Appendix A

Embro Dam and Conservation Area Existing Environmental Conditions Report

(this includes appended report “Flow Characteristics of Harrington Creek at Harrington Dam and Youngsville Drain at Embro Dam”)

Prepared by UTRCA, Updated October 2016

Embro Dam and Conservation Area

Existing Environmental Conditions

Updated October 13, 2016

UPPER THAMES RIVER
CONSERVATION AUTHORITY

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Introduction

The Upper Thames River Conservation Authority in partnership with Zorra Township is undertaking an environmental assessment of the Embro Dam under the Conservation Ontario Class Environmental Assessment process. This report describes much of the existing natural environment conditions for the Embro Dam and Conservation Area. This report includes measurement, inventory, analysis, and observations undertaken by Upper Thames River Conservation Authority (UTRCA) resources during 2015 of streamflow, water quality, aquatic environment, natural heritage, cultural setting, and limited hydrogeological background information. Similar information is gathered and interpreted routinely by the Authority in support of watershed focused environmental efforts. Contributing local watershed context and historical information where available is brought forward for comparisons. Community contributions have been considered to date.

The information in this report will be considered in the presentation and analysis of alternatives for the Embro Dam by the consultant. The consultant as contracted through the Terms of Reference for the overall Assessment has further augmented the environmental information with further study of the physical environment and will interpret all the resources information collected.

The report is a draft which will be finalized with additional information as required before final publication with the Assessments documentation.

Project Study Area

Embro Dam and Conservation Area is on Youngsville Drain, a tributary of Embro Creek. Embro Creek outlets into the North Branch Creek which eventually outlets into the Middle Thames River. Embro Conservation Area (Embro CA) is part of Mud Creek watershed. The Mud Creek watershed drains an area of approximately 157 km^2, and includes portions of the Townships of Zorra (69%) and East Zorra-Tavistock (31%). Land use within the Mud Creek watershed is primarily agriculture (86%) with other land use including natural vegetation (13%), urban (1%), water (<1%), and aggregates (<1%).

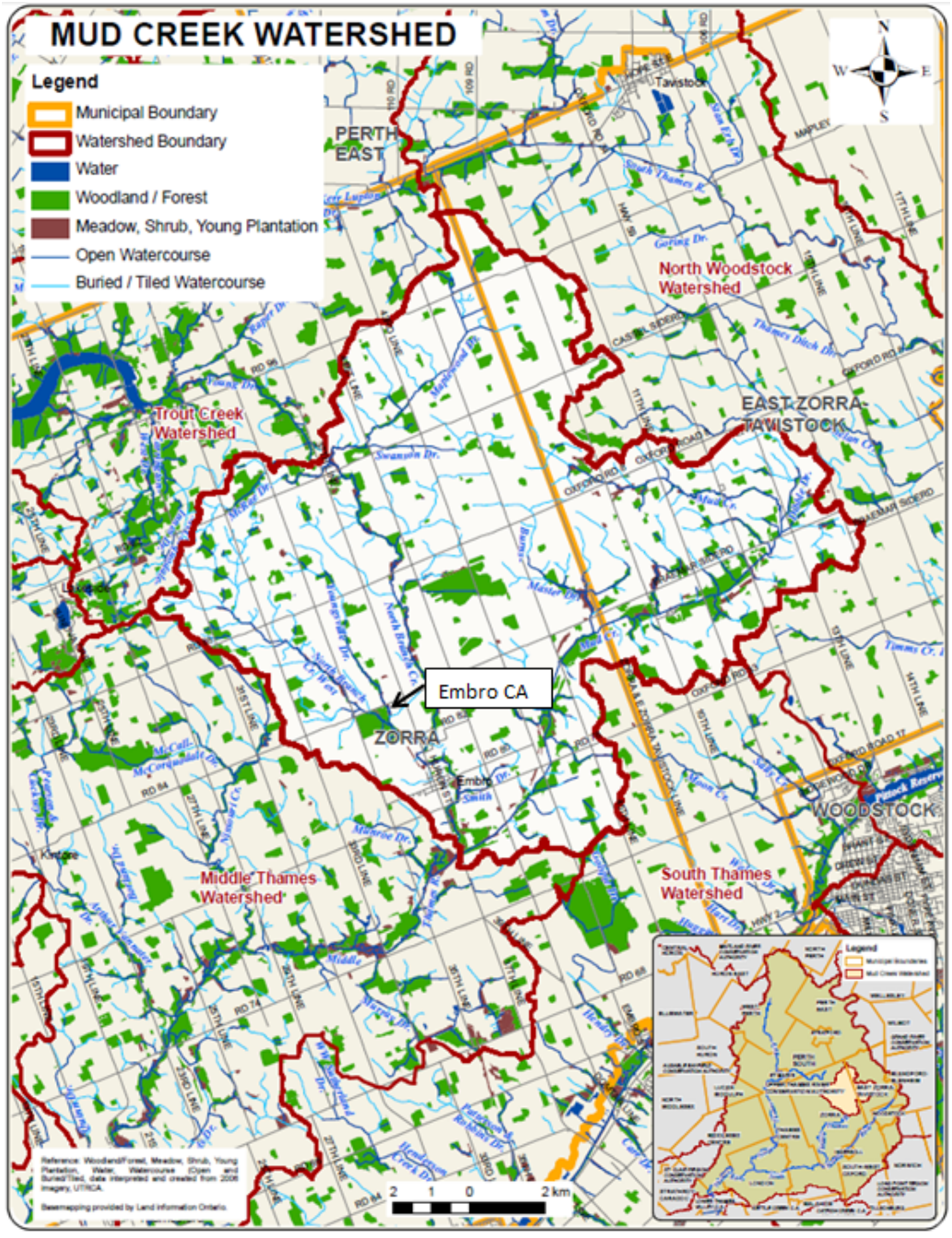


Figure 1: Mud Creek watershed (Source: UTRCA)

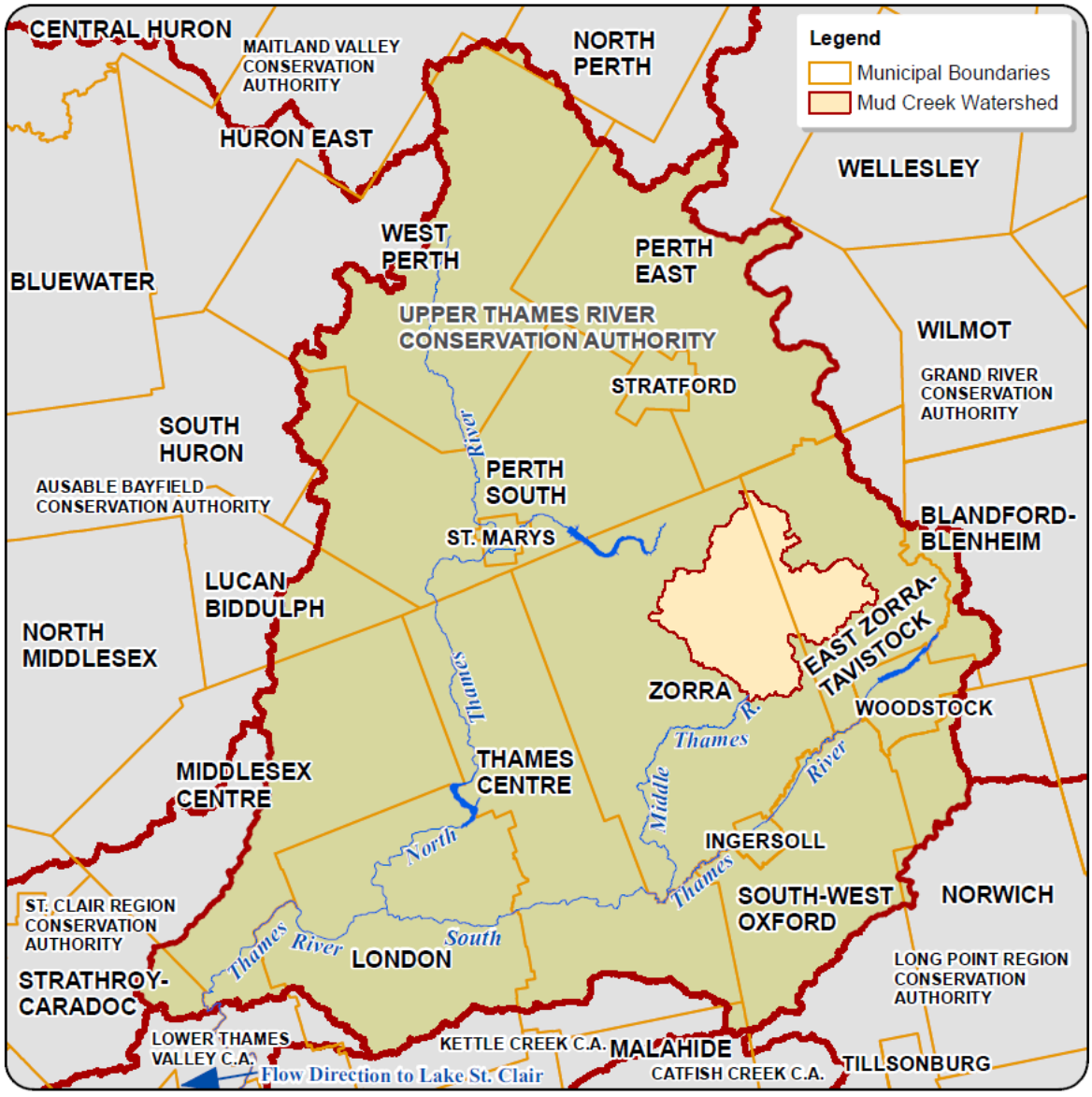


Figure 2: Mud Creek watershed in relation to Upper Thames watershed (Source: UTRCA)

The study area for the Embro Dam will include the lands within the Embro Conservation Area (Embro CA) and adjacent lands as necessary. Embro CA is on County Road 84 in Oxford County, Township of Zorra, Lot 15, Concession 4.

Embro CA is about 8.5 hectares (21 acres) with approximately 5.7 hectares (14 acres) in tree cover, some of it mixed plantation and some natural woodland, and approximately 2 hectares (5 acres) of manicured lawn, unmanicured grass/marsh with a scattering of shade trees. The reservoir/pond area is approximately 0.8 hectares (2 acres).

Between 1997 and 2010, through various partnerships and programs, trees, wildflowers, and grasses have been planted in the Embro CA, with trail enhancements being carried out in 2012.

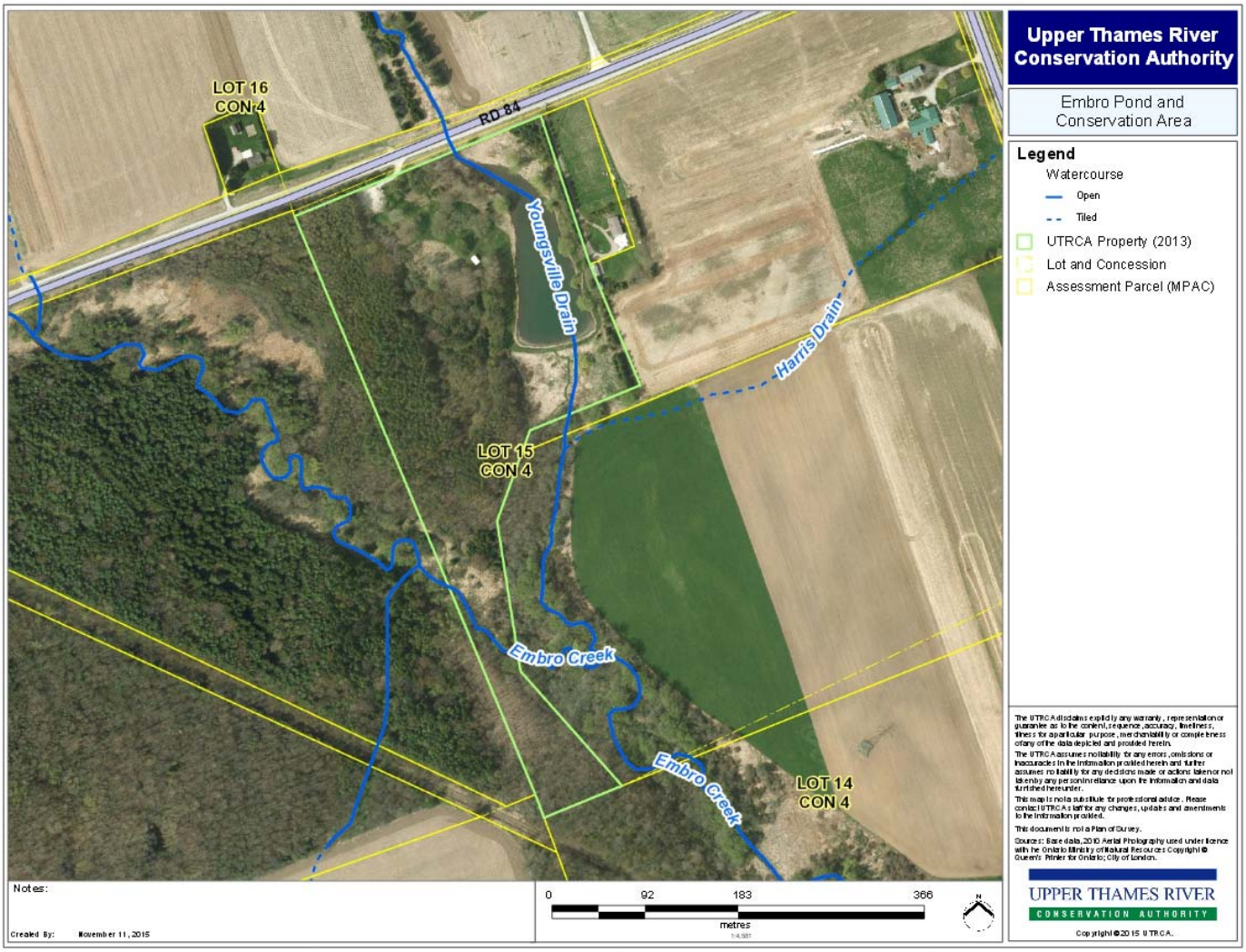


Figure 3: Embro Conservation Area (Source: UTRCA)

More detailed information about various physical and biological features of the Embro Dam study area are discussed below.

