reach WC-1 and WC-2. Upstream of the dam (WC-1), sediment sizing is noticeably smaller then downstream (WC-2) where the channel gradient is steeper. Table 3.4.6 presents percentile (D_{10}, D_{50}, and D_{90}) findings of the baseline data collection in which future size distributions can be compared to.

Table 3.4.6: Substrate Size Distribution Results		
Cross-Section Location	**Percentile**	**Average Substrate Size (cm)**
WC-1	D_{10}	1.1
	D_{50}	7.8
	D_{90}	19.2
WC-2	D_{10}	4.3
	D_{50}	10.7
	D_{90}	28.8

3.4.4.4 Bathymetric Survey

A bathymetric survey of the Belfountain Dam Headpond was conducted using a Total Station and canoe to traverse the pond. The existing bed of the pond was surveyed in transects with spacing between points approximately 1.5 m. At each survey point the top of the sediment was surveyed and the depth of sediment recorded by probing the sediment until resistance.

Results of the bathymetry survey indicate that the thickest sediment deposition is located along the east bank where the thalweg is projected around the pond headwall as well as behind the dam. A second area of high sediment accumulated is located along the west bank of the pond. A pattern in sediment depth versus water depth is evident; in areas here sediment depth is high, the associated water depth is low and where sediment depth is low, water depth is high.

Results from the bathymetry survey are displayed in plan, profile and cross section in Appendix F. Based on the bathymetry survey the estimated volume of sediment is 2500 m^3 (+/-).

3.4.4.5 Headpond Sediment Analysis

Three (3) sediment cores were retrieved from the pond, Figure 3.4.2 illustrates the locations. The sediment cores were analyzed for grain size distributions and organic composition. Two (2) additional samples were collected from areas of thickest sediment accumulation within the headpond and provided to an accredited laboratory for chemical analyses. Given the rural nature of the Study Area, no PAH's or heavy metals were tested.

Figure 3.4.2: Location of Sediment Cores taken from Belfountain Dam Headpond.

Sediment Core Analysis

Sediment core samples ranges in depth from 0.6 m to 1.5 m and generally showed intermittent layers of silt, fine sand and organic material, with isolated layers of medium and very fine sand. Figure 3.4.3 provides an example of the core stratigraphy. Refer to Appendix F for a detailed discussion and additional figures.

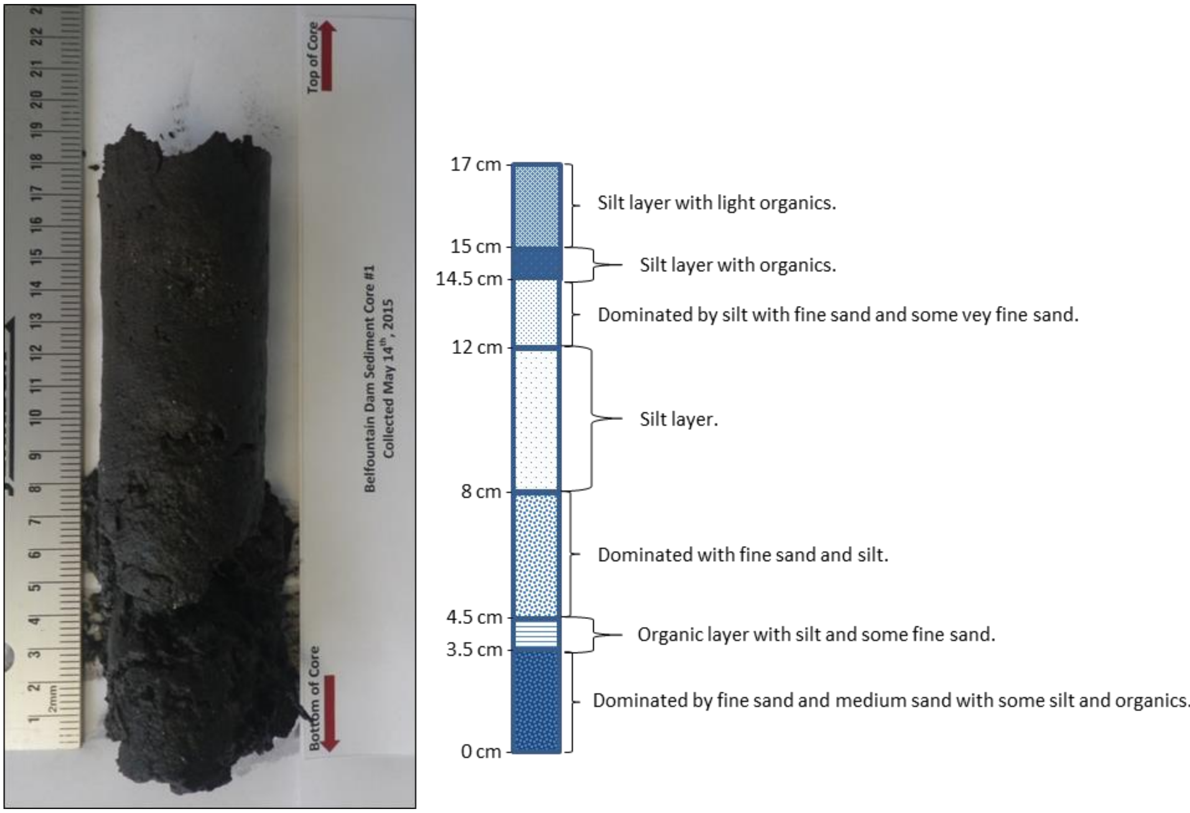


Figure 3.4.3: Belfountain Dam Headpond Sediment Core #1 Stratigraphic Sequence.

Sediment Quality

Two (2) additional sediment samples were taken from the Belfountain Dam Headpond to evaluate sediment quality at the locations shown in Figure 3.4.4.

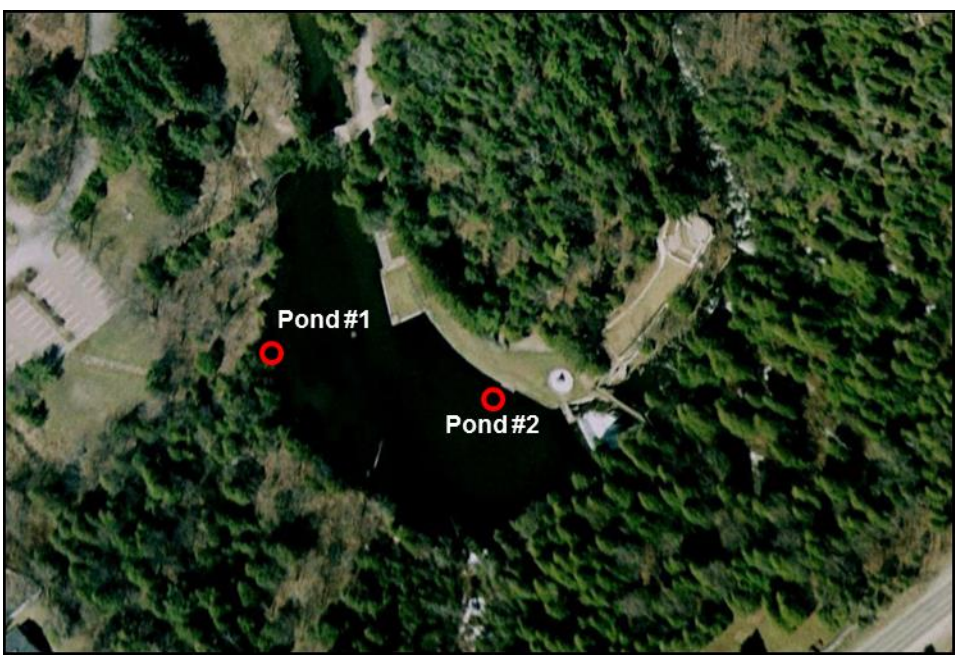


Figure 3.4.4: Location of Sediment Samples Taken from Belfountain Dam Headpond.

The results from the sediment quality laboratory analysis were compared to the provincial regulatory guidelines; *Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario: An Integrated Approach (2008*). Full results of the analysis are provided in Appendix J. Under Provincial Guidelines, sediment quality testing is often used as an initial screening tool to determine the level of risk associated with possible sediment contamination. Following the Guidelines, it can be determined if there are contaminants of potential concern within the study area and whether or not the contaminants are comprised of substances that can potentially biomagnify. With the purpose of protecting the overall aquatic environment, the Guidelines set safe levels for metals, nutrients and organic compounds (NOTE: heavy metals where not included in this analysis). Three levels of effect are established: No Effect Level, Lowest Effect Level, and Severe Effect Level, where the Lowest Effect Level and Severe Effect Level are based on the long-term effects which the contaminants may have on sediment dwelling organisms. The No Effect Level is based on levels of chemicals which are so low that significant amounts of contaminants are not expected to biomagnify.

The definition of the three levels of effect are:

<u>The No Effect Level (NEL):</u> indicates a concentration of chemical in the sediment that does not affect fish or sediment dwelling organisms. At this level negligible transfer of chemicals through the food chain and no effect on water quality is expected. Sediment meeting the NEL are considered clean.

<u>The Lowest Effect Level (LEL):</u> indicates a level of contamination that can be tolerated by the majority of sediment dwelling organisms. Sediments meeting the LEL are considered clean to marginally polluted.

<u>The Severe Effect Level (SEL):</u> indicates a level of contamination that is expected to be detrimental to the majority of sediment dwelling organisms. Sediments exceeding the SEL are considered to be heavily contaminated.

With reference to the 2008 Guidelines, the results of the analysis for the Belfountain Headpond sediment showed that values for organochlorine pesticides as well as Volatile Organic Compounds (VOCs) fall below laboratory detection limits, therefore below the criteria for the Severe Effect Level (SEL).The results also showed that the samples may or may not be above the Lowest Effect Level (LEL) because the laboratory detection levels were higher than the LEL values provided in the Guidelines.

With respect to the hydrocarbon analyses, both samples indicated the presence of both diesel fuel (F3) and heavier material such as motor oil (F4) (ref. Appendix J, Table 5.2). Based on the 2008 Provincial Guidelines for total hydrocarbons, the LEL threshold is 4 µg/g. Both Pond samples exceed this value, but are well below the SEL threshold of 10,000 µg/g.

