Upper Thames River Conservation Authority

Embro Dam Class Environmental Assessment DRAFT Report

June 2017

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EXECUTIVE SUMMARY

Introduction

The Upper Thames River Conservation Authority (UTRCA) is responsible for the maintenance and operations of Embro Dam, situated in Zorra Township (**Figure 1-1**). Results of a 2007 (Acres) Dam Safety Assessment revealed concerns pertaining to insufficient spillway capacity, insufficient freeboard, embankment stability, and the conveyance of flood flows through the emergency spillway. A subsequent 2008 (Naylor/LVM) embankment stability analysis study concluded that the Embro Dam did not meet dam safety guidelines stability criteria and was not considered stable under existing conditions. The dam was classified as having a 'Low Hazard', based on MNR (2011) Dam Hazards due primarily to the rural area in which the dam is situated and the few low density of residential dwellings in the area.

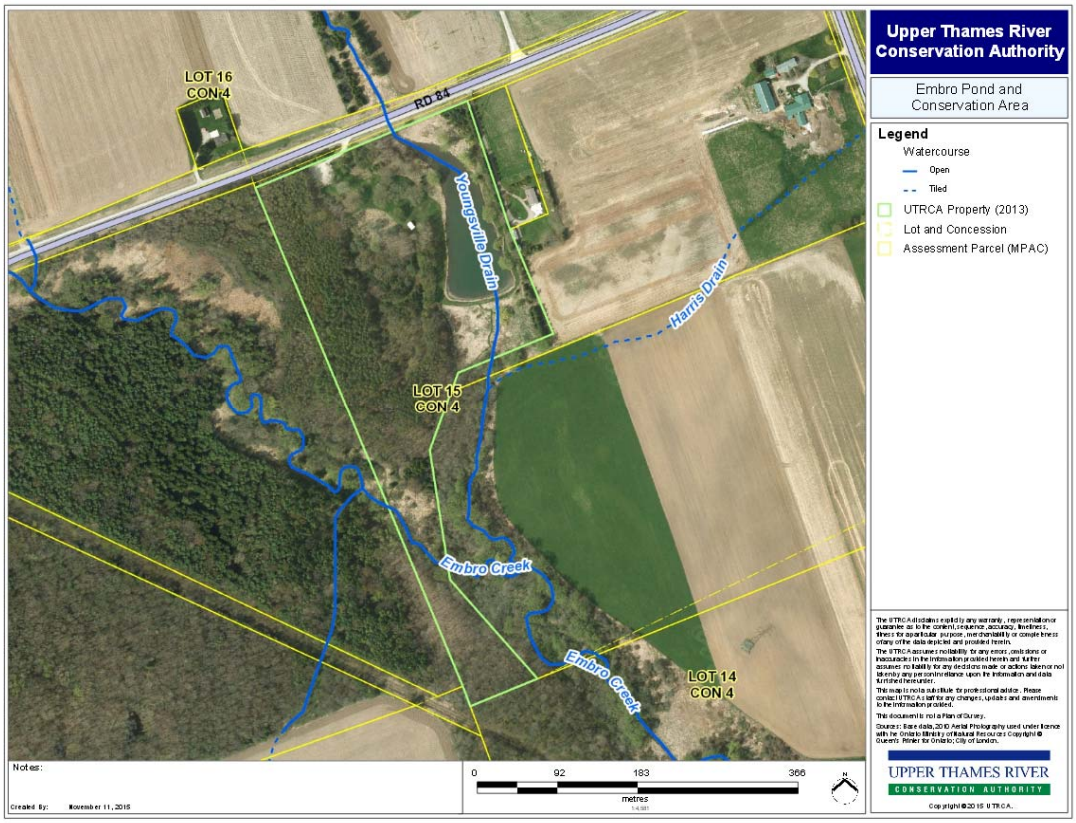

Figure 1-1. Embro Conservation Area (outlined in green, Source: UTRCA)

The UTRCA, in partnership with Zorra Township, initiated a Class Environmental Assessment due to the significant concerns related to the structural integrity and hydraulic capacity of the Embro Dam. The objective of this EA study was to identify, evaluate, and ultimately to recommend an alternative (including Do-Nothing) that will allow the Upper Thames River Conservation Authority (UTRCA) to move forward with resolution to the problem statement regarding the future of Embro Dam.

Background

The Embro Dam is situated 2 km north of the Village of Embro, in Embro Conservation Area (ECA). The dam is situated on Spring Creek which is also commonly referred to as Youngsville Drain situated in the Town of Embro, includes a dam and pond; both are under UTRCA ownership.

The Embro Conservation Area, in which the dam and pond are situated, supports a system of hiking and cross-country skiing trails. The Embro Pond Association entered into a lease agreement with UTRCA in 1999 for maintenance of Embro CA. excepting the dam. Various initiatives have been undertaken that have included planting of native trees and wildflowers. A hardwood forest regeneration project was also implemented in the conservation area.

Existing Conditions

Review of background materials and site conditions was completed to define and confirm the problem statement. Characterization of existing conditions was completed through review of background information; completion of field investigations, data collection, data analyses and monitoring. This included a general assessment of the study area and investigations of Youngsville Creek downstream and upstream of the dam, and within pond.

Youngsville Drain is a tributary of the North Branch Creek within the Mud Creek watershed. The drainage area to the dam and pond is approximately 7.0 km^2; this is made up of mostly agricultural lands.

The wooded area of Embro Conservation Area (CA) is part of a larger significant natural heritage feature that includes the Oxford County Forest. Results of a three season botanical inventory revealed that 31% of the species within the 5.4 ha of Embro CA are non-native; no plant species at-risk, or rare or uncommon or sensitive species were found on the land or in the reservoir/pond. The reservoir has a dense growth of rooted aquatic waterweeds and pondweeds, but all three native species are common. There are very few rooted emergent wetland plants along the edges of the pond owing to the steep sides and constant water levels. The overall quality of the vegetation within Embro CA was rated as average or moderate.

During the three season bird survey, 40 species (common and mostly forest birds) were recorded. Only one species-at-risk bird (Barn Swallow) was observed although no evidence of nesting was found. The reservoir provides limited significance for a few resident waterfowl for raising broods (e.g., Wood Ducks, Canada Geese). These are common species. Migrating waterfowl make little use of the Embro Reservoir during spring migration, likely due to the isolation of this pond from other ponds or lakes in the area

Downstream of Embro Dam, Youngsville Drain Creek appeared to have been previously straightened and was considered to be stable. Through the aquatic assessment, twenty-one (21) different species were recorded downstream of the dam; the diverse community included cold water species and both permanent and seasonally present warm water species. The presence of Brook Trout below the dam indicates the presence of numerous seeps and the cooling effect of aquatic vegetation. Benthic analyses revealed pollution tolerant taxa in this section of the creek that were indicative of ‘fairly poor’ water quality. Measurements of water temperature revealed warmer water downstream than upstream of the pond; the pond appears to provide a warming effect.

Bathymetric surveys of Embro Pond showed that approximately 27-35% of the available pond volume has filled with sediment. Analysis of the accumulated sediment indicated that the sediment was not defined as hazardous waste according to Schedule 4 Leachate quality criteria (Ontario, 2015) but did exceed MOE (2011) Table 2 standards for Cyanide and Boron when considering sediment for agricultural, residential, or Industrial/commercial/community property reuse. The footprint of Embro Pond was determined to have no archaeological potential.

Youngsville Drain, upstream of the backwater effects due to the pond was considered to be geomorphologically ‘in transition’ and was considered to be aggradational. Results from the aquatic assessment suggested that this portion of Youngsville Drain provides good quality cold water habitat.

Only eight (8) species were recorded, including Brook Trout; the low species diversity likely reflects the barrier to fish migration due to the dam. Benthic analyses revealed that pollution sensitive taxa were observed in this portion of the creek that were indicative of 'fairly poor' water quality. Water temperature was cooler upstream than downstream of the dam.

Alternative Selection and Evaluation

Through review of study findings, seven potential alternative solutions were identified to address the dam and embankment instability concerns that were identified in the Acres (2007) and Naylor (2008) studies. These included:

1) Do Nothing
2) Repair Dam
3) Remove Dam and Establish Natural Channel
4) Remove Dam and Construct One or More Offline Ponds/Wetlands with a Natural Channel
5) Partially Remove Dam, Lower Crest and Naturalize the Remaining Perimeter

Evaluation of the potential alternatives was completed for each of the technical, environmental, socio-cultural and economic categories as defined in MOE (2014). The specific criteria that were evaluated were selected based on study area characteristics and factors considered especially relevant by the study team and/or the community. Ranking of each criterion was undertaken to determine the preferred alternative considering an equal category weighting.

The preferred alternative, resulting from both the equal and the weighted evaluation processes, was Alternative 3 (**Figure 7-1**). In this alternative, the dam would be removed and a naturalized channel would be established. The alternative recognizes the benefit of removing the dam to improve fish migration opportunities into cold water habitat.

Subsequent to Public Information Centre 3, a member of the public proposed an additional alternative. This alternative was reviewed and considered by the study team. That alternative shows thoughtful consideration for the reduction of liability and cost associated with any works in the area. The alternative included elements that are similar to Alternatives 2, and 5 and was thus not advanced to an additional alternative for inclusion in the evaluation process. Instead, draining the pond and lowering the dam crest to accommodate a fish ladder could be considered as a variation on Alternative 5 that incorporates elements of Alternative 3 (i.e., naturalized channel in area of exposed pond bottom).

Prior to development of detailed design, additional study is required to further characterize Youngsville Drain hydrology, examine potential effects of pond removal on nearby groundwater wells, and undertake further archaeological assessment. Where possible, the detailed design should address and incorporate elements considered important by the community that include: walking trials and viewing areas for birds, habitat creation for brook trout.

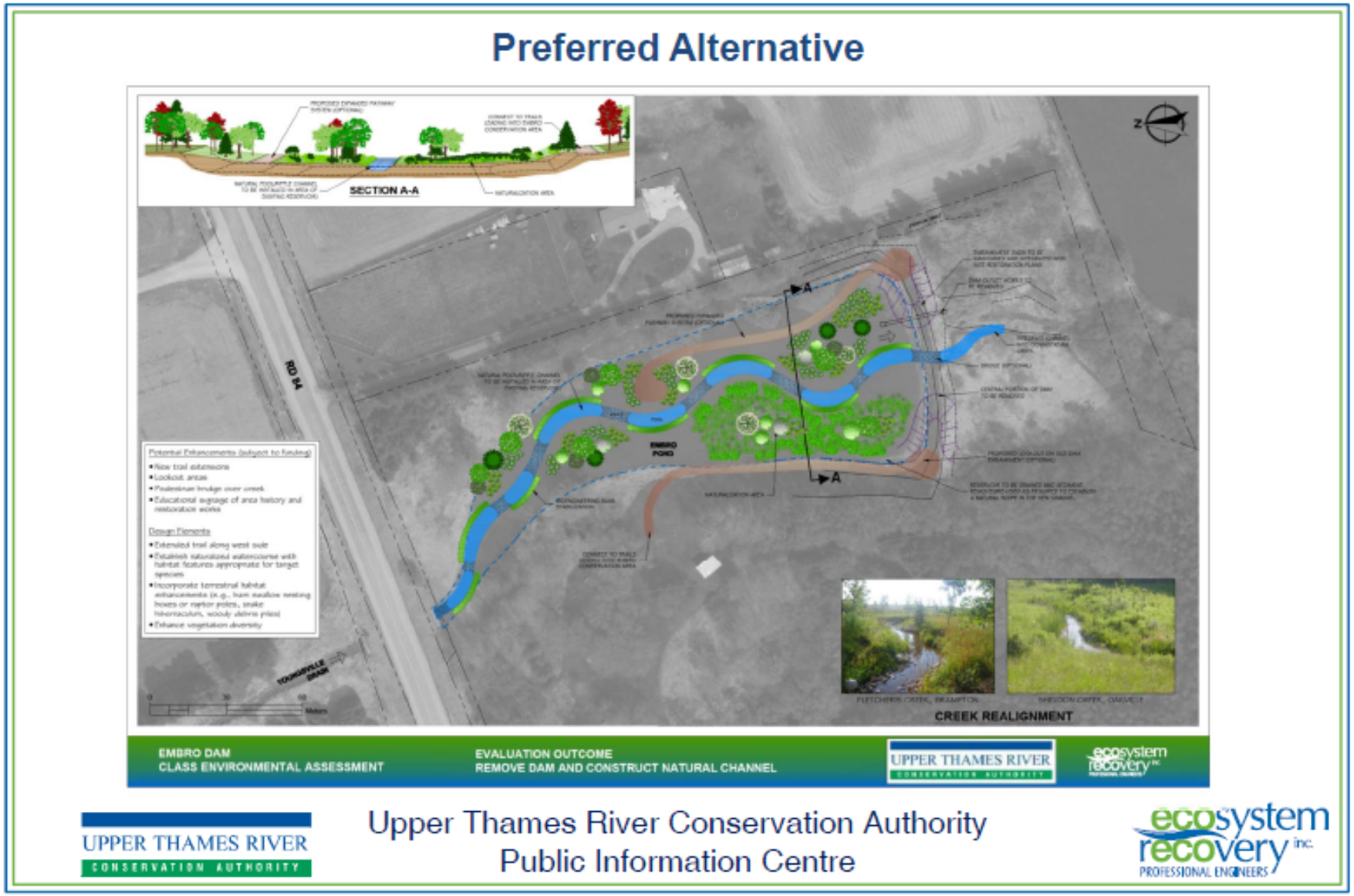

Figure 7-1. Preferred Alternative

Public Consultation

Public Consultation was undertaken throughout the study process which included not only the immediate community, but also First Nations, and organizations that may be interested in the project and/or agencies that must be consulted during the Class EA process. Public meetings were held to communicate study findings and study process to the community and to obtain public feedback to consider and incorporate into the study. In addition to three (3) public information centres (PIC), UTRCA also participated in additional communication with a community member who was actively engaged in the study process. All public notices, PIC presentation materials and draft reports were posted on the UTRCA website to provide public access.

Public comment and feedback received during the PICs and subsequent questionnaires were reviewed and used to inform the alternative evaluation process and refinement of the preferred alternative. While the preferred alternative is generally accepted by the community; a variation of Alternative 5 was felt, by a community member, to provide a more cost effective approach that would also reduce UTRCA liability for failure. This variation provides limited environmental benefits and could, in fact, contribute to adverse environmental conditions.

Conclusion

An Environmental Assessment study was initiated by UTRCA with the intent of identifying the preferred alternative for addressing the failure of Embro dam to meet dam safety guidelines with respect to its spillway and embankment. Review of existing conditions through background review and field studies demonstrated environmental impacts of the pond on water quality, fish species diversity, and channel function. No constraints were identified that would limit works associated with any of the potential alternatives. Through the evaluation process, Alternative 3 (remove dam and naturalize channel) was determined to be preferred. Preparation of design drawings for the preferred alternative should consider design elements that would support existing community use of the Embro Conservation Area and provide habitat creation and/or enhancement opportunities. Consideration should be given to initiating a Dam Safety Review if implementation of the preferred alternative is delayed. MNRF (2011) recommends that Dam Safety Reviews be completed on a maximum 10 year cycle; the last reviews were completed in 2017 and 2018.

EXECUTIVE SUMMARY

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1. Introduction

1.1 Study Problem

The Upper Thames River Conservation Authority (UTRCA) acquired the Embro dam, situated in Zorra Township, in 1958. The UTRCA is responsible for its maintenance and operations and, in 2002, initiated a Dam Safety Assessment which was completed by Acres in 2007. Results of their assessment identified concerns about insufficient spillway capacity, spillway instability, insufficient freeboard, embankment stability and the conveyance of flood flows through the emergency spillway. A suite of recommended repairs, if found to be feasible, were recommended for each structure to address these issues. An embankment stability analysis was subsequently undertaken by Naylor (LVM) in 2008 to further investigate the structural integrity of the dam. That study concluded that the dam did not meet current standards and was not considered stable under existing conditions. Recommendations for long-term stability of the dam were included in the 2008 report.

Due to the significant concerns raised in the engineering assessments, related to the structural integrity and hydraulic capacity of the Embro Dam, a Class Environmental Assessment was initiated by the Upper Thames River Conservation Authority, in partnership with Zorra Township. The objective of this study was to identify, evaluate alternatives (including Do-Nothing), and ultimately to recommend an alternative that will allow the Upper Thames River Conservation Authority (UTRCA) to move forward with resolution as to how best to address the dam and spillway deficiencies while balancing technical, environmental, social, and environmental responsibilities.

1.2 Study Area

The Embro Dam is located 2 km north of the village of Embro, in the Embro Conservation Area (**Figure 1-1**). Embro CA is on County Road 84 in Oxford County, Township of Zorra, Lot 15, Concession 4. The Embro Dam is situated on Spring Creek which is also known as Youngsville Drain; it is a tributary of North Branch Creek (Mud Creek Watershed) which flows into the Middle Thames River. Since 1958, the dam, pond and surrounding area have been used for recreational purposes.

Immediately upstream from the reservoir, at the north end of the site, Youngsville Drain crosses under Oxford Road 84 (Country Road 16) through a culvert. The entrance to the dam, pond and park area is from Country Road 16. The site is bounded by a driveway/residential property to the east, forested lands to the west, agricultural lands to the south and Country Road 16 to the north.

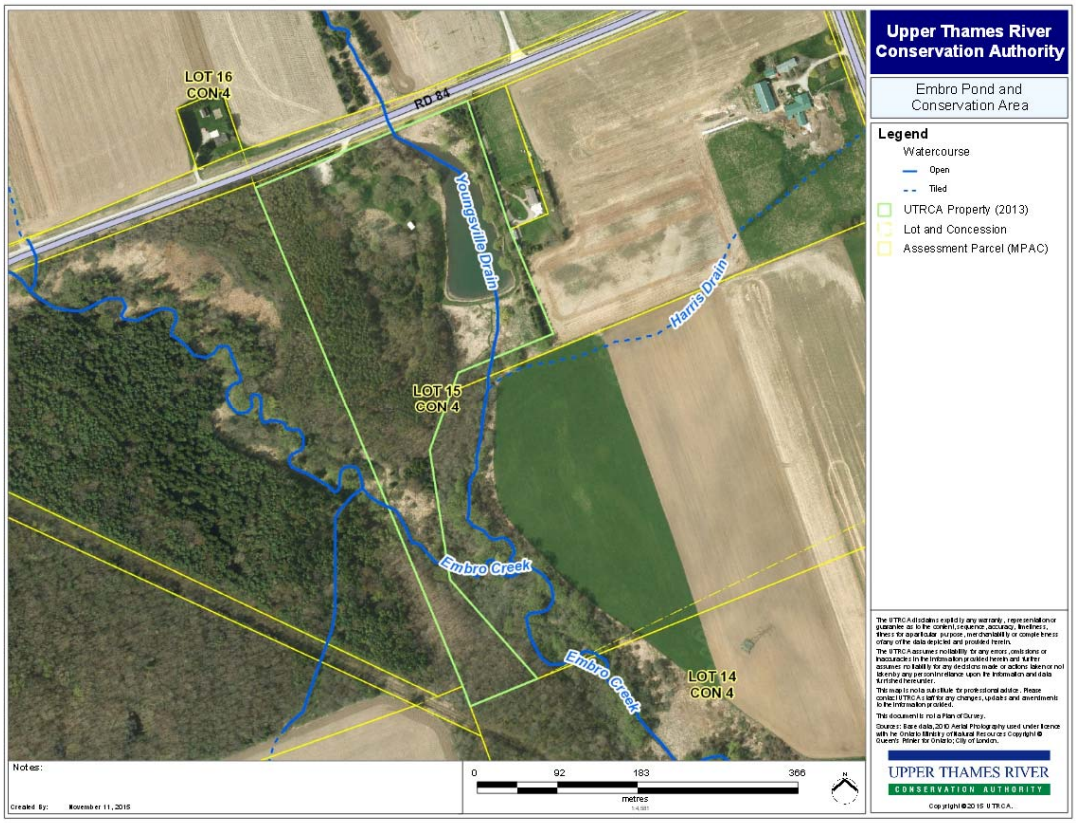


Figure 1-1. Embro Conservation Area (outlined in green, Source: UTRCA)

1.3 Background

1.3.1 History

The UTRCA acquired the Embro dam in 1958 which involved the purchase of 5.7 hectares of the Oxford County Forest and 2.7 hectares of the Charles Harris property. At that time, the dam was in poor condition and the spillway was damaged (note; the original date of construction is unclear). In 1959, the dam was replaced with a 91 meter structure; a 183 m long and 91 m wide lake/pond was created upstream of the dam. The pond was intended for recreational and water supply purposes. The Embro Conservation Area officially opened on October 26, 1959

In 1995, the provincial operating funding support for Conservation Authority “small dams” was cut and as a result, the Township of Zorra contributes 100% of the operating costs. The dam was overtopped in the summer of 2000, but only minor damage was reported (Acres, 2007).

1.3.2 Embro Conservation Area

Today, the Embro Dam Pond and conservation area attracts local residents and visitors to the site for recreational purposes including hiking (2.4 km of trails) and picnicking. The Embro Dam is a significant landmark to the local community and adjacent residents.

1.3.3 Dam Safety Assessment

In 2002, UTRCA initiated dam safety studies and Acres International was retained to undertake a dam safety review of the Embro Dam. The dam safety assessment (DSA) was carried out based on the draft "Ontario Dam Safety Guidelines" (ODSG) published by the Ministry of Natural Resources under the Lakes and Rivers Improvement Act and the Canadian Dam Association Safety Guidelines.