Flow Characteristics

To properly assess and design the different options that exist in regards to Embro Dam, it is necessary to understand the streamflow characteristics of Youngsville Drain. The flow characteristics were studied and the details of this study are located in Appendix A: Flow Characteristics of Harrington Creek at Harrington Dam and Youngsville Drain at Embro Dam. A prorating relationship between the flow downstream of Embro Dam and the flow downstream of Harrington Dam was developed with the flow at Embro being approximately 69% of the flow at Harrington. Based on this relationship it was determined 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 the Harrington monitoring periods from May 24, 2008 – April 9, 2011, March 26, 2012 – September 12, 2012, and April 23, 2015 – August 28, 2015, the contribution of the flow calculated for downstream of Embro Dam to the total flow at the monitoring station downstream of Thamesford was 3.5%, 12.4%, and 6.4%, respectively. 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. 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 at the location downstream of Embro Dam. Due to the low magnitude of the flows, the accuracy limitations of the flow velocity meter, and inflow to Youngsville Drain in between the upstream and the downstream measurement locations, it is recommended that monitoring be continued to increase the confidence in assessing the flow characteristics of Youngsville Drain and the effect of the water control structures on the flow.

Hydrogeology

The UTRCA collected physical geography map information and well record information to describe general information on the hydrogeological setting of Embro Conservation Area and the local area around the dam. Ministry of Environment and Climate Change (MOECC) well records were obtained. All information collected was transferred to the consultant Ecosystem Recovery Inc. for their analysis.

Topography, Geology, and Soils

The Embro Pond catchment area includes Sutherland-McDonald Drain, Ross Drain, Glendinning Drain, Matheson-McCorquodale Drain, and Matheson Smith Drain. Groundwater flow gradient is from the north to the south towards the community of Embro.

The following maps illustrate the physical surface and subsurface conditions and contribute to the understanding of surface and groundwater resources in the Youngsville Drain catchment.

The general topographic setting of Embro CA in the downstream reaches of Youngsville Drain catchment is shown on the map in Figure 4. North Branch Creek meets Embro Creek immediately south of Embro CA. The lowest elevation point the catchment area is 315 m at Embro CA where Embro Creek leaves the CA. Embro CA is located in some of the highest elevations in the UTRCA watershed.

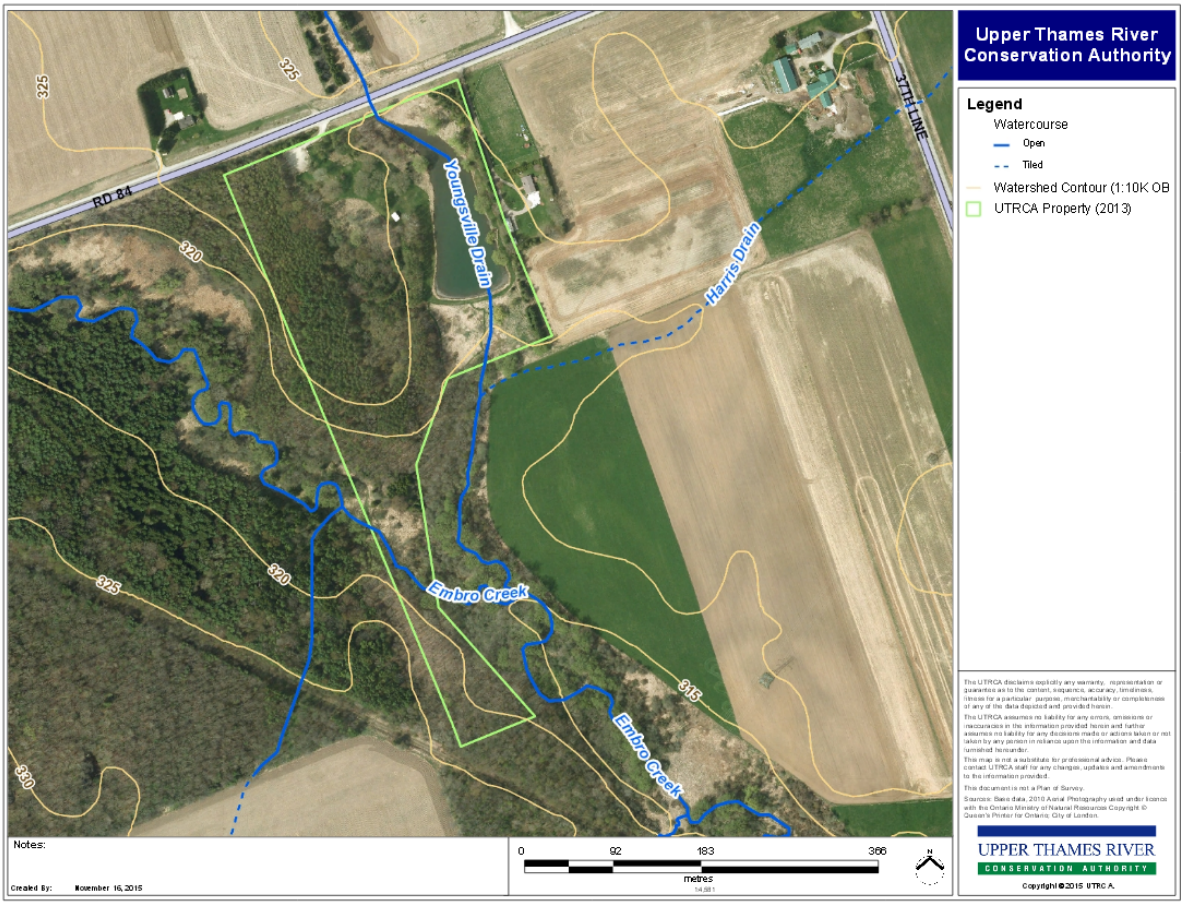


Figure 4: Elevation of Embro Conservation Area (Source: UTRCA)

The catchment area is dominated by till and has a moderate groundwater recharge rate. The surficial geology and groundwater recharge of the Embro CA area is shown in Figures 5 and 6, respectively.

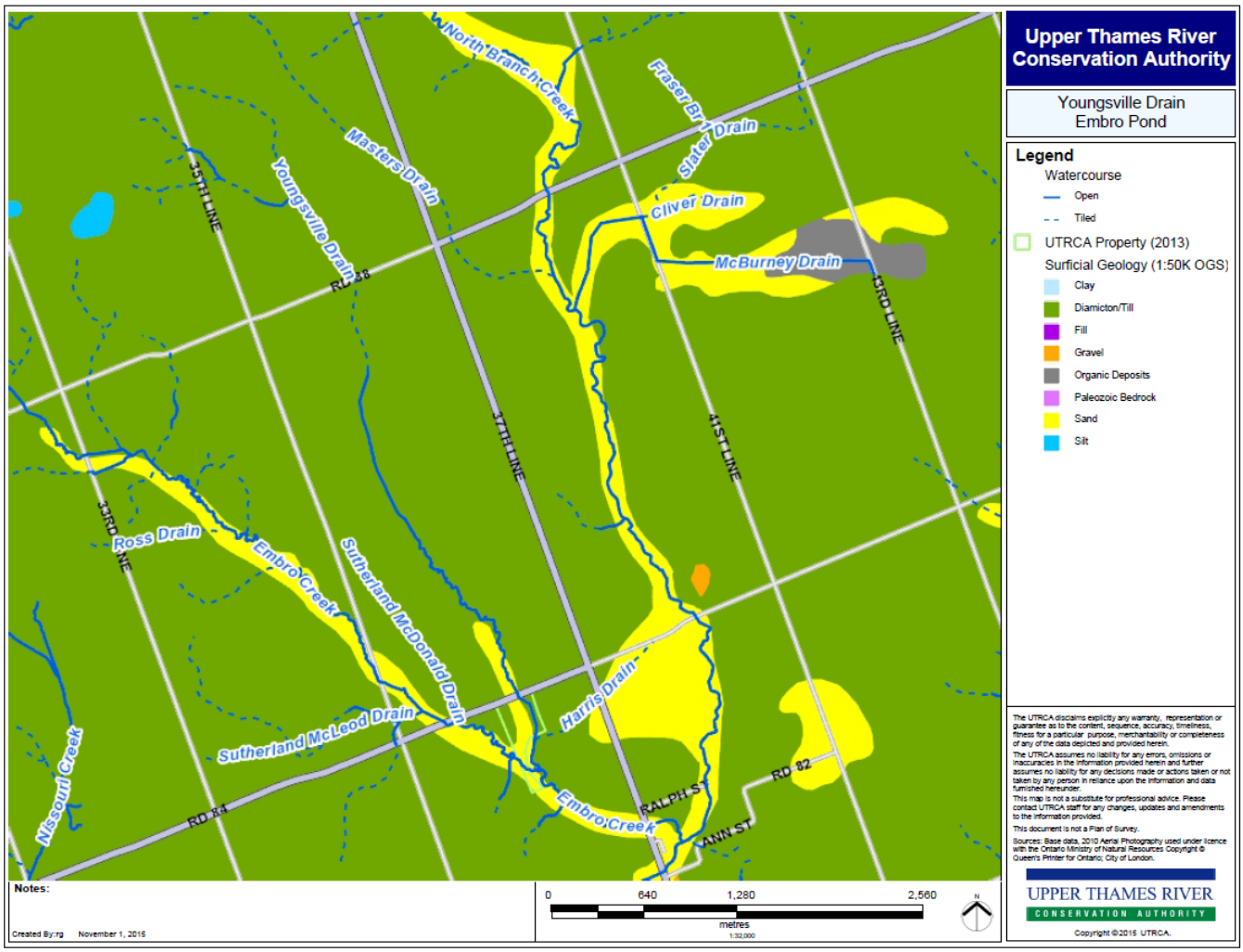


Figure 5: Surficial geology of the area around Embro CA (Source: UTRCA)

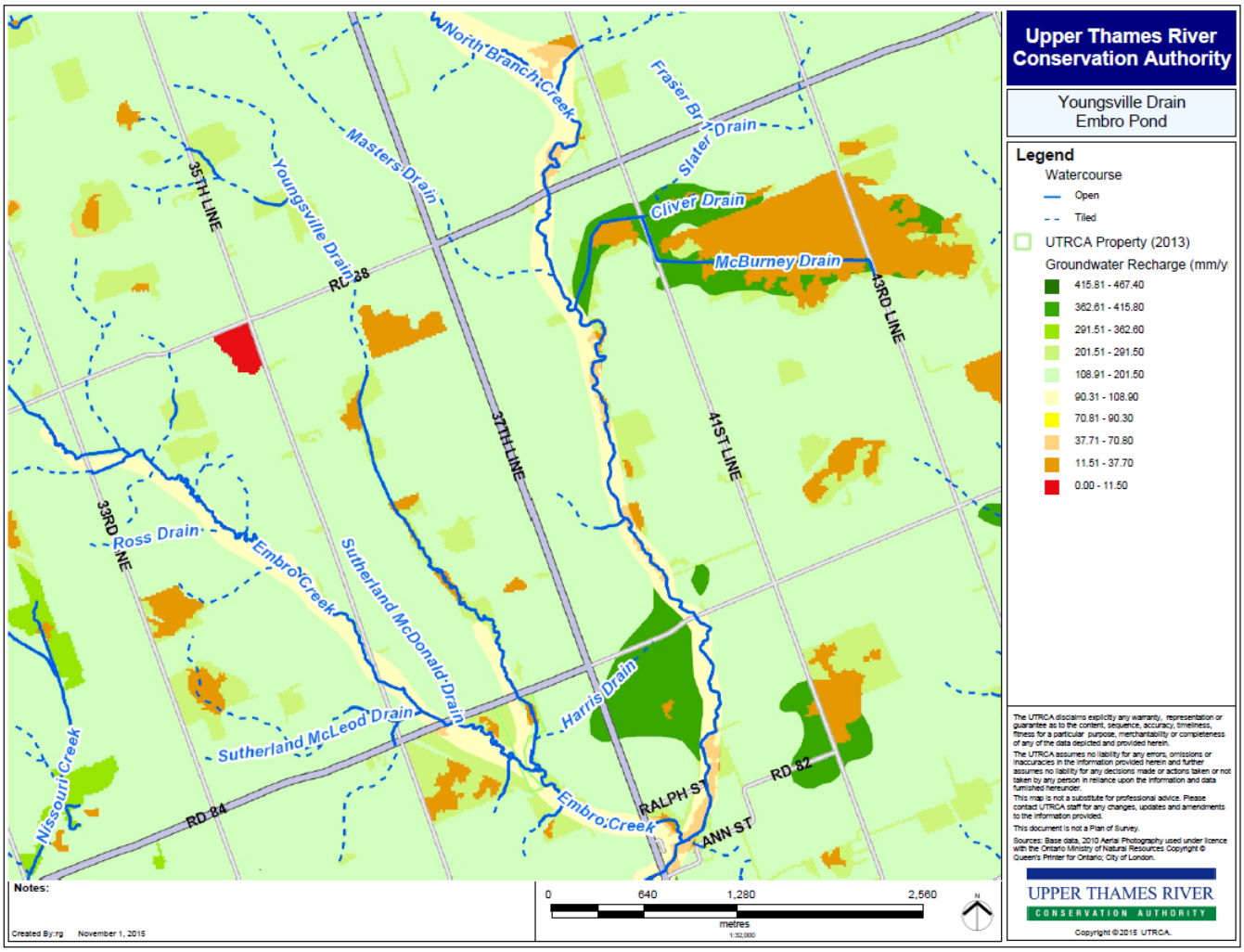


Figure 6: Groundwater recharge (mm/y) of the area around Harrington CA (Source: UTRCA)

Private Well Survey

All background information and individual well records were retrieved from the Ministry of the Environment and Climate Change (MOECC) and provided to Ecosystem Recovery Inc. for analysis by their sub-consultant Englobe (formerly LVM). Figure 7 shows the locations of the known wells in the area. The wells shown on the Embro Dam are Bore Holes for the past Dam Safety investigations.