Based on the three levels of effect, it can be conservatively estimated that the Headpond sediment is marginally polluted. This conclusion is drawn from the laboratory results falling significantly below the SELbut not meeting, with certainty, the LEL criteria (i.e., if a single parameter value for a given material is at, or above, the LEL value, it is anticipated that the material may have adverse effects on some sediment dwelling organisms). Following the decision making framework set out in the Provincial Guidelines (2008), further assessments should be conducted due to the potentially elevated levels of hydrocarbons to further quantify the level of environmental risk. Further assessments could be completed to identify potential biomagnification concerns, sediment toxicity as well as any existing impairment to the benthic community. It is also noted that the samples analyzed were bulk samples providing results for the top 10 -15 cm of sediment (i.e. did not provide the vertical sediment profile) and that further assessment, depending upon the Preferred Alternative may be warranted. The future analyses would determine whether the results are 'localized', confined to the upper layer, or consistent throughout the stratigraphic sequence as well as contributing attributes.

3.4.5 Conclusions

3.4.5.1 Stream Morphology

As described in the Belfountain Complex Management Plan Background Report (CVC, 2014), the study area has a complex network of physiography and geology, specifically at the location of the dam there is a change in bedrock formations from Manitoulin bedrock upstream of the dam to Queenston Shale bedrock downstream from the dam. This change from underlying hard-rock to a softer more erodible shale likely created a natural reach break via a knick-point or substantial gradient change along the river suitable for the historic development of a mill. As such, the presence of the dam itself cannot be directly linked to the general channel characteristics within the study area (i.e., steeper gradient downstream). Direct effects of the dam on channel morphology can be seen in the deep scour pool immediately downstream and the accumulation of sediment and ponding of water, which acts to over widen the upstream, natural channel. Additionally, while fine grain sediment is actively accumulating upstream of the dam and downstream sediment deprivation is likely occurring to some degree, lack of finer grain sediments located downstream from the dam (as observed during field reconnaissance) could be attributed to higher flow velocities able to readily transport the particles out of the study area. Therefore, the absence of the dam may not substantially improve grainsize distributions within WC-2.

Results of the RGA indicate that both WC-1 and WC-2 are in a transitional state with channel widening being the predominant geomorphic process affecting the channel. Being classified as transitional indicates that the river falls below the threshold for active form adjustment (i.e., transition from single thread to multiple thread or anastomosing) however should be considered as sensitive to future adjustments to the regime. Adjustments to channel discharge, sediment load, sediment size distribution, or gradient may produce changes to overall morphology of the channel.

Current conditions within the study area indicate that the channel is widening, while this is a natural channel process there are opportunities to work with these channel dynamics, which would provide more channel complexity and function. The installation of instream structures along channel banks, such as log or rock deflectors, would narrow cross section width, provide localize bank stabilization and offer more diverse aquatic habitat. By narrowing the cross section there will be a corresponding increase in channel depth, this will aid in sediment transport through increased channel velocity.

3.4.5.2 Sediment

The results from the sediment core analysis indicate that the accumulated headpond sediment is predominantly composed of fine grain silty-fine sand with some organic debris. Based on the sediment quality analysis, there are not likely to be any significant implications for disposal or remediation as the quality analysis determined that the samples fall below the SEL which would indicate heavy contamination. However, hydrocarbon levels should be assessed further with additional samples to determine the exact extent and quantity to confirm compliance. How the sediment with the potential hydrocarbon contamination is treated and managed would depend upon the preferred alternative and the results of more detailed chemical and biological analyses. For instance, if the headpond were converted to a natural channel or additional table land, the sediment could be left, undisturbed, or have a 'cap' placed on the material. Another possibility would be excavation, and given the volume and chemical nature, there may be an opportunity to sufficiently dilute the material to be safely used as fill.

While minimal contaminants were found within the two sediment samples, further testing and analysis should be conducted in order to confirm any potential mitigation measures that may be required for removal and disposal. The level of organochlorine pesticide and VOC contaminants within the samples indicate that if the sediment remains in the channel for natural transport downstream, the potential for adverse effects relating to the in-stream health of the ecosystem is minimal. The level of Hydrocarbon contamination could potentially have negative effects however levels of existing contamination (including spatial contamination and vertical contamination) should be further analysed and compared to background levels, expected levels for rural-parklands, as well as hazardous levels for human and animal/organism contact in order to guide mitigation recommendations.

3.5 Aquatic Ecology

3.5.1 Purpose

Aquatic ecology is the study of water based ecosystems and the interactions and relationships between aquatic organisms and habitat parameters. The objective of an aquatic assessment is to identify the fisheries/aquatic community and the types of aquatic habitat available. This allows for the identification of any rare or sensitive species present as well as their critical habitat. The information can then be used to assess project impacts, mitigation and compensation measures. For the Class EA, available background data has been summarized in order to provide an understanding of the aquatic resource characteristics of the project Study Area and identify potential opportunities and constraints.

3.5.2 Background Information

CVC staff has conducted various fisheries assessments within the Study Area. CVC's Integrated Watershed Monitoring Program (IWMP) has established one (1) sampling station upstream of the dam and one station downstream of the dam within BCA.

A total of thirteen (13) species of fish have been captured within the BCA by both MNRF and CVC, two (2) of which, the brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*), are not native (CVC, 2014). Brown trout were introduced to the Credit River between 1948 and 1957 and are now self-sustaining below the Belfountain Dam; the CRFMP recognizes and manages for the presence of brown trout below Belfountain Dam. Rainbow trout are understood to be occasionally stocked upstream of the Belfountain Dam, and have been captured below the dam since 1999, however individuals are expected to migrate downstream to Lake Ontario and not be able to return upstream due to barriers. The Belfountain Dam now acts as a barrier between the native brook trout (*Salvelinus fontinalis*) population upstream of the dam and the naturalized brown trout population downstream (CVC, 2014). A natural falls existed in this location prior to construction of the dam, and this feature may have acted as a partial or complete barrier to a number of fish species.

Two (2) of the species captured within this area are of significance for fisheries management planning: the brook trout and Atlantic salmon. Historically, the local reach of the West Credit was home to two (2) salmonoids; Atlantic salmon and brook trout, as well as a variety of other resident species (CVC, 2014). The historic presence of Atlantic salmon upstream of the Belfountain Dam, or the natural falls that preceded, is unknown. Resident brook trout populations require high quality habitats which include clear, well oxygenated, cold streams. This habitat type occurs within the main river and tributaries that occur above and along the Niagara Escarpment.

Due to anthropogenic effects related to European settlement the Atlantic salmon disappeared from many of its original spawning grounds such as those found within the West Credit River. In order to reintroduce Atlantic salmon to the Credit River, Belfountain Dam has been a stocking area with approximately 500,000 fish stocked since 1996 (CVC, 2014). Stocking of Atlantic salmon by MNRF has occurred both downstream and upstream of the dam (CVC, 2014).

Brook trout and Atlantic salmon have been identified as a priority species within the Credit River Fisheries Management Plan (CRFMP, CVC/MNRF, 2002, 2015). The CRFMP recommends that these two (2) species be protected from the negative competition effects from non-native naturalized species (e.g. brown trout and rainbow trout), as well as any thermal effects from backwatered ponds such as the Belfountain Dam Headpond (CVC, 2015). The improvement of water quality and quantity is also a priority for the conservation of these species (CVC/MNRF, 2015). Changes in the most recent version of the CRFMP indicate that both Atlantic salmon and brook trout should be able to co-exist above the dam, based on their historic co-existence in the Credit River.

The American eel (*Anguilla rostrate*), which is an Endangered species within Ontario under the Endangered Species Act, has also been captured downstream of the Belfountain Dam. This species has been identified as a target recovery species for this area (CVC/MNRF, 2015).

The local landscape of the Niagara Escarpment contains high soil porosity which results in high groundwater discharge rates and steep gradient streams with narrow valleys which provides ideal conditions to support coldwater fish communities. The area upstream of the dam is comprised of a diversity of fisheries habitats which included riffle, runs, and pools. The substrate is comprised of coarse sand, pebbles, cobbles and boulders. Various species of tricoptera, ephemeroptera, and plecoptera are prevalent within the upstream reach. These species are often indicators of good water quality conditions. Previous data on the benthic population has indicated "fair" water quality conditions within the upstream reach (CVC, 2005). Furthermore the fisheries population upstream of the dam has been given an index of biological integrity (IBI) score of "fair" (CVC, 2005). Refugia for cold water species, such as brook trout, are present in the form of overhanging vegetation, deep pools, and undercut banks throughout the reach.

In the stream reaches, downstream of the dam the channel is confined by the valley wall. The substrate is larger than that of the reaches upstream of the headpond and contains more boulder sized materials due to detached bedrock from the valley wall. There are more riffle and run habitats below the dam as the slope increases downstream of the dam. Refugia within this area consists of overhanging vegetation, deep pools, undercut banks, exposed roots and large boulders. Previous data on the benthic population has indicated "very good" water quality conditions within the downstream reach. Furthermore the fisheries population downstream of the dam has been given an index of biological integrity (IBI) score of "excellent" (CVC, 2005).

The headpond itself supports a cool/warm water fish community including blacknose/longnose dace and white sucker. There is a potential for brook trout to utilize the headpond as over wintering habitat, however, given the heavy amounts of silt, shallow water depths, extent of winter ice cover and potential for over-crowding, the value of this overwintering habitat is unclear. The benthic community within the pond has substantially less sensitive benthic species than what has been identified both upstream and downstream (CVC, 2005). The decline in sensitive species can be correlated to the decline in water velocity, predominance of fine sediment, and the increase in water temperature due to backwatering.

The current state of the Belfountain Dam has raised concerns as to its potential negative effects on the aquatic environment. The shallow headpond of the Belfountain Dam is slowly filling with sediment and likely allows the water to warm before it flows over the dam. The thermal effects of this are not currently affecting the fisheries which may be due in part by the well vegetated riparian zone located along the river, as well as the groundwater discharge that occurs throughout the reach, including around the margins of the headpond (CVC, 2014). A concern has been raised regarding the potential for mobilization of the sediments above the dam and possible impacts of downstream transport of fine sediment and any associated contaminants. The temperature/dissolved oxygen regime in the pond may also be a source of concern, should anoxic conditions occur resulting in release of nutrients/contaminants from the sediment. The disruption of this sediment could have many negative impacts for the species downstream of the dam. Furthermore, the buildup of sediment behind the dam may have reduced the quality of gravel spawning areas through the headpond, though the historic substrate condition is unknown (may have been bedrock).