The Acre) report was completed in 2007 and includes an assessment of the dam and components, detailed site inspections, identification of repairs/maintenance, preparation of an emergency action plan, assessment of operation and equipment and associated documentation. Key highlights of the DSA include:

- The dam classification is small based on height and reservoir size;
- The dam is classified as having a "Very Low" Incremental Hazard Potential (IHP) structure for a dam failure during a flood event;
- The inflow design flood (IDF) is the flood resulting from the 50 year, 8 day spring snowmelt event (i.e., 9.4 cms (Acres, 2007));
- With three stop logs removed in the fall, the dam is overtopped during the passage of the IDF and has inadequate freeboard.
- The spillway has inadequate capacity to pass the IDF;
- Upstream and downstream embankment slopes do not meet stability acceptance criteria;
- Excavation of the emergency spillway is required in order to properly convey flood flows away from the left downstream toe of the dam.

Based on their dam safety assessment, Acres (2007) recommended that additional investigations be undertaken to assess embankment stability. Recommendations were also provided, if implementation was feasible, including: concrete repairs and embankment repairs including flattening slopes/adding berms, excavation of the emergency spillway to create a path away from the dam toe, removal of large vegetation from embankments, shoreline and outlet erosion protection, debris removal, sign installation, regrading and adding riprap to the downstream channel, and redesign of the emergency spillway. The costs associated with maintenance repairs to ensure ongoing safe operation were estimated to be $62,350 in 2004 (Acres) and about $80,820 in 2007 (Acres); these costs were updated by Burnside in 2010 to be ~ $188,00 which included additional works pertaining to the upstream and downstream slopes of the dam embankment. These number quotes were based on cost estimates of the general scope of work and similar projects in Ontario.

In 2008 Naylor Engineering Associates Ltd was retained by the UTRCA to perform a visual inspection and assess the geotechnical stability of the Embro dam embankment and to provide recommendations for addressing any deficiencies that would meet current dam safety guidelines. Key findings from their investigation included the following:

- The dam at Embro Pond comprised of silt and sand fill over native silt, peat, clay and glacial till;
- Groundwater was measured within the fill in the dam during the field work;
- The existing dam did not meet dam safety guidelines and stability criteria and was not considered stable under existing conditions;
- Recommendations included extending and flattening upstream and downstream embankments and re-construction of the dam were provided.

1.3.4 Hazard Classification

In August 2011, the Ministry of Natural Resources released the "Dam Safety Review Best Management Practices" document. Under the jurisdiction of the Lakes and Rivers Improvement Act (LRIA), the Ministry of Natural Resources and Forestry has the authority to govern design, construction, operation, maintenance and safety of

dams in Ontario. The best management practices have been developed to ensure safe management of Ontario dams. As part of the dam safety review (DSR) process, all factors affecting the safety of a dam are reviewed based on current knowledge and standards.

Results of the original Embro Dam DSR (Acres International, 2007) classified the dam hazard as follows:

- Loss of Life: VERY LOW
- Economic and Social Losses: VERY LOW
- Environmental Losses: VERY LOW

Using the updated (2011) Dam Hazard Classification, Ecosystem Recovery re-evaluated the hazards for Embro Dam, resulting in the following classifications (See **Appendix H)**:

- Life safety: LOW
- Property Losses: LOW
- Environmental Losses: LOW
- Cultural-Built Heritage Losses: LOW

The low hazard associated with dam failure is due, primarily, to the rural area in which the dam is situated and the few permanent dwellings in the area.

1.3.5 Legislative Network

The Ministry of Natural Resources, through the Lakes and Rivers Improvement Act (LRIA), regulates alterations, improvements, and repairs to existing dams. Under Section 16 of the LRIA, "no person shall alter, improve, or repair any part of a dam… unless the plans and specifications … have been approved" by the Ministry of Natural Resources and Forestry. Likewise, under Section 2(1)(b) of Ontario Regulation 454/96, Ministry (MNR, 2007) approval is required to make alterations, improvements, or repairs to a dam that holds back water in a river, pond, or stream if these may affect the dam's safety, structural integrity, the waters or natural resources. Section 2(2) of Ontario Regulation 454/96 further specifies that LRIA Section 16 approval is required before a person operates a dam in a manner different from that contemplated by previously approved plans and specifications (see: https://www.ontario.ca/page/dam-management, https://www.ontario.ca/page/alterations-improvements-and-repairs-existing-dams for additional information).

Any works submitted for LRIA approval requires supporting reports, supporting analyses and calculations, and drawings that are completed by a Professional Engineer. LRIA approval may be issued if the proposed works meet the standards outlined in the LRIA technical bulletins (https://www.ontario.ca/page/alterations-improvements-and-repairs-existing-dams#section-2). Ministry standards for dam safety in Ontario are outlined in the LRIA Administrative Guide (MNR 2011) and associated technical bulletins (http://www.owa.ca/assets/files/policy/LRIA-Administration-Guide.pdf).

1.4 Study Objectives

The Upper Thames River Conservation Authority, in partnership with Zorra Township initiated a Class EA study under the Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Projects (2013). The objective of the study is to identify, evaluate, and ultimately recommend an alternative that will allow the Upper Thames River Conservation Authority (UTRCA) to move forward with resolution to the problem statement regarding the future of Embro Dam, in the Township of Zorra.

The specific objectives of a dam focussed Environmental Assessment such as this study are to identify alternatives that:

- Address the dam stability concerns identified in the DSA studies
- Provides environmental enhancements wherever possible
- Provide opportunities for continued and/or enhanced public use of the Embro CA
- Minimizes environmental impacts during, and post, construction
- Results in low future maintenance
- Minimizes capital and maintenance costs

2. Environmental Assessment Process

2.1 Ontario's Environmental Assessment Act

The Embro Dam study is subject to the provisions of Ontario's *Environmental Assessment Act*. The Act requires that an environmental assessment of any major public sector project that has the potential for significant environmental effects be undertaken prior to implementation to determine the ecological, cultural, economic and social impact of the project.

The Act exists to "provide for the protection, conservation, and wise management of Ontario's environment". The act mandates clear terms of reference, focused assessment hearings, ongoing consultation with all parties involved — including public consultation — and, if necessary, referral to mediation for decision. Environmental assessment is a key part of the planning process and must be completed before decisions are made to proceed on a project.

To comply with the requirements of the Act, two types of environmental assessment processes can be applied to projects:

1. **Individual Environmental Assessment** (under Part II of the Act): This process includes the development of a project-specific Terms of Reference that is submitted for review and approval to the Minister of the Environment. This process is typically applied to large, unique or complex projects that do not have precedents that demonstrate a predictable and manageable environmental impact.
2. **Class Environmental Assessment**: This process applies to routine projects that have predictable and manageable environmental effects, and follow a Terms of Reference that has been previously approved for certain types of projects. Provided that the approved Class EA process is followed, the project will comply with Section 13(3) a, Part II.1 of the *Environmental Assessment Act*.

2.2 Conservation Ontario Class Environmental Assessment Process

Conservation Ontario has developed the Class Environmental Assessment for Remedial Flood and Erosion Control Projects document to specify a planning and design process which ensures that environmental effects are considered when undertaking remedial flood and erosion control projects.

According to the Conservation Ontario Class EA document, a remedial flood and erosion control project includes projects undertaken by Conservation Authorities which are required to protect human life and property from impending flood or erosion problems.

The Conservation Ontario Class EA process includes the following tasks:

- Initiate the Class EA and publish Notice of Intent;
- Prepare a baseline environmental inventory including the characterization of existing conditions, such as hydraulics, natural environment (terrestrial, aquatic and wildlife ecology) and geomorphology;
- Develop alternative remedial measures and select the preferred measure;
- Conduct a detailed analysis of environmental impact;
- Prepare study report documentation.

The Conservation Ontario Class EA process is illustrated in **Figure 2-1**.

2.3 Part II order

A project that is carried out following an approved Class Environmental Assessment process will comply with Part II of the *Environmental Assessment Act*, and will thus not require an Individual Environmental Assessment and approval from the Minister of the Environment. However, if during the project planning and consultation process there are agency or public concerns that cannot be resolved through consultation, negotiation, or revisions to the Environmental Study Report, then the concerned party may make a request to the Minister of Environment for a Part II Order to comply with Part II of the Environmental Assessment Act (i.e., a higher level of assessment) before proceeding with the proposed undertaking. Such a request is called a "Part II Order".

The request for a Part II Order should be made only when there are outstanding significant environmental issues that cannot be resolved during the class EA process. The Part II Order must focus on potential environmental effects of the project, and must not be made for the sole purpose of delaying or stopping the project or include issues that are not related to the project.

The request must be made in writing to the Minister of the Environment, within 30 days after the proponent has issued a Notice of Completion of the environmental study report. The proponent must also be copied on the request. Ministry staff will review the request, consider evaluation criteria, consult with other technical staff and make a recommendation to the Minister. Depending on the project, the ministry's review typically lasts between 30 and 66 days. The Minister can:

- Deny the Part II Order request, with or without conditions;
- Refer the matter to mediation; or
- Require that an Individual EA be prepared in order to comply with Part II of the Act.

If a Part II Order request is made prior to filing of the Notice of Completion, the requestor will be advised to bring the concerns to the attention of the proponent (i.e., the UTRCA).

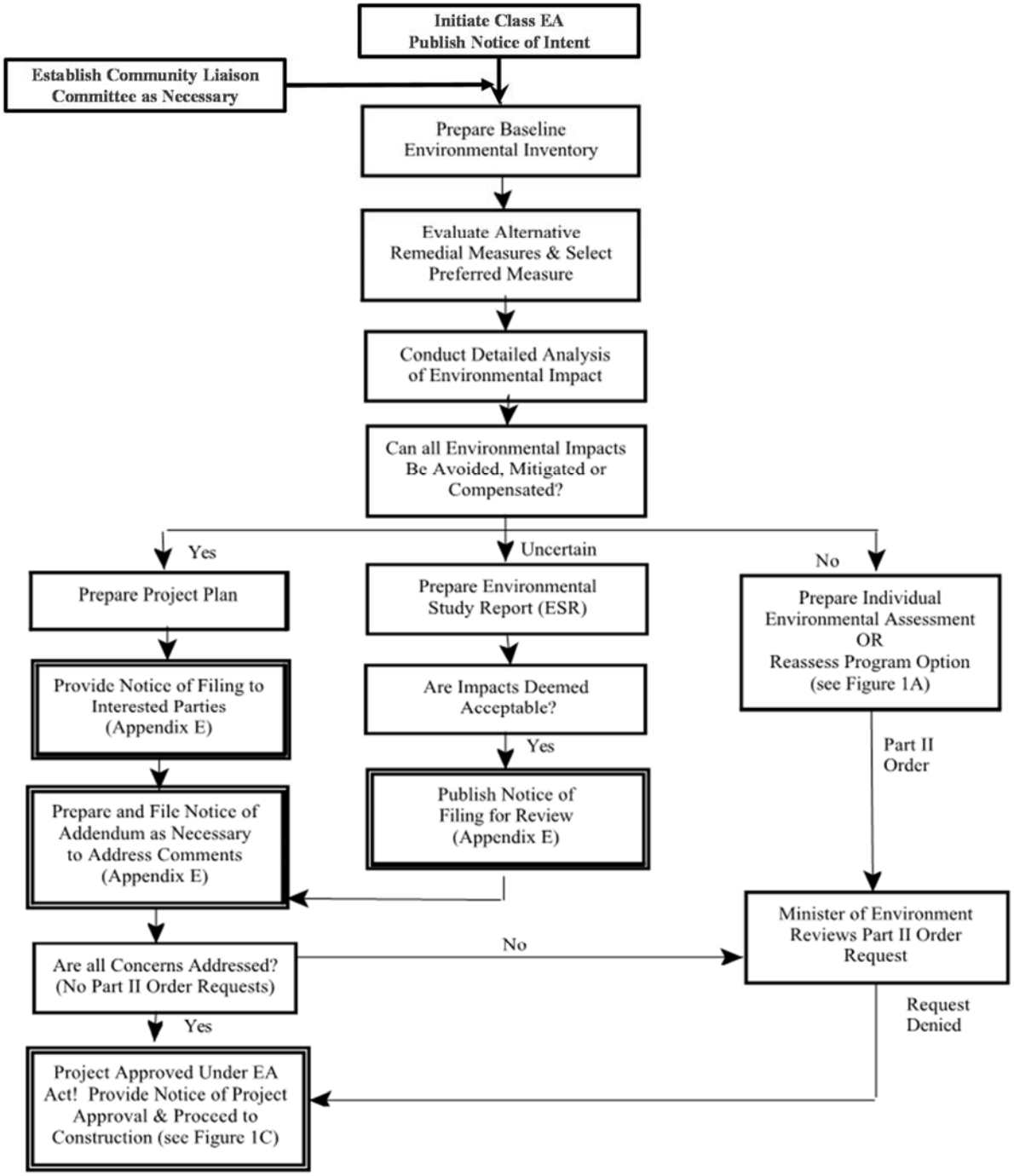


Figure 2-1. Conservation Ontario Class EA Process (http://conservationontario.ca/images/Policy__Planning/Class_EA/Class_EA_June_2013.pdf)

3. Existing Conditions

Existing and historical conditions of Embro Dam, the pond, and adjacent area were characterized to provide an effective basis for the evaluation of potential alternatives that could address the concerns identified through the Dam Safety Assessment (Acres, 2007). Components included in the characterization focused on the geology and physiography, hydrotechnical (i.e., hydrogeology hydrology and hydraulics), fluvial geomorphology, aquatic and terrestrial environments, water quality, and socio-cultural settings.

The data required to characterize site conditions were gathered through a combination of site visits, field investigations, and desktop reviews of existing reports and mapping and are summarized in this chapter. The characterization of existing conditions was completed through a collaborative effort with UTRCA staff. Reports prepared by UTRCA are provided, in full, in **Appendices A, B, C** and **D**. A summary is provided in the sub-sections below.

3.1 Drainage Network and Watershed

The Embro dam is located on Youngsville Drain (also called Spring Creek) which is a tributary of North Branch Creek (Mud Creek Watershed). Embro Dam and its pond occur in the Embro Conservation Area (see **Figure 1-1)** which is situated within the Mud Creek watershed, a subwatershed of the Middle Thames River (See **Figure 3-1** and **Figure 3-2).** An overview of the watershed is provided in **Appendix A**.

From the downstream limit of the Embro Dam Pond, Youngsville Drain flows south for approximately 300 m before its confluence with the North Branch Creek (west). From this point, the North Branch Creek (west) flows south through the village of Embro, and crosses under 37th Line/Huron Street at three locations. The lower limit of the Mud Creek watershed is approximately 1.7 km south of the village of Embro. The Mud Creek watershed includes Zorra Township (69%, 109 km^2) and the Township of East Zorra-Tavistock (31%, 48 km^2).

The drainage area to the dam and pond is approximately 7.0 km^2; this is made up of mostly agricultural lands. The catchment area of Embro Pond i, Sutherland-McDonald Drain, Ross Drain, Glendinning Drain, Matheson-McCorquodale Drain and Matheson Smith Drain.

The general topographic setting of Embro CA in the downstream reaches of Youngsville Drain catchment is shown on the map in **Figure 3-3.** North Branch Creek meets Embro Creek immediately south of Embro CA. The lowest elevation point in the catchment area is 315 m where Embro Creek leaves the Conservation Area. Embro CA is located in some of the highest elevations in the UTRCA watershed.

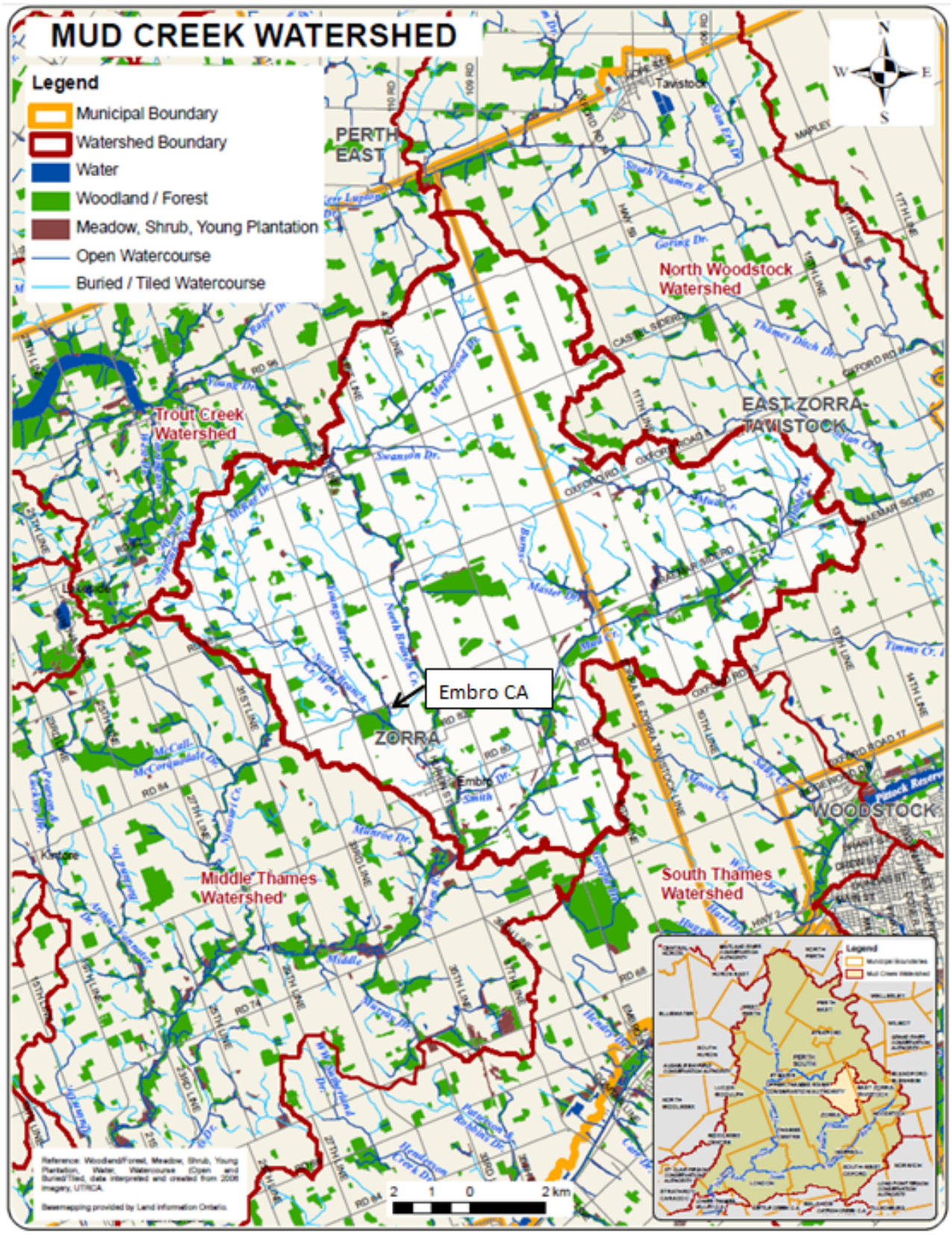


Figure 3-1. Location of the Embro Conservation Area (CA) in the Mud Creek Watershed (Source: UTRCA, 2015; Appendix A).