Figure 7: Known wells in the area of Embro CA (Source: MOECC)

Surface Water Quality

A series of five water samples were collected at four locations in the area of Embro CA: one upstream of the pond, two in the pond, and one downstream of the dam (see map in Figure 8). This monitoring provides a snapshot of water quality, and is limited to the conditions of April to October 2015. Embro Pond was part of a past targeted watershed study and remediation work, with water monitoring occurring from 1986 to 1994. This data has been included in the evaluation of the results, which can be found in Appendix B: Embro Pond Water Quality Assessment.

Most 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 full runoff conditions (June 1) and one date had rain with partial runoff conditions (October 9).

Samples were analysed at ALS Laboratories in London. Samples were analyzed for Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus, Orthophosphate, *E. coli*, Chloride, and Suspended Solids. Field measurements were taken with a YSI multi-parameter meter for Dissolved Oxygen, pH, Conductivity,

and Temperature. Continuous temperature measurements were taken from June 1 to September 23 using dataloggers recording in half hour intervals.

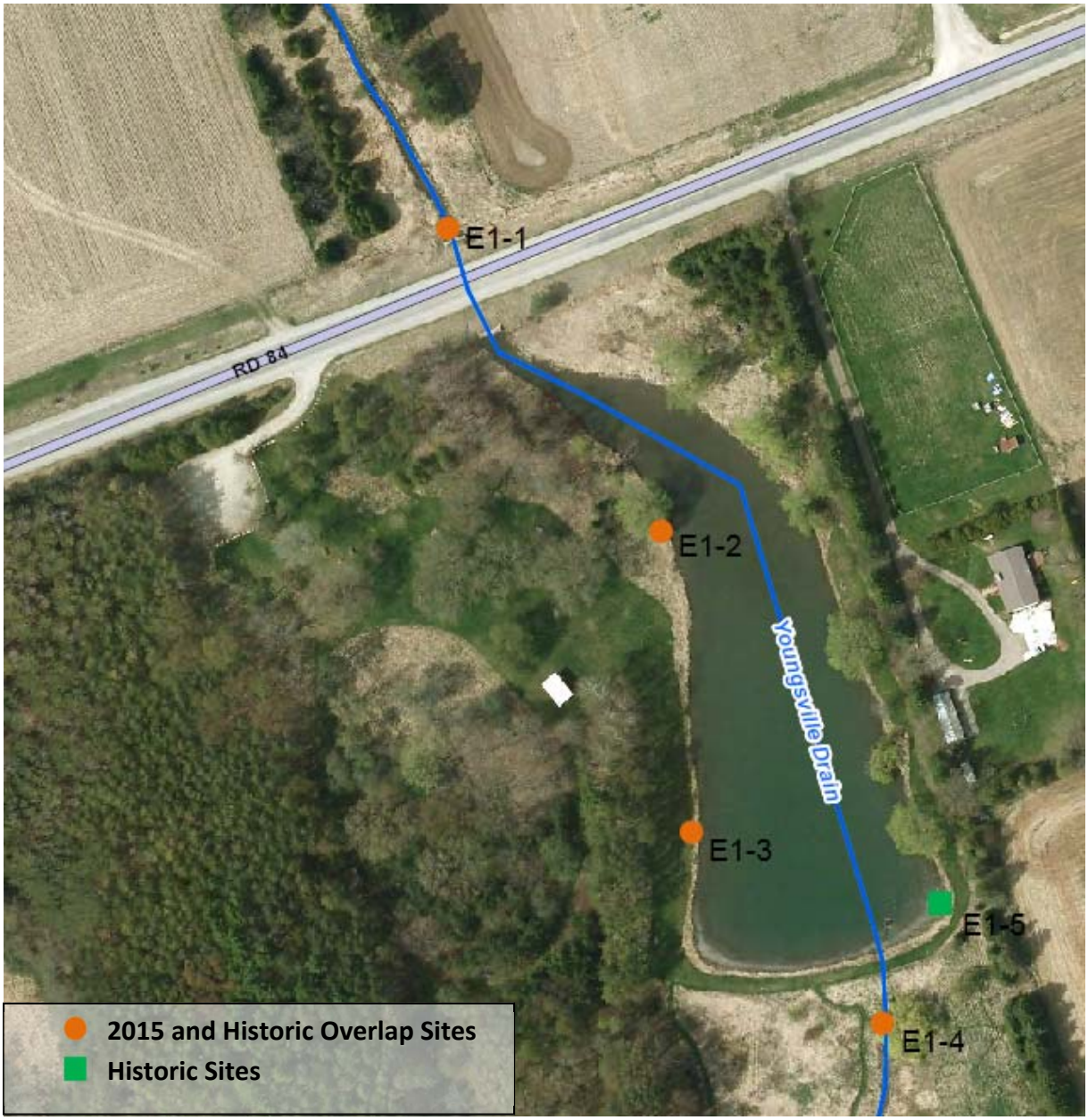


Figure 8: Embro Pond water quality sampling sites 2015 (Source: UTRCA)

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

Temperature differences are apparent between upstream and downstream of the pond based on continuous measurements and show a greater difference as the summer progressed, likely as a result of the warming effect of the pond.

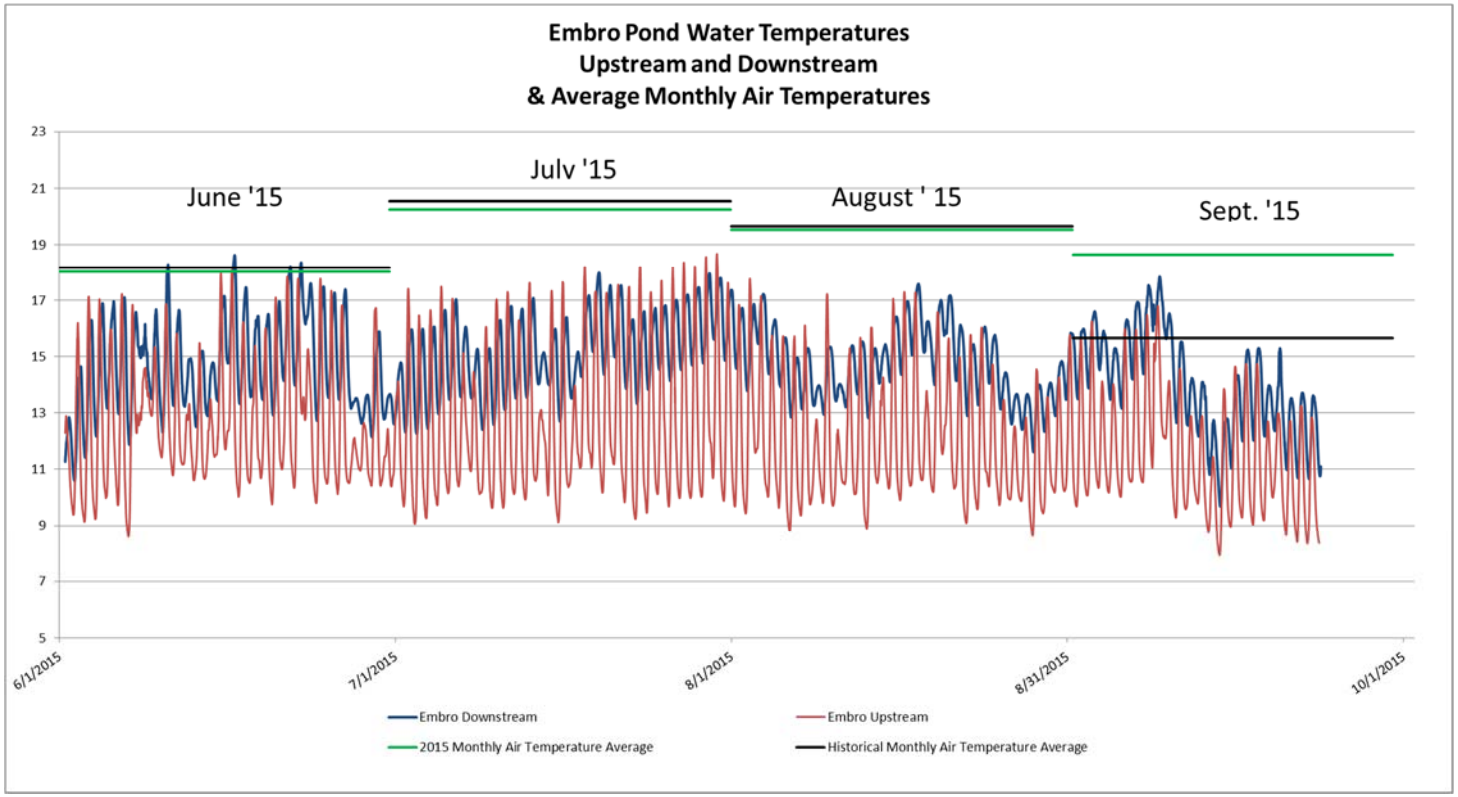


Figure 9: Temperature upstream and downstream of Embro Pond, June – Sept 2015 (Source: UTRCA)

Both upstream and downstream temperatures show a diurnal pattern with day time highs and night time lows. Upstream has a wider range of diurnal temperatures with approximately 6C change compared with 2-3C change downstream, as can be seen in Figure 10.

Stream temperature data for June, July and August 2015 were taken during periods in which monthly air temperature averages were similar to historical monthly air temperature averages (ref. Environment Canada - London Airport). The September 2015 air temperature average was higher than historical September air temperature averages, which may have kept the water temperature higher than normal.

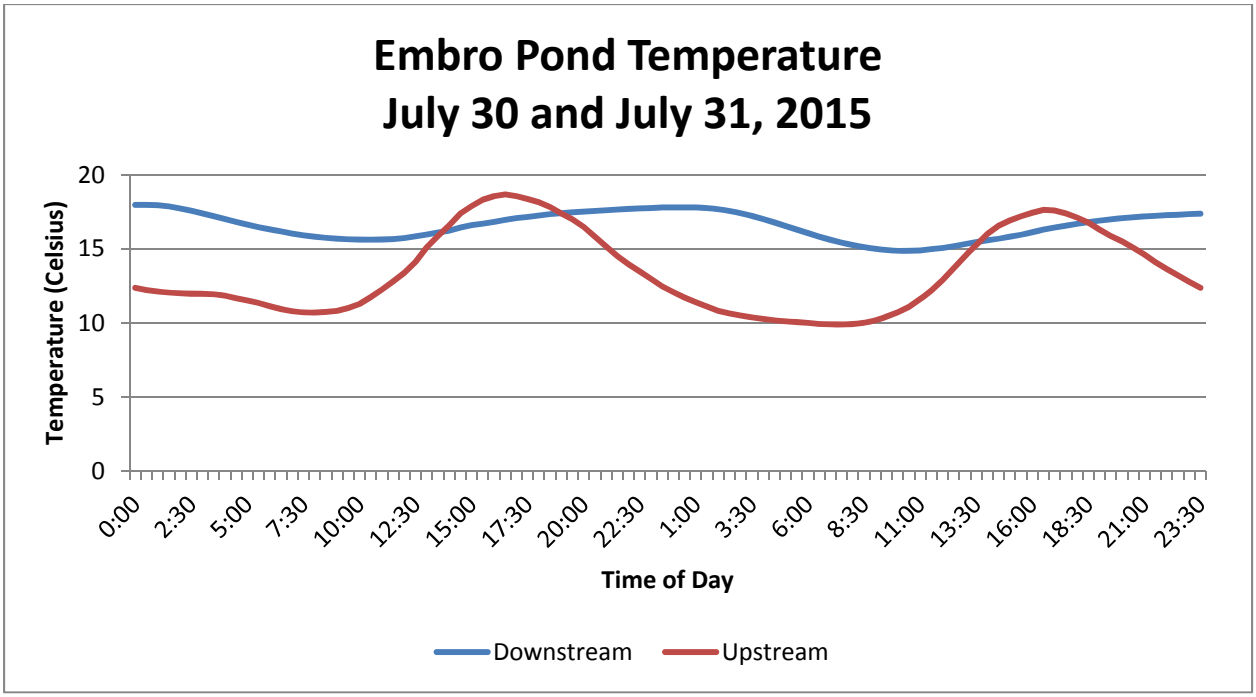


Figure 10: Temperature upstream and downstream of Embro Pond showing in detail the diurnal changes, July 30 – 31, 2015 (Source: UTRCA)

Ponds can act as a settling basin for sediment and associated contaminants such as phosphorus, and these can accumulate in the bottom sediments. These contaminants can be re-suspended when disturbed such as during more extreme flow conditions. Sampling of the bottom sediments would give an indication of any accumulation.

Aquatic Ecology

Electrofishing and benthic surveys were carried out during the spring, summer and fall of 2015. The map in Figure 10 shows the different sampling sites. A list of recorded fish and benthic species, separated into sampling location, is provided in Appendix C: Embro Dam area Fish and Benthic Records.