The Credit River Fisheries Management Plan includes a management objective to protect and restore sensitive species such as brook trout, Atlantic salmon and American eel (CVC/MNRF 2002, 2015). The Belfountain Dam and Headpond have created both positive and negative effects within the surrounding environment and to these sensitive species. The dam and headpond have created slow moving and fast moving river habitats, utilized by many odonate species, and have created a barrier which has reduced competition between native brook trout and non-native brown trout (CVC, 2014). However, the slow-moving waters within the headpond are also causing the water to warm which could negatively impacting coldwater fish communities and sensitive species. Fish movement is impeded, and while this reduces competition between native brook trout and introduced brown trout, it also prevents any individuals, such as Atlantic salmon and American eel, from moving upstream of the dam (CVC, 2014).

3.5.3 Opportunities and Constraints

In keeping with the CRFMP, stabilization of the Belfountain Dam represents an opportunity to protect and restore sensitive species, such as brook trout, Atlantic salmon and American eel, and their habitats.

Should the dam remain in place, the requirement for repair/replacement presents an opportunity to enhance fish passage around the structure. This could provide access for Atlantic salmon and American eel to potentially former upstream habitat, while preventing passage by other species.

The new CRFMP (CVC/MNRF 2105) is currently in draft form. At this time, it is unclear whether a fishway will be required for either American eel or Atlantic salmon, although MNRF has indicated that the presence of American eel is not a constraint to the Class EA planning process.

3.6 Terrestrial Ecology

3.6.1 Purpose

Terrestrial ecology is the study of flora and fauna species and their habitats found only on landforms as well as the interactions and relationships between organisms. The objective of the terrestrial study is to identify the types of landforms present as well as the flora and fauna associated with these landforms. This allows for the identification of any rare or sensitive species present as well as their critical habitat. This information can then be used to complete an evaluation of the impacts of various project alternatives and develop mitigation and compensation measures. For the Class EA, available background data has been summarized in order to provide an understanding of the natural heritage characteristics of the project study area and identify potential opportunities and constraints.

3.6.2 Background Information

3.6.2.1 Flora

A detailed inventory and assessment of the terrestrial system was carried out within the Belfountain Complex. The Belfountain Complex includes the BCA, the Willoughby Property, and the Cox Property (CVC, 2015a). The assessments were conducted by the Credit Valley Conservation. The following three life science areas of natural and scientific interest are situated within the vicinity of the pond:

- Credit Forks Life Science ANSI;
- Dufferin Lake Life Science ANSI; and
- Caledon Meltwater Deposits Earth Science ANSI

All three (3) properties contain portions of the Credit Forks – Devil's Pulpit Environmentally Significant Area (ESA) (CVC, 2005).

The BCA contains high quality woodland and valleyland environments. The woodland environments surrounding the Belfountain Dam were classified using the Ecological Land Classification protocol and included dry-fresh poplar mixed forests, fresh-moist white cedar-sugar maple mixed forests, and dry-fresh white cedar-hardwood mixed forests (CVC, 2015a). Of the total area of forest cover in BCA, deciduous forests make up the largest component of the canopy (44%), followed by mixed forest (33%) and coniferous forest (23%) (CVC, 2015a). BCA did not contain any wetland or grassland habitat types and is largely dominated by woodland habitat. All of the wetland and grassland habitat types within the complex are located within the Willoughby and Cox properties (CVC, 2015). One species at risk, butternut (*Juglans cinerea*), was observed in various areas throughout the three properties (CVC, 2015a). This species has been assessed as "Endangered" under the species at risk act due to the spread of the butternut canker.

Within the Belfountain Complex, a total of 409 plant species have been recorded, of which 107 (26%) are non-native (CVC, 2015a). These non-native species are most abundant in areas of disturbances, particularly along property boundaries where invasive garden plants have spread. Invasive species are prevalent in the forests of BCA, with an abundance of garlic mustard (*Alliaria petiolata*), goutweed (*Aegopodium podagraria*) and European lily-of-the-valley (*Convallaria majalis*) and occurrences of the highly invasive Japanese knotweed (*Fallopia japonica*) (CVC, 2015a).

In 2012, a tufa formation was discovered at Silver Creek Conservation Area and Belfountain Dam. These formations are extremely rare and are formed by calcium precipitated out of water which combines into larger rock formations. Currently this tufa has not been designated by the MNRF (Wallis, 2013).

3.6.2.2 Fauna

Mammals

Twelve (12) species of mammals have been recorded within the Belfountain Complex and include American mink (*Mustela vison*), striped skunk (*Mephitis mephitis*), eastern red bat (*Lasiurus borealis*), red squirrel (*Tamiasciurus hudsonicus*), grey squirrel (*Sciurus carolinensis*), red fox (*Vulpes vulpes*), northern raccoon (*Procyon lotor*), northern flying squirrel (*Glaucomys sabrinus*), white-tailed deer (*Odocoileus virginianus*), and porcupine (*Erethizon dorsatum*) (CVC, 2015a). Two (2) of the mammalian species identified within the Belfountain Complex are considered to be sensitive to human activities or disturbances and include the porcupine and northern flying squirrel (CVC, 2015a).

Two (2) of the mammal species observed on the property have been identified as Endangered: the little brown myotis (*Myotis lucifugus*) and the northern myotis (*Myotis septentrionalis*) (CVC, 2015a). The little brown myotis and northern myotis were designated as Endangered in 2012 due to the introduction of a fungal disease known as White Nose Syndrome (*Geomyces destructans*) (GOC, 2015). White Nose Syndrome grows in humid, cold environments such as those found in hibernacula. In 2011, White Nose Syndrome was identified on a dead little Brown myotis in BCA (CVC, 2015a). The northern myotis is a forest dependant bat species which was not previously known to occur in the Credit River watershed until it was discovered in 2007 (CVC, 2015a).

Amphibians

Nine (9) species of amphibians have been observed within BCA and the Willoughby and Cox properties through vernal pool surveys and incidental observations, including wood frog (*Lithobates sylvaticus*), northern leopard frog (*Lithobates pipiens*), green frog (*Lithobates clamitans*), eastern red-backed salamander (*Plethodon cinereus*) and spotted salamander (*Ambystoma maculatum*) (CVC, 2015a). The majority of these species were located on the Willoughby property within the marsh area.

One (1) species at risk, the Jefferson salamander (*Ambystoma jeffersonianum*), was also noted within this property. Although no vernal pools were located within the BCA surrounding the dam there are several hibernation and foraging habitats as well as several potential migration routes within the surrounding woodland habitat.

CVC has been working with MNRF to delineate potential Jefferson salamander habitat within the area surrounding the dam (Sylvester, pers.com 2015). This effort classified potential habitat functions, Vernal Pool (breeding habitat), Foraging, Dispersal and/or Migration and Hibernation areas within BCA. Most areas within the general construction footprint of the project represent possible dispersion/migration habitat, however the access road, the wooded area upslope from the manicured lawn and on the south side of the dam represent possible foraging, dispersal/migration and hibernation habitat.

Reptiles

Two (2) species of reptiles have been reported in the Complex. The eastern snapping turtle (*Chelydra serpentina*), which is listed as Special Concern under the Endangered Species Act was observed within BCA crossing the access driveway at the gatehouse (CVC, 2015a). A single observation of eastern gartersnake (*Thamnophis sirtalis sirtalis*) was recorded within the Willoughby property (CVC, 2015a). All three properties contained an abundance of potential hibernacula including rock crevices and outcrops, talus slopes, rock piles and other burrows.

Birds

Within the Belfountain Complex, 72 bird species have been recorded. Of these 72 species, 27 are forest specialist species, 23 are habitat generalist species, 15 are edge and early successional species, 5 are wetland species and 2 are long distance migrant species (CVC, 2015a).

Avian habitat within the forested area within BCA was evaluated using breeding bird surveys. This evaluation was part of a larger, watershed-wide program to assess and monitor the integrity of forest ecosystems within the Credit River watershed (CVC, 2015a). The results of the evaluation indicate a ranking of “good” for the forest bird community. The bird community contained obligate species, area sensitive species, and specialist ground-nesting birds. Habitat specialists included the scarlet tanager (*Piranga olivacea*) and black-throated green warbler (*Dendroica virens*) (CVC, 2015a). Ground-nesting bird species identified include ovenbird (*Seiurus aurocapillus*), Canada warbler (*Wilsonia candensis*), hermit thrush (*Catharus guttatus*), and Veery (*Catharus fuscescens*) (CVC, 2015a). The BCMP study area also contains eleven (11) area-sensitive forest breeding birds (CVC, 2015a). These species are considered sensitive due to their dependence on relatively large, contiguous habitat patches to successfully reproduce as well as sensitivity to noise and human encroachment. Eight (8) of the eleven (11) species within the study area have probable or confirmed breeding status, thus designating the forests within BCA, and the Willoughby and Cox properties as Significant Wildlife Habitat under both the provincial and regional guidelines (CVC, 2015). Examples of area-sensitive forest species within the Belfountain Complex include black-and-white Warbler (*Mniotilta varia*), hairy woodpecker (*Picoides villosus*), red-breasted nuthatch (*Sitta canadensis*), white-breasted nuthatch (*Sitta carolinensis*), and black-throated blue warbler (*Dendroica caerulescens*) (CVC, 2015a). During the nocturnal owl surveys, an eastern screech owl (*Megascops asio*) and great horned owl (*Bubo virginianus*) were recorded within the area (CVC, 2015a). These species have exhibited stable populations due to the woodlot’s large patch size and high natural cover.

The complex also contains optimal cavity-nesting habitat such as standing snags and cavity trees that are of high value to wildlife such as cavity-nesting birds. Thirteen (13) cavity-nesting birds have been identified within the complex, including wood duck (*Aixsponsa*), pileated woodpecker (*Dryocopus pileatus*) and northern flicker (*Colaptesauratus*) (CVC, 2015a).