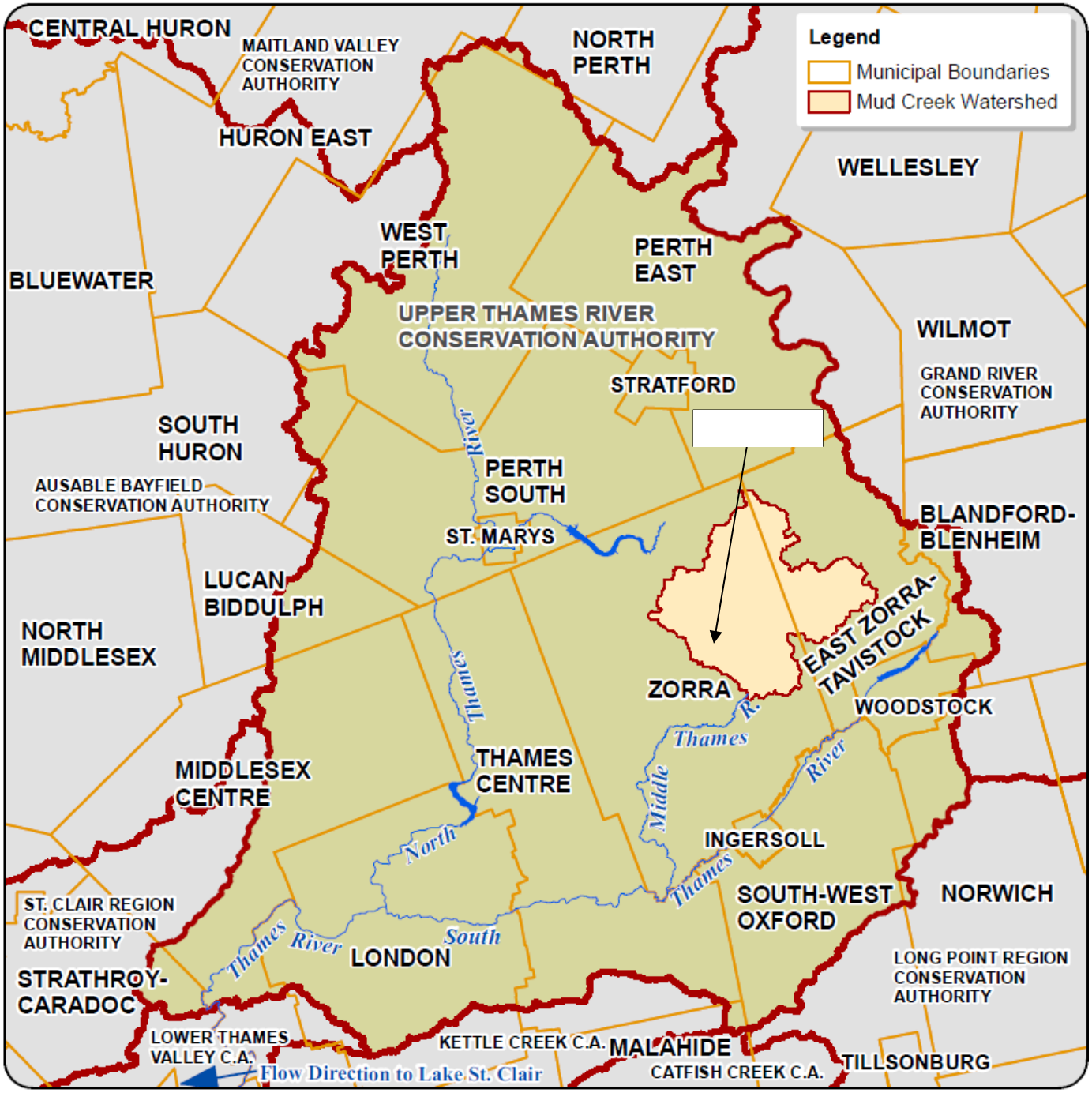


Figure 3-2. Mud Creek watershed in relation to Upper Thames watershed (Source: UTRCA, 2015; Appendix A)

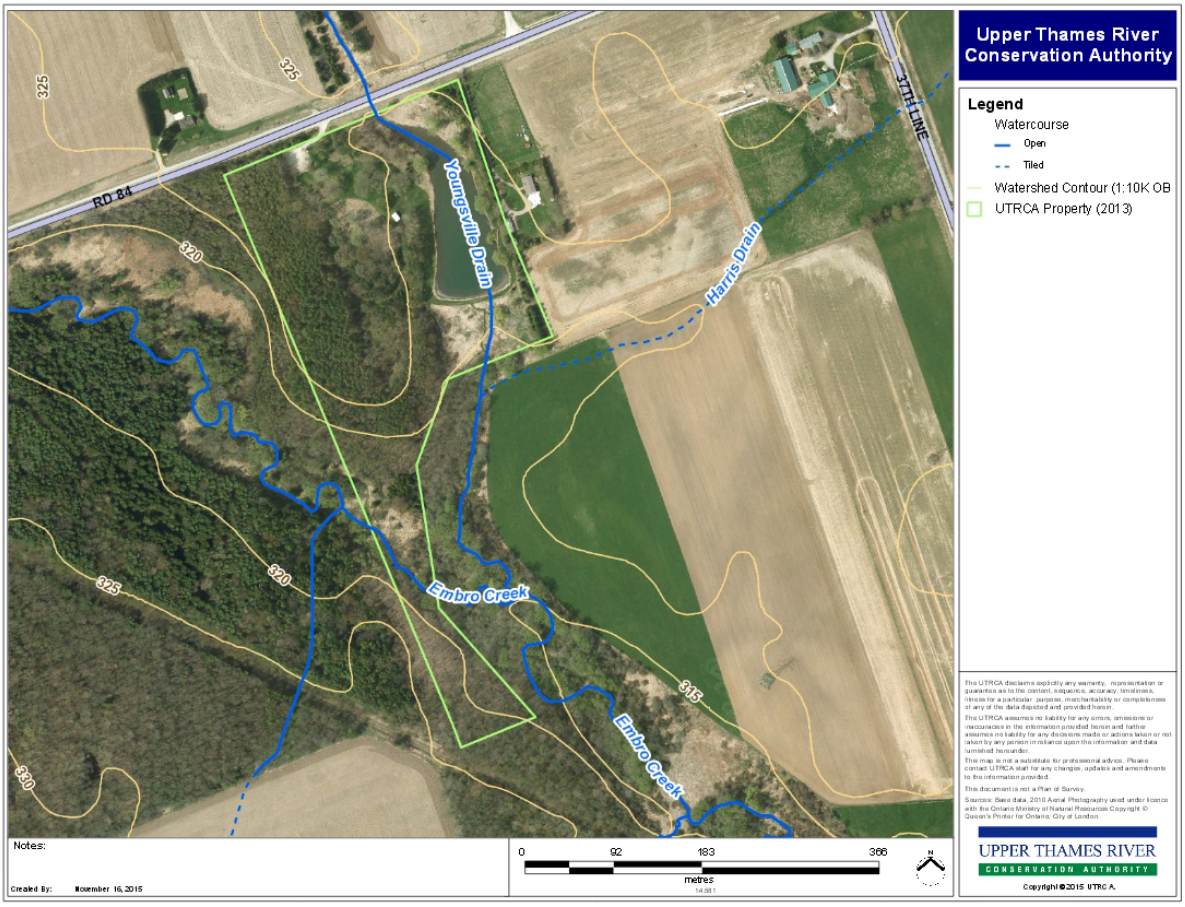


Figure 3-3. Elevation of Embro Conservation Area (Source: UTRCA, 2015; Appendix A)

3.2 Physiography, Geology and Subsurface Conditions

An overview of study area geology was provided in the Naylor (2008) report which has been extracted and copied below:

> *The Embro Conservation Area is situated in the Oxford Till Plain Physiographic Region of Southern Ontario. The region is occupied by a drumlinized till plain with glacial meltwater valleys. The dominant soil materials are silt and sand tills.*
>
> *The region is underlain by Middle Devonian Bedrock of the Paleozoic System. The predominant rock type is limestone of the Dundee Formation. The soil cover over these rocks is approximately 30 m thick, although the bedrock is exposed in the ancient river valleys, notably in Beachville. The bedrock is approximately 400 million years old and was formed in a shallow sea environment.*

Insight into subsoil conditions was also provided in the Naylor (2008) report and is as follows (borehole and cross-section data are provided in **Appendix E**):

> *In general, the subsurface stratigraphy at the site comprises fill overlying native glacial till.*
>
> *Peat was encountered 2.2 to 3.4 m below existing grade in a borehole (BH 4) that was drilled on the west embankment of the dam. The peat comprises black amorphous peat with wood. The moisture content of the peat was 108%, indicating saturated conditions.*

Silt and clay deposits were contacted beneath the fill (of the embankment). *It comprises loose to dense brown silt with trace clay and sand.*

Glacial till was encountered beneath the fill, peat, silt and/or clay in all of the boreholes. The glacial till extended below the termination depths of the boreholes. The texture ranged from silty-clay with some sand and trace gravel, to sandy silt with some gravel and trace clay.

Further detail regarding the subsurface materials is in the Naylor (2008) report.

Mapping of the surficial geology of the study area was provided by UTRCA (2015) and is shown on **Figure 3-4**.

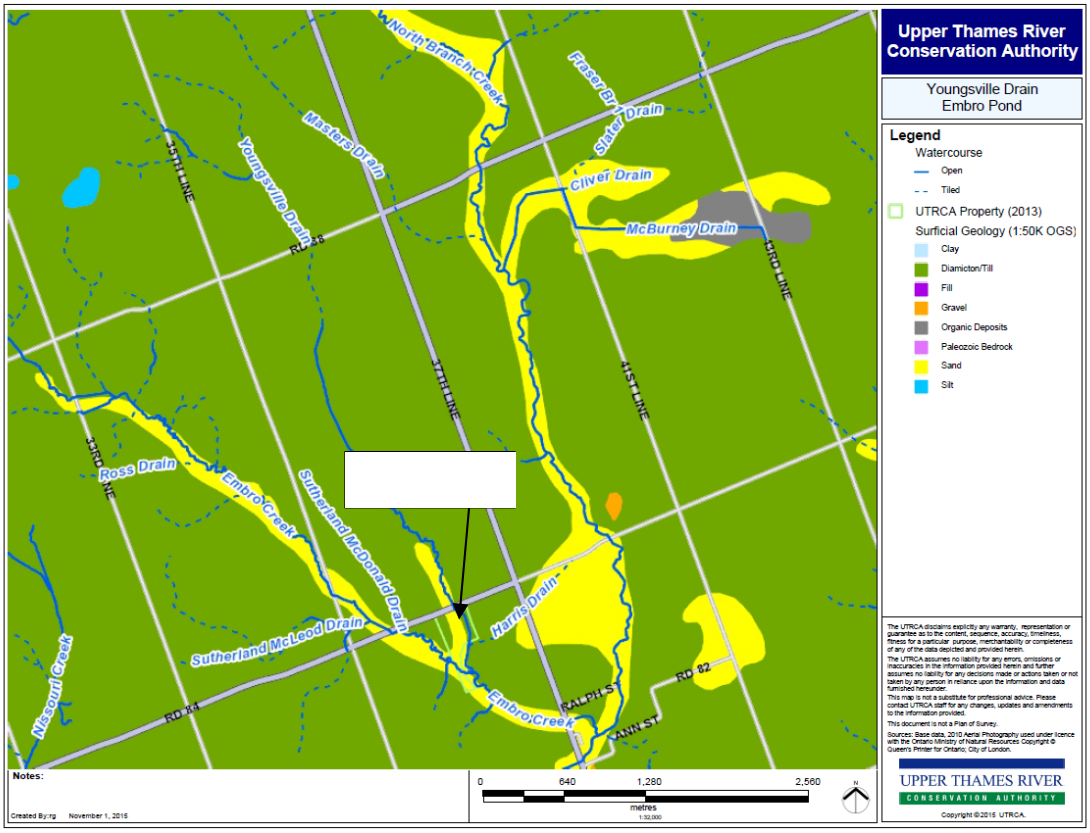


Figure 3-4. Surficial geology of the area

3.3 Embro Dam and Pond

The original construction date of the Embro dam and pond are unknown; the dam was considered for acquisition in 1947 and was purchased by UTRCA in 1958. The Embro dam controls a small drainage area of 7 km^2 comprised of mostly agricultural land. The dam forms a reservoir of approximately 0.5 ha (length of ~ 190 m) with an estimated volume of 0.03 x 10^6 m^3. The dam (~ 100 m long) incorporates low earth fill embankment along the south end of the pond; the entire dam is situated on overburden. The dam has a height of approximately 4.5 m and freeboard of 1.1 m. The dam impounds water year round and includes approximately 3.4 m of head acting across the dam.

Upstream pond slopes are inclined between 3 and 4:1. Downstream slopes of the dam are inclined between 2 and 3:1. The downstream slope is densely vegetated with grass, bushes and some trees; two gullies has eroded on this slope, as a result of the emergency spillway overflow and heavy discharge through the concrete pipe conduit (Acres, 2007). There is no slope protection on the pond side of the embankment and the slope is overgrown with cattails and marsh vegetation.

Results of the Acres (2007) stability analyses indicate that neither the upstream nor downstream embankment slopes meet criteria for load combinations pertaining to normal water level. (i.e., acceptance criteria is 1.5; calculated values are 1.24 and 1.16 for the upstream and downstream slopes respectively). The downstream slope also does not meet the acceptance criteria (1.3) for the extreme event (i.e., IDF; calculated value of 1.16))

The outlet of the dam includes a concrete bottom draw inlet structure covered with grated trash-rack at the top of the inlet. A 762 mm diameter (inner) concrete pipe conveys flow from the pond to a pool at the creek outlet. A grassed, emergency spillway is located at the left abutment. This spillway has a clear width of about 4.0 m; inlet invert is 0.6 m below the crest of the dam. The spillway runs parallel to the outlet channel before its confluence with the watercourse. The spillway is not well defined downslope of the crest of the dam.

Results of the Dam Safety Assessment completed by Acres (2007), and the subsequent geotechnical assessment of the embankment by Naylor (2008) (i.e., the upstream and downstream embankment slopes do not meet slope stability acceptance criteria) revealed that the Embro dam did not meet dam safety guidelines, including instability of earth embankments. Improvements to the embankments and spillways were recommended. A summary of the dam assessments was provided in **Section 1.3**.

3.3.1 Sedimentation

The pond bed elevation was assessed in 1974 and again as part of the current (2015) study. Figures showing water depth in each of the time periods were prepared by UTRCA and are illustrated in **Figure 3-5**. While the actual values may not be clearly legible, the figures show a decrease in area of deep water (dark blue) and a corresponding increase in shallow water (light blue) over time.

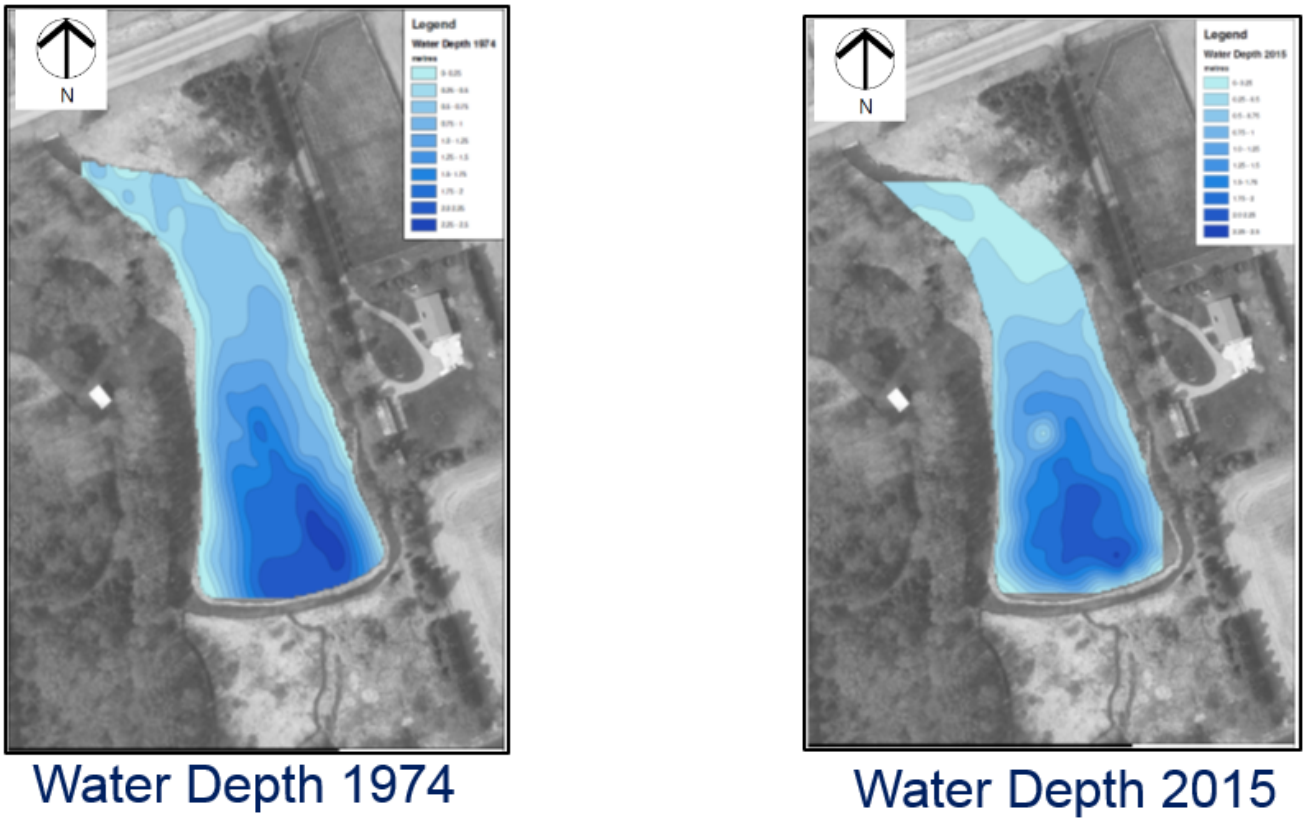


Figure 3-5. Comparison of water depth between 1974 and 2015 bathymetric surveys.

Results of the water depth assessments were plotted on a profile through Embro Pond (**Figure 3-6**). The figure shows that infilling appears to have been greatest at the pond inlet; this is expected since sediment load from Youngsville Drain will drop from suspension as flows enter a slower velocity area.

The bathymetric data were used to quantify the volume of sediment that had been deposited between 1974 and 2015 (i.e., 6,611 m^3). This data was used to determine an average rate of infilling (i.e., 161 m^3/yr). Based on the data, it is clear that the Embro pond is ~ 27 – 35 % full of sediment. Complete filling-in of the pond, at the existing sedimentation rate, would occur in ~ 115 years. It is important to keep in mind that the impetus for this study is the safety of the dam structure and not the sedimentation.

Note: *members of the public present at the Public Information Centre suggested that dredging of the Embro Pond occurred in 1980. No official record of this dredging event was available. If the pond was indeed dredged in the 1980s, then the rate of sedimentation as presented in this report may underestimate the actual rate of infilling.*

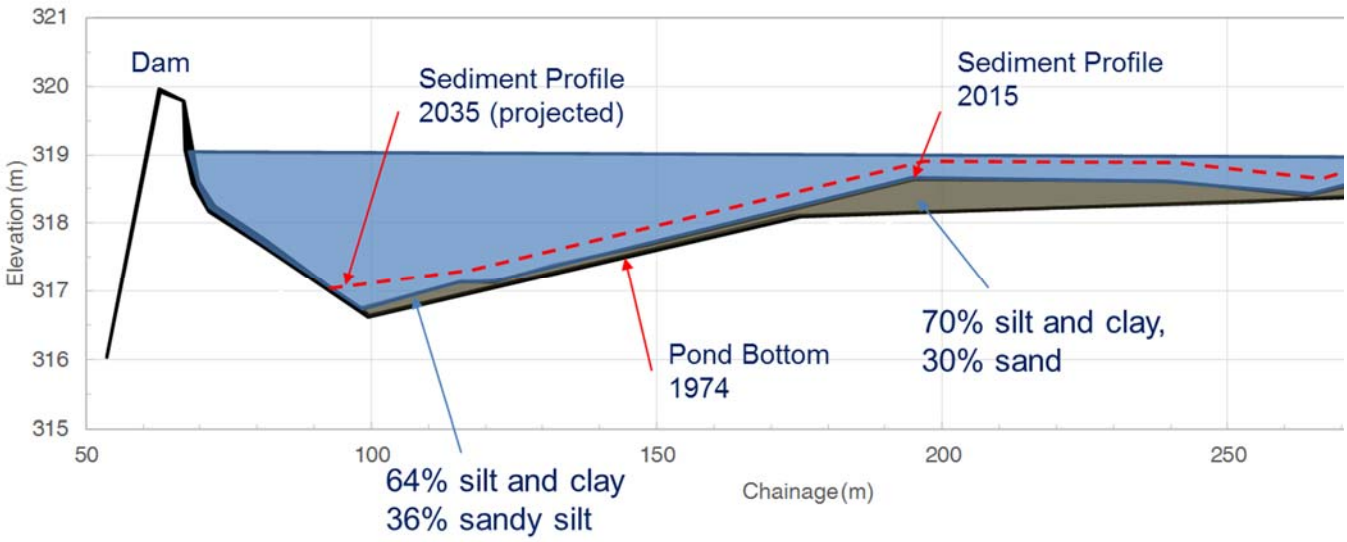


Figure 3-6. Sediment profiles in Embro pond.

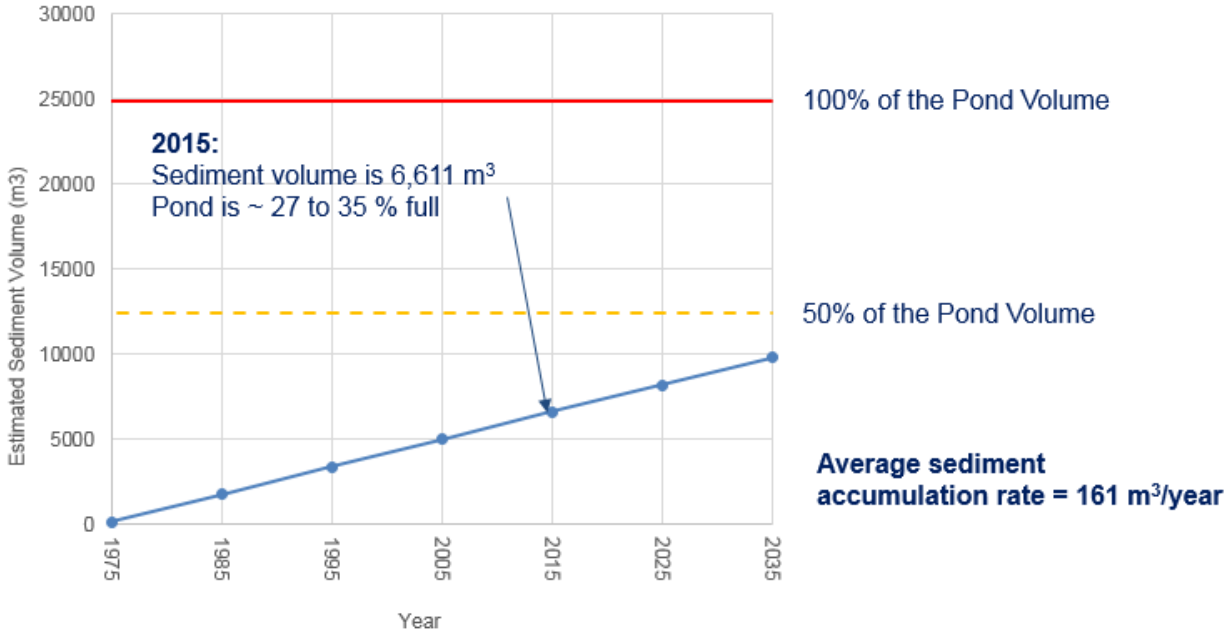


Figure 3-7. Rate of pond infilling

3.3.2 Pond Sediment Quality and Grain Size

Sampling of pond sediment was completed to assess sediment quality for the context of sediment management in the event of dredging. The analytical results are based on one sediment sample collected in the downstream end of the pond. The intent of the sampling was to investigate parameters including: metals and inorganics, volatile organic compounds, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), organo-chlorinated pesticides, conductivity, pH, sodium adsorption ratio (SAR), grain size analysis.