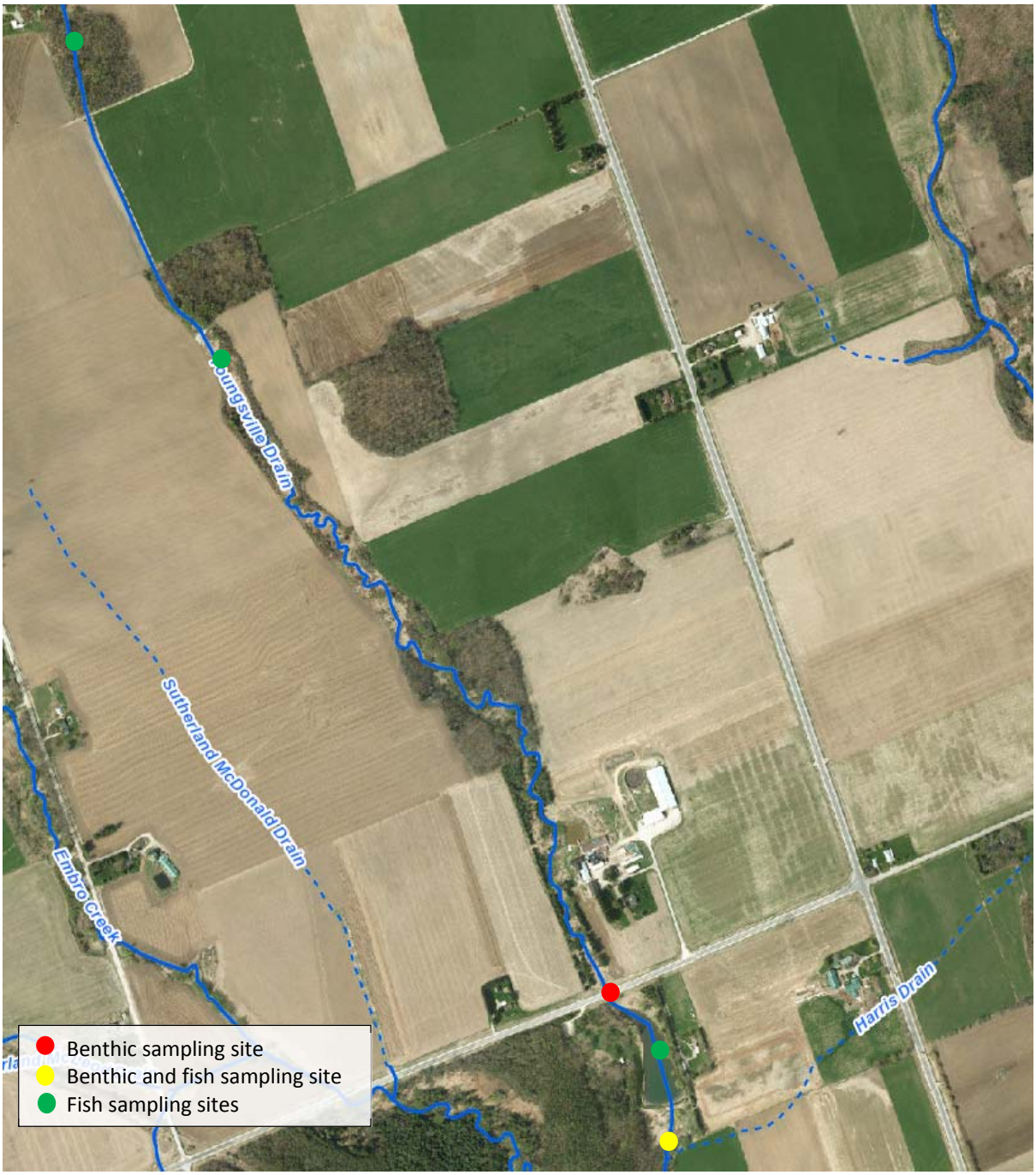


Figure 11: Embro Dam area benthic and fish sampling sites (Source: UTRCA)

Fisheries Resources

An electrofishing survey of the Embro Pond as well as downstream of the dam was conducted on April 15, 2015. The site downstream of the dam was surveyed two more times, once on July 8, and once on October 19, 2015 to provide three season data. 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. All specimens were identified to species, recorded, and released. Sample records, including historic records, are tracked in an MS Access database and provided in Appendix C: Embro CA Fish and Benthic Records.

Brook Trout, a coldwater species, 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 allowing 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 present likely passed over and became trapped below the dam.

Based on 2015 and previous fish surveys, a large discrepancy in species diversity exists between up and downstream of the pond, with eight species recorded upstream and 21 species downstream. This species list can be found in Appendix C. The low species diversity is fairly typical of trout dominated systems but also likely reflects the impact of the barrier to fish movement presented by Embro Dam and Pond. The diverse downstream community includes cold water species and both permanent and seasonally present warm water species.

Five of the eight 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 a fairly stable fish community. Thirteen of the 21 species sampled downstream of Embro Pond were found during 2015, also representing the more common species historically. This also indicates that Embro Dam is an effective barrier to fish movement limiting upstream fish community diversity.

Benthic Resources

Benthic invertebrates are organisms that live on the bottom or in the sediment of a water body. Because they are diverse, generally sedentary, and responsive to environmental alterations, benthic invertebrates are often sampled to study water quality (Jones, N.E. 2011).

To determine water quality, a value from 0 to 10, called a biotic index, is assigned to benthic invertebrate taxa. This value indicates their sensitivity and tolerance to pollution. Lower numbers indicate pollution sensitivity and high numbers indicate tolerance. A weighted average of the biotic index and the number of invertebrates in each taxa in the sample gives a value called a Family Biotic Index (FBI). The water quality ranges for the FBI values can be found in Table 1.

FBI Value	Water Quality
< 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 1: Water quality ranges for FBI values

Benthic invertebrate sampling was conducted in the spring (May 5) and fall (September 23), 2015, at sites on Youngsville Drain 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 was 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: Embro Dam area Fish and Benthic Records.

While the 2015 spring results were almost identical, better water quality was evident upstream in the fall, with pollution sensitive taxa found above the pond 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 2 below compares the FBI values of the 2015 Youngsville Drain samples to values of 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).

Benthic Sample Location	**Spring 2015 FBI**	**Fall 2015 FBI**	**Average FBI**	**Water Quality**
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

Table 2: Comparison of FBI values for Embro CA, Mud Creek, and UTRCA watersheds (Source: UTRCA)

Vegetation and Wildlife Inventory

This study examines the vegetation and bird and wildlife of Embro CA to determine the habitat quality and to flag any rare or sensitive species or communities that might be impacted if the Embro Dam and reservoir area were changed.

A three-season botanical inventory was completed in 2015 of 5.4 ha of the Embro CA, within 100 m of the reservoir. Of the 198 plant species found, 31% are non-native, an average or moderate number compared 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. Efforts to plant native trees and tallgrass prairie plants into the CA have added to the diversity of the site. 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.

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 trigger distance of the Embro CA that need to be considered and, in fact, no wetlands 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.

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 creek within Embro CA.

In conclusion, there are no sensitive plants, plant communities, birds or wildlife that would be threatened from changes to the environment in Embro Conservation Area.

A detailed report of the vegetation, bird, and other wildlife inventory can be found in Appendix D: Embro Conservation Area Vegetation and Bird Inventory 2015.

Cultural

History of Study Area

As written in the book "25 Years of Conservation on the Upper Thames Watershed 1947-1973", the UTRCA acquired the dam in disrepair in 1958. The dam was replaced with a 91 meter (300 feet) structure and a lake 183 meters long by 91 meters wide (600 x 300 feet) was created. After purchasing 5.7 hectares (14 acres) of the Oxford County Forest and 2.7 hectares (6.7 acres) of the Charles Harris property, the Embro Conservation Area officially opened on October 26, 1959, embracing an area of approximately 11.7 hectares (29 acres). In 1968, the conservation area was expanded to accommodate the general public (Upper Thames River Conservation, 1973).

In 1993, the Embro Pond Community Association took over management of the conservation area.

Current Uses

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

Through various partnerships and programs, trees, wildflowers, and grasses have been planted in the Embro CA. 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 CA. About six memorial trees have been planted in the CA in previous years.

Bibliography and Reference Documents

Jones, N.E. 2011. *Benthic Sampling in Natural and Regulated Rivers. Sampling Methodologies for Ontario's Flowing Waters*. Ontario Ministry of Natural Resources, Aquatic Research and Development Section, River and Stream Ecology Lab, Aquatic Research Series 2011-05. Retrieved from https://dr6j45jk9xcmk.cloudfront.net/documents/2668/stdprod-103416.pdf.

Upper Thames River Conservation Authority. 1973. *Twenty Five years of Conservation on the Upper Thames Watershed 1947-1973.*

See the following reference documents:

Embro Dam Safety Review HATCH, 2007

Mud Creek Watershed Report Card, 2012. Retrieve from http://thamesriver.on.ca/wp-content/uploads//WatershedReportCards/RC_Mud.pdf

Appendices

Appendix A: Flow Characteristics of Harrington Creek at Harrington Dam and Youngsville Drain at Embro Dam

Appendix B: Embro Pond Water Quality Assessment

Appendix C: Embro Dam area Fish and Benthic Records

Appendix D: Embro Conservation Area Vegetation and Bird Inventory 2015

Appendix B

Embro Pond Water Quality Assessment

Prepared by UTRCA, Updated October 2016

Appendix B

Embro Pond Water Quality Assessment

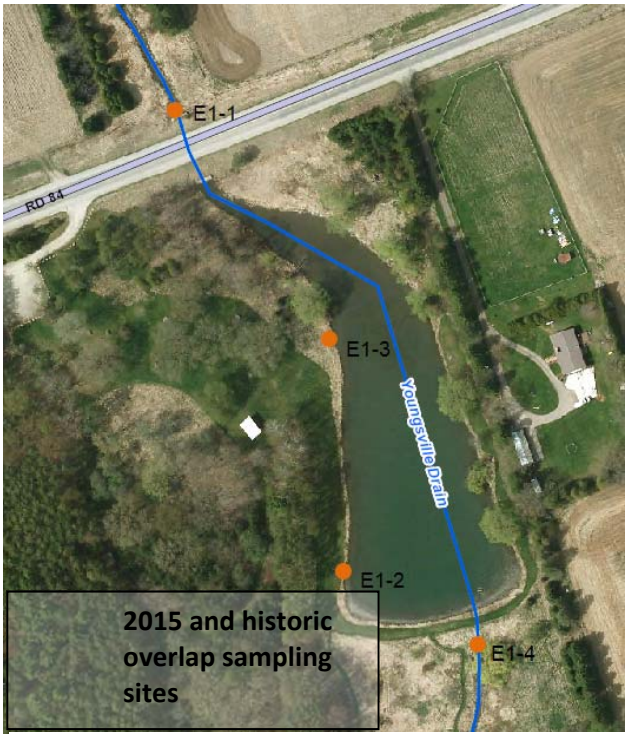
Updated October 13, 2016

Contents

Purpose and Background

Embro Pond is located just north of the community of Embro and is located within the larger Mud Creek subwatershed on the Middle Thames River. The Embro Pond is on the upper portion of the Youngsville Drain and has an upstream drainage area of 665 hectares. The Youngsville Drain is a potential coldwater stream system. The purpose of this study was to initiate monitoring in 2015 to give a general assessment of water quality conditions in the pond and immediately upstream and downstream. This monitoring gives us a snapshot of water quality and is limited to the conditions of 5 sampling occasions from April to October in 2015 with past monitoring from 1986 to 1994 being evaluated as well.

As part of an evaluation of water quality in Embro Pond, 5 samples were taken in 2015 at 4 locations, one upstream, 2 in pond, and one downstream (see Map 1). Embro Pond was part of a past targeted watershed study and remediation work, with water monitoring occurring from 1986 to 1994. This data was included in the evaluation of the results (see figures in Appendix). Three of the five 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 full runoff conditions (June 1) and one date had rain with partial runoff conditions (October 9). Samples were analysed at ALS Laboratories in London. Samples were analyzed for Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus, Orthophosphate, *E. coli*, Chloride, and Suspended Solids. Field measurements were taken with a YSI multi-parameter meter for Dissolved Oxygen, pH, Conductivity, and Temperature. Continuous temperature measurements were taken from June 1 to September 23 using a datalogger recording in half hour intervals.



Results: Water Chemistry and Bacteria

Results are provided for 7 parameters which are related to land use activities. Pond samples were combined for analysis.

Temperature

Fate and Behaviour: Water temperature in the river system varies with seasonal changes and also throughout the day, warming in the daytime and cooling in the evening and overnight. Water temperature can have an effect on water quality and the water's ability to hold dissolved oxygen. As water warms, it has a reduced ability to retain oxygen. Optimizing cooler temperatures is desired to maintain oxygen levels and reduce excess algae growth. This can help to support diverse and healthy fish communities.

Sources: Water temperatures can be cooled by groundwater inputs, stream shading, and natural deeper channel flow. Water temperatures can be warmed by widened channelized streams, ponding, and reduced shading and tree cover.

Standards: There is no standard for temperature but the Ministry of Environment and Climate Change states that the natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.

Monitoring Results:

- Stream temperature data for June, July and August 2015 were taken during periods in which monthly air temperature averages were similar to historical monthly air temperature averages (ref. Environment Canada - London Airport) . The September 2015 air temperature average was higher than historical September air temperature averages, which may have kept the water temperature higher than normal.
- The temperatures upstream are consistently cooler than downstream temperatures indicating the pond has a warming effect.
- The difference in temperature from upstream to downstream ranges from 0 to over 7C, with an average difference of 2.5C change.
- For both upstream and downstream, the stream temperature shows a diurnal pattern with day time highs and night time lows but upstream has a wider range of diurnal temperatures with approximately 6C change from day time highs to night time lows. The downstream temperatures remained warmer with less diurnal change of 2-3C, and with the range becoming smaller as the summer progressed likely as a result of the pond holding the heat through the night.
- The historic monitoring from 1986 to 1994 shows a similar pattern where upstream temperatures are cooler than the pond and downstream temperatures. Historic monitoring shows variation which can be related to cooler or warmer temperatures and the months in which the sampling took place.