It has been noted by CVC that the headpond of the Belfountain Dam has limited value to wildlife due to its design, cultural vegetation and the presence of a fountain in its centre; however it does provide feeding opportunities for some water forager species (CVC, 2015a).

3.6.3 Opportunities and constraints

The area surrounding Belfountain Dam is home to several species at risk. In order to avoid any adverse impacts to these species, steps will need to be taken to avoid harm to the species and its habitat. Most notably will be the avoidance of certain timing windows such as the breeding bird period (April-August) and the salamander migration period (March-May). As in any park setting, there are opportunities to improve terrestrial habitat, though it is expected this opportunity will be limited by the desire to maintain the cultural landscape expected by visitors to the park.

3.7 Cultural & Built Heritage

3.7.1 Purpose

Credit Valley Conservation (CVC) has cited the conservation and enhancement of cultural heritage attributes as one of the key objectives of the Class EA. While rendering the dam and headpond area safe for the public, CVC intends to maintain and improve the cultural heritage attributes of the Belfountain Complex (Cultural Heritage Landscape Inventory Report [2009] and Cultural Heritage Background Study for the Belfountain Complex [2013]). The purpose of the cultural and built heritage assessment is to identify and document any cultural and built heritage resources and recommend any mitigation measures where impacts cannot be avoided. Built heritage resources are defined as “one or more significant buildings, structures, monuments, installations or remains associated with architectural, cultural, social, political, economic or military history and identified as being important to a community.” Cultural heritage landscapes are defined as “a defined geographical area of heritage significance which has been modified by human activities and is valued by a community...it involves a grouping(s) of individual heritage features such as structures, spaces archaeological sites and natural elements, which together form a significant type of heritage form, distinctive from that of its constituent elements or parts”. This work is based on a systematic qualitative process carried out to assess the potential heritage value of a given property based on its physical and design characteristics, historical land use and associations, and context, both social and environmental.

3.7.2 Approach

The evaluation of Built Heritage and Cultural Heritage Landscapes for this project was conducted in accordance with *Ontario Regulation 9/06* under the *Ontario Heritage Act (OHA)*, as amended in 2005 and the guidelines presented in the MTCS’s *Ontario Heritage Tool Kit.* The scope of work for this assignment consisted of the following tasks.

- Background historic research, including consultation of primary and secondary source research and historic mapping. Historical overview of agents and themes of historical and cultural landscape significance, and their changes over time;
- Data collection to obtain a listing of cultural heritage structures/objects and cultural heritage landscapes on current National, Provincial and Municipal heritage lists, (easements and designations);

- Field review, including photographic documentation, to confirm or update the data collected from secondary sources and to identify any new information (A property inspection of the study area was conducted on April 28th 2015. The weather was sunny and warm and did not impede the inspection in any way.);
- Assessment of the immediate vicinity surrounding the study area to ensure that adjacent heritage resources are identified for potential impacts; and,
- Report preparation with recommendations.

Based on a review of all pertinent information and information collected during the site visit, the built heritage resources and cultural heritage landscapes observed were assessed based on provincial policy guidelines. The province states that "significant built heritage resources and significant cultural heritage landscapes shall be conserved" (PPS, 2005: Section 2.6.1). These resources may be identified through designation or heritage conservation easement under the *OHA.* A property must meet one or more the following criteria as outlined in *Ontario Regulation 9/06* under the *Ontario Heritage Act (OHA)*, as amended in 2005 in order to be considered significant:

1. The property has design value or physical value because it:
   a) Is a rare, unique, representative or early example of a style, type, expression, material or construction method,
   b) Displays a high degree of craftsmanship or artistic merit, or
   c) Demonstrates a high degree of technical or scientific achievement.

2. The property has historical value or associative value because it:
   a) Has direct associations with a theme, event, belief, person, activity, organization or institution that is significant to a community,
   b) Yields, or has the potential to yield, information that contributes to an understanding of a community or culture, or
   c) Demonstrates or reflects the work or ideas of an architect, artist, builder, designer or theorist who is significant to a community.

3. The property has contextual value because it:
   a) Is important in defining, maintaining or supporting the character of an area,
   b) Is physically, functionally, visually or historically linked to its surroundings, or
   c) Is a landmark.

Resources within the Study Area have been assessed on a preliminary basis against the above criteria to determine whether they have any cultural heritage value or interest. They have also been considered in terms of potential project impacts and mitigation measures. Refer to Appendix I for the *Draft Belfountain Conservation Area Cultural Heritage Evaluation Report* (Amec Foster Wheeler, July 2015); the appendices in this report contain figures and photographs associated with the following section.

3.7.3 Background Information

A number of sources were consulted for this report, including historical mapping, which was used to examine land use history in an attempt to determine the types and locations of a variety of historical features that have since been altered or are no longer present. Furthermore, historic photographs and images, assessments, maps, and land record databases were consulted to document a list of previous property owners and land use patterns. Archival sources were obtained from the previous reports, the CVC, and from the Peel Archives.

The earliest documented Euro-Canadian occupation of the study area and its immediate vicinity occurred at the 19th-century Westerveld site, the 19th-century Willoughby Industrial Heritage site and the late 19th-century Mack Park site.

The Belfountain area was first surveyed in 1819-1820 by Samuel Rykman who believed that the Credit River would be able to support mills. In 1825, William Frank came to Belfountain, settled and built a grist mill and is credited with damming the western branch of the Credit River (Trimble, 1975). The dam that Frank built was further upstream and not in Mack's Park. Between 1825 and 1846 Frank sold the property and mill to Jonothan 'Grize' McCurdy who built a sawmill near Frank's gristmill between the Credit River and Mill Street. Grize McCurdy and his family lived in a shanty across the road from the mill (Trimble, 1975). The community that grew around these two mills became known as McCurdy's Mills. By 1860 a general store, a tavern with an attached blacksmith, a tannery, two additional sawmills and a flour mill were added to the settlement. Charles Grasley's sawmill, which was down the river from McCurdy's mill also made roofing shingles for the community (Trimble, 1975). With booming industrial employment opportunities in McCurdy's Mills (Belfountain), the settlement continued to grow. During this time, a nickname for the town came about due to a cooper, Peter McNaughton, who took residence and constructed a building for his cooperage resembling a barrel. Because of this strange building, the nickname 'Tubtown' became well known, and was often used in preference over McCurdy's Mills or McCurdy's Village (Whiteside, 1975).

The Tremaine Map of Peel County published in 1859 shows the village with spelling variations such as Bellfountain and Bellefountain, although Belfountain was the primary name used.

By the 1870's, after the introduction of the Credit Valley Railway and the opening of quarries, the population grew once more. However by the late 19th century, when milling and quarrying industries began to slow, people were still drawn to the scenic beauty and recreational opportunities of the area, including the "Devil's Pulpit" which was described as a nice place for 'pic-nics'.

In 1908 Charles Mack, a wealthy Torontonian manufacturer, purchased the parcel of land that is now the BCA. Mack made his fortune with the invention of a cushion rubber stamp. Soon afterwards, he constructed a recreational area with numerous decorative features, and built summer retreats for himself and others. Mack built a log framed structure in the woods and had stone stairs leading up to it from the main grassy area with two stone pillars on either side containing the markings "Luck-e-nuf". Mack attempted to create landscapes that mimicked those he had viewed on his travels; the dam was an attempt to recreate Niagara Falls. In addition, he hired Sam Brock, a local stone mason, to build a suspension bridge and several stone walls and walkways. All of these items were built in the early 1900's. In 1914, Mack opened the area to the public as a park. During this time, Mack provided a rent free cottage, the Bide-a-wee, for business girls who could not afford a vacation. There was also a boat house available on the headpond.

After Mack died, his widow sold the park. However, the park continues to be used as Mack intended it. CVC began to acquire parcels of the Belfountain Complex in 1959. As stated in the Draft Belfountain Management Plan Background Report (CVC, 2014), "parcel dispositions were the results of alleviating access or encroachment issues and account for a very small percentage of the total acreage of the Complex". Table 3.7.1 indicates the parcel acquisition within the BCA (CVC, 2014).

Table 3.7.1: Parcel Acquisition within the Belfountain Conservation Area

Parcel Transferor	Parcel Transferee	Transfer Date	Hectares
William Rodger (originally Mack's Park)	CVC	06 June 1959	3.48
Harold Humphrey Gray	CVC	08 December 1961	0.16
Gerhard and Annemarie Kletke	CVC	22 December 1964	0.22
Jessie Crosby	CVC	14 September 1966	0.02
Stewart Scott	CVC	19 January 1968	0.55
Ivy Landon	CVC	14 September 1970	0.08
Margaret Elliott	CVC	30 October 1970	0.06
Harry Albert Willis	CVC	02 November 1970	3.47
Eric Ramskogler	CVC	30 December 1970	0.06
Larry Wayne Goss	CVC	02 June 1971	0.13
Edgar Ireland	CVC	13 June 1972	0.20
Harry Hepworth	CVC	30 March 1973	0.11
George Brock	CVC	25 September 1974	0.12
CVC	David & Janice Reed	01 April 1986	0.15
CVC	Grace Hobbs	29 May 1986	.008
Robin & Karen Christie	CVC	11 February 1994	3.87
Eric Hayden & Margaret Watts	CVC	27 December 2007	0.44
		Total	**13.136**

Table 3.7.2 lists the historic photographs relevant to our current study. These photographs can be found in Appendix I.

Table 3.7.2: Summary of Historical Images			
Plate	**Date**	**Description**	**Source**
1	Late 19th Century	Photograph of Belfountain looking northeast. Photo dates to around 1800. Early phases of construction of Mack's Park.	CVCA
2	Early 20th Century	Photograph of Mack's Park Early 20th Century. View of water fountain and suspension bridge in background.	CVC
3	Early 20th Century	Photograph of Mack's Summer House in Belfountain.	CVC
4	Early 20th Century	Photograph of Mack's Park, including the dam, waterfall, fountain, suspension bridge and entrance into caves.	CVC
5	Early 20th Century	Photograph of one of the summer cottages at Mack's Park.	CVC
6	Early 20th Century	Photograph of cottages that are recessed back from the main pathway at Mack's Park	
7	Early 20th Century	Photograph of Mack's bridge and falls at Belfountain.	CVC
8	Early 20th Century	Photograph of the headpond at Mack's Park and Mack's boathouse.	CVC
9	Early 20th Century	Photograph of a summer cottage in the background at Belfountain along the Credit River.	CVC
10	Early 20th Century	Photograph of the suspension bridge and entrance into the caves and Mack's Park.	CVC
11	Early 20th Century	Photograph of the Village of Belfountain.	CVC
12	Early 20th Century	Photograph of the Belfountain Post Office	CVC

Since 1959 there have been minimal changes to the aesthetics of Mack's Park. The look has very much remained as Mack finished it, albeit with changes to the retaining walls, onsite buildings (cottages, boathouse, change rooms) and other features that required updates related to safety, repair and re-purposing.