The sediment testing results were summarized and compared to MOE (2011) Table 2 standards, O. Reg. 153/04 under Part XV.1 of the Environment Protection Act. The Table 2 standards pertain to the potential for reuse, or disposal of sediment, if excavated. The results are compiled in **Appendix I**.

The sediment testing, when compared to MOE Table 2 standards, shows that one parameter (Cyanide – a weak acid dissociable) was outside of standard limits. The cyanide (weak acid dissociable) concentration (0.102 mg/kg) is double the recommended threshold (0.051 mg/kg) at the upstream sampling location, when considering reuse of the material for agricultural, residential, or Industrial/commercial/community property use. Results for the downstream sample location were below the MOE limits. Further investigation will be required to determine if dredged sediment should be landfilled; such investigation would occur during detailed design/maintenance planning.

Through the Public Consultation process, concerns were identified by a member of the public regarding the cyanide levels and potential implications for public health. The threshold values for exposure is 5 – 11 mg/kg for oral ingestion and 11 -100mg/kg for inhalation or dermal exposure. These thresholds are higher than the threshold value for sediment reuse (0.051 mg/kg) as defined by MOE under the Environment Protection Act. Hence, there is minimal concern for health risk to inhalation or dermal exposure due to cyanides. The origin of the cyanide could be variable and include algae, plants, apple seeds (note, history of throwing apples into pond), and agricultural runoff. Given the low concentration relative to risk to humans, no further investigation has been undertaken

Numerous parameters included in the sediment samples were not detectable below a set limit due to the constraints of the lab testing and samples. The MOE parameter limit was, at times, below the detection limit of the lab and/or samples. In such cases, whether or not the samples exceeded the MOE limits is unknown. Additional sediment analyses should be considered during detailed design, to further evaluate the opportunities for sediment management if sediment dredging is required.

The Toxic Characteristic Leaching Procedure (TCPL) was also applied to the samples to identify the potential management strategy of the sediment in conjunction with works required to implement an alternative. The TCLP results are included with the sediment testing results in **Appendix I** and are compared to Schedule 4 Leachate quality criteria (Ontario, 2015), O. Reg. 461/05 under the Environmental Protection Act which forms the basis for the definition of hazardous waste. The TCLP results did not exceed regulation limits set out in Schedule 4 and was thus not defined as hazardous waste.

Grain size analyses of the sediment samples were completed to determine the percentage of sands, and silts and clays. Results of the sampling indicated that the sediment was dominated by silt and clay and had a smaller fine sand component. The distribution in grain sizes was similar between the upstream and downstream samples collected in the pond; pond (upstream): 70% silt and clay, and 30% fine sand (sandy silt, trace clay) and pond (downstream): 64% silt and clay, and 36% sand (silt and sand, trace clay) (See **Figure 3-6**).

3.4 Hydrotechnical Environment

3.4.1 Hydrology

At the Embro dam, the surface drainage area, consisting predominantly of agricultural landuse, is 7 km^2. An estimate of the peak flood flows and hydrographs for the 2 to 500 year return period flows was undertaken as part of the Acres (2007) report. Since the study area is not located at, or near, an appropriate Water Survey of Canada monitoring station, the estimate of flood flows was based on modeling as outlined in the Acres (2007) report. Acres (2007) determined that the 8 day snowmelt volume of 9.4 cms would have a recurrence interval of 1:50 years; this corresponds to the Inflow Design Flood (IDF) (see Canadian Dam Association (2007) Dam Safety Guidelines). This recurrence interval is more frequent than predicted by other methods outlined in the Acres (2007) report, but considered to be reliable.

The surface water hydrology of Youngsville Drain was studied by UTRCA staff (see separate report in **Appendix A**). The purpose of the analyses was to determine average flow rates and the unit area flow rate for each catchment area, to assess the response of the stream to drought and low water conditions, to assess the contribution of the stream to the overall flow from its subwatershed, and to examine the effect of the water control structures on upstream and downstream flow rates. A summary of key findings is provided below.

- Analyses have demonstrated that the 645.6 hectare catchment area of Youngsville Drain contributed greater unit area flow rates to the Thames River than those monitored at the following nearby stream gauging stations:
    i) Trout Creek near Fairview
    ii) Avon River above Stratford
    iii) Fish Creek
    iv) Trout Creek near St. Mary's

- Based on monitoring undertaken in 2011, 2012, and 2015, Youngsville Drain, downstream of Embro Dam contributes 3.5%, 12.4%, and 6.4% respectively, of the total flow measured downstream of Thamesford.

- Based on the relationship in flows between Harrington Creek and Youngsville Drain, the groundwater recharge characteristics of the Youngsville catchment area, field observations of springs in the catchment

area, and the close proximity to shallow overburden aquifers, it is predicted that Youngsville Drain has a high resiliency to drought/low flow conditions. This resiliency is likely due to groundwater contributions.

- Flow measurements during base flow conditions indicated that the flow upstream of the backwater effects of Embro Dam was approximately 92% of the flow measured downstream of Embro Dam. This represents an 8 % increase in flows through the pond (i.e., from upstream to downstream, which is likely attributable to groundwater contributions.

3.4.2 Groundwater

The UTRCA reviewed internal thematic mapping and Ministry of Environment and Climate Change (MOECC) well records to characterize the general hydrogeological setting of Embro Conservation Area and the local surrounding area. The well records were examined and classified as shallow or deep on **Figure 3-8**. The shallows wells generally represent those that were drilled in association with field studies rather than those used for other purposes (drinking water).

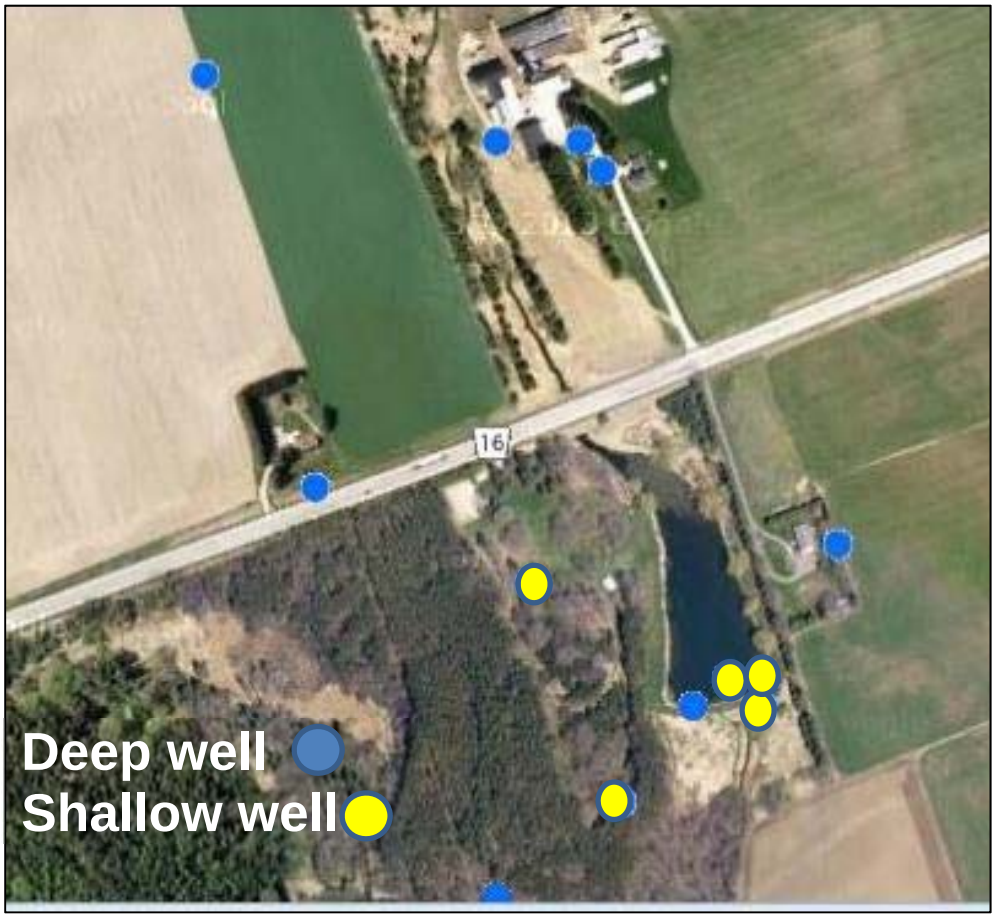


Figure 3-8. Known wells in the area of Embro CA (Data Source: MOECC; Appendix A)

Mapping reveals that the catchment area is dominated by till (**Figure 3-4**); the groundwater occurs in the fill layer that is above the glacial till. The Groundwater flow gradient is from the north to the south, towards the community of Embro. Thematic mapping indicates that there is a moderate groundwater recharge rate (**Figure 3-9**).

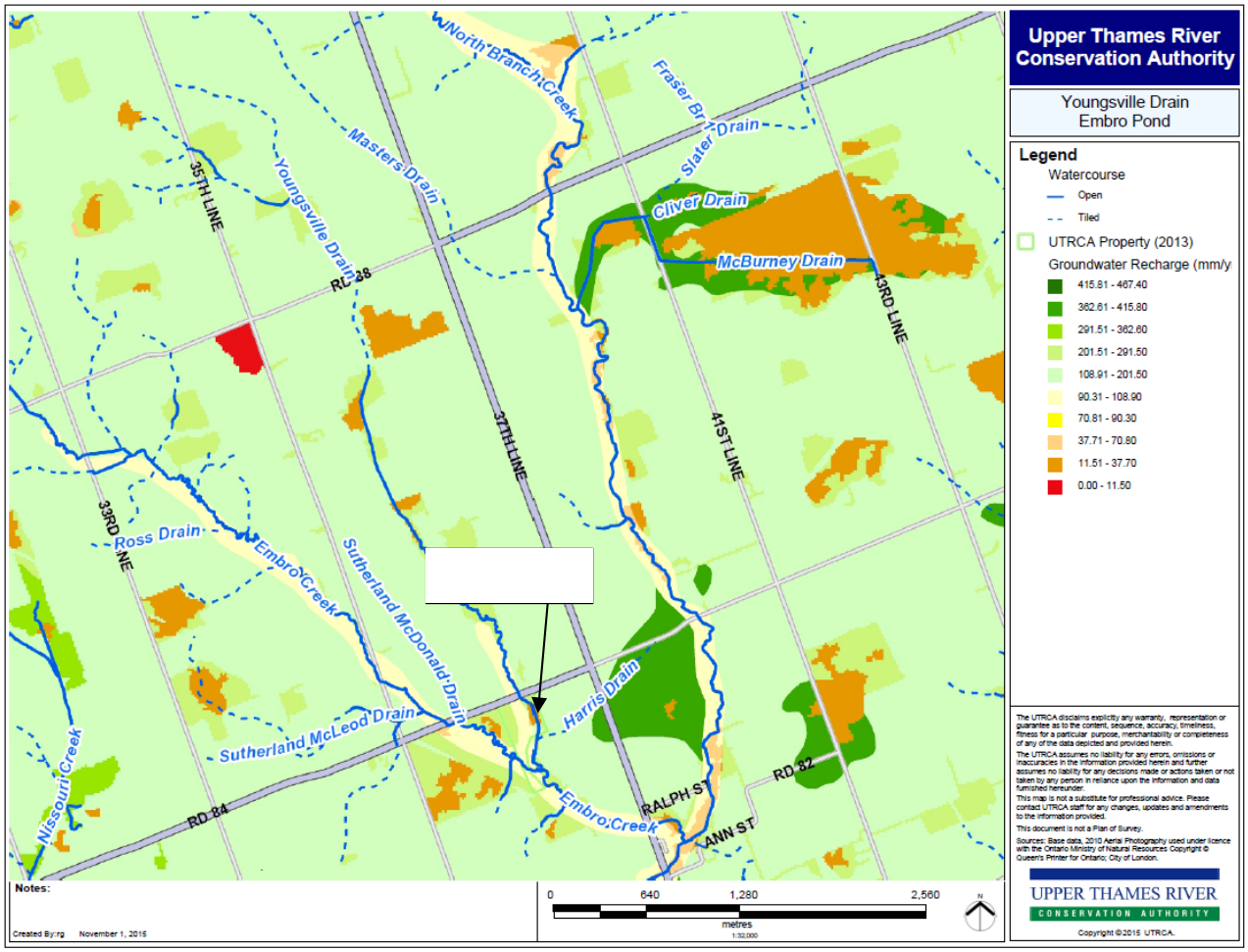


Figure 3-9. Groundwater recharge (mm/y) of the area around Embro CA (Source: UTRCA; Appendix A)

3.5 Fluvial Geomorphology

The intent of the fluvial geomorphic assessment was to characterize channel form and gain insight into channel processes along Youngsville Drain in the vicinity of Embro Pond. Youngsville Drain is a tributary of Mud Creek and flows from a north to southerly direction.

A review of historical channel conditions was completed to gain insight into changes that have occurred within the study area. UTRCA provided airphotos dated from 1955, 1972, 1989, 2000, 2010; additional aerial imagery was available from Google Earth (2015). Key observations are summarized below; a collection of historical airphotos of the study area is provided in **Appendix F**.

- In 1955, Embro pond was not yet constructed south of Road 84 and Youngsville Drain meandered within its floodplain. Upstream of Road 84, Youngsville Drain was sinuous and appears to be situated in a field (grasses, herbaceous plants) with few trees. A hedgerow occurs east of the creek and separates the creek from active landuse.
- In 1972, construction of Embro pond was complete (note: pond was completed in 1959). Channel realignment/straightening occurred, beginning at ~ 95 m north of Road 84. Channel modifications appear to have occurred at the outlet of the dam (widening, deepening, and straightening).
- In 1989, floodplain vegetation west of Youngsville Drain, and north of Road 84, appears to be naturalizing and increasing in diversity. Some channel planform development appears to be occurring at the upstream limit of the channel straightening
- In 2000 and 2010, overall, no change in planform configuration is evident in comparison to the 1989 aerial image.

A geomorphic field investigation was undertaken on June 11, 2015 to assess existing conditions along Youngsville Drain, both upstream and downstream of Embro Pond. During the field assessment, three reaches were identified. A brief description of dominant channel characteristics is provided by reach below. The reach delineation is demonstrated on **Figure 3-10** the surveyed channel bed profile is illustrated in **Figure 3-11** which includes a profile through Embro Pond based on 2015 water depth mapping provided by the UTRCA.

Figure 3-10. Reach delineation along Youngsville Drain.

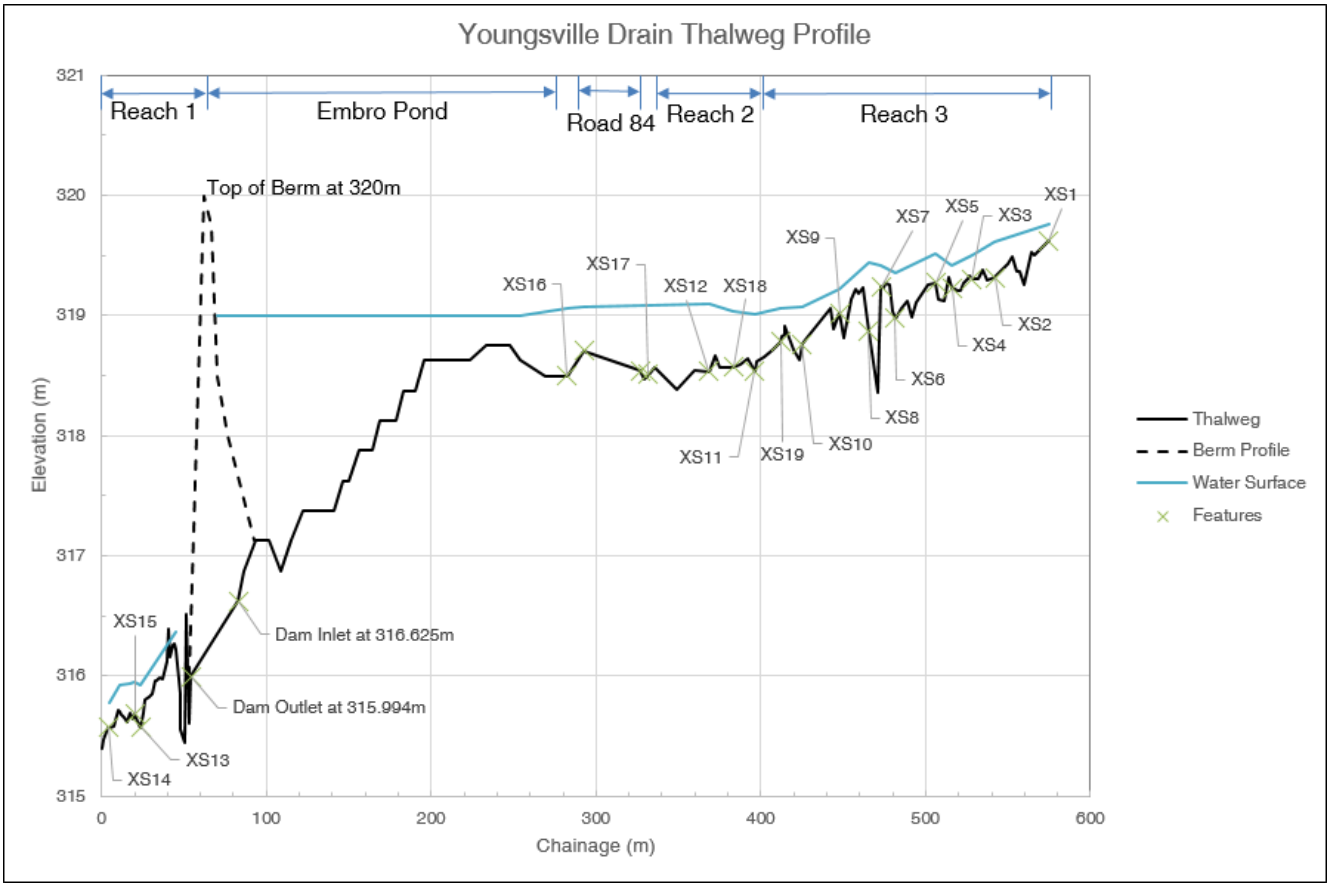


Figure 3-11. Surveyed channel bed profile along Youngsville Drain.

Reach 1. Downstream of Embro pond:

- From the outlet of Embro pond to the end of the UTRCA property, the watercourse was relatively straight; a slight meander was beginning to form near the downstream limit of the reachError! Reference source not found.. The creek was likely straightened in conjunction with construction of the dam.
- The channel cross-sections were generally symmetrical in shape and trapezoidal. The cross-sections were set within a larger channel. Riparian vegetation consisted of dense grasses and herbaceous plants; roots extended to the bottom of the banks. Towards the downstream end of the reach, shrubs and trees were overhanging into the creek.
- The dominant bed morphology along the entire reach was riffle/run with shallow pools. The channel bed consisted primarily of cobbles and gravel. Glacial till was exposed along the toe of the bank along a pool.
- Overall, the Youngsville Drain appeared to be stable throughout the reach.

Reach 2. Embro pond inlet to 85 m upstream of Road 84:

- In this portion of the watercourse, Youngsville Drain appeared to be under backwater conditions and influenced by water levels from Embro Pond. The backwater conditions extended 85 m upstream of Road 84; the channel was straight.
- The cross-sections were well-connected to the floodplain. The cross-section configuration was generally trapezoidal and did include a defined thalweg position. The channel width increased in the downstream

direction as expected in a backwater condition; the width:depth ratio for the two cross-sections was relatively narrow and ranged from 6.66 to 9.32.

- Channel banks were well vegetated with grasses and herbaceous plants; the fine and dense rooting network extended to the water surface. The bank configuration was generally irregular which is characteristic of banks influenced by backwater conditions in which hydration of bank materials leads to erosion. The relatively low banks indicate good floodplain accessibility during high flows.
- The channel bed morphology was poorly developed and was relatively uniform in configuration. Channel bed materials consisted primarily of silt and sand sized particles with few gravels. The bed materials were 'soft' due to their hydrated condition. Submerged aquatic plants were observed on the channel bed.
- Application of the Rapid Geomorphic Assessment (RGA) for this reach indicated that the channel is 'in regime'. The dominant process within the reach is deposition. Gradual widening of the cross-section is expected due to the hydration effect typically associated with backwater conditions.

Reach 3. From 85 m to 235 m upstream of Road 84:

- In Reach 3, Youngsville Drain was a meandering watercourse that was situated towards the west side of a ~ 30 m wide channel corridor that was separated from adjoining agricultural land uses by a row of cedar trees. The watercourse was situated towards the west side of this corridor. Riparian vegetation typically consisted of grasses and herbaceous plants along the east bank, and cedar or willow trees along the west bank. The vegetation and fine dense rooting network typically extended to the water surface.
- Along the east side of the channel, two locations were identified at which surface drainage was actively being conveyed over the bank into the creek. The source of water was not investigated.
- The cross-sections were generally uniform in configuration and well-connected to the channel banks. Average pool width was only slightly wider than riffles and the width:depth ratios were similar. This reflects the control of grassy and herbaceous bankside vegetation on channel form.
- Banks were generally steep. No active erosion was noted. Undercutting of the banks was generally minimal (up to 8 cm), but measured up to 24 cm underneath a root wad 17 cm and occurred at the bottom of the rooting zone and/or the interface with underlying stratigraphic materials. Along the lower bank, a soft rock was observed which resembled a conglomerate rock type (i.e., round gravels situated within a fine matrix of silt and sand sized particles. The cobble and gravel sized sediment observed on the channel bed consisted of this conglomerate **material**; pressure exerted onto the particles would cause it to break into smaller pieces.
- The channel bed morphology has developed into the soft conglomerate sedimentary rock. Field measurements revealed that from distance from the top of this unit to the channel bed was 30 cm, suggesting that the channel has incised this depth into the materials. The dominance of riffle/run features along the channel bed is a result of this resistant bed material. Shallow pools have formed and occur along the outside bends of meanders. The underlying bedrock controls profile development and reflects the relatively small difference in depth between pool and riffle sections. The deepest pool evident on **Figure 3-11** was 0.87 m deep; in general, all other pool depths were considered to be shallow (i.e.,, residual depths ranged from 0.15-0.28 m).
- Analysis of the topographic channel bed profile, provided by UTRCA, was undertaken. This revealed that the average water surface grade during the field survey (June 11, 2015) was 0.32 % and the average bankfull grade was 0.43 %.
- Application of the RGA for this reach indicated that the channel is 'in transition' and is dominated by aggradational processes. Indicators of aggradation include lateral bars of silt and very fine sands which were observed along the channel.