Figure 2: Embro Dam temperature upstream and downstream

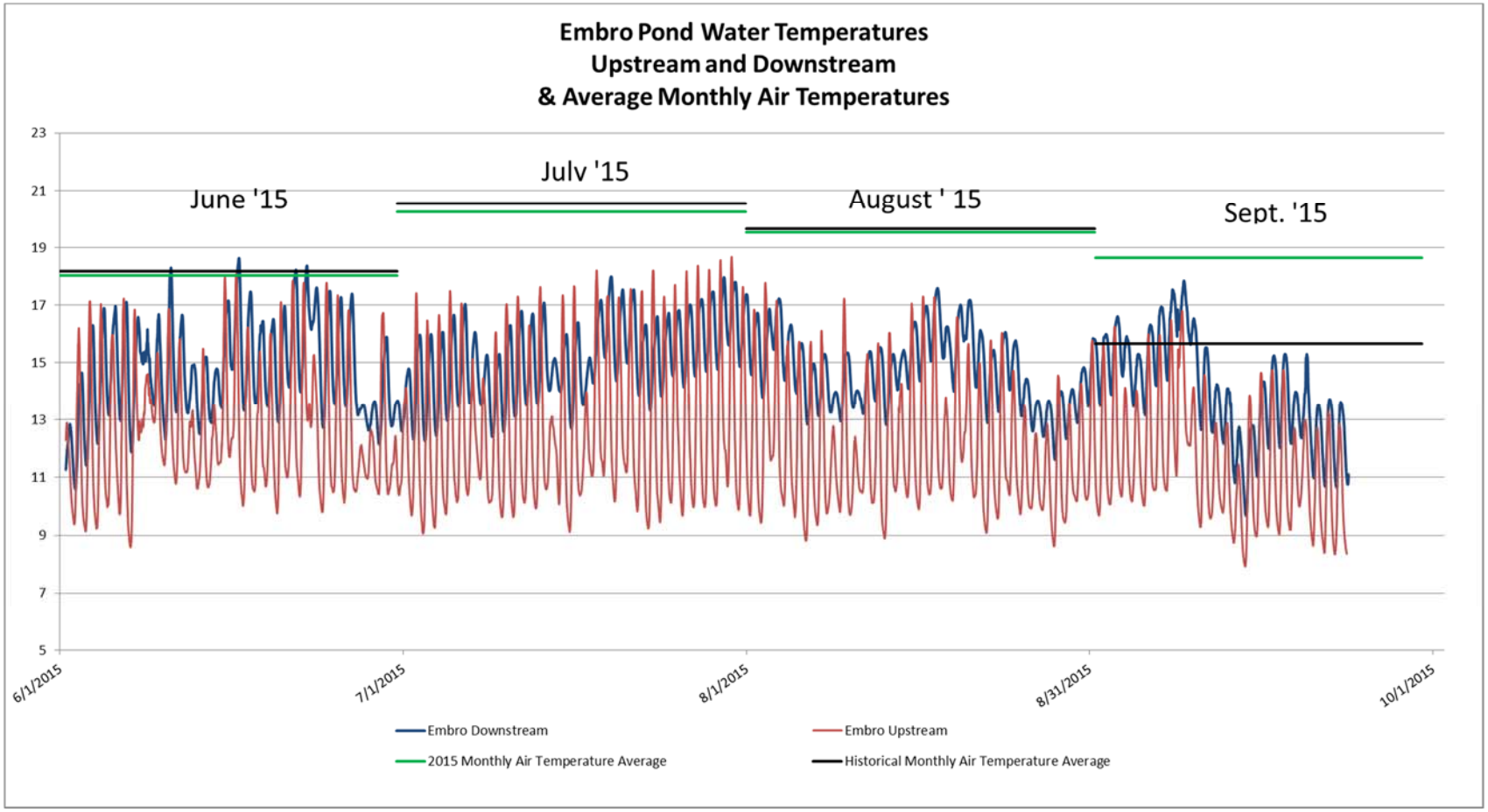
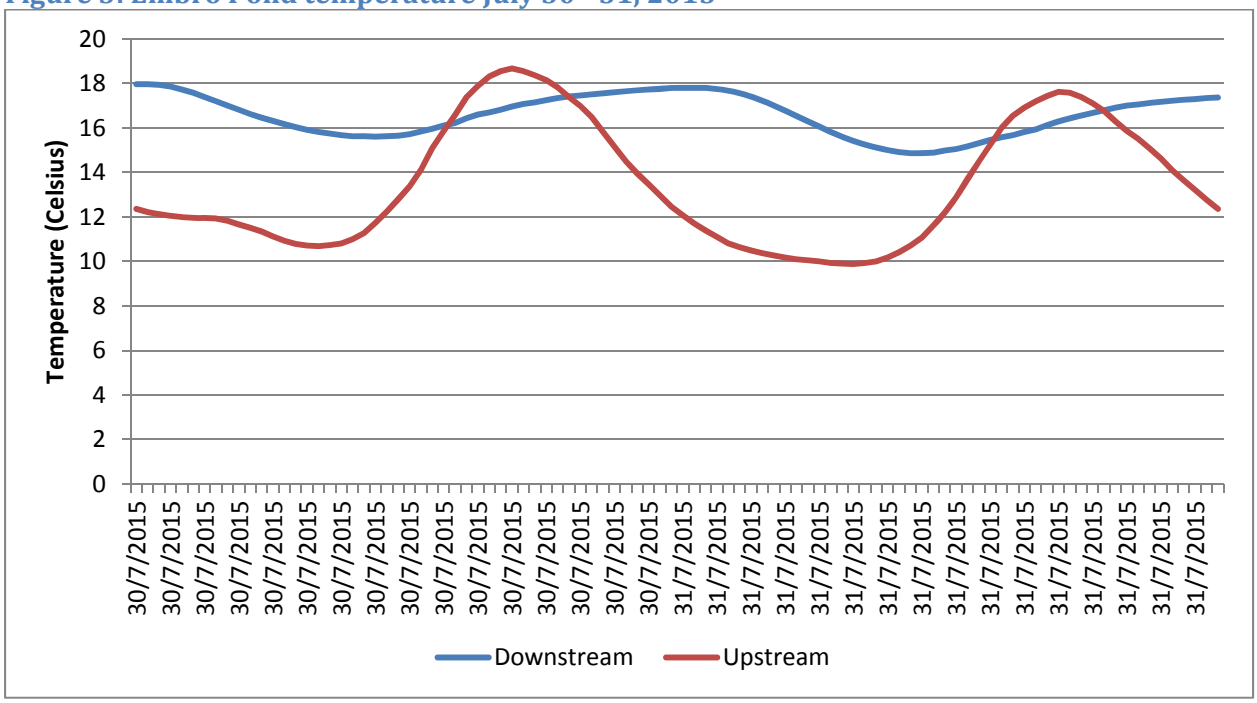


Figure 3: Embro Pond temperature July 30 - 31, 2015



E. coli Bacteria

Fate and behavior: *Escherichia coli* (*E. coli*) are a type of fecal bacteria found in human and animal waste. Their presence in water indicates fecal contamination. *E. coli* are a strong indicator for the presence of other pathogens found in human and animal waste.

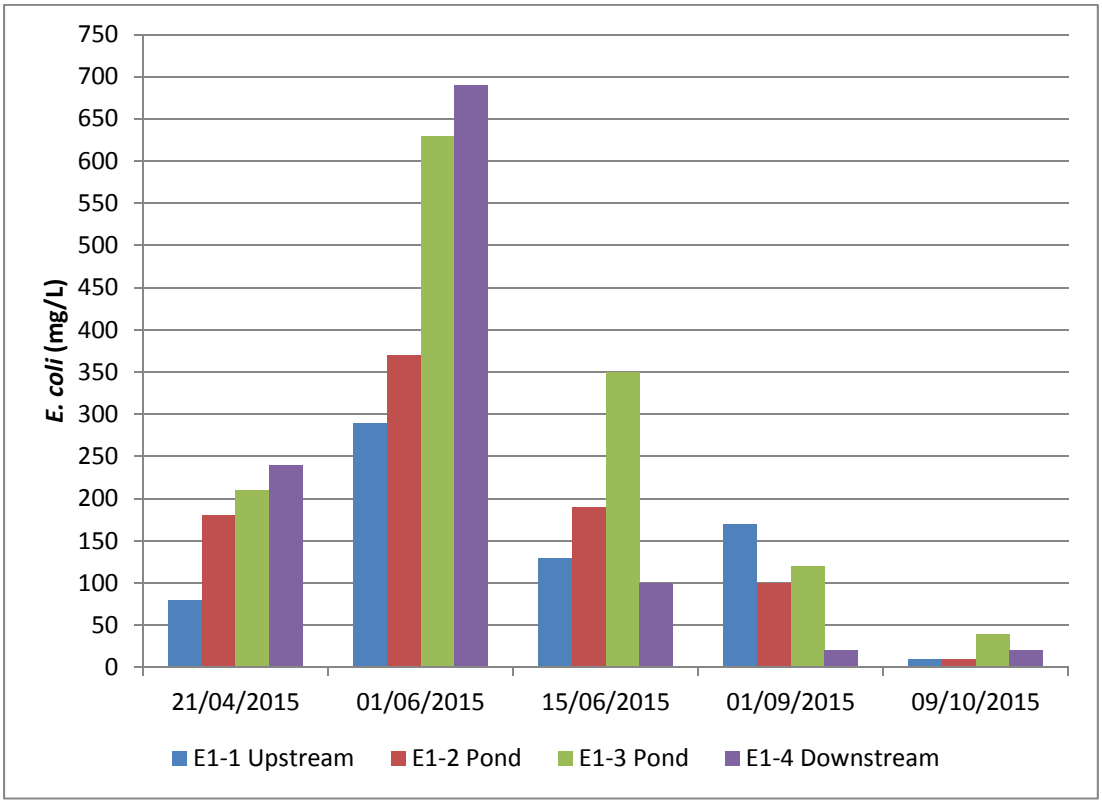
Sources: Potential sources of fecal bacteria include upstream runoff from biosolids/sewage, livestock or wildlife waste, faulty private septic systems, and other stormwater runoff.

Standards: The Provincial Water Quality Objective (PWQO) for recreational waters is 100 *E. coli*/100 mL. This guideline is used as a target for comparison, recognizing that Embro Pond is not monitored as recreational water.

Monitoring Results:

- Concentrations of *E. coli* bacteria are similar to *E. coli* levels in area streams with fairly low numbers at three of the 5 sampling dates.
- The June 1 rain event shows higher *E. coli* levels as expected.
- 2015 upstream *E. coli* levels are fairly comparable to historic data and lower than many of the years. 2015 pond and downstream data is slightly higher than most of the historic data.

Figure 4: 2015 E. coli



Total Phosphorus and Orthophosphate

Fate and Behavior: Phosphorus is not directly toxic to aquatic life, but elevated concentrations can lead to undesirable changes in a watercourse including excess plant growth, reduced oxygen levels, reduced biodiversity, and harmful algae. Orthophosphate, which is a form of phosphorus most biologically available to plants, was also measured.

Sources: Phosphorus sources can include commercial fertilizers, animal waste, and domestic and industrial wastewater including soaps and cleaning products. Phosphorus binds to soil and is readily transported to streams with eroding soil.

Standards: Ontario has an interim Provincial Water Quality Objective (PWQO) of 30 *u*g/L of total phosphorus to prevent the nuisance growth of algae.

Monitoring Results:

- For most dates and locations in 2015, concentrations of total phosphorus were low and close to the Provincial Objective. Two dates (April 21 and September 1) for one of the pond sites had quite high phosphorus levels with no obvious explanation.
- Historic and 2015 upstream phosphorus levels are low with the majority of the data close to objective levels. Historic median levels of phosphorus improved from 1986 to 1994 in the pond and remain at similar levels in 2015. Historic downstream levels have been higher than upstream and pond levels.
- Orthophosphate levels are also low with some samples below the detection limit for 2015. Only the June 1st rain event showed higher orthophosphate levels as expected. The lowest numbers are in the mid to late summer and early fall when plant uptake of this more biologically available form of phosphorus is at its peak.
- Historic and 2015 upstream orthophosphate levels are low with the majority of the data close to objective levels. Historic median levels of orthophosphate improved from 1986 to 1994 in the pond and remain at similar levels in 2015. Historic downstream levels have been higher than upstream levels.

Figure 5: 2015 Total Phosphorus

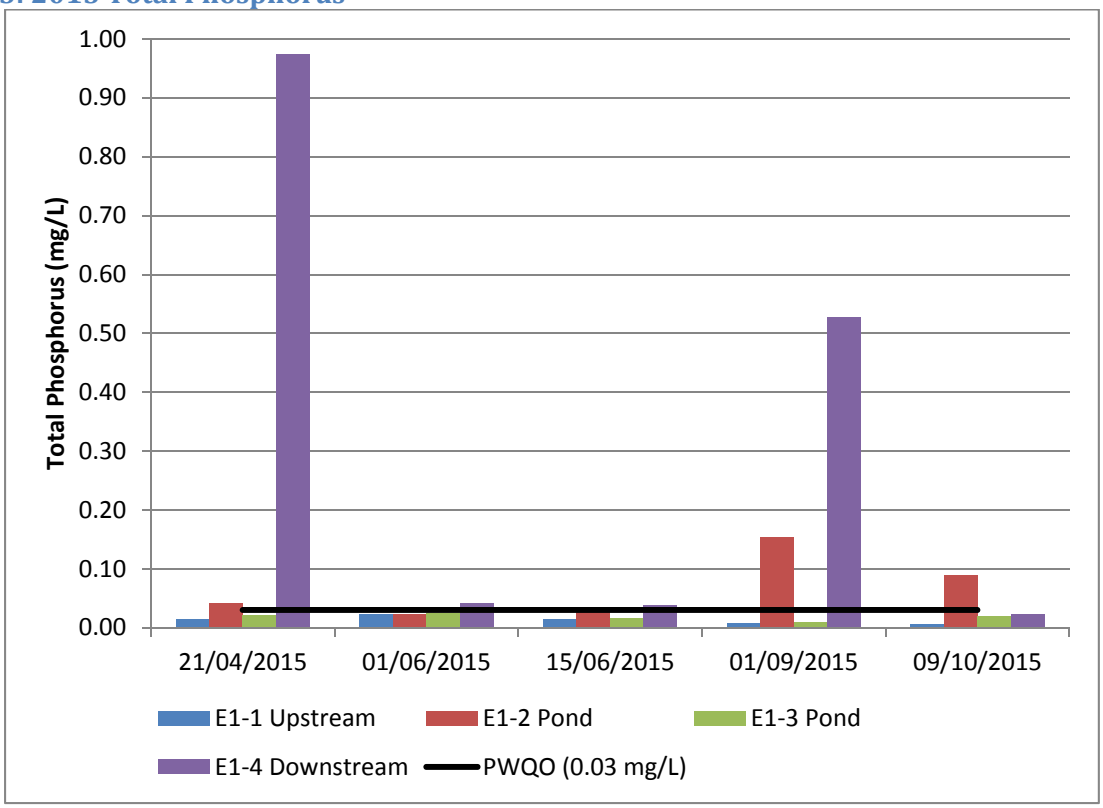
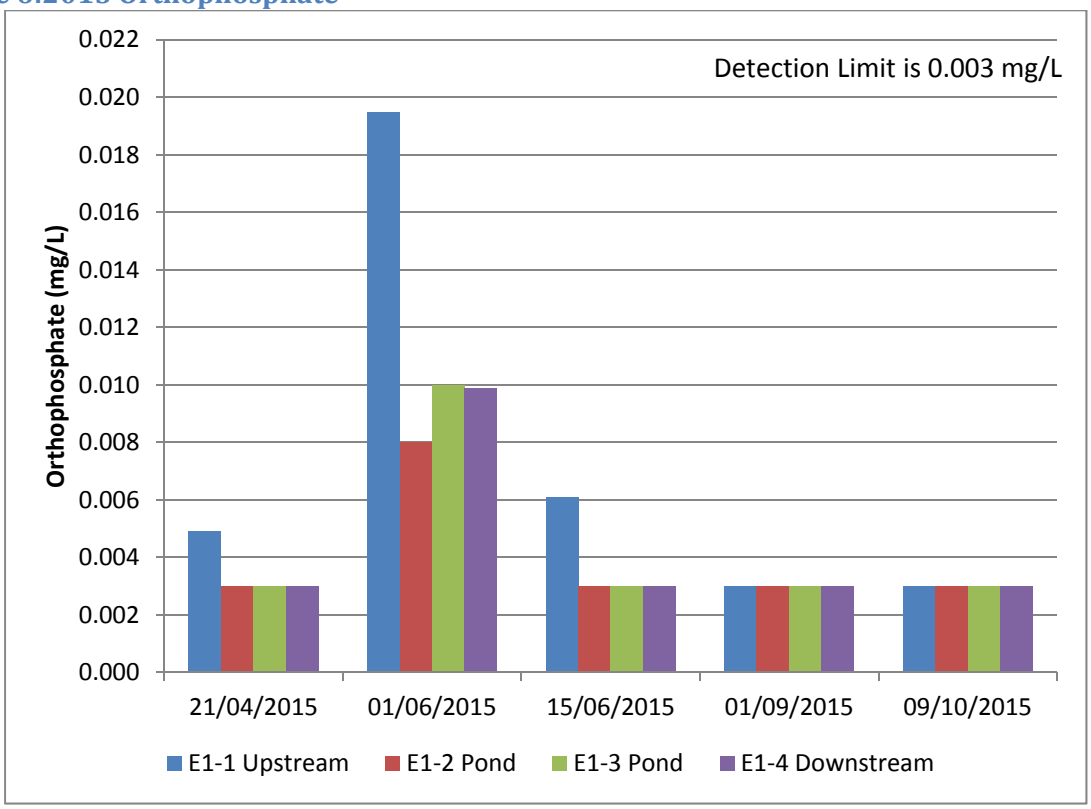