3.8 Archaeology

3.8.1 Purpose

The objectives of a Stage 1 archaeological assessment, as outlined by the MTCS *Standards and Guidelines for Consultant Archaeologists* (S&G 2011), are as follows:

- To provide information about the property's geography, history, previous archaeological fieldwork and current land conditions;
- To evaluate in detail the property's archaeological potential, which will support recommendations for Stage 2 survey for all or parts of the property; and
- To recommend appropriate strategies for Stage 2 survey.

The scope of work for the Stage 1 background study consisted of the following tasks:

- Contact the MTCS to determine if recorded archaeological sites exist in the vicinity (1-km radius) of the property through a search of the Ontario Archaeological Sites Database;

- Contact the MTCS to determine if there are any known reports of previous archaeological fieldwork within a radius of 50 m around the study area;
- A desktop review of the study area's physical setting to determine it's potential for both historic and pre-contact human occupation, including its topography, hydrology, soils, vegetation, and proximity to important resources and historic transportation routes;
- Conduct a walk-through inspection of the property and note information relevant to an evaluation of current archaeological potential;
- Mapping, photographing and other relevant graphics;
- A review of the potential for historic occupation as documented in historical atlases and other archival sources; and
- Preparing a report of findings with recommendations regarding the need for further archaeological work if deemed necessary.

A Stage 1 Report (Stage 1 Archaeological Background Study and Property Inspection, BCA, Amec Foster Wheeler, June 18, 2015) has been completed and is included in Appendix J. The contents of the Stage 1 Report have yet to be reviewed by the Ministry of Tourism, Culture and Sport, and as such are subject to change. The following information has been summarized and paraphrase from the Stage 1 Report.

3.8.2 Background Information

The Stage 1 Archaeological Assessment relies heavily on background information to provide historic and archeologic context used to determine the potential for archaeological resources in a given study area. The MTCS has been contacted to determine the presence of recorded archaeological sites and to obtain previous archaeological investigations. In addition archives containing historic photos and maps and other information available from CVC and Peel Region have been reviewed.

Mack Park is a registered archaeological site in the Ontario Archaeological Sites Database (OASD, Site: AjHa-10). One other site is within one-kilometre of our study area is the Willoughby Industrial Heritage Site (AkHa-20). This site was first recorded in 1989 by Historica Research Ltd. and Archaeological Services Inc and Site Record notes that the "site encompasses a provincially significant cultural heritage landscape composed of 19th century sandstone quarries, a railway spur line, 2 dams, bridge abutments and potential for pre-contact and other currently unknown subsurface deposits". Eight (8) additional sites are located within 3 kilometers and are summarized in Appendix J.

There has been one previous archaeological investigation within the BCA (ref. Historic Horizon Inc., April 2005) for Mack Park. The report made the following conclusions:

1. The BCA is of high archaeological heritage potential because of its proximity to the Credit River and the Niagara Escarpment, the presence of the several early mill sites and a rare early 20th century landscaped public park. As the assessment outlined in this report was very limited, a more extensive Stage 2 archaeological assessment is recommended if any additional disturbance of any new area becomes necessary.

2. The site of the Mack house has been removed and is deemed to be of no further archaeological concern.

3. Although about 2 metres along the inner side of the ravine retaining wall are now removed and of no further archaeological concern, the portion of this area that has not yet been examined may hold further remnants of Grasely's mill and should be subjected to archaeological monitoring if any further construction work is planned.

3.8.3 Stage 1 Property Inspection

A Stage 1 property inspection was performed on Lot 10, Concession V, Caledon Township, Region of Peel. The inspection was conducted by Ms. Devon Brusey (R410) and Mrs. Linda Axford of Amec Foster Wheeler Environment & Infrastructure on April 28, 2015 to determine archaeological site potential and to determine the degree to which recent development and landscaping alterations may have affected that potential. Advance permission-to-enter was obtained by the client prior to inspection. Observations and photographs from the inspection are provided in Appendix J.

3.8.4 Archaeological Potential & Recommendations

There are several factors in determining archaeological potential, some of which include, proximity to natural resources like water and vegetation, distinguishing features in the landscaping, and types of soils. It is also important to consider other registered archaeological sites in the vicinity. Historic research provides the basis for determining historic archaeological potential including a review of resources like land registry records, census, historic maps and aerial photographic evidence, and a property inspection of the project area assist in determining archaeological potential.

The BCA is a well-known historic park with a rich history. Many of the park features created by Charles Mack remain aesthetically similar to the original park. The park's proximity to the Credit River and to previously registered historic Euro-Canadian and pre-contact Aboriginal sites outside the park add to the potential of uncovering more historic and pre-contact components to the Mack Park site. Of the total study area, 6.6% (0.9365 hectares) is low and wet, 5.4% (0.7687 hectare) has already been assessed, and 88% (12.49 hectares) has archaeological potential and warrants Stage 2 archaeological assessment.

In light of the foregoing results, the following recommendation is made:

- Prior to land altering activities within any portion of the study area deemed to have archaeological potential (ref. Appendix J, Figure 14), a Stage 2 archaeological assessment by means of test pit survey must be carried out in accordance with the Ministry of Tourism, Culture and Sport's *Standards and Guidelines for Consultant Archaeologists (*2001).

The above recommendation is subject to Ministry of Tourism, Culture and Sport approval, and it is an offence to alter any of the study area without Ministry of Tourism, Culture, and Sport concurrence.

No grading or other activities that may result in the destruction or disturbance of the study area is permitted until notice of Ministry of Tourism, Culture, and Sport approval has been received. Archaeological sites recommended for further archaeological fieldwork or protection remain subject to Section 48 (1) of the *Ontario Heritage Act* and may not be altered, or have artifacts removed from them, except by a person holding an archaeological license.

3.9 Financial/Economic Aspects

3.9.1 Purpose

The purpose of the financial component of the study is to provide an overview of the anticipated economic impact, both to CVC, the local community and regionally, associated with the preferred option identified through the environmental assessment process, as well as to add financial context and comment, at an overview level, to the option under consideration.

3.9.2 Financial Summary

A review of the Belfountain Complex Background Report Draft (CVC 2014), and supplemented by additional program budget information provided by Credit Valley Conservation for recent tax years for the BCA, has been summarized for the period 2007 through 2014 to provide an overview of actual spending and fee revenue trends and is included in Appendix K.

It can be observed from the financial summary illustrated in Figures 3.9.1 and 3.9.2 that:

- Day use fees make up on average 62% of program revenues and have increased more or less in line with total program revenues during this period;
- Total program revenues represent approximately 70% of program spending during this period, and are lower in 2010 and 2014 which have been years of higher than average spending;
- Little reliance has been placed on donations or revenue from fundraising events until 2014;
- Labour as a percentage of program spending has typically been about 70% in the past, and has increased to 80% in 2014 with the reintroduction of contracted labour;
- The net budget, representing the amount that must be raised through taxes (program expenditures less program revenues), has increased at a greater rate than program revenues over this period; and,
- There is a considerable amount of fluctuation in spending, and in the amount to be raised from taxes from year to year.

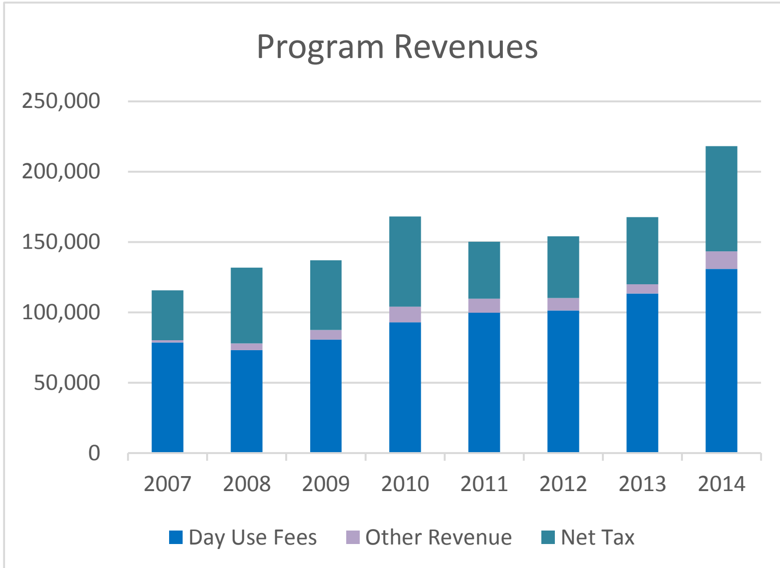


Figure 3.9.1: Belfountain Conservation Area Revenues

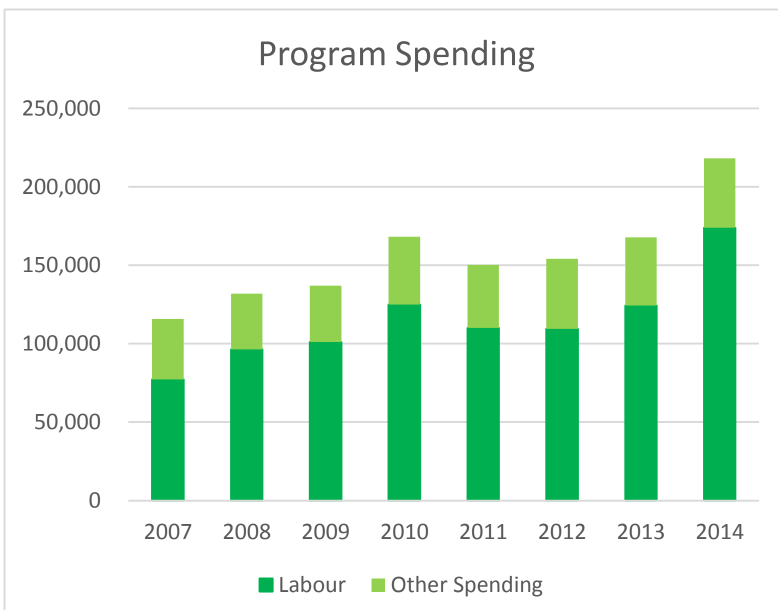


Figure 3.9.2: Belfountain Conservation Area Spending

3.9.3 Local & Regional Economy

The Ministry of Tourism, Culture and Sport has made available the Ontario Tourism Regional Economic Impact Model (TREIM) which enables municipalities and organizations like CVC to make an assessment of the economic impact of visitors' and businesses' spending within user-selected geographies. The model is also useful to assess the potential economic impact of new tourism-related infrastructure investment within an identified regional area. The model output provides estimates of the impact of tourism-related activities on gross domestic product (GDP), labour income and employment and tax revenues. Further the model quantifies each of the estimates in terms of:

1. *Direct expenditures* – generally related to the expenditures that are made in relation to an infrastructure project (e.g. refurbishment or construction of a dam);
2. *Indirect expenditures* – expenditures made that indirectly affect the infrastructure project (e.g. the industries supplying the materials necessary to construct the infrastructure); and
3. *Induced expenditures* – generally related to expenditures made by the direct and indirect industries as they spend their earnings.

Generally, it is observed that the total projected economic impact related to a new infrastructure investment project will be greater than the amount of the initial investment due to the effect of an economic multiplier. Use of the TREIM model enables a municipality to quantify the anticipated economic impact of a planned new capital investment in a tourism or recreational infrastructure project.

Although TREIM is not proposed to be simulated for all alternatives for the Belfountain Dam as part of the alternative evaluation, the principles of the TREIM model can be applied at a high level. That is, the greater the capital expenditure, the greater (positive) the local/regional economic impact. If the cost of the Preferred Alternative is sufficient (TREIM uses expenditure inputs in the millions of dollars), TREIM would be simulated to understand the economic impact.

3.9.4 Key Constraints & Opportunities

Day use fees represent a significant portion of total program revenues and impact to visitation should therefore be considered when evaluating the management alternatives for the dam and headpond.

With program spending generally increasing, and revenue relatively constant, the following opportunities for alternative revenue could be considered:

- Donations and fundraising activities are becoming a good source of alternative revenue for discretionary services where the tax base is becoming increasingly constrained. Fundraising opportunities may be tied with existing annual events such as the fall Salamander Festival. New fundraising activities or special events may serve to increase awareness of the special heritage and cultural features available in the BCA, thereby also attracting more visitors to the area. Individuals with a special interest in maintaining or enhancing the natural heritage features in the conservation area may wish to consider including Credit Valley Conservation as a beneficiary in their will. These are all opportunities that are being explored through CVC's Foundation.

- Day use fees may be able to be increased. It has been shown that the median family income within the primary trade area is significantly greater than the Ontario median family income according to 2006 Census data, which may suggest that visitors to attractions in this area may be less resistant to increases in cost.

- There may be other alternative sources of revenue (e.g. a festival that charges a premium on the day pass) that could be investigated and developed in order to raise the funding that will be necessary in order to maintain and enhance the cultural and natural heritage features under study.

- Use of a reserve may wish to be considered in order to set aside day use fee revenue in years when the number of visitors is higher than anticipated in order to offset years where the number of visitors is unexpectedly lower than usual. Since the number of visitors attending the conservation area attractions is affected most by uncontrollable weather patterns, use of a reserve would be valuable in managing the net tax impact from year to year.

3.10 Summary of Baseline Inventory – Key Constraints & Opportunities

This section provides a summary of the key outcomes, constraints and opportunities that have been identified by each discipline study carried out in support of the Baseline Inventory. The items summarized are expected to influence and guide the development and evaluation of alternatives, may be important for assessing the impact of alternatives and/or are critical in developing a plan to mitigate impacts.

Hydrology & Hydraulics

- Should the dam be proposed to remain, the HPC will need to updated, including selection of the appropriate IDF.
- Any alteration to the performance of the dam must not have an impact on upstream or downstream property, including the Stonecutters Dam.

Structural Engineering

- The dam spillway structure does not have the required sliding factor of safety under the usual summer and winter loading conditions (ref. Terraprobe 2013) in accordance with the Technical Bulletins (MNRF, 2011). Mitigation will be required if the dam is proposed to remain.
- Based on the visual site inspection, the dam structure is in a good condition with localized poor areas of defective concrete that will require rehabilitation.
- The retaining wall along the north embankment is unstable during flood or flood-earthquake combined conditions (ref. Terraprobe 2013). Mitigation will be required if the dam is proposed to remain.
- Based on the visual site inspection, the concrete retaining walls are in a fair to good condition overall with localized areas of defective concrete and undermining, which will require rehabilitation.
- The stability of the south masonry embankment could be jeopardized by the active soil erosion or slope instability of the south earth embankment. Remedial measures to stabilize the south earth embankment will be required.

Geotechnical Engineering

- A test pitting investigation program is to be completed to obtain information on the left abutment retaining wall backfill and overburden soil behind the backfill.
- Review of topography and manual assessment of the soil cover of the right abutment slope is required to assess the stability of the slope and assess possible alternatives.

Stream Morphology

- The change from underlying hard-rock to a softer more erodible shale likely created a natural reach break via a knick-point or substantial gradient change along the river. As such, the presence of the dam itself cannot be directly linked to the general channel characteristics within the study area (i.e., steeper gradient downstream).
- Direct effects of the dam on channel morphology can be seen in the deep scour pool immediately downstream and the accumulation of sediment and ponding of water, which acts to over widen the upstream, natural channel.
- While fine grain sediment is actively accumulating upstream of the dam and downstream sediment deprivation is likely occurring to some degree, lack of finer grain sediments located downstream from the dam (as observed during field reconnaissance) could be attributed to higher flow velocities able to readily transport the particles out of the Study Area. Therefore, the absence of the dam may not substantially improve grainsize distributions downstream.
- Results of the RGA indicate that Study Area reaches are in a transitional state with channel widening being the predominant geomorphic process affecting the channel. Being classified as transitional indicates that the river falls below the threshold for active form adjustment. Adjustments to channel discharge, sediment load, sediment size distribution, or gradient may produce changes to overall morphology of the channel.
- Opportunities exist to improve channel dynamics, which would improve sediment transport and aquatic habitat and function (e.g. log or rock deflectors).

Headpond Sediment

- Headpond sediment is predominantly composed of fine grain silty-fine sand with some organic debris and has an approximate volume of 2500 m^3.
- Sediment quality does pose significant implications for disposal or remediation, however some sediment quality mitigation may be required, depending on the results of more detailed sediment sampling. If the headpond sediment were to be dredged and pollutants mitigated (e.g. dilution through mixing with clean material), management and disposal of the material could likely be done either on site (i.e., landscaping fill) or by transporting offsite for use or disposal elsewhere.
- The low level of contaminants within the samples also indicate that if the sediment remains in the channel for natural transport downstream, there would be a low risk of adverse effects to the in-stream ecosystem expected.

Aquatic Ecology

- The Belfountain Dam acts as a barrier between the native brook trout (*Salvelinus fontinalis*) population upstream of the dam and the naturalized brown trout (*Salmo trutta*) population downstream, but also prevents any aquatic species, such as the stocked Atlantic salmon and the endangered American eel, from moving upstream of the dam.
- The slow-moving waters within the headpond have the potential to create a warming effect which could negatively impact coldwater fish communities and sensitive species downstream of the dam.
- The creation of a gated, fish ladder and/or fishway would promote fish passage for Atlantic salmon and American eel while also keeping the dam in place and preserving opportunities for future fisheries management alternatives.
- Any works completed within the dam must be done in accordance with the Fisheries Act by avoiding serious harm to fish. Emphasis will be placed on ensuring no serious harm occurs to the American eel which is classified as endangered under the Ontario Species at Risk Act.

Terrestrial Ecology

- The BCA contains high quality woodland and valleyland environments.
- There are several species at risk surrounding the study area which include butternut (*Juglans cinerea*), little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), Jefferson salamander (*Ambystoma jeffersonianum*), eastern snapping turtle (*Chelydra serpentina*), chimney swift (*Chaetura pelagica*), Canada warbler (*Cardellina canadensis*), eastern wood peewee (*Contopus virens*), wood thrush (*Hylocichla mustelina*), and Louisiana waterthrush (*Parkesia motacilla*). The presence of these species at risk will effect when any works surrounding the dam may take place in order to avoid important timing windows.
- It has been noted by CVC that the headpond of the Belfountain Dam has limited value to wildlife due to its design and the presence of a fountain in its centre; however it does provide feeding opportunities for some water forager species.

Cultural & Built Heritage

- Mack Park, a part of BCA, is designated as a Cultural Heritage Landscape in the Town of Caledon Cultural Heritage Inventory (BC-13 Mack's Park, BCA, 10 Credit Street).
- Numerous built heritage resources have been identified within the Study Area.
- The following recommendations are made to mitigate potential project effects on heritage resources and will be considered in the development and evaluation of alternatives:

    1. When the preferred remediation option is selected and specific potential project impacts to heritage resources can be identified, appropriate mitigation measures should be proposed;

2. In general, the rehabilitation, removal, or rebuilding of the dam and the subsequent changes to the headpond should respect the both the structure and the landscape as physical records of their time, place and use;
3. New interventions should be physically and visually compatible, but identifiable as new work;
4. Documentation of the existing structure should be undertaken before any rehabilitation work is done; and,
5. Heritage interpretive signage should be created that tells the history of the site and depicts it with representative early photos of the site.