3.6 Natural Environment

Assessment of natural environment conditions within the study are was completed by UTRCA staff. A summary of the key findings is provided in the sub-sections below and details are presented in **Appendix C and D**.

3.6.1 Aquatic Ecology

Electrofishing and benthic surveys were carried out during the spring, summer, and fall of 2015 at the sampling sites shown on **Figure 3-12.** A list of recorded fish and benthic species, separated into sampling location, is provided in **Appendix C**.

3.6.1.1 Fisheries Resources

Youngsville Drain has been sampled extensively in the past, both upstream and downstream of pond, and found to support a fairly stable brook trout dominated community. Two samples on upstream reaches (May 7, 2015 and November 2014) were deemed adequate to confirm fish community composition. In an effort to augment existing data, an electrofishing survey of Embro Pond and Youngsville Drain downstream of the dam was conducted on April 15, 2015. The site downstream of the dam was surveyed two more times (July 8 and October 19, 2015) to provide three season data. All specimens were identified to species, recorded, and released. Sample records, including historic records, are tracked in an MS Access database and are provided in **Appendix C**.

Brook Trout were recorded in large numbers upstream of the dam, suggesting that Youngsville Drain provides good quality cold water habitat. The Brook Trout below the dam indicate that the numerous seeps and extensive aquatic vegetation that develops throughout the summer months (limiting sunlight penetration) counteract the warming effect of the pond and allow the cool water habitat to persist. The absence of young- of- the- year trout in the samples indicate that the cool water habitat is somewhat marginal, not permitting trout recruitment. Trout that were recorded likely passed over, and became trapped, downstream of the dam.

Results of the 2015 sampling, and previous fish surveys, reveal a large discrepancy in species diversity between up, and downstream, of the pond (i.e., eight (8) species recorded upstream and 21 species downstream). The low species diversity is fairly typical of trout dominated systems but likely also reflects the impact of the barrier to fish movement that is due to the Embro Dam and Pond. The diverse downstream community includes cold water species and both permanent, and seasonally present, warm water species.

Five (5) of the eight (8) species historically found upstream of Embro Dam were recorded during 2015. As these were primarily the most commonly encountered fish in previous surveys, this is considered to be a fairly stable fish community. Thirteen (13) of the 21 species sampled downstream of Embro Pond were found during the 2015 sampling; these species also represented the historically more common species. Results of the 2015 sampling indicate that Embro Dam is an effective barrier to fish movement and limits the upstream fish community diversity.

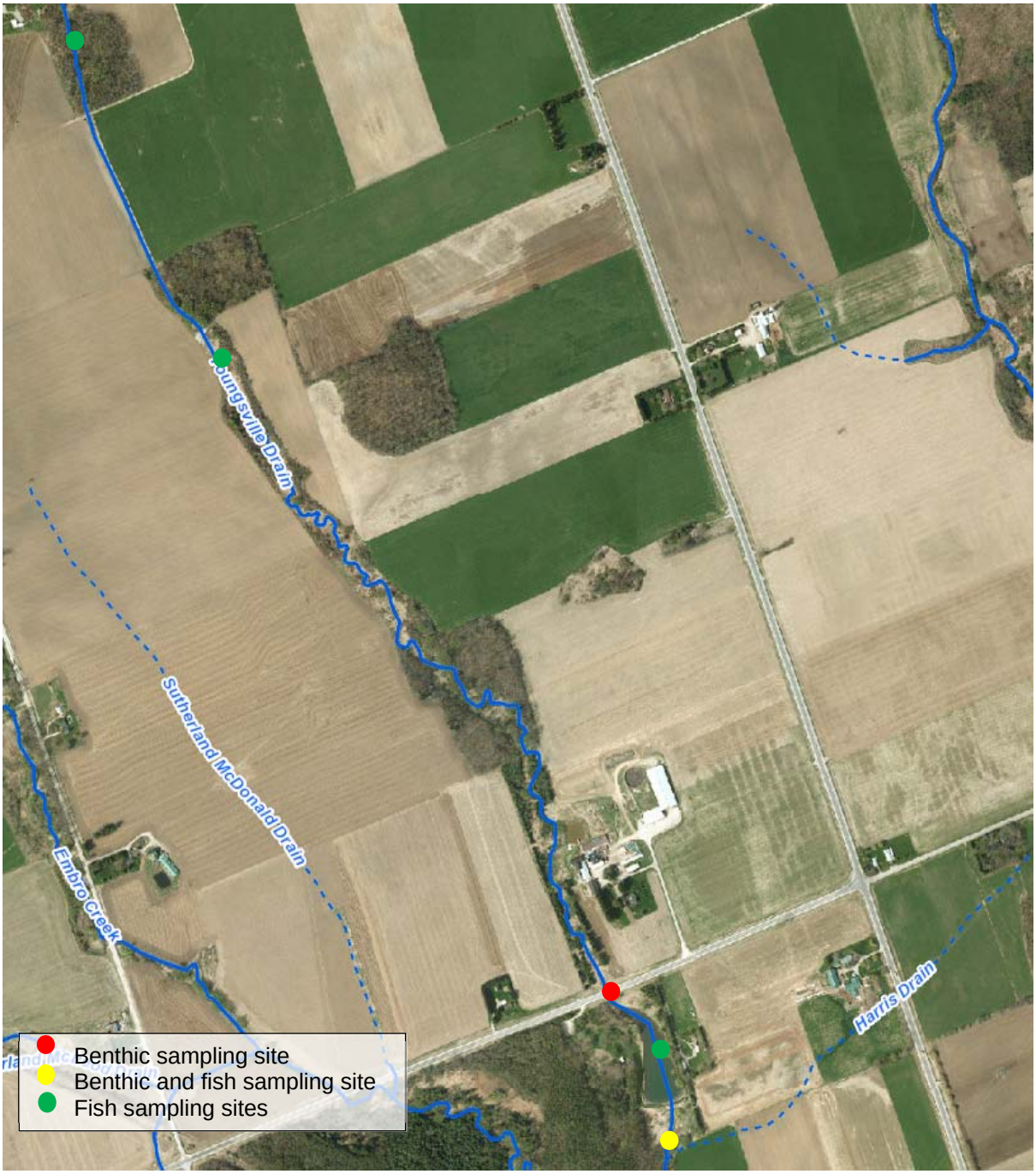


Figure 3-12. Embro Dam area benthic and fish sampling sites (Source: UTRCA; Appendix C)

3.6.1.2 Benthic Resources

Benthic invertebrate sampling was conducted in the spring (May 5) and fall (September 23) of 2015, both up upstream of Embro Pond and downstream of the dam. Sampling was conducted using a traveling kick and sweep method, and samples handled and analyzed using methods consistent with Provincial (OBBN) and Federal (CABIN) protocols. Samples were preserved in the field, randomly subsampled in the lab and identified to the Family taxonomic level. Resulting data were entered into, and analyzed, using an MS Access database. Sample

records (including historic records) with calculated Family Biotic Index (FBI) are provided in **Appendix C.** The water quality ranges for the FBI values can be seen in **Table 3-1**.

While the 2015 spring results were almost identical between the two sites, better water quality was evident upstream than downstream in the fall; pollution sensitive taxa found above the pond were replaced by more pollution tolerant taxa (primarily aquatic worms) below the dam. The minimal difference between upstream and downstream results could indicate that the upstream site is suffering somewhat from nutrient enrichment and the negative pond effects are counteracted by some nutrient filtering and assimilation.

Historic benthic invertebrate data for Youngsville Drain is limited to two samples upstream of Embro Pond (2003 FBI = 6.11, 2008 FBI = 6.04), and a one-time sample downstream of Embro Dam in 2010 (FBI = 5.81). All three historical FBI values indicate "fairly poor" water quality.

Table 3-2 below compares the FBI values of the 2015 Youngsville Drain samples to average FBI values for the Mud Creek and Upper Thames watersheds. The 2015 Embro values indicate slightly poorer water quality than the average value for all samples of the Upper Thames watershed processed for 2015 to date (FBI = 5.68), and is similar to the long term UTRCA average of FBI = 5.99. It is slightly better than the value utilized for the most recent (2012) Mud Creek Watershed Report Card (FBI = 6.20). All values are within the same water quality range of "fair" to "fairly poor", which is below the provincial guideline target of "good" water quality (FBI < 5.00).

Table 3-1: Water quality ranges for FBI values

< 4.25	Excellent
4.25 – 5.00	Good
5.00 – 5.75	Fair
5.75 – 6.50	Fairly Poor
6.50 – 7.25	Poor
> 7.25	Very Poor

Table 3-2: Comparison of FBI values for Embro Conservation Area, Mud Creek and UTRCA watershed (Source: UTRCA)

				Water
Youngsville Drain upstream of Embro Pond	5.82	6.06	5.94	Fairly poor
Youngsville Drain downstream of Embro Dam	5.84	6.37	6.12	Fairly poor
Mud Creek watershed 2012	N/A	N/A	6.20	Fairly poor
UTRCA watershed 2015	N/A	N/A	5.68	Fair
Provincial Guideline (target only)	N/A	N/A	< 5.00	Good

3.6.2 Vegetation and Wildlife Inventory

The UTRCA completed a study to examine the vegetation, birds, and wildlife of Embro CA to flag any rare or sensitive species that might be impacted if changes to the Embro Dam and reservoir are undertaken. A detailed report of the vegetation, bird, and other wildlife inventory can be found in **Appendix D**.

Vegetation

A three-season botanical inventory was completed in 2015 of 5.4 ha of the Embro Conservation Area, within 100 m of the reservoir. The intent of the field study was to examine the vegetation, birds and wildlife of Embro CA and to identify any rare or sensitive species that might be impacted by proposed alternatives for the study area.

Findings from the field assessment indicated that, of the 198 plant species found, 31% were non-native; this represents an average or moderate number in comparison to other natural areas and parks within the Upper Thames watershed. The overall quality of the terrestrial habitats (Cultural Savanna, Cultural Meadow and Mixed Forest) was assessed as average or moderate. Previous efforts to plant native trees and tallgrass prairie plants into the CA have added diversity to the study area. The reservoir has a dense growth of rooted aquatic waterweeds and pondweeds, but all three native species are common. There are very few rooted emergent wetland plants along the edges of the pond owing to the steep sides and constant water levels.

Embro pond was classified as shallow aquatic habitat since the water depth was < 2 m. very few wetland emergent plants were observed which was likely due to the steep side slopes and consistent water levels within the pond. Duckweed and algae were observed to float on the pond surface and four rooted aquatic species were identified. The vegetation was not considered to provide good cover for fish species that are adapted to ponds.

No plant species-at-risk or Special Concern species were found in the study area (on the land or in the water) and no records of plant Species at Risk were found within a 2 km radius. The four plant species with SRanks of S1-S3 (rare or uncommon) have all been planted in the two tallgrass prairie plots in Community 1 and are not dependent on the pond habitat. No plant Species at Risk or rare or uncommon or sensitive species were found on the land or in the reservoir that would be a limiting factor to future site works or conservation area changes. There are no wetlands within the 120 m of the Embro CA that need to be considered and, in fact, no wetlands were identified within 1000 m of the study area.

The wooded areas of Embro CA area part of a larger significant natural heritage feature that includes the Oxford County Forest as defined by the Oxford Natural Heritage System (ONHS 2006). This feature would not be a limiting factor to future site changes.

Birds and Wildlife

A three season bird survey was undertaken in 2015 as well. Most of the 40 species of birds recorded in the study area are common species and most are forest birds. One bird species-at-risk, the Barn Swallow (Threatened), was seen in the study area but it was not nesting here. Since it nests in old buildings, its nesting habitat will be unaffected by changes to the dam/reservoir.

The reservoir does provide limited significance for a few resident waterfowl for raising broods (e.g., Wood Ducks, Canada Geese). These are common species. Migrating waterfowl make little use of the Embro Reservoir during spring migration, likely due to the isolation of this pond from other ponds or lakes in the area.

The only species that should be given consideration is the Snapping Turtle, a species of Special Concern that was seen in the reservoir by the UTRCA surveyor. Should a lowering of the reservoir be required, a slow summer-time drawdown of the reservoir should safeguard any individuals by allowing them to move into nearby stream habitats, and ultimately, back into the restored area within Embro CA.

Through the public consultation process, a resident indicated that a red-backed salamander was observed on his property (i.e. not in, or adjacent to Embro CA). UTRCA staff completed only incidental observations of salamanders during the field assessment of vegetation.

In conclusion, based on the UTRCA assessment of vegetation, birds and wildlife as document in **Appendix D**, there are no sensitive plants, plant communities, birds or wildlife that would be threatened from changes to the environment in Embro Conservation Area.

3.7 Surface Water Quality

An assessment of surface water quality in the study area was undertaken by UTRC staff to supplement data that had been collected between 1986 and 1994 as part of a past targeted watershed study and remediation work. A comprehensive report is provided in **Appendix B**. Key findings are provided within this section.

The 2015 field program included the collection of five water samples at four locations in the area of Embro CA (i.e., one upstream of the pond, two in the pond, and one downstream of the dam as illustrated on **Figure 3-133**). Given the limited duration of sampling, the monitoring provides only a snapshot of water quality that is limited to the conditions extending from April to October 2015.

Most water quality samples were taken during low flow conditions. The dry conditions in the summer and fall of 2015 resulted in minimal opportunity to monitor runoff conditions. There was some variation in flow based on minimal rain but only one date had rain with runoff conditions (June 1).

Samples were analysed at ALS Laboratories in London for Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus, Orthophosphate, *E. coli*, Chloride, and Suspended Solids. Field measurements were taken with an YSI multi-parameter meter for Dissolved Oxygen, pH, Conductivity, and Temperature. Continuous temperature measurements (i.e., half hour intervals) were taken from June 1 to September 23 using a datalogger. Results are presented in **Appendix B** and summarized here. Data from the 1986 to 1994 monitoring work has been included in the evaluation of the 2015 monitoring results.

In general, the water quality in Youngsville Drain where it was sampled upstream, downstream and in Embro Pond, showed good results for 2015; numbers were typical of the Middle Thames watershed and other Upper Thames streams. The headwaters of this area include some healthy riparian areas with groundwater recharge creating the potential for good quality coldwater stream.

Most parameters showed similar results to the historic data with E. coli showing some improvement. Most parameters had relatively low levels with the exception of nitrate which was consistently above the guideline both historically and in 2015. In **Appendix B,** results of the water quality sampling are plotted and discussed in further detail.

Temperature differences are apparent between upstream (lower) and downstream (higher) of the pond during the 2015 continuous monitoring. Differences in temperature increased as the summer progressed and is considered attributable to the warming effect of the pond. During the 2015 sampling, the least, average and maximum temperature differences from upstream to downstream were plus 0^{o}C, 2.5^{o}C, and 7.0^{o}C respectively.

Water temperature affects aquatic habitat and the survival potential of eggs and health of fish. In **Figure 3-14**, the optimal temperature range for Brook and Rainbow Trout spawning/egg survival, and the mean critical temperature for fish survival as defined by Hasnain (2010) are plotted on the temperature graph. Results clearly demonstrate that the water is often warmer both upstream and downstream of the dam than the optimal spawning/egg survival temperatures.

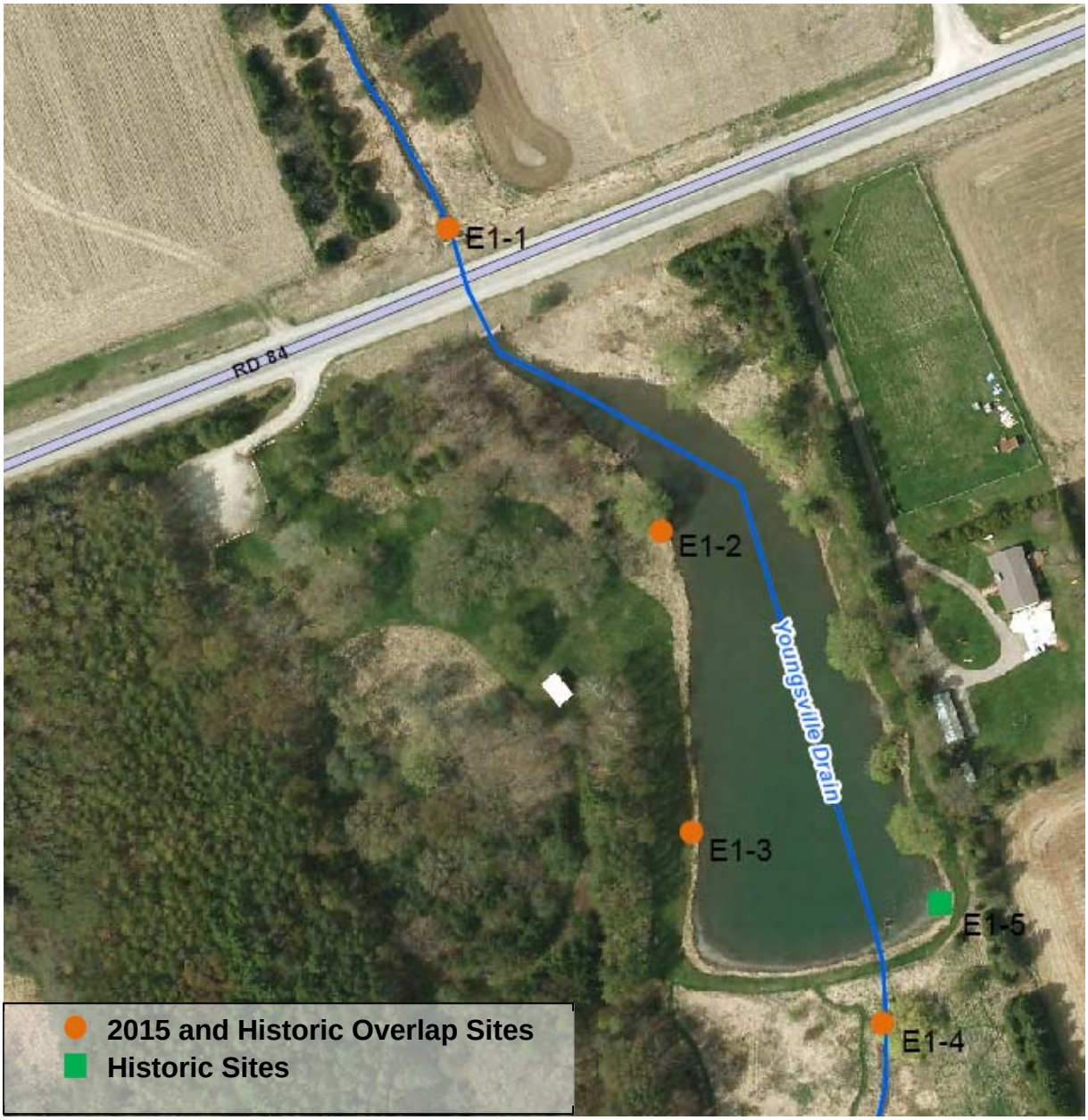


Figure 3-133. Embro Pond water quality sampling sites 2015 (Source: UTRCA; Appendix B)

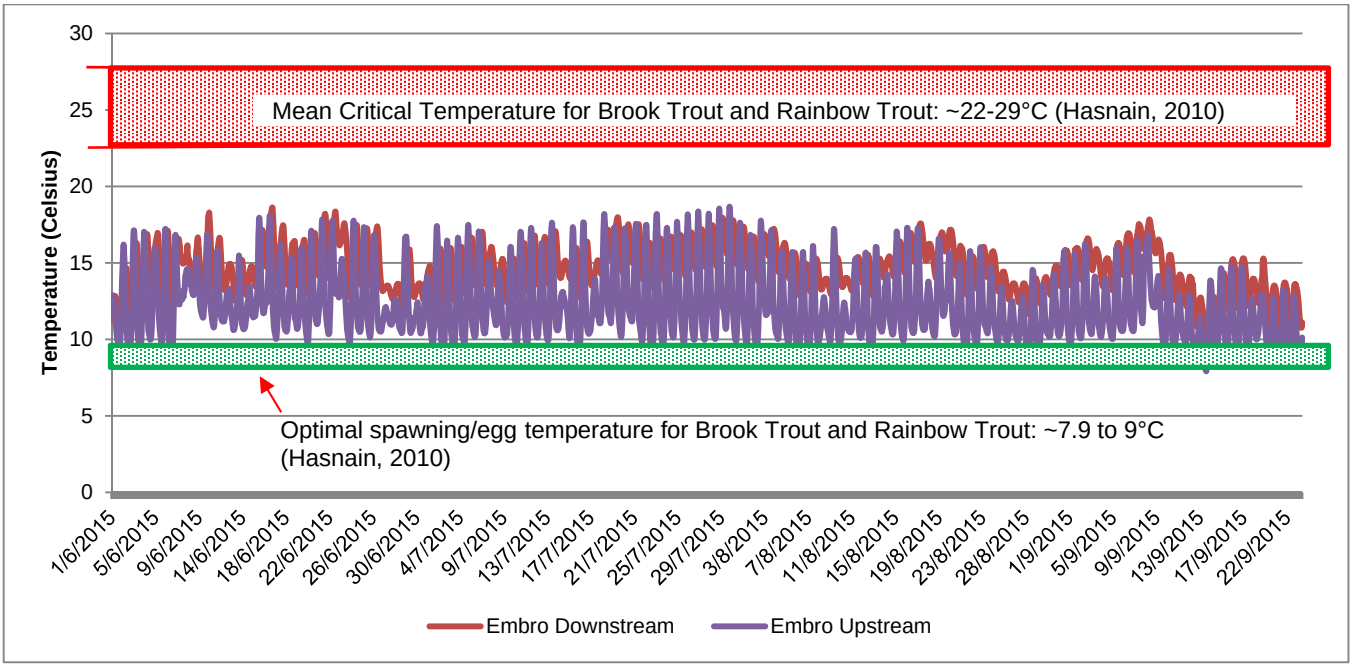


Figure 3-14. Temperature Upstream and Downstream of Embro Pond (Source: UTRCA, Appendix B)

3.8 Socio-Cultural Environment

3.8.1 Existing Use

The Embro Dam and pond are located in Embro Conservation Area (Embro CA). The Embro CA officially opened on October 26, 1959. In 1968, the conservation area was expanded to accommodate the general public (Upper Thames River Conservation Authority, 1973). The Embro CA encompasses an area of approximately 11.7 hectares, including the dam and pond. In 1993, the Embro Pond Community Association took over management of the conservation area.