Figure 6:2015 Orthophosphate



Nitrate

Fate and Behaviour: Nitrate is a nutrient that does not adsorb to sediment and moves readily through surface runoff to streams and through soil into groundwater. Elevated levels in a watercourse can be toxic to aquatic organisms, especially amphibians.

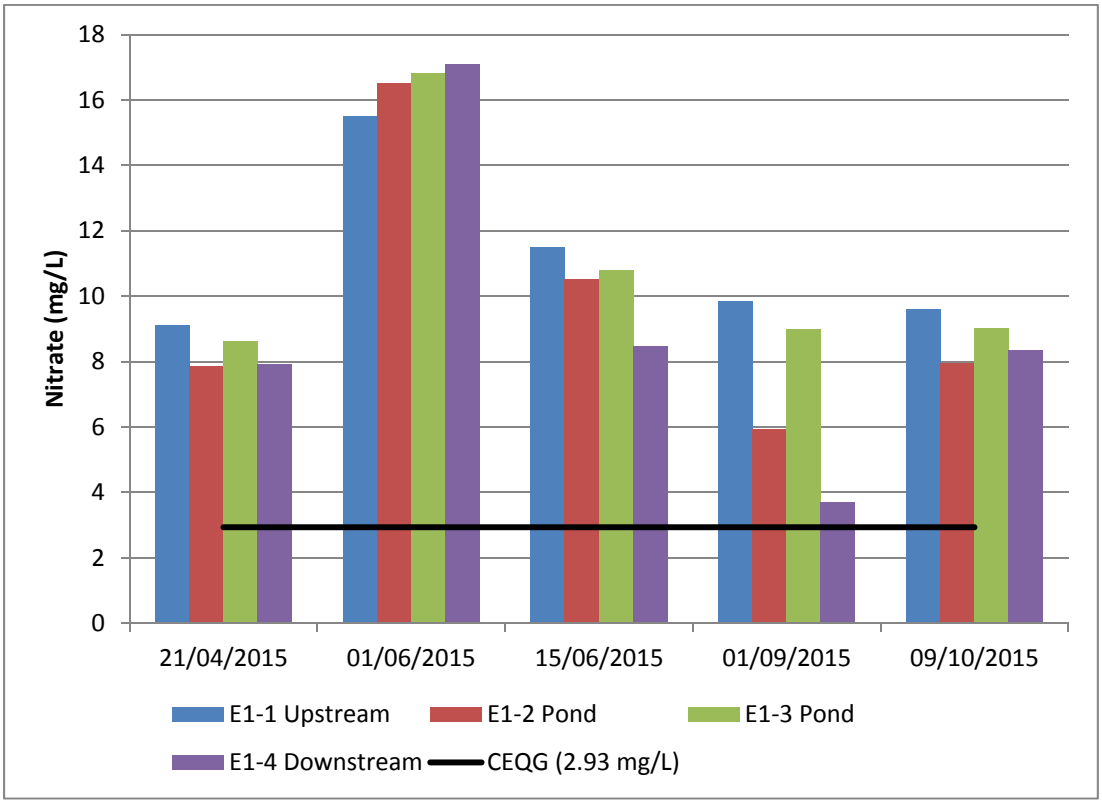
Sources: Nitrate sources can include sewage/animal waste, commercial fertilizers, septic systems, atmospheric deposition and natural decomposition of organic wastes.

Standards: Ontario does not have a Provincial Water Quality Objective for aquatic life but the Canadian Environmental Quality Guideline (CEQG) to protect aquatic life from direct toxicity to nitrate is 2.93 mg/L.

Monitoring Results:

- For 2015 the nitrate levels are consistently above the aquatic life guideline and in range similar to the Middle Thames watershed which is somewhat higher than other Upper Thames streams.
- Nitrates were higher during the rain event sample in 2015 which is to be expected for a water soluble nutrient.
- Historic data was consistently above aquatic guidelines and in a similar range to 2015 nitrate levels.

Figure 7: 2015 Nitrate



Chloride

Fate and Behaviour: Chloride moves easily with water and persists in the river system. Nearly all chloride added to the environment will eventually migrate to surface water or groundwater. Chloride can be toxic to aquatic organisms at high concentrations, and affects growth and reproduction at lower concentrations.

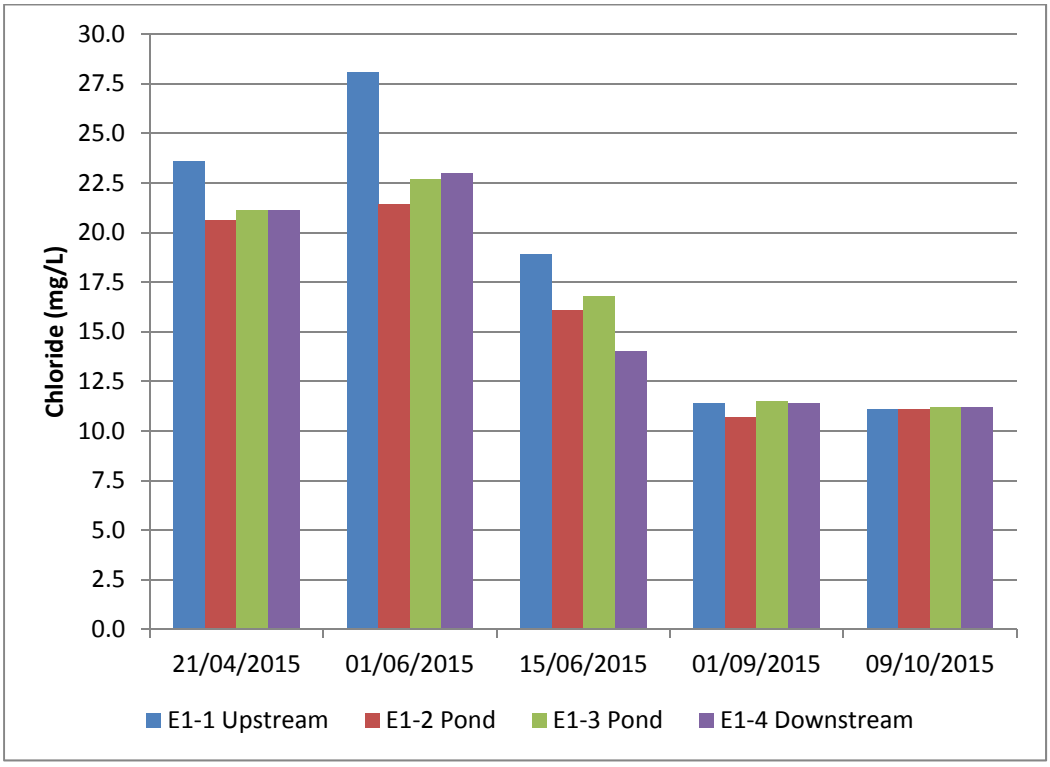
Sources: The highest loadings of chloride are typically associated with the application and storage of road salt (e.g.calcium chloride). Urban streams tend to have the highest chloride concentrations.

Standards: Ontario does not have a Provincial Water Quality Objective for aquatic life. A Canadian Environmental Quality Guideline (CEQG) for the long-term exposure of toxicity for sensitive aquatic species is 120 mg/L.

Monitoring Results:

- All samples are well below the guideline for chloride for both 2015 and historic samples and fall within a similar range.
- April to June had somewhat higher levels than samples later in the season but still very low compared to the guideline.
- The timing of sampling for this study did not provide data for winter or early spring runoff when chloride levels would be expected to be higher as a result of road salt runoff.

Figure 8: 2015 Chloride



Suspended Solids

Fate and Behaviour: Suspended solids consist of silt, clay, and fine particles of organic and inorganic matter. These particles can be carriers of phosphorus, metals, and other contaminants. Suspended solids can be detrimental to aquatic organisms including fish.

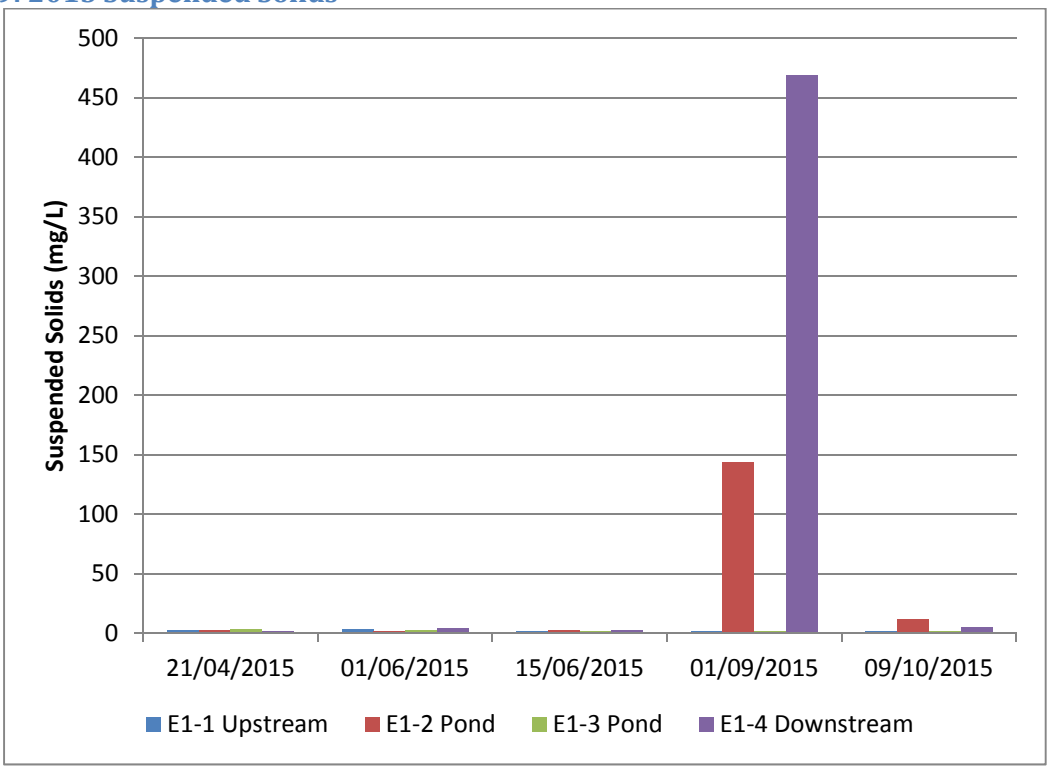
Sources: Soil erosion is the most common source of suspended solids to a watercourse. This can be from cultivated land, construction, development, eroded stream banks or natural erosion of stream beds.

Standards: There is no established standard for suspended solids. However, turbid water is undesirable for healthy aquatic life, recreation, and aesthetics.

Monitoring Results:

- Suspended solid levels are fairly low and similar to other sites across the Upper Thames watershed.
- For most dates and locations in 2015, concentrations of suspended solids were low with the exception of September 1st for the two pond locations had quite high suspended solids levels with no obvious explanation. The phosphorus levels were also high for these sites on this date.
- Historic and 2015 suspended solids levels were all typically below 30 mg/L with median levels between 10 to 15 mg/L.

Figure 9: 2015 Suspended Solids



Dissolved Oxygen

Dissolved oxygen is important for fish and other aquatic life. Dissolved oxygen levels below 4 mg/L can have an adverse effect on fish communities. Cooler water temperatures help to retain dissolved oxygen in water. Water flowing through natural stream channels with rock/riffles improves oxygen levels. Stagnant areas and decaying vegetation reduce oxygen levels.

Results: Spot field measurements were taken for dissolved oxygen using the YSI meter. This limited data gives a general indication of oxygen conditions at the time of sampling recognizing dissolved oxygen levels vary throughout the day. Readings upstream and downstream were similar and showed good oxygen levels, ranging from 7mg/l to 12 mg/l. The pond also had good readings with a range of 8 to 15 mg/L except September 1st when the readings were 1 mg/L and 5mg/L. This could be due to warm temperatures and vegetation die-off.