Archaeology

- Mack Park is a registered archaeological site in the Ontario Archaeological Sites Database (OASD, Site: AjHa-10).
- The Willoughby Industrial Heritage Site (AkHa-20) is within one-kilometre of the Study Area
- 88% (12.49 hectares) of the Study Area has archaeological potential and warrants Stage 2 archaeological assessment
- It is recommended that prior to land altering activities within any portion of the Study Area deemed to have archaeological potential (ref. Appendix J, Figure 14), a Stage 2 archaeological assessment by means of test pit survey must be carried out in accordance with the Ministry of Tourism, Culture and Sport's *Standards and Guidelines for Consultant Archaeologists (*2001).

Financial

- Day use fees represent a significant portion of total program revenues and impact to visitation should therefore be considered when evaluating the management alternatives for the dam and headpond.
- With program spending generally increasing, and revenue relatively constant, the following opportunities for alternative revenue could be considered:

  - Donations and fundraising activities are becoming a good source of alternative revenue for discretionary services where the tax base is becoming increasingly constrained. Fundraising opportunities may be tied with existing annual events such as the fall Salamander Festival. New fundraising activities or special events may serve to increase awareness of the special heritage and cultural features available in the BCA, thereby also attracting more visitors to the area. Individuals with a special interest in maintaining or enhancing the natural heritage features in the conservation area may wish to consider including Credit Valley Conservation as a beneficiary in their will. These are all opportunities that are being explored through CVC's Foundation.

  - Day use fees may be able to be increased. It has been shown that the median family income within the primary trade area is significantly greater than the

Ontario median family income according to 2006 Census data, which may suggest that visitors to attractions in this area may be less resistant to increases in cost.

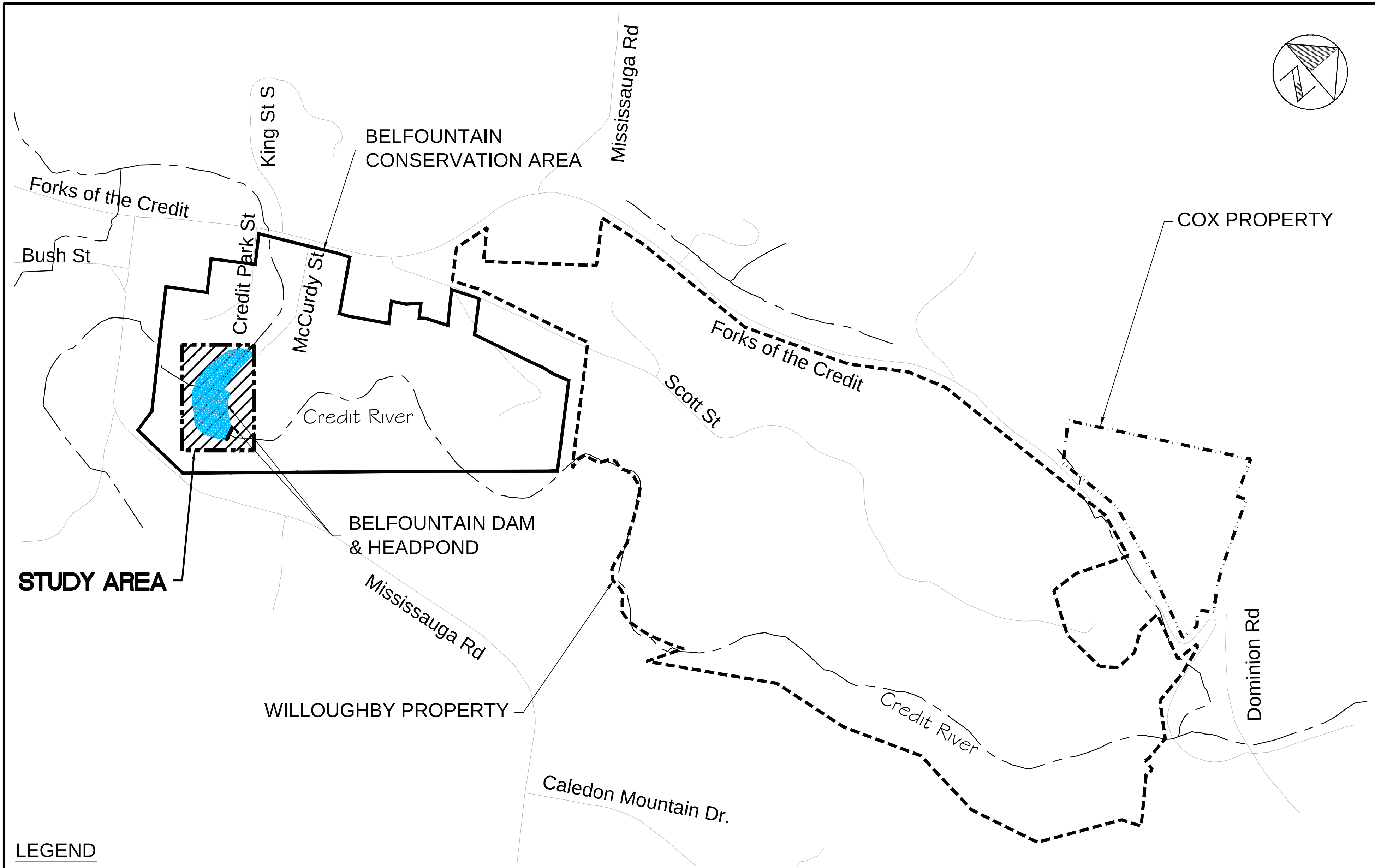
- There may be other alternative sources of revenue (e.g. a festival that charges a premium on the day pass) that could be investigated and developed in order to raise the funding that will be necessary in order to maintain and enhance the cultural and natural heritage features under study.

- Use of a reserve may wish to be considered in order to set aside day use fee revenue in years when the number of visitors is higher than anticipated in order to offset years where the number of visitors is unexpectedly lower than usual. Since the number of visitors attending the conservation area attractions is affected most by uncontrollable weather patterns, use of a reserve would be valuable in managing the net tax impact from year to year.

4.0 NEXT STEPS

The next steps in the Class EA are to develop and evaluate alternatives for the management of the Belfountain Dam and Headpond. A long-list will be developed to consider all practical and feasible alternatives for the future of the dam. The long-list will be developed by the Project Team with input from CVC staff. Once the alternatives have been characterized and the impacts (positive or negative) are understood, the alternatives will be evaluated. The evaluation will be completed using criteria selected to represent the broad range of potential impacts across the physical, biological, cultural and socioeconomic environments and the criteria will be related back to the study objectives. *Technical Report 2: Alternative Development & Evaluation* will be prepared to document the assessment.

Plotted: 2015-07-16 Plotted By: josh.seraj
Last Saved: 2015-03-13 Last Saved By: josh.seraj
Path: P:\Work\TP114113\water\dwg\March 2015\Fig-1(NEW).dwg