Today (2016), Embro CA is approximately 8.5 hectares with approximately 5.7 hectares in tree cover, some of it is defined as mixed plantation and some as natural woodland; approximately 2 hectares consist of manicured lawn, unmanicured grass/marsh with a scattering of shade trees. The footprint of the reservoir/pond area is approximately 0.5 hectares.

The Embro CA supports a system of hiking and cross-country skiing trails, totaling 2.4 km in length, within the plantation of the Embro CA and neighbouring Oxford County Forest. The trails are accessible from the conservation area parking area, off Road 84. Picnic tables and shelters are also located in the CA.

Various initiatives have been undertaken within the watershed that have benefitted the Embro CA. This includes the UTRCA Community Nature Program which resulted in the planting of over 80 trees and 2800 native wildflowers and grasses by 75 students at Embro CA. In 2010-2011, a Hardwood Forest Regeneration project was implemented at Embro Conservation Are; in addition to planting 2100 native hardwood seedlings, UTRCA thinned a 5 ha conifer plantation to encourage regeneration of the forest. That project was funded by Oxford County and the Clean Water Program (CWP).

In July 2015, a “Memorial Tree Sign” was unveiled within the Embro CA. In a program run through the Township of Zorra, in the future, memorial trees purchased through UTRCA may be planted within the Conservation Area. About six memorial trees have been planted in the Embro CA in previous years.

3.8.2 Archaeological Assessment

A Stage 1 Archaeological Assessment was conducted in order to determine the archaeological potential of the study area; this includes identification of previously known archaeological sites, if any, and to provide recommendations for further assessment if necessary. The results of the archaeological assessment for Embro Dam are summarized in **Figure 3-15** and in **Appendix G**.

The background information revealed no record of previously completed work, reports, or known archaeological sites within the study area. The Embro Dam study area has the potential for archaeological sites based on location, drainage and topography, and based on the application of land-use modelling. The Youngsville Drain, historically surveyed roadways (Road 84 and 37th Line), and an area of early Euro-Canadian settlement represent local indicators of archaeological potential.

The existing condition of the study site has a reduced archaeological potential due to sloped lands greater than 20 degrees, permanently wet lands, and extensive land alterations. In terms of archaeological potential, the Embro Dam study area is characterized by 2.09 ha (66.8% of study area) of archaeological potential and 1.05 ha (33.2% of study area) of land identified as areas of no archaeological potential. The 2.09 ha of lands identified as having archaeological potential are within 300 m of a feature of archaeological potential and it is noted that test pit surveying is required for further assessment in the event that any works are proposed for the area (ARA, 2015).

Figure 3-15. Archaeological Assessment Results for Embro Dam CA (see Appendix G)

4. Alternative Solutions

Alternative solutions were developed for Embro Dam, to address the identified issues with the dam structure, and to achieve the objectives of the project, with consideration of the technical, environmental, social and economic aspects of the dam. Previous studies have identified concerns about insufficient spillway capacity, insufficient freeboard, embankment stability and flood flow conveyance through the emergency spillway. A subsequent embankment stability analysis (Naylor/LVM in 2008) was completed to further investigate the structural integrity of the dam; the study indicated that the dam does not meet current standards and is not considered stable under existing conditions.

4.1 Alternatives

Alternative solutions to address the identified issues were identified and are presented below for further evaluation and consideration. Conceptual plans of the alternative solutions are included on the following pages (**Figures 4-1 to 4-5).** It is relevant to note that any alteration, improvement, or repair of any part of a dam must be approved by the Ministry of Natural Resources and Forestry under the Lakes and Rivers Improvement Act. It is likely that, the Ministry will apply 2007 Dam Safety Guidelines. Approval must also be obtained for dam removal projects.

4.1.1 Alternative 1: Do nothing

No significant works would be undertaken to address stability issues at the dam, or to enhance the natural or social environment in the project area. The existing aesthetic and current uses would be maintained, although, over time, the aesthetic would deteriorate due to continued sediment infilling.

Regular monitoring would be completed and minor limited works would be undertaken to provide temporary stabilization of the dam; however, these are not anticipated to be effective in mitigating risk to public safety, The risk of dam failure would persist with associated environmental consequences (flooding, erosion, uncontrolled/ unmanaged sediment movement) and potential risk to the public; liability of the UTRCA in the event of failure would not be reduced and insurance costs may increase. There would be no improvement to water quality or fish passage potential.

4.1.2 Alternative 2: Repair Dam (install granular shell on both sides of the embankment, remove vegetation, extend outlet pipe, provide emergency spillway, install rock protection)

In this alternative, dam repairs would be implemented as outlined in the embankment stability analysis report (Naylor, 2008) to create a stable structure and spillway. This would enable compliance with Dam Safety Guidelines (CDA, 2007), and would maintain the current aesthetic and uses of the pond.

Dam repairs would incur a moderate cost, relative to the other alternatives identified for this study. The dam will impede the continuity of downstream sediment movement and thus continue to induce sediment deposition within the reservoir; this will reduce the visual aesthetic over time, or require future maintenance. The pond will continue to accumulate sediment over time, which will affect the aesthetic appearance and/or require future maintenance. No improvements to upstream fish passage potential and water quality (temperature) would be made.

4.1.3 Alternative 3: Remove dam and establish natural channel.

The existing earthen dam, outlet structure, and spillway would be decommissioned and removed. A natural channel would be established for Youngsville Drain in the location of the existing reservoir and dam structure, and the surrounding lands would be restored with natural vegetation. The channel would be restored based on principles of fluvial geomorphology and would be intended to convey the bankfull (~ 1.6 yr) flow event; larger flows would spill onto the adjacent floodplain.

This alternative removes the risk of dam failure, provides an opportunity to diversify terrestrial habitat, enables a continuity of sediment transport, reconnects upstream and downstream in-stream aquatic habitat, and maintains creek temperatures (i.e. no warming due to water residence time in pond). Opportunities for public recreation enhancement can be developed, if funding is available, to develop additional pathways (east side of pond), to include a bridge over the new channel, and to create look-out points.

Sediment that is dredged or excavated may be reused on-site, where feasible to create floodplain materials. It is expected that some sediment will require off-site disposal.

Dam removal and restoration of a naturalized channel will have a moderate cost. This alternative changes the current aesthetic by removing the open water feature. Any shallow wells that might be affected by this alternative are at risk and may need to be mitigated (i.e., shallow wells drilled deeper); a study to identify all shallow wells that might be affected, and which should be mitigated, will need to be completed prior to initiating detailed design.

4.1.4 Alternative 4: Remove dam and construct one or more offline ponds/wetlands

Alternative 4 includes the decommissioning and removal of the existing earthen dam, outlet structure and spillway. A naturalized channel would be restored for Youngsville Drain and one or more offline ponds and/or wetlands would be constructed within the footprint of the existing reservoir.

This alternative provide an opportunity to remove risks associated with dam failure, to remove the barrier to upstream fish migration and to reconnect upstream and downstream aquatic habitat, to provide a continuity for sediment transport, and to maintain water temperature. The offline pond/wetland will provide an open water view/aesthetic, although this will be different than under existing conditions. The offline ponds/wetlands would provide aquatic habitat for waterfowl and terrestrial species. The ponds would be connected to the watercourse during higher than baseflow levels (or another design storm event) to allow for water inputs/augmentation, flushing effect, and flow circulation. Risk of algal growth would be managed through offline pool design; some risk for mosquito borne diseases may exist. The surrounding lands would be restored with extensive natural vegetation and provide for a diversity of aquatic and terrestrial habitat, including waterfowl.

Sediment that is dredged or excavated may be reused on-site, where feasible to create floodplain materials or landscape features. It is expected that some sediment will require off-site disposal.

The cost of implementing this alternative is relatively high and changes the aesthetic of the existing area. Opportunities for public recreation enhancement can be developed, if funding is available, to develop additional pathways (east side of pond), include a bridge over the new channel and create look-out points.

4.1.5 Alternative 5: Partially remove dam, lower crest and naturalize the remaining perimeter

In this alternative, the existing dam crest would be lowered and the spillway capacity increased to address the identified stability issues. Further enhancement of the berm may be necessary to address concerns and incorporate recommendations identified by Naylor (2008) to ensure long term stability. The risk for dam failure is thus reduced.

In this alternative, the size of the reservoir would decrease which would reduce the solar heat gain in comparison to existing conditions. This alternative maintains the current aesthetic of an open, but smaller, water feature. The exposed area previously occupied by the pond water would be restored with natural vegetation. Upstream of the ponded water, a naturalized channel will need to be established to maintain aquatic habitat continuity and to maintain concentration of flow up to bankfull flows. Implications of a lower pond on the backwater conditions that occur upstream of County Road 84 will need to be considered and mitigated. The presence of a dam feature will continue to impede upstream fish passage and affect water temperatures seasonally. A fish ladder could be constructed; this would typically be effective in providing fish passage to only a portion of fish species (i.e., those

species that can negotiate the slope and flow velocities occurring in a ladder. A geotechnical assessment should be completed to determine if a fish ladder would compromise berm stability and/or identify measures to mitigate such effects. The dam will impede the continuity of downstream sediment movement and thus continue to induce sediment deposition within the reservoir; this will reduce the visual aesthetic over time, or require future maintenance. Sediment that is dredged or excavated may be reused on-site, where feasible to create floodplain materials or landscape features. It is expected that some sediment will require off-site disposal.

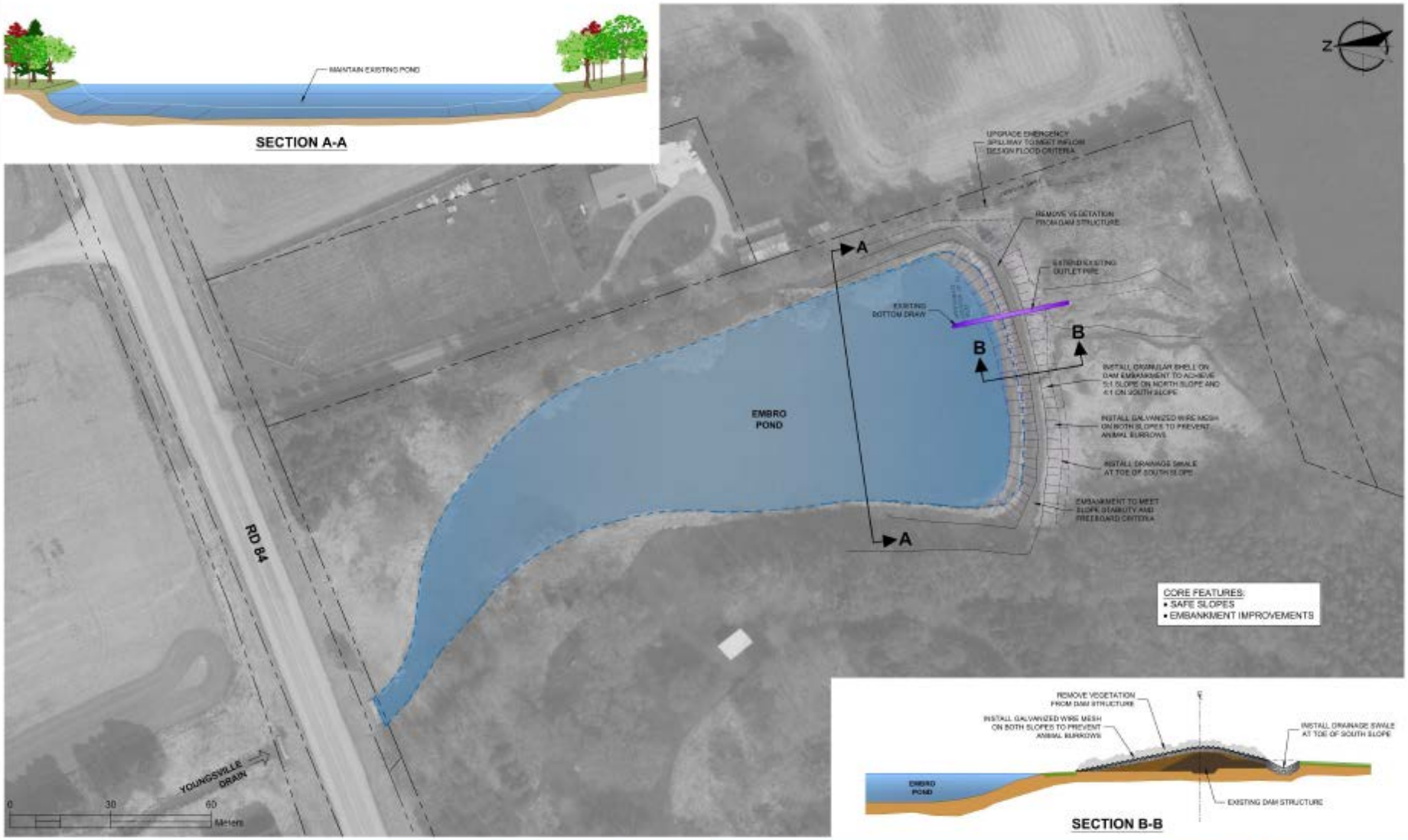
The cost of this alternative is relatively high due to berm stabilization measures, sediment removal and naturalization work.

EMBRO DAM CLASS ENVIRONMENTAL ASSESSMENT

ALTERNATIVE 1
DO NOTHING

ecosystem recovery inc. PROFESSIONAL ENGINEERS

FIGURE 4-1



EMBRO DAM CLASS ENVIRONMENTAL ASSESSMENT

ALTERNATIVE 2
REPAIR/ RECONSTRUCT EXISTING DAM

ecosystem recovery INC. PROFESSIONAL ENGINEERS

FIGURE 4-2

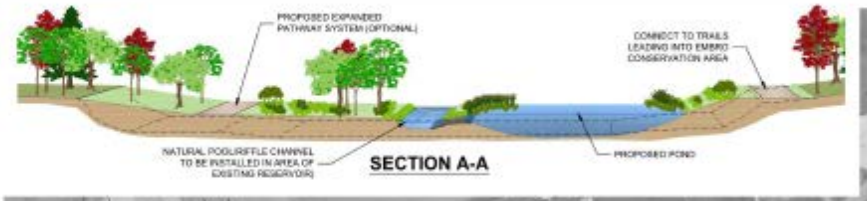
CREEK REALIGNMENTS

EMBRO DAM CLASS ENVIRONMENTAL ASSESSMENT

ALTERNATIVE 3
REMOVE DAM AND CONSTRUCT NATURAL CHANNEL

ecosystem recovery inc. PROFESSIONAL ENGINEERS

FIGURE 4-3



SECTION A-A

POND WITH CREEK

CORE FEATURES:
- NEW PATHWAYS/TRAIL CONNECTIONS
- NATURALIZATION AREAS
- SAFE SLOPES
- NATURAL CHANNEL
- SHORELINE ENHANCEMENT
- OFFLINE POND/WETLAND

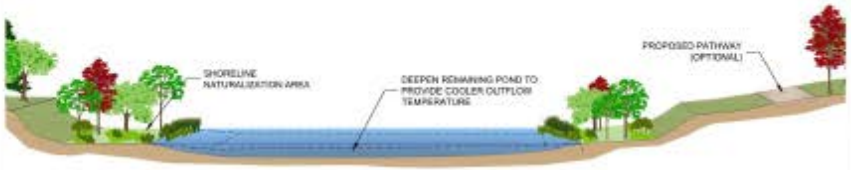
OPTIONAL FEATURES:
(subject to funding)
- PEDESTRIAN BRIDGE
- EXPANDED TRAIL
- LOOKOUT

EMBRO DAM CLASS ENVIRONMENTAL ASSESSMENT

ALTERNATIVE 4
REMOVE DAM AND CONSTRUCT OFFLINE POND(S) OR WETLAND(S)

ecosystem recovery inc. PROFESSIONAL ENGINEERS

FIGURE 4-4



SECTION A-A

CORE FEATURES
- NEW PATHWAYS/TRAIL CONNECTIONS
- NATURALIZATION AREAS
- SAFE SLOPES
- NATURAL CHANNEL
- SHORELINE ENHANCEMENT

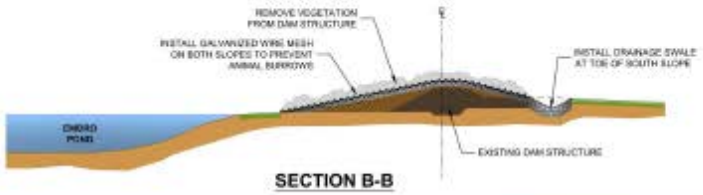
OPTIONAL FEATURES
(subject to funding)
- EXPANDED TRAIL
- LOOKOUT

EMBRO POND

RD 84

YOUNGSVILLE DRAIN

REALIGNED CREEK



SECTION B-B

EMBRO DAM CLASS ENVIRONMENTAL ASSESSMENT

ALTERNATIVE 5
LOWER DAM CREST AND OUTLET AND NATURALIZE NEW POND PERIMETER

ecosystem recovery INC. PROFESSIONAL ENGINEERS

FIGURE 4-5

4.1.6 Additional Alternative Consideration

Through the public consultation process, a member of the public provided additional ideas for consideration in the alternatives, following PIC 3 (see documentation in **Appendix J**). These ideas, quoted from the public correspondence are briefly presented (*in italics*) and discussed below.

> *Drain pond and repair overflow with consideration of a fish ladder from outflow pipe to new creek level. Draining of the pond would reduce wetness factors and seepage factors in the berm, making the repairs suggested by Naylor unnecessary. This option assumes that funding is available for flood control as well as dam removal.*

This alternative maintains existing dam infrastructure and changes how the water in the pond is managed; the impounded area would function similarly to an on-line storm water management facility. A reduction in pond footprint would require some restoration/naturalization for a channel within the now exposed areas of the pond bottom to ensure continuity of flow and habitat. Consideration for the effect of pond lowering on the upstream channel (i.e., currently backwatered) would need to be given which may require in-stream works to reduce negative impacts.

Inclusion of a fish ladder would require local modification (lowering) of the berm (note: a fish ladder can also be included in Alternatives 2 and 5). During high flow events, some impoundment of the flood waters would continue, behind remaining portions of the berm. Confinement of flow at the pond outlet may exert additional stress on the adjacent portions of berm and may require reinforcement of the berm. Typically, fish ladders are only effective at providing access to a portion of the fish species within a watercourse due to configuration of the fish ladder and associated hydraulic conditions. In this regard, fragmentation of aquatic habitat will continue.

The effect of the alternative on adjacent channel sections and aquatic environment will need to be considered with respect to geomorphic form, water quality (e.g., temperature), and continuity of aquatic habitat and flow. If the proposed alternative includes restoration of a channel, then the alternative becomes a hybrid of Alternative 3 and 5, but not an improvement from an environmental perspective. From an overall function perspective, the proposed alternative is closest to Alternative 5 and is not expected to result in substantial cost savings.

Similar to Alternative 5, the alternative variation suggested by the private citizen will require approval by the Ministry of Natural Resources and Forestry for a change in water level operations. Similarly, the implication of berm modifications on berm stability will need to be assessed from a geotechnical perspective and consider the altered hydraulic conditions at the berm outlet to the fish ladder.

Overall, the alternative suggested by the private citizen shows thoughtful consideration for the reduction of liability and cost associated with any works in the area. The alternative includes elements that are similar to Alternatives 2, and 5 (See **Sections 4.1.2** and **4.1.5**), and was thus not advanced to an additional alternative for inclusion in the evaluation process. Instead, draining the pond and lowering the dam crest to accommodate a fish ladder could be considered as a variation on Alternative 5 that incorporates elements of Alternative 3 (i.e., naturalized channel in area of exposed pond bottom).

4.2 Alternative Cost Estimates and Funding Opportunities

As part of the economic evaluation of the alternatives, construction and maintenance costs, and the potential availability for funding is considered (**Section 5.1**). This section provides an overview of cost estimates and funding opportunities.

4.2.1 Construction and Maintenance

A preliminary estimate of the potential costs for each alternative, from a construction and maintenance perspective was developed. These estimates were intended to inform the evaluation process, to inform the UTRCA regarding potential funding estimates, and to inform the public.