Metals

A suite of metals, including copper, lead, zinc and iron was tested in each sample as part of standard laboratory tests on two sample dates (April 21 and June 1). Metals are long lasting in the environment where they tend to accumulate in streambed sediments. Metals can bio-accumulate in fish and wildlife and can be toxic to aquatic life at elevated levels. Metals tend to be low in non-urban areas and are typically very low across the Upper Thames watershed.

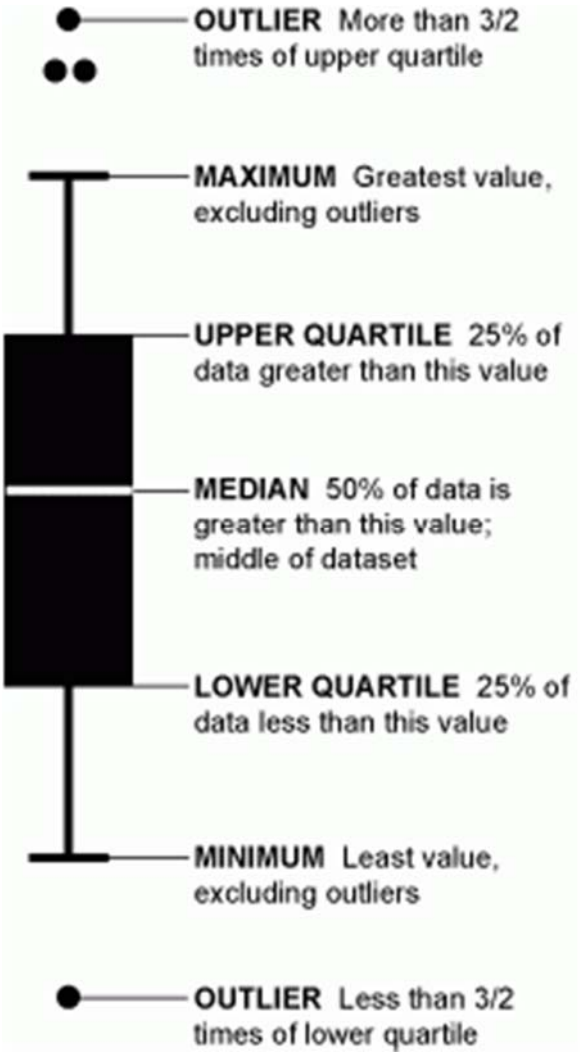
Results: All sample results on both dates showed very low to non-existent metals in the samples. Only one pond site on April 21st had levels of iron just above the Provincial objective for aquatic life.

Discussion

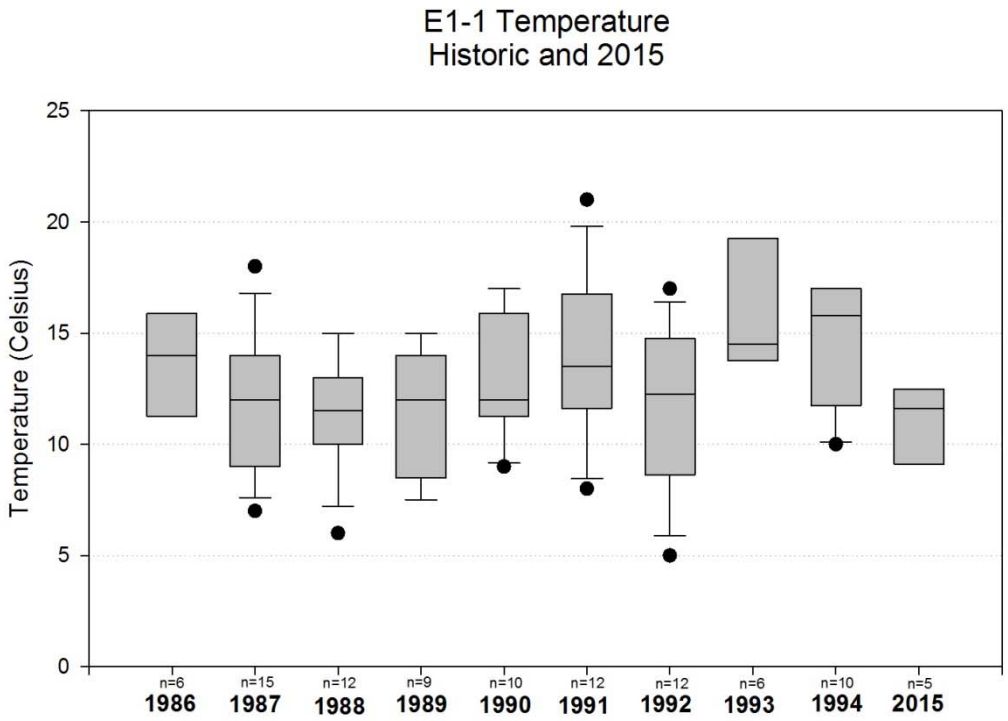
- In general, the water quality in the Youngsville Drain where it was sampled upstream, downstream and in Embro Pond showed levels typical of the Middle Thames watershed and other Upper Thames streams for 2015. The headwaters of this area include some healthy riparian areas with groundwater discharge creating this potential 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.
- Temperature differences are apparent between upstream and downstream of the pond based on continuous measurements and show a greater difference as the summer progressed, likely as a result of the warming effect of the pond.
- Ponds can act as a settling basin for sediment and associated contaminants such as phosphorus, and these can accumulate in the bottom sediments. These contaminants can be resuspended when disturbed such as during more extreme flow conditions. Sampling of the bottom sediments would give an indication of any accumulation.