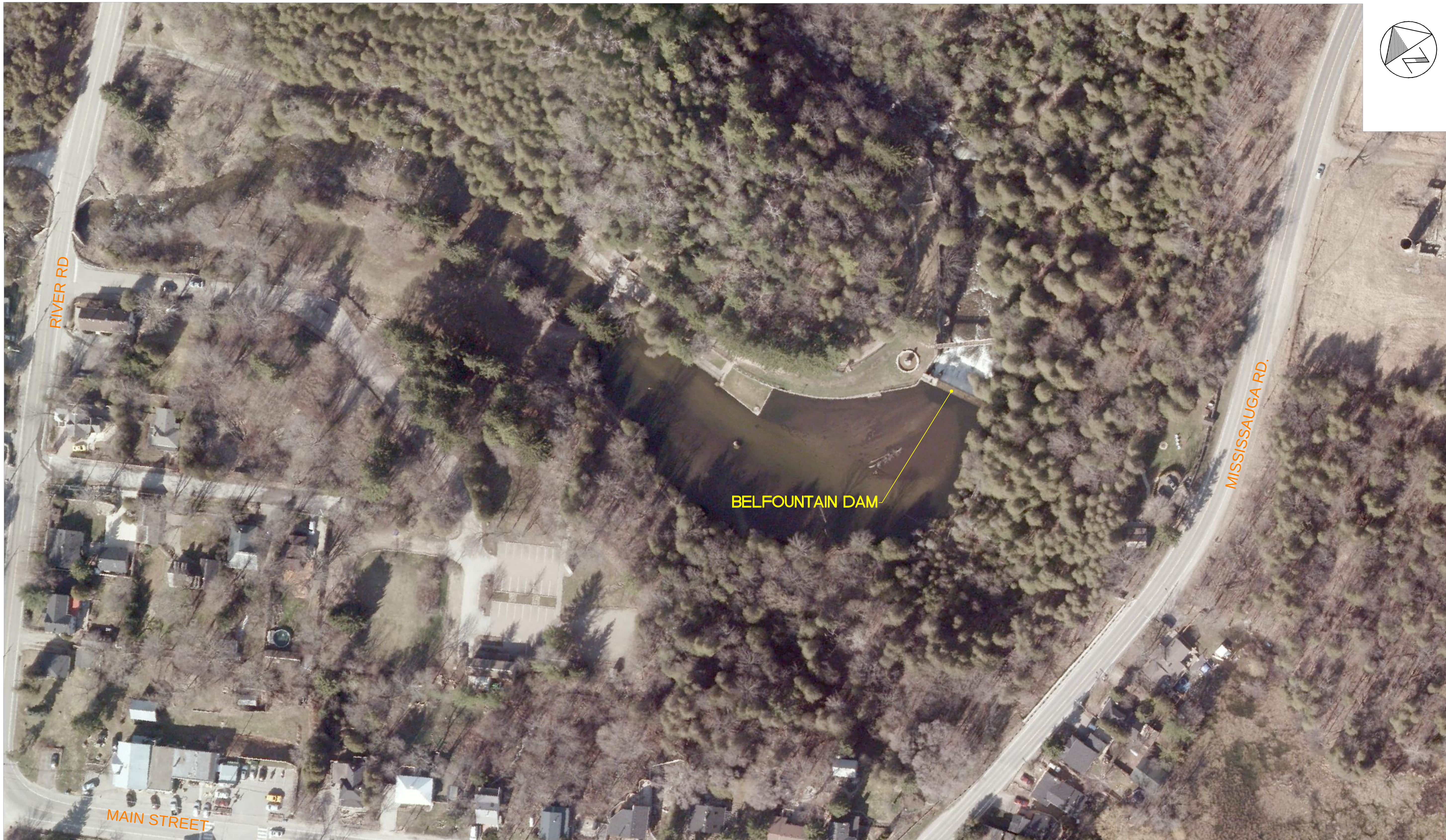


LEGEND

- BELFOUNTAIN CONSERVATION AREA
- WILLOUGHBY PROPERTY
- COX PROPERTY
- STREAM LINE

SCALE VALID ONLY FOR LETTER VERSION

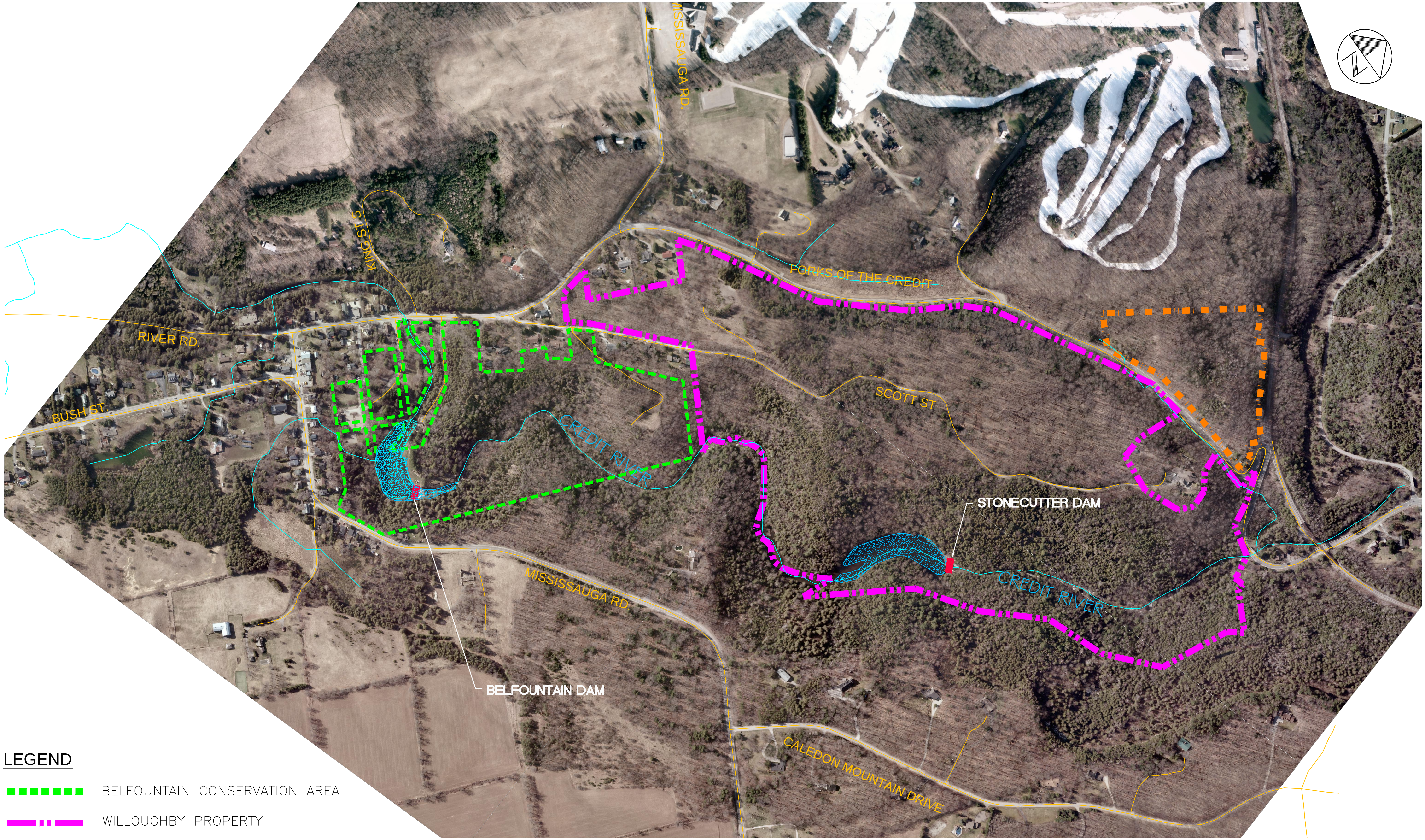
BELFOUNTAIN DAM AND HEADPOND CREDIT VALLEY CONSERVATION	STUDY AREA LOCATION PLAN	amec foster wheeler	Scale 1:7500 (0 25 50 100) Consultant File No. TP114113 Figure No. 1



SCALE VALID ONLY FOR 24"x36" VERSION

BELFOUNTAIN DAM AND HEADPOND CREDIT VALLEY CONSERVATION	STUDY AREA	amec foster wheeler	Scale 1:600 0 5 10 20 Consultant File No. TP114113 Figure No. 2

Plotted: 2015-07-16 Plotted By: josh.seraj
Last Saved: 2015-07-16 Last Saved By: josh.seraj
Path: P:\Work\TP114113\water\dwg\July 2015\Fig-2.dwg



LEGEND

- BELFOUNTAIN CONSERVATION AREA
- WILLOUGHBY PROPERTY
- COX PROPERTY
- STREAM LINE
- EXISTING HEADPOND

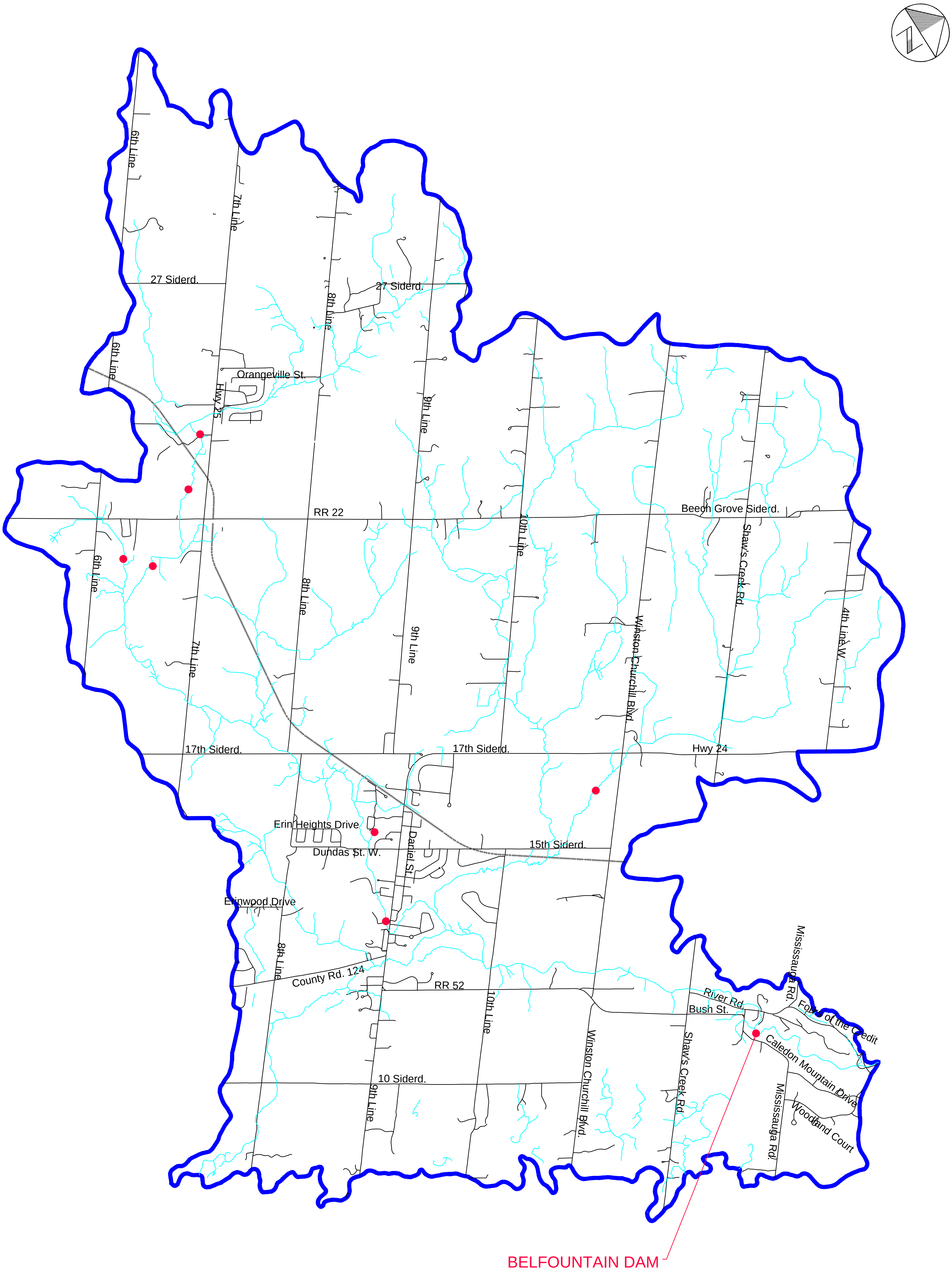
SCALE VALID ONLY FOR 24"x36" VERSION

BELFOUNTAIN DAM AND HEADPOND CREDIT VALLEY CONSERVATION	BELFOUNTAIN COMPLEX	amec foster wheeler	Scale 1:3000 (0 25 50 100) Consultant File No. TP114113 Figure No. 3

Path: P:\Work\TP114113\water\dwg\March 2015\Fig-3.dwg

Plotted By: josh.seraj
Last Saved By: josh.seraj

Plotted: 2015-07-16
Last Saved: 2015-04-22



LEGEND

CREDIT RIVER WATERSHED BOUNDARY

WATERCOURSE

DAM LOCATION

Path: P:\Work\TP114113\water\dwg\March 2015\Fig-4.dwg

Plotted: 2015-07-16 Plotted By: josh.seraj

Last Saved: 2015-03-12 Last Saved By: josh.seraj

SCALE VALID ONLY FOR 24"x36" VERSION

BELFOUNTAIN DAM AND HEADPOND CREDIT VALLEY CONSERVATION	CREDIT RIVER WATERSHED BOUNDARY PLAN	amec foster wheeler	Scale 1:25000 (0 250 500 1000) Consultant File No. TP114113 Drawing No. 4