The cost estimates were based on unit costs for similar projects undertaken by Ecosystem Recovery, UTRCA, and others. In this regard, the key components of the work necessary to construct the alternative were identified and typical costs applied (e.g., site mobilization, pond dredging, sediment disposal, embankment improvements, spillway construction, dam removal, site restoration etc.). The costs include estimates for mitigating impacts to nearby shallows wells (i.e., drill deeper wells). All costs are based on 2016 price estimates (**Table 4-1**).

Components of operation and maintenance activities are not required annually; some maintenance activity (e.g., dredging) may occur once every 10 years. Costs for maintenance activities were provided by UTRCA. The estimated costs were reduced to an annual rate, to enable better comparison between alternatives. This data can also be used for budget planning purposes by the UTRCA. In addition to costs pertaining to maintenance and operations, the effect of the alternatives on insurance costs should be considered.

Table 4-1. Cost estimates of alternatives.

Alternative 1 Do Nothing			$1,500 to $5,000 per year, Site /sediment restoration ($80,000) [1]
Alternative 2 Repair Dam	Improve dam embankment and outlet, construct emergency spillway, rock protection	$150,000 to $200,000	$1,500 to $20,000 per year, Dam retirement (75 yrs) costs $80,000[1]
Alternative 3 Remove dam and construct natural channel	Dam removal, channel construction, sediment removal, site restoration	$250,000 to $320,000	$1,500 to $3,000 per year
Alternative 4 Remove dam and construct offline pond / wetland	Dam removal, channel construction, sediment removal, offline pond construction, site restoration	$350,000,to $450,000	$1,500 to $5,000 per year

[1] – price based on 2016 value

4.2.2 Potential Funding Sources

Implementation of any alternative, except Alternative 1, will require funding in excess of that collected to date for routine maintenance and operations. Potential funding sources that may be available, depending on the alternative are summarized in **Table 4-2**. The actual funding sources that may be accessible to the project, once implementation is planned should be reviewed; that is, some funding sources may no longer be available and/or new funding opportunities may exist.

Table 4-2. Potential funding sources.

Source	
Upper Thames River Conservation	Project Management at cost .
Municipal Contributions	Zorra Township provides $10,000 annually for operation and maintenance, and required studiesand repairs.
2014 New Building Canada Fund: Provincial-Territorial Infrastructure Component, Small Communities Fund Program	
Recreational Fisheries Conservation Partnerships Program	
Water and Erosion Control Infrastructure Funding (WECI)	
Fundraising	Financial donations from residents and/or organizations could also be obtained to support implementation, or enhancement of an alternative.

5. Evaluation of Alternatives

The process of evaluating alternatives is clearly outline in the MOE (2014) Code of Practise: Preparing, Reviewing and Using Class Environmental Assessments in Ontario and in the Class Environment Assessment for Remedial Flood and Erosion Control Projects (Conservation Ontario, 2012). Evaluation of each of the alternatives is accomplished systematically by identifying evaluation criteria and completing a comparative evaluation process. This chapter provides an overview of the evaluation process that was used to determine the preferred alternative. As part of the environmental assessment process, the technical steering committee and public provided input into the final evaluation process used in this study

5.1 Evaluation Criteria

To identify the alternative that best addresses study objectives, each alternative outlined in **Section 4** was rated against evaluation criteria that are broadly set out by MOE (2014) and includes consideration for technical, economic, environmental, and social factors relevant to the study area. MOE (2014) recommends specific criteria within each factor that should be evaluated; the final selection of criteria is informed by the study area characteristics, findings, and concerns of the public. The evaluation criteria are listed in **Table 5-1** below.

Table 5-2 shows the rating scale used to assess each alternative against the evaluation criteria and in comparison to the other alternatives. The rating provides a numerical basis for evaluation in contrast to symbols, which are more difficult to tabulate.

Each of the category scores is adjusted to be out of 25% (i.e., equally weighted) since each criteria category is considered to be equally important; this is in keeping with the MOE (2014) Environmental Assessment process. Once each category score is calculated and normalized/weighted, then these are summed to derive an overall category score (i.e., technical, economic, environmental and social). The category scores allow for a comparison between alternatives. Tabulation of all category scores is completed to define an overall score. The top score is ranked as preferred.

Table 5-1 - Alternatives Evaluation Criteria

Criteria	Description
Technical/Engineering (25% of score)	
Dam Safety	Effectiveness of the alternative to meet Dam Safety Guidelines, reduce risk of failure
Protection of Properties	Effectiveness of the alternative in mitigating risk (flooding, failure) to adjacent properties
Constructability	Potential to implement the project using conventional, accepted practices
Implementability	Potential to implement the alternative, based on common accepted management practise
Approvability	Potential for regulatory agencies to grant approval for implementation
Natural Environment (25% of score)	
Aquatic (Creek) Habitat Impacts/Enhancement	Effectiveness of the alternative to enhance fisheries resources; fish diversity, food source, and fish passage
Aquatic (Pond) habitat Impacts/Enhancements	Effectiveness of the alternative to enhance pond habitat (fish, fowl, wildlife) resources, diversity, food source
Terrestrial Habitat Impacts/Enhancement	Potential for impact and/or enhancement to connectivity and terrestrial habitat (amphibian, avian, mammal) due to implementation of the alternative
SAR Impacts/Enhancement	Potential for impact and/or enhancement to wildlife habitat and existing SAR in the project area
Geomorphology/Sediment Transport	Effectiveness of the alternative to promote dynamic stability of channel processes and mitigate sediment impacts
Groundwater Impacts/Enhancement	Potential for impact and/or enhancement to groundwater regimes in the project area (baseflow, recharge, water table, etc.)
Water Quality Impacts/Enhancement	Effectiveness of the alternative to improve water quality, TSS, phosphorous, nutrient uptake
Social/Cultural (25% of score)	
Impact to Private Property	Measure of the impact to adjacent private property (i.e., loss of property, access to property)
Impact to Public Access	Measure of impact to public access (e.g., trails, recreation - picnic, fish, boat)
Impact to Public Safety	Measure of the impact to public safety in the surrounding area resulting from the alternative
Impact to Cultural/Heritage Features	Potential impact to existing cultural and/or heritage features in the project area
Recreational Impacts/Enhancement	Measure of the impact to existing recreation and opportunities to enhance recreational activities in the project area
Economic (25% of score)	
Construction Costs	Relative measure of the initial costs to install/construct the proposed works, including environmental mitigation, sediment management etc.
Maintenance/Future Costs	Relative measure of the ongoing maintenance costs following implementation (or continued maintenance)
Availability of Funding	Estimate of the availability for funding to implement the alternative

Table 5-2 - Evaluation Ranking Criteria

1	Least positive, or negative impact • Most cost • Environmental degradation • Difficult to implement
2	Minor negative impact
3	Neutral impact
4	Positive impact
5	Most positive or beneficial impact • Least cost • Environmental improvement/gain

5.2 Evaluation Matrix

The alternative evaluation is shown in **Table 5-3**. Each of the criteria identified in **Table 5-1** was assigned a rank (**Table 5-2**). The evaluation matrix received input from each of the discipline leads involved in this study based on their knowledge of their study findings; public input received through the public consultation process was also considered through the evaluation process. The completed matrix was subject to further review, input, and adjustment from the technical steering committee. Thus, the evaluation matrix was subject to a rigorous evaluation process.

Table 5-3. Alternative evaluation matrix.

Criteria	Description	Alternative 1 Do Nothing	Alternative 2 Repair Dam	Alternative 3 Remove Dam and Construct a Natural Channel	Alternative 4 Remove Dam and Construct Offline Pond(s) or Wetland(s)	Alternative 5 Lower Dam Crest and Outlet and Naturalize New Pond Perimeter
TECHNICAL/ENGINEERING						
Flooding Impacts/Enhancement	Effectiveness of the alternative to manage or reduce flooding, or not cause negative impacts to flooding					
Dam Safety/Integrity	Effectiveness of the alternative to address dam safety requirements, reduce risk of failure	1	4	5	5	4
Protection of Properties	Effectiveness of the alternative in mitigating risk (flooding, failure) to adjacent properties	1	2	5	5	3
Constructability	Potential to construct the project using conventional, accepted construction and engineering practices	5	5	5	5	5
Implementability	Potential to implement the alternative, based on common accepted management practise	3	3	5	5	3
Approvability	Potential for regulatory agencies to grant approval for implementation	1	3	5	4	3
	TOTAL CATEGORY SCORE	**11**	**17**	**25**	**24**	**18**
	NORMALIZED CATEGORY SCORE (25% WEIGHTING)	**11**	**17**	**25**	**24**	**18**
	CATEGORY RANKING (1 = most preferred; 5 = least preferred)	**5**	**4**	**1**	**2**	**3**
NATURAL ENVIRONMENT						
Aquatic (Creek) Habitat Impacts/Enhancement	Effectiveness of the alternative to enhance fisheries resources; fish diversity, food source, and fish passage	1	1	5	5	1
Aquatic (Pond) habitat Impacts/Enhancements	Effectiveness of the alternative to enhance pond habitat (fish, fowl, wildlife) resources, diversity, food source	3	4	1	3	5
Terrestrial Habitat Impacts/Enhancement	Potential for impact and/or enhancement to connectivity and terrestrial habitat (amphibian, avian, mammal) due to implementation of the alternative	1	1	4	5	4
SAR Impacts/Enhancement	Potential for impact and/or enhancement to potential SAR in the project area	1	1	4	5	3
Geomorphology/Sediment Transport	Effectiveness of the alternative to promote dynamic stability of channel processes and mitigate sediment impacts	1	1	5	5	2
Groundwater Impacts/Enhancement	Potential for impact and/or enhancement to groundwater regimes in the project area (baseflow, recharge, water table, etc.)	3	4	4	3	3
Water Quality Impacts/Enhancement	Effectiveness of the alternative to improve water quality, temperature, TSS, phosphorous, nutrient uptake	1	2	5	4	3
	TOTAL CATEGORY SCORE	**11**	**14**	**28**	**30**	**21**
	NORMALIZED CATEGORY SCORE (25% WEIGHTING)	**8**	**10**	**20**	**21**	**15**
	CATEGORY RANKING (1 = most preferred; 5 = least preferred)	**5**	**4**	**2**	**1**	**3**
SOCIAL / CULTURAL ENVIRONMENT						
Impact to Private Property	Measure of the impact to adjacent private property (i.e., loss of property, access to property)	4	4	4	3	3
Impact to Public Access	Measure of impact to public access (e.g., trails, recreation - picnic, fish, boat)	3	4	3	3	4
Impact to Public Safety	Measure of the impact to public safety in the surrounding area resulting from the alternative	1	3	4	3	3
Impact to Cultural/Heritage Features	Potential impact to existing cultural and/or heritage features in the project area	5	5	1	1	4
Recreational Impacts/Enhancement	Measure of the impact to existing recreation and opportunities to enhance recreational activities in the project area	3	3	3	4	4
	TOTAL CATEGORY SCORE	**16**	**19**	**15**	**14**	**18**
	NORMALIZED CATEGORY SCORE (25% WEIGHTING)	**16**	**19**	**15**	**14**	**18**
	CATEGORY RANKING (1 = most preferred; 5 = least preferred)	**3**	**1**	**4**	**5**	**2**
ECONOMIC						
Construction Costs	Relative measure of the initial costs to install/construct the proposed works, including environmental mitigation, sediment management, etc.)	5	4	3	2	1
Maintenance/Future Costs	Relative measure of the ongoing maintenance costs following implementation (or continued maintenance)	1	3	4	4	3
Availability of Funding	Estimate of the availability for funding to implement the alternative	3	3	5	4	2
	TOTAL CATEGORY SCORE	**9**	**10**	**12**	**10**	**6**
	NORMALIZED CATEGORY SCORE (25% WEIGHTING)	**15**	**17**	**20**	**17**	**10**
	CATEGORY RANKING (1 = most preferred; 5 = least preferred)	**4**	**2**	**1**	**2**	**5**
	OVERALL NORMALIZED CATEGORY SCORE (100% WEIGHTING)	**50**	**63**	**80**	**76**	**61**
	PREFERRED OVERALL RANKING (1 = most preferred; 5 = least preferred)	**5**	**3**	**1**	**2**	**4**

Notes: Scoring ranks alternatives in their potential to address the criteria from a least positive to a most positive impact, 1 being the least positive and 5 being the most positive

The alternatives presented are envisioned as improvements to the existing conditions which are anticipated to address the problem statement

Negative impacts which may be involved in some alternatives, such as site disturbance, are temporary and are seen as mitigatable impacts

6. Public Consultation

Public Information Centres (PICs) are the primary method to consult with members of the public, communicate important project details, and request feedback on the Class EA process and results. The main objectives of the public consultation process include the following:

Inform the public and stakeholders about the project;

- Fully inform agencies and regulators of the Class EA progress in order to solicit early feedback;
- Develop public support for the preferred project solutions; and
- Meet or exceed the requirements of the Class EA process.

The UTRCA established a web page that provided all study documentation available for public review. This included copies of presentation materials (slide shows, boards), questionnaires and public feedback received, and draft study reports. **Appendix J** contains all documentation prepared through the public consultation process.

6.1 Notice of Intent

A comprehensive stakeholder contact list has been developed to support the public consultation process, identifying agencies and organizations that may be interested in the project and/or agencies that must be consulted during the Class EA process; this included consultation with First Nations. This contact list was formed on the basis of project mailings (Commencement/Completion Notice, Notice of PIC, etc.).

A Notice of Intent was been prepared to inform the public of the project and provide contact information for Ecosystem Recovery and UTRCA staff for interested members of the public. This notice was mailed to recipients on the contact list. In addition, the Township set-up a project-specific page on their website with a summary of the project and links to the UTRCA website where copies of presentations, draft reports, and notices were available. A notice of commencement was also posted to the project website (http://thamesriver.on.ca/water-management/recreational-dams/classea-harrington-embro-dams/). A copy of the Notice is included in **Appendix J**.

6.2 Public Information Center #1

The first Public Information Center was held on June 23, 2015 at the Embro Community Centre. The purpose of this PIC was to outline the Environmental Assessment process, present background information and the methodology that was used to complete the characterization of existing conditions at the project site.

The PIC consisted of a presentation of PIC materials followed by an open house format with presentation boards displaying project information. Ecosystem Recovery and UTRCA staff hosted the PIC and were available to address questions and concerns from attendees. Thirteen people recorded their attendance on the PIC sign-in sheet.

A detailed questionnaire was prepared and provided to attendees, providing a guided tool to obtain high quality feedback on the projects. Two questionnaires were completed by attendees and submitted to the project team, with the following input:

- “Would be better to restore creek to original condition. Brook Trout are resident above Embro Pond. Thames River Anglers hatchery has raised and reintroduced them. Downstream of the pond supports some Brook Trout but no reproduction takes place due to water quality and temperature. Removing the pond would remedy this.”

- "Good visual exhibits and clear PowerPoint. Difficult to manage some questions but speakers remained polite and informative. Thank you. Perhaps draw e.g., of Woodstock Pond where residents opposed suggestion to drain pond and authorities listened. The pond remains.

Questionnaires and PIC presentation material can be found in **Appendix J**.

6.3 Public Information Center #2

The second Public Information Center was held on May 10, 2016 at the Embro Community Centre. The meeting was attended by three councillors and the mayor of Zorra Township and two (2) members of the public. The purpose of this PIC was to present a summary of findings from the completed studies and site inventories and to present the different potential alternative for the dam. Solicitation of public feedback was undertaken with respect to the study components, the potential alternatives, identification of additional alternatives, and consideration of elements to be considered in the evaluation of alternatives.

The PIC consisted of an open house format with a formal presentation of study findings and a review of the potential alternatives that were presented on display boards. The PIC was hosted by UTRCA and Ecosystem Recovery. UTRCA staff who had been involved with the project were available to address questions and concerns from attendees.

A detailed questionnaire was prepared and provided to attendees to guide the feedback process on the project. Comments were provided by one of the member of the public in attendance at the meeting, and two stakeholder groups (Thames River Anglers Association (TRAA) and Stewardship Oxford (SOX)), a summary of key items raised by the groups and community member is as follows:

- Alternatives that perpetuate status quo, deteriorating environmental conditions, or lack of upgrade to contemporary environmental status are not preferred
- Cost-benefit analyses of Alternatives 2 and 4 may be beneficial to better assess these alternatives
- Preference for wetland over pond for alternative 4.
- Dislike for artificial structures.
- Management for pond or wetland may be required into the future to ensure no adverse impacts on the watercourse.
- Preferred alternative should be cheaper of taking out the dam and develop a natural watercourse or follow the Acres and Naylor reports and refurbish the dam.
- Recommendations were provided to further consider climate change effects, liability, and to undertake additional documentation and review of existing conditions (water temperature, fish species, etc.)

Suggestions for enhancement of the technical study reports and/or clarification of specific findings presented at PIC 2 and/or within the draft existing condition reports that had been made available to the public were addressed through updates to the report, where these were within the scope of an Environmental Assessment study and/or direct communication with the author of the letter. A copy of correspondence is provided in **Appendix J**.

All respondents were asked which alternative they liked best. Several respondents provided more than one answer and several respondents provided general considerations that were summarized above. Based on the questionnaire, the respondents indicated that they liked Alternative 3 most (see **Table 6-1**); this is reflected in the comments summarized above.

Table 6-1. Summary of PIC 2 questionnaire results

1. Do nothing	
2. Repair dam	1
3. Remove dam and construct a natural channel	3
4. Remove dam and construct offline ponds or wetlands	
5. Lower dam crest and outlet and naturalize new pond perimeter	

One member of the public provided correspondence which outlined various questions and concerns relating to specific study area findings and study process. UTRCA undertook additional consultation with this private citizen as outlined in Section 6.5

A copy of the PIC presentation materials, questionnaire and a summary of the discussions that followed the presentation can be found in **Appendix J**.

6.4 Public Information Center #3

The third Public Information Center (PIC) was held on October 17, 2016 at the Embro Community Centre. The meeting was attended by three councillors and eight (8) members of the public, including representatives of non-government agencies. The purpose of this PIC was to present the alternative evaluation process, and to confirm the preferred alternative for the dam.

The PIC consisted of an open house format with a formal presentation that provided a brief overview of the project, the preliminary alternatives, a summary of PIC 2 feedback, the evaluation process, and selection of the preferred alternative. Presentation boards displaying the evaluation matrix and preferred alternative were provided for review and discussion throughout the open house. . Ecosystem Recovery and UTRCA staff hosted the PIC and were available to address questions and concerns from attendees.

A questionnaire was prepared to obtain feedback regarding the preferred alternative. Three (3) responses were received after the PIC, two of which were from non-government agencies (NGO) (Ontario Rivers Alliance, Thames River Anglers Association) and one from an active member of the public. The content of the responses is summarized below:

- The two NGO's indicated strong support for the preferred alternative.
  Feedback from the private resident questioned various components of the EA study, the evaluation process, derivation of the preliminary cost estimates for each alternative, and encouraged further exploration alternatives that would be less costly and reduce liability for UTRCA.

A copy of the PIC presentation materials, questionnaire and a summary of the discussions that followed the presentation can be found in **Appendix J**.

Based on the public comments received, UTRCA initiated further dialogue with the private resident as outlined in **Section 6.5**.

6.5 Additional Consultation

In response to comments provided by one member of the public, UTRCA project staff undertook additional consultation with this private citizen. Ecosystem Recovery provided technical support to UTRCA in all communications provided to this citizen. The additional consultation occurred after both PIC 2 and PIC 3.

In conjunction with feedback regarding the alternatives presented at PIC 2, the private citizen provided comprehensive written communication that outlined various concerns regarding study findings. In response, updates to relevant sections of the existing condition reports, and figures, were made, to provide additional clarification and/or to provide context for the results questioned. A copy of all written communications is provided in **Appendix J**.

Following PIC 3, the private citizen provided additional correspondence. UTRCA met with the citizen to discuss various items raised in the correspondence which included further discussion regarding the EA evaluation process and to further explore his suggestions for additional dam alternatives. A formal response was provided by the study team in response to key concerns and suggestions raised in the written communications (see **Appendix J**). Consideration of the alternative suggestions provided by the citizen are included in **Section 4.1.6**.

7. Selection of Preferred Alternative

The purpose of the Class EA is to evaluate the existing technical, natural, social, and economic conditions related to the identified problem or opportunity, to develop and evaluate potential alternatives to address the problem, and to select a preferred alternative that would proceed to implementation. This section describes the results of the alternative evaluation process which included input received from the public, and describes the preferred approach for addressing identified erosion issues in the study area.

7.1 Preferred Alternative

The preferred alternative, determined through the evaluation process is Alternative 3 (**Figure 7-1**). In this alternative, the dam would be removed and a naturalized channel would be established. The preferred alternative creates an opportunity to remove risk of dam failure, to limit future maintenance costs, and to enhance both the aquatic and terrestrial environments. In addition to the alternative description provided in **Section 4.1**, further description of the preferred alternative is provided below. Additional studies, as outlined in **Section 8.1**, will need to be undertaken to support the detailed design process.

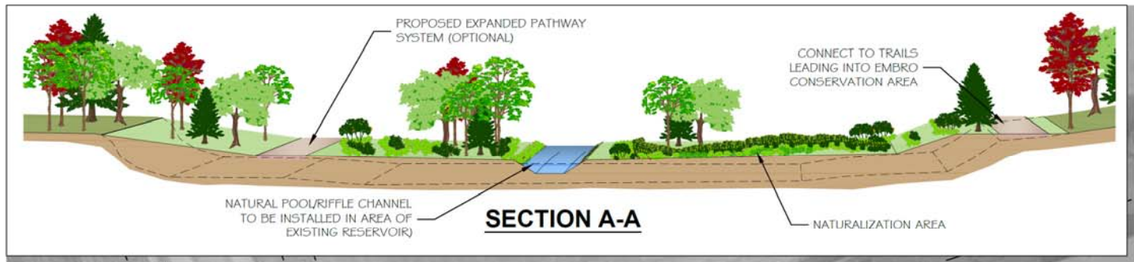
The existing embankment and dam outlet would be modified/removed. The opening of the embankment would be sufficiently wide to enable conveyance of design floods. The remaining ends of the embankment would be maintained and integrated into the site restoration works; this could include re-vegetation and/or establishment of a lookout area.

Establishment of a defined channel within the existing footprint of the Embro dam impoundment is a key defining feature of the preferred alternative. While it is recognized that Youngsville Drain has adjusted to the grade control that has been exerted by Embro dam, review of the topographic profile through the creek and impounded area behind the dam reveals a nearly 1.5% grade **(Figure 7-2**). If it is assumed that minimal excavation of the area behind the dam has occurred in conjunction with establishment of the dam (though some excavation is expected to have occurred in conjunction with any dredging activity), then the topographic profile of the ground surface approximate the original slope of the land, prior to dam establishment. The 1.5% slope shown on the profile is within the natural range of a riffle-pool watercourse and should pose no constraints to the re-establishment of a geomorphologically stable and functioning channel. The proposed design will need to be mindful of the implication of dam removal on the currently backwatered areas upstream of Road 84. Similarly, the design will need to be mindful of the transition into the downstream, existing channel. Proposed works should not contribute to an increase in erosion/deposition within the adjacent portions of the Youngsville Drain.

While allowing the flow from Youngsville Drain to re-establish a defined watercourse can be considered, such an approach should be mindful of the fact that the impounded area has been modified due to dredging activity and accumulation of fine sediment. A loss of channel boundary forming materials has occurred (i.e. to establish channel banks). Thus, while allowing some natural processes to re-shape the channel (e.g., upstream of Road 84) may be considered, it is recommended that some active channel restoration work be undertaken.

The restored watercourse should incorporate principles of fluvial geomorphology and include, where possible, aquatic habitat elements that are beneficial/preferred by resident species. The planform and profile (e.g., riffle-pool) configuration of the watercourse should be suitable for the energy and bankfull flow conditions (i.e., recurrence interval of ~ 1.6 yrs) that occur within the study area, provide floodplain connectivity (i.e., for larger than bankfull flows), and consider implication of larger flow events on both the floodplain and the channel.

Incorporation of bioengineered materials is recommended to minimize risk of erosion and channel failure in the area immediately post-construction. Vegetative plantings that enhance bank stability through the rooting network are recommended. Woody debris could be implemented in the design.



SECTION A-A

N

RD 84

OVERFLOW SWALE

EMBANKMENT ENDS TO BE MAINTAINED AND INTEGRATED INTO SITE RESTORATION PLANS

DAM OUTLET WORKS TO BE REMOVED

INTEGRATE CHANNEL INTO DOWNSTREAM CHANNEL

PROPOSED EXPANDED PATHWAY SYSTEM (OPTIONAL)

A

BRIDGE (OPTIONAL)

NATURAL POOL/RIFFLE CHANNEL TO BE INSTALLED IN AREA OF EXISTING RESERVOIR)

CENTRAL PORTION OF DAM TO BE REMOVED

POOL

EMBRO POND

PROPOSED LOOKOUT ON OLD DAM EMBANKMENT (OPTIONAL)

A

RESERVOIR TO BE DRAINED AND SEDIMENT REMOVED/REUSED AS REQUIRED TO ESTABLISH A NATURAL SLOPE IN THE NEW CHANNEL

NATURALIZATION AREA

BIOENGINEERING BANK STABILIZATION

CONNECT TO TRAILS LEADING INTO EMBRO CONSERVATION AREA

Potential Enhancements (subject to funding)

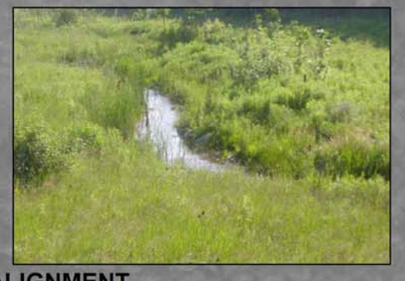
- New trail extensions
- Lookout areas
- Pedestrian bridge over creek
- Educational signage of area history and restoration works

Design Elements

- Extended trail along west side
- Establish naturalized watercourse with habitat features appropriate for target species
- Incorporate terrestrial habitat enhancements (e.g., barn swallow nesting boxes or raptor poles, snake hibernaculum, woody debris piles)
- Enhance vegetation diversity

YOUNGSVILLE DRAIN

0 30 60 Meters



CREEK REALIGNMENT

EMBRO DAM CLASS ENVIRONMENTAL ASSESSMENT

PREFERRED ALTERNATIVE
REMOVE DAM AND CONSTRUCT NATURAL CHANNEL

ecosystem recovery inc. PROFESSIONAL ENGINEERS

FIGURE 7-1

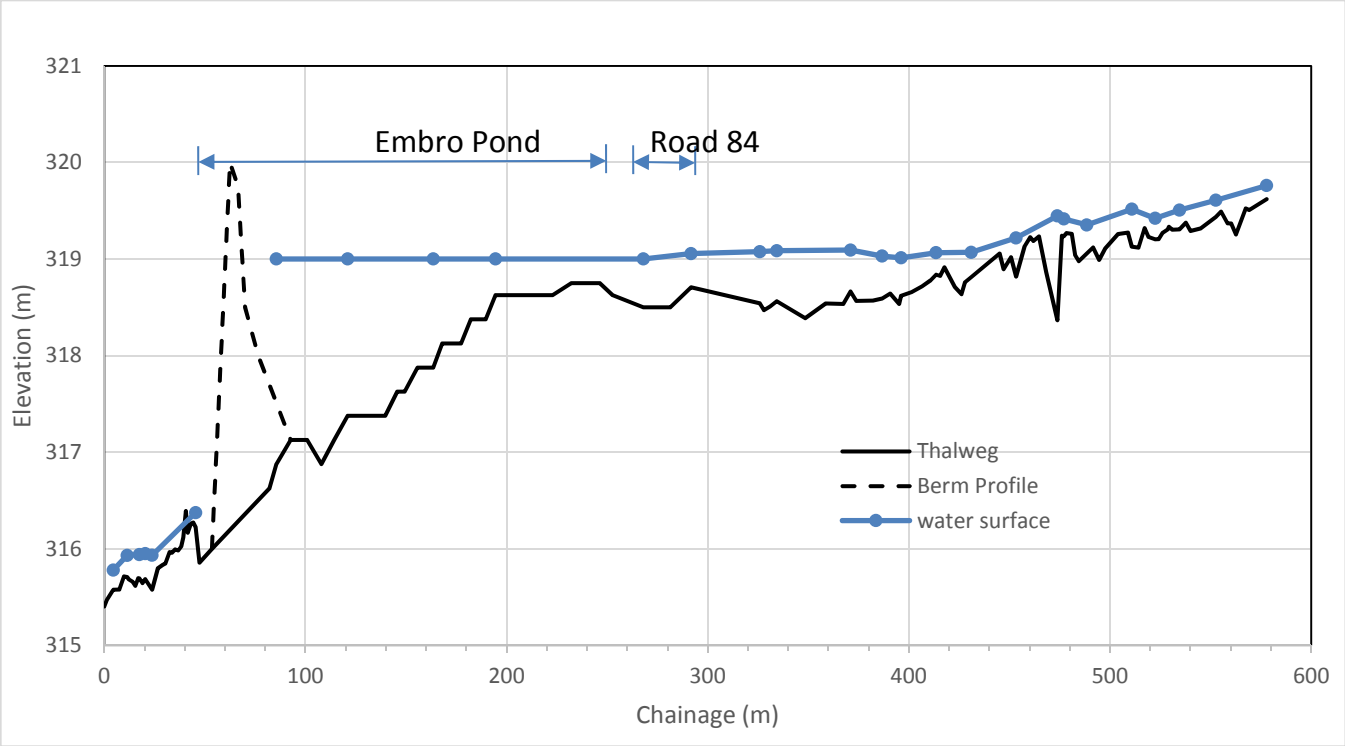


Figure 7-2. Topographic profile through study area.

Establishment of a trail leading into the conservation area, from the area near the picnic shelter should be considered. A bridge could be incorporated into the design, subject to funding availability, to enable a crossing over the watercourse, and connectivity to a trail along the east side of pond. A viewing area could be established along the creek. Educational signage could be established within the area to educate the public regarding the history of the Embro Conservation Area and the restoration works that have been undertaken.

7.2 Potential Impacts and Mitigation

Regardless of which alternative is determined to be preferred through the evaluation process, implications of the alternative on one or more of the criteria in the evaluation matrix can be foreseen. A review of key impacts and potential mitigation measures associated with the preferred alternative are summarized below.

Technical: Removal of the dam and the associated impoundment may interfere with nearby shallow groundwater wells. It is recommended that a shallow well inventory/assessment be completed to identify and further assess potential impacts of dam removal on the operation of these wells. If impacts are identified, then new (deeper) wells should be drilled.

Removal of the dam and impounded area, in conjunction with the re-establishment of a defined 'bankfull' channel, will decrease backwater effects into the Youngsville drain upstream of Road 84. Flood events (i.e., larger than the bankfull or 2 year flow) will spill onto a newly established floodplain adjacent to the designed watercourse; this floodplain connectivity will provide for temporary water storage and thus mitigate peak flows during flood events.

Environmental: From an environmental perspective, a loss of open water conditions will occur with removal of the dam. This will represent a loss for waterfowl and for any resident fish species within the pond.

The currently impounded area will be replaced with terrestrial habitat and an open watercourse feature. Opportunities to enhance the terrestrial corridor and to provide enhanced diversity of vegetation will occur. The vegetation will contribute to improved water cooling conditions and will enable capture of sediment and other pollutants during flood events (i.e., on the floodplain). Opportunities to enhance terrestrial conditions are provided through grading on the floodplain.

Removal of the fish migration impediment that is created by the dam increases the habitat connectivity of Youngsville Drain and enables access to upstream habitat. This will contribute to an increase in fish species diversity. Aquatic habitat enhancement will occur through the naturalized channel restoration and riparian vegetation.

Improvements to water quality are anticipated, specifically with respect to water temperature. That is, the removal of the 'online' pond will decrease the warming effect that occurs with impounded water. Further, the establishment of vegetation that can provide shade to the area will contribute to cooling.

Social and Cultural: The recreational opportunities currently associated with the Embro dam and pond will change. A loss of fishing and recreational boating (canoe) will occur through the preferred alternative. The recreational opportunities that may be implemented include trail enhancement, educational signage, and enhanced opportunities for 'birding' and viewing of other wildlife species.

Financial Funding to support implementation of the preferred alternative would include funds that may be available from the Upper Thames Conservation Authority, Zorra Township, Provincial funding sources, and non-government agency initiatives. A summary of currently available funding sources is provided in **Table 4-2**.

8. Project Implementation

8.1 Next Steps

It is recommended that the UTRCA proceed with implementation of the preferred alternative as described in **Section 7**, subject to budgetary constraints. Funding for this alternative will define the time frame for implementation. Once funding is available, additional study requirements should be initiated, to inform the detailed design process; these include, but are not limited to the following:

- Locate and assess all shallow wells that may be affected by implementation of the preferred alternative and identify what, if any, mitigation measures will need to be incorporated into the detailed design.
- Hydrologic study review/update to quantify design flows for the study area.
- Determine sediment disposal options with additional sediment samples.

Detailed design and supporting analyses are required to determine the appropriate restoration/mitigation approach and materials given the flow characteristics through Youngsville Drain. Engineering drawings for tender and construction will need to be produced. Following the completion of design and acquisition of the required permits and approvals (see **Section 8.2**), eligible contractors should be evaluated on the basis of their previous creek rehabilitation and erosion control experience, with particular emphasis on in-water work experience, to help contribute to the quality and effectiveness of implementation.

Consideration should be given to initiating a Dam Safety Review if implementation of the preferred alternative is delayed. MNRF (2011) recommends that Dam Safety Reviews be completed on a maximum 10 year cycle; the last reviews were completed in 2007 and 2008.

8.2 Design Considerations

The detailed design should incorporate findings from the EA study and supplement this with additional study as outlined in **Section 8.1**, and other data needs necessary to support the design process. The design should be based on sound engineering practise with due consideration for enhancement of the natural environment. The selection of restoration materials (substrate gradation, bank treatments) should replicate natural conditions and include diversity that will sustain various ecosystem components that will enhance the health of Youngsville Creek (e.g., macroinvertebrates). Similarly, the design parameters should support a functioning and geomorphically stable watercourse.

8.3 Permits and Approvals

The detailed design of the proposed erosion control works, when completed, must be submitted for approval to Upper Thames Region Conservation Authority (UTRCA) along with the completed “Application for Development, Interference with Wetlands and Alterations to Shorelines and Watercourses” form (pursuant to Ontario Regulation 160/06), prior to any construction activities taking place.

An application for approval from the Department of Fisheries and Oceans (DFO) under the *Fisheries Act* may also be required; UTRCA staff will evaluate the proposed works for their potential to create a Harmful Alteration, Disruption or Destruction (HADD) of aquatic habitat in the study area, UTRCA may issue a Letter of Advice with requirements for habitat compensation. If no such compensation can be arranged for the anticipated HADD, an application to DFO will be required.

Under Section 16 of the Lakes and Rivers Improvement Act, ‘no person shall alter, improve, or repair any part of a dam… unless the plans and specifications for whatever is to be done have been approved’ by the Ministry of Natural Resources and Forestry. Likewise, under Section 2(1)(b) of Ontario Regulation 454/96, Ministry approval is required to make alternations improvements or repairs to a dam that holds back water in a river, pond, or

stream if these may affect the dam's safety, structural integrity, the waters or natural resources. Further, Section 2(2) of Ontario Regulation 454/96 specifies that LRIA Section 16 approval is required before a person operates a dam in a manner different from that contemplated by previously approved plans and specifications (see: https://www.ontario.ca/page/alterations-improvements-and-repairs-existing-dams for additional information).

8.4 Preliminary Cost Estimate

A preliminary cost estimate was prepared for the each of the alternative. This cost estimate includes all works associated with removal of the dam outlet, embankment, dredgate disposal, drilling of deeper wells, channel restoration, restoration plantings and trail, based on the concept design description in current dollars and market conditions. The preliminary cost estimate is $250,000 to $320,000. The actual total costs will vary depending on when implementation will be executed, findings from the groundwater well assessment, and on materials used as some materials tend to have fluctuating costs such as rock and armourstone.

8.5 Mitigation Measures and Monitoring Program

To ensure the future protection of ecological features within the preferred site, the following mitigation features should be implemented during construction, and illustrated in the detailed design drawings:

- **Erosion and Sediment Control**: Mitigation measures must be used for erosion and sediment control to prohibit sediment from entering the surrounding natural areas. The primary principles associated with sedimentation and erosion protection measures are to: (1) minimize the duration of soil exposure, (2) retain existing vegetation, where feasible, (3) encourage re-vegetation, (4) divert runoff away from exposed soils, (5) keep runoff velocities low, and (6) trap sediment as close to the source as possible. To address these principles, the following mitigation measures are proposed:
  - According to Ontario Provincial Standard Specifications, silt fencing (OPSD 219.110) is required along all construction areas.
  - All surfaces susceptible to erosion should be re-vegetated through the placement of seeding, mulching or sodding immediately upon completion of construction activities.
  - All dewatering required for construction is to be discharged to a sediment trap at least 15m away from the watercourse.
- **Grading Techniques**: Site grading and runoff controls should be developed during final design to mitigate potential stormwater runoff impacts to the surrounding natural areas. This plan should provide for post-construction contours that minimize runoff to the natural areas.
- **Construction Timing**: To mitigate impacts to breeding birds, any tree and site clearing should take place between September and March 31st and avoid the months of April through August. This is to ensure that works do not disturb any potentially nesting birds. This is in accordance with the Migratory Birds Convention Act. Fisheries timing windows should be determined in consultation with the MNR. For fall spawning fish (e.g., Brook Trout), in-water works are typically not permitted between October 1st and May 31st; this should be confirmed.
- **Breeding Bird Surveys**: Should tree clearing be scheduled within the months of April through August, comprehensive breeding bird surveys need to be conducted prior to tree clearing to ensure there is no disturbance of nesting/breeding birds. Surveys should document the location of breeding pairs and potential location of nests. Should nests/breeding pairs be discovered within the clearing area, the location should be clearly marked/flagged and a 10 metre buffer surrounding the nest be implemented. The space within this buffer should be protected until the young are fully fledged. An ecologist with ornithological experience should conduct the surveys and monitor the nests (should nests be discovered) periodically. Clearing can only be undertaken if the ecologist is satisfied there are no breeding/nesting pairs within the affected area.

- **Plantings**: If trees larger than 150mm diameter at breast height (DBH) need to be removed during construction, the goal should be to replace native species at a 2:1 ratio.

8.5.1 Construction Impacts and Monitoring

The potential negative effects to the natural environment as a result of the proposed work can be reduced with the implementation of standard mitigation measures. The following describes general mitigation measures that are recommended for implementation during the proposed works:

- Extensive sediment and erosion control measures (e.g., silt fencing, trenching) should be established prior to the commencement of any construction activities and remain in place until all disturbed areas are fully stabilized to retain sediment on site and prevent its entry to the creek and wetland communities;
- Clearing of riparian trees and/or shrubs should be minimized such that physical and biological functional attributes of the terrestrial vegetation can be maintained as they relate to aquatic ecological function;
- All exposed areas should be kept to a minimum at all times to minimize the potential for soil erosion and sedimentation within the creek;
- Reinforced sediment control measures, such as double silt fencing, is recommended for select locations in order to provide enhanced containment and erosion protection for adjacent environmentally sensitive areas;
- The proposed timing of construction, e.g., winter and/or summer, does not conflict with fish spawning times (MNR restricted in-water work timing window), which for Brook Trout supporting systems is from October 1st to May 31st ;
- Machinery will arrive on site in a clean, washed condition and is to be maintained free of fluid leaks;
- Wash, refuel and service machinery and store fuel and other materials for the machinery away from water to prevent any deleterious substance from entering the water;
- Re-vegetation of disturbed areas should be completed promptly and through consultation with UTRCA;
- All activities, including maintenance procedures, shall be controlled to prevent the entry of petroleum products, debris, rubble, concrete or other deleterious substances into the creek;
- Re-fuelling and servicing and inspection of all construction equipment should take place no less than 30 metres away from the creek to ensure no leakage of any deleterious substances to the creek or the local environment;
- Construction material, excess fill, construction debris, stockpiling and empty containers should be stored no less than 30 metres away from the water to ensure no run-off of any deleterious substances to the creek occurs;
- Prior to dewatering, all fish should be removed from the area to be isolated and dewatered. Fish should be released downstream of the work area and nets installed to prevent their reintroduction into the work area. Dewatering pump intakes should be screened (*Freshwater Intake End-of-Pipe Fish Screen Guidelines*, DFO) in a manner that prevents fish from becoming impinged and injured. Fish passage must be maintained at all times, see Section 3.2.4 - *Fish Passage.* Silt and debris accumulated around the temporary cofferdams should be removed prior to the removal of all isolation materials to prevent entry of sediments to the watercourse; and
- Use dams made of non-earthen material, such as water inflated portable dams, pea gravel bags, concrete blocks, steel or wood walls, clean rock, sheet pile, or other appropriate designs to separate the dewatered work site from flowing water.

In addition to environmental mitigation measures during construction, measures to protect critical habitat for endangered species and species of special concern are recommended.

Construction monitoring is undertaken during the implementation of proposed works to ensure that methods for mitigating concerns and for environmental enhancement are performed as planned and approved, and that any problems that may arise during construction are effectively addressed. Construction activities are to be undertaken in accordance with all applicable guidelines, policies, regulations and statutes.

Construction monitoring is to be undertaken by the proponents of the project (e.g., UTRCA) or agents thereof. Responsibilities for construction monitoring include:

- Ensuring adherence to the approved design and monitoring requirements;
- Meetings with project construction staff to ensure the function and correct installation of mitigation measures are understood;
- Providing direction in unplanned situations with the potential for environmental impacts; and
- Addressing noted deficiencies promptly, as required, with construction staff and proponents.

Detailed monitoring and compliance records are to be developed as construction progresses, and submitted to the project proponents for review on request.

8.5.2 Post-Construction Monitoring

Post-construction monitoring of the creek remediation works is to be undertaken to assess the effectiveness and environmental performance of the project. For the preferred alternative, the following components and features are to be monitored following the completion of construction, as required:

- Locations where erosion control works appear to be deficient, if any, through indications of erosion or channel migration;
- Movement of rock or other erosion control works from installed locations;
- Indications of additional/excess sedimentation in the channel;
- Degree of establishment of bioengineering installations;
- Success of site restoration measures and riparian plantings;
- Algae or excessive plant growth in the channel;
- Description and/or photographs of any fish or other wildlife observed; and
- Signs of vandalism or other social-based encroachments onto the creek corridor, outside of established pathways and bridges.

The post-construction monitoring report is to include, as required:

- An assessment of the effectiveness of the undertaking in addressing the identified issues of the EA;
- Documentation of follow-up maintenance;
- A summary of the baseline inventory with respect to any potential impacts that were identified;
- Documentation of any changes in the baseline conditions as a result of the remedial works, including a photographic record;
- Identification of measures that will be undertaken to address any identified impacts; and
- A schedule for ongoing maintenance and monitoring

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