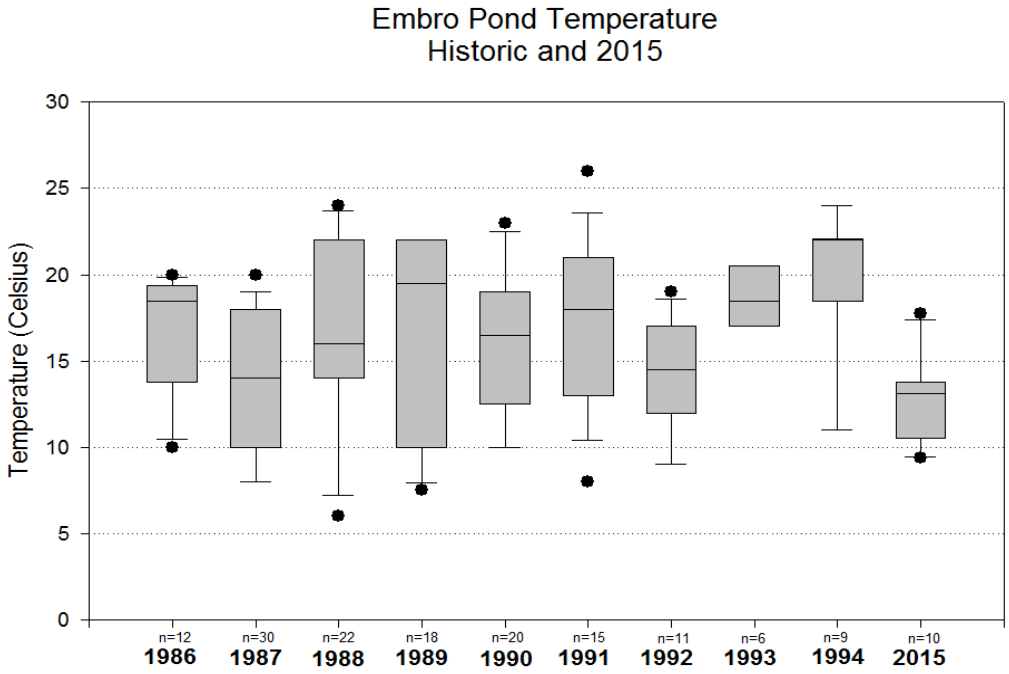
APPENDIX: HISTORICAL AND 2015 BOXPLOTS

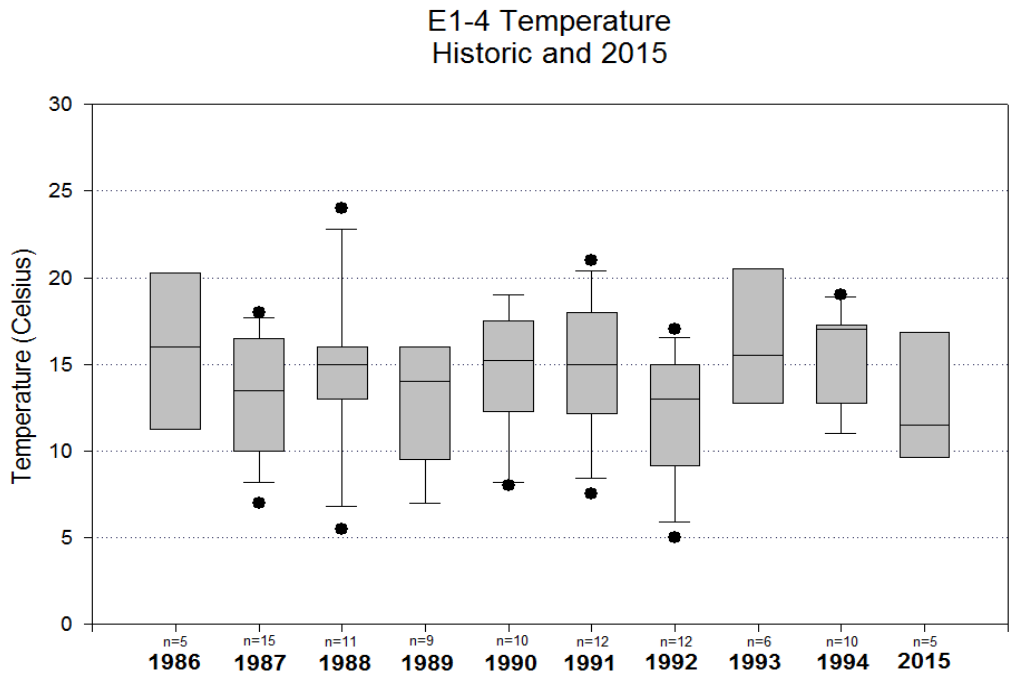
How to Read a Boxplot



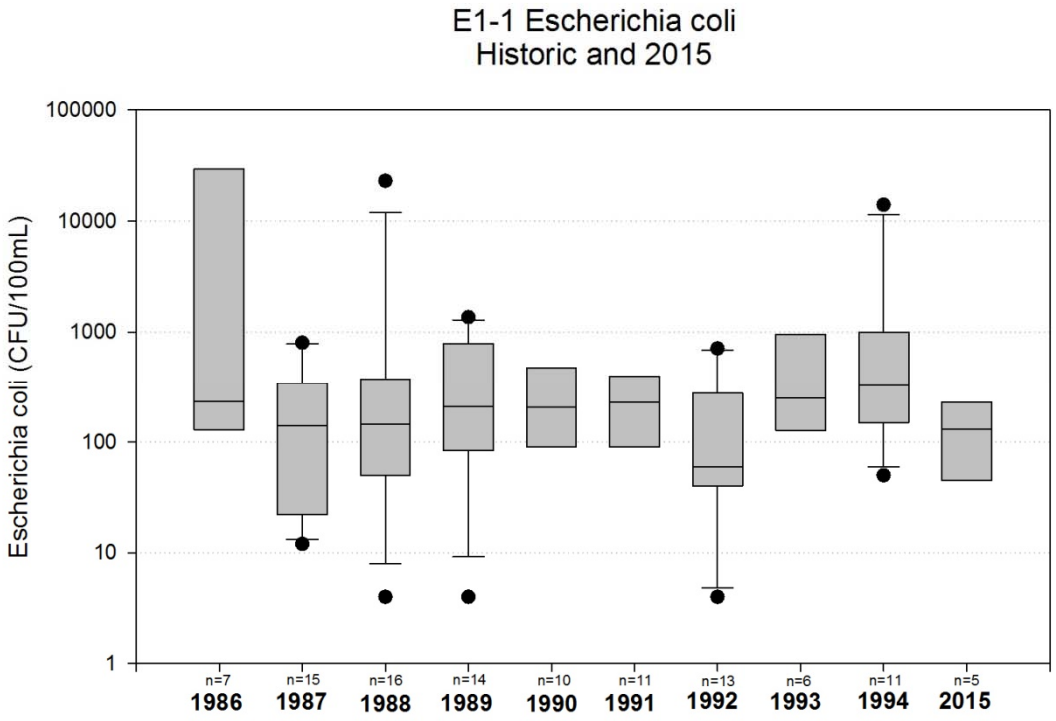
TEMPERATURE

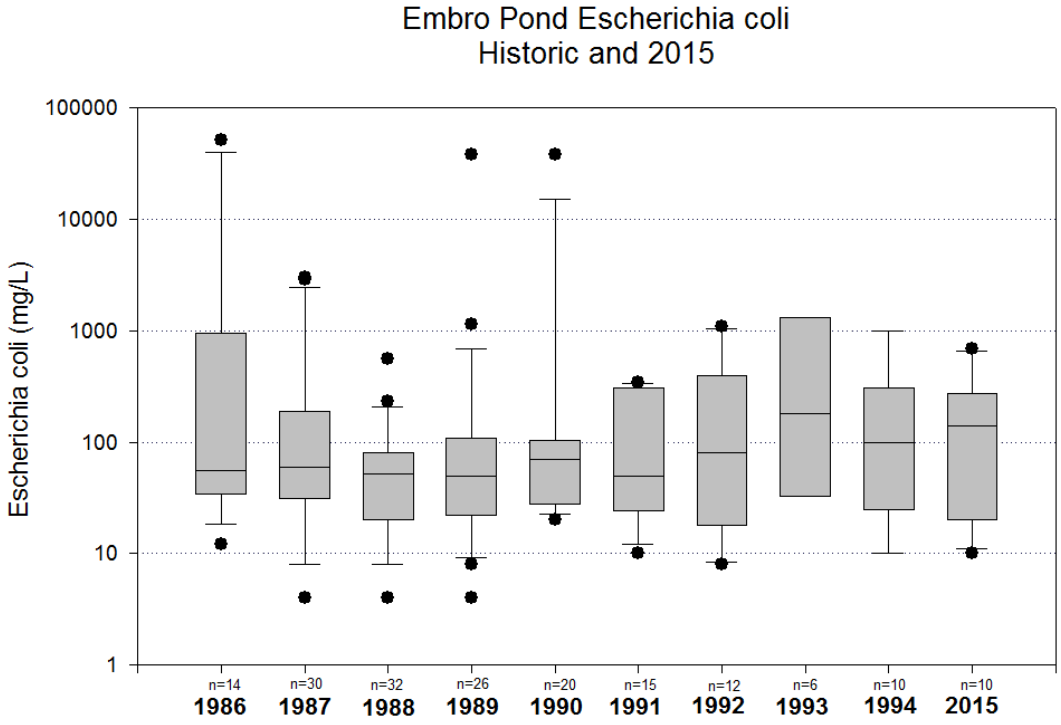


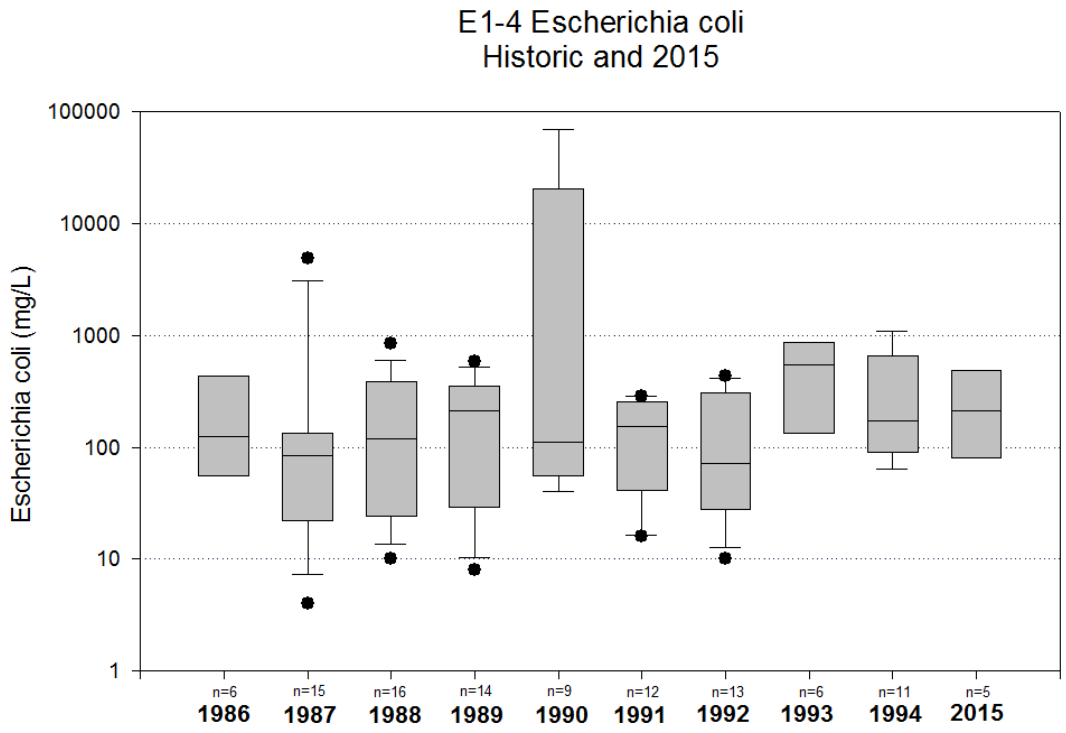



E1-4 Temperature
Historic and 2015
Temperature (Celsius)
30
25
20
15
10
5
0
n=5
1986
n=15
1987
n=11
1988
n=9
1989
n=10
1990
n=12
1991
n=12
1992
n=6
1993
n=10
1994
n=5
2015

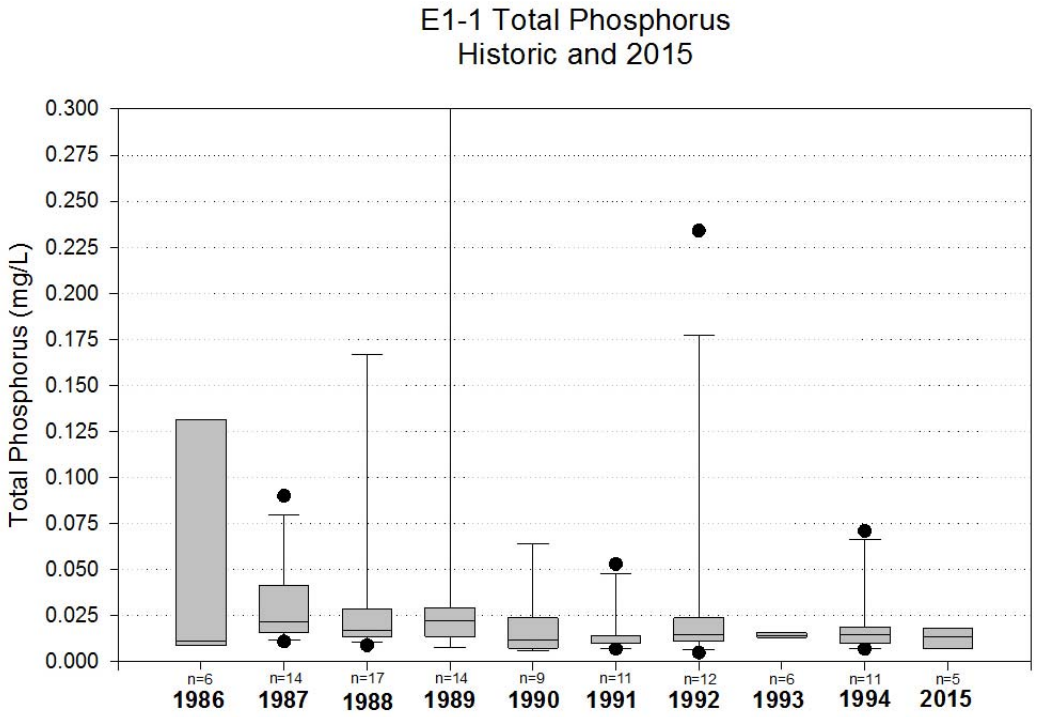
E. COLI


E1-1 Escherichia coli
Historic and 2015
Escherichia coli (CFU/100mL)
100000
10000
1000
100
10
1
n=7
1986
n=15
1987
n=16
1988
n=14
1989
n=10
1990
n=11
1991
n=13
1992
n=6
1993
n=11
1994
n=5
2015

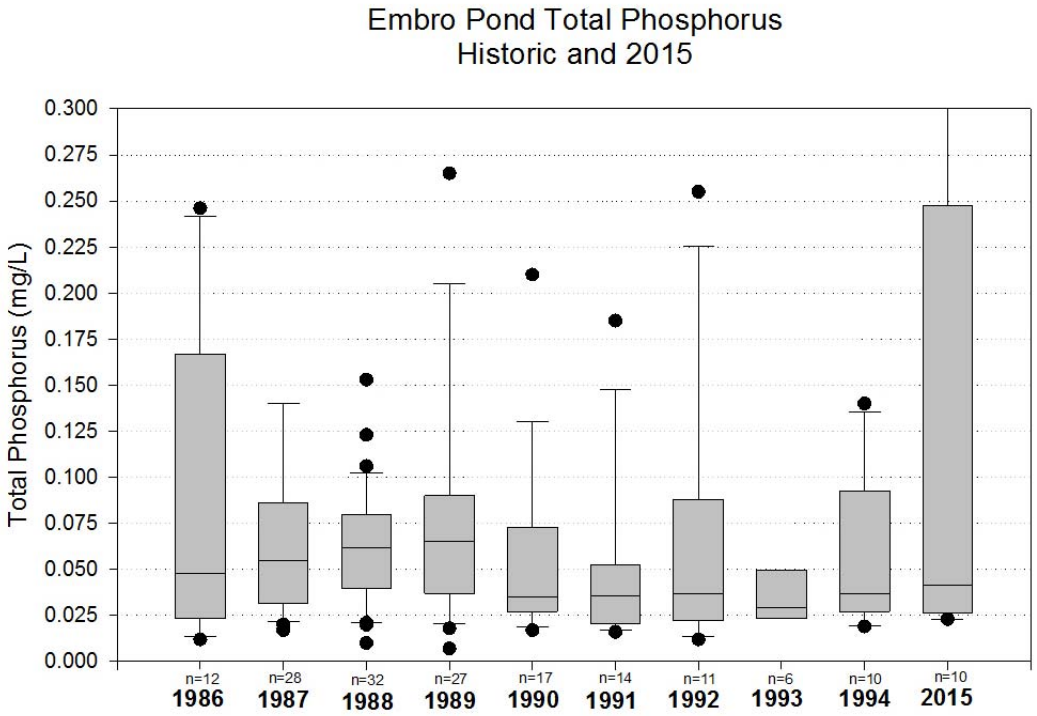

Embro Pond Escherichia coli
Historic and 2015
Escherichia coli (mg/L)
100000
10000
1000
100
10
1
n=14 1986
n=30 1987
n=32 1988
n=26 1989
n=20 1990
n=15 1991
n=12 1992
n=6 1993
n=10 1994
n=10 2015

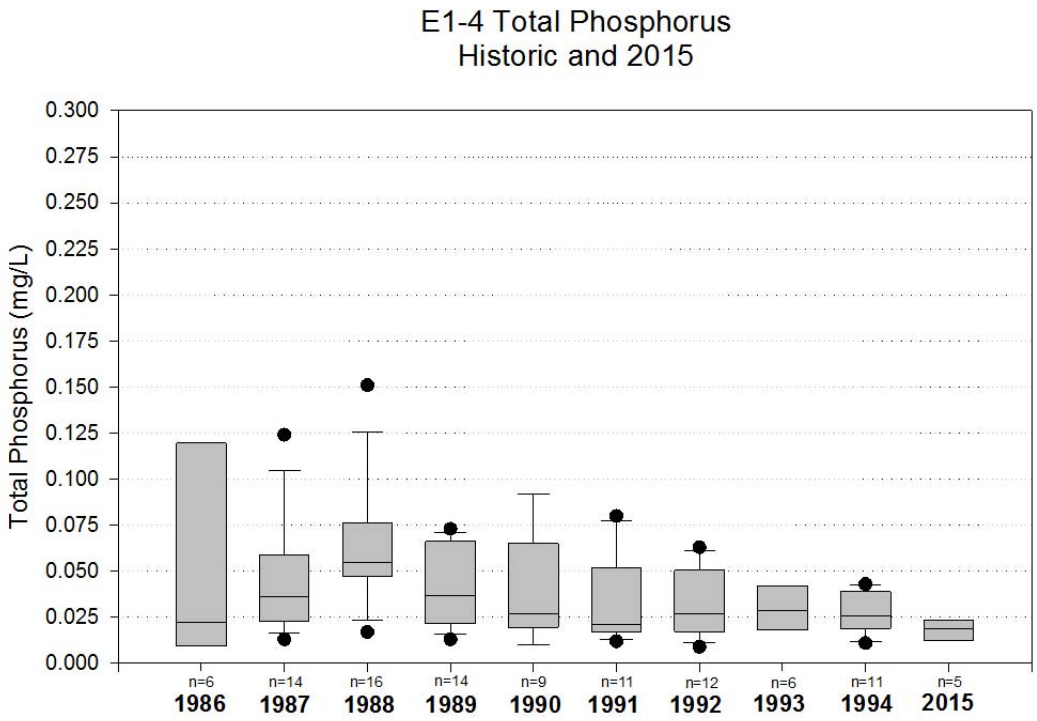

E1-4 Escherichia coli
Historic and 2015
Escherichia coli (mg/L)
100000
10000
1000
100
10
1
n=6 1986
n=15 1987
n=16 1988
n=14 1989
n=9 1990
n=12 1991
n=13 1992
n=6 1993
n=11 1994
n=5 2015

TOTAL PHOSPHORUS

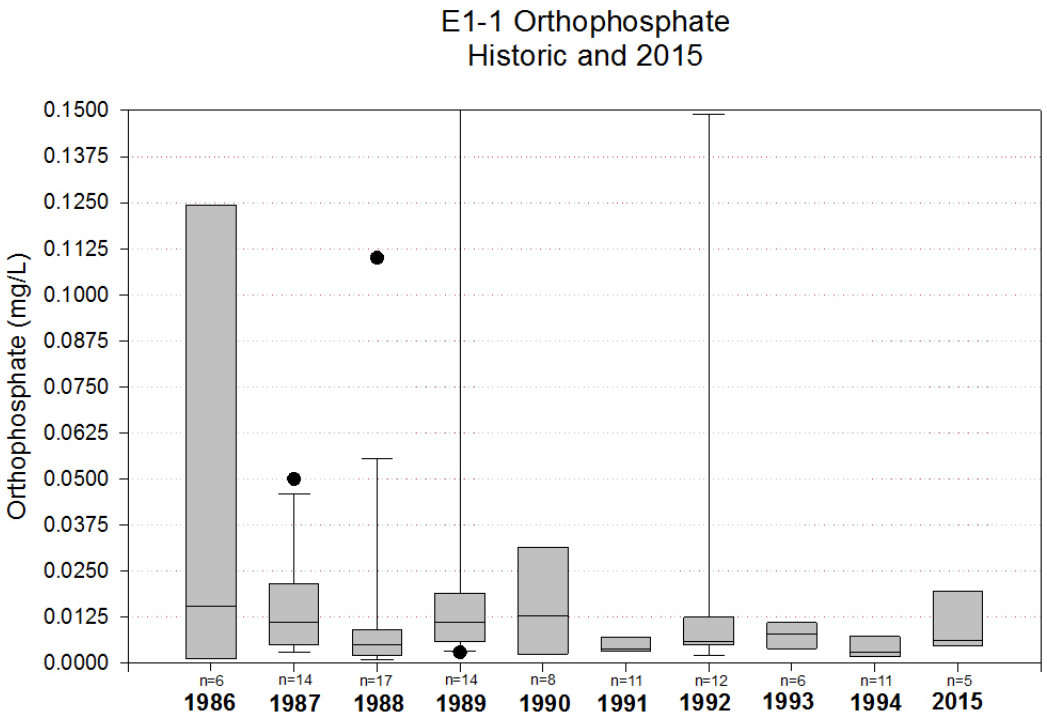


The scales of these graphs were adjusted according to the majority of the data for better visual comparison of results and several outliers are not shown on these graphs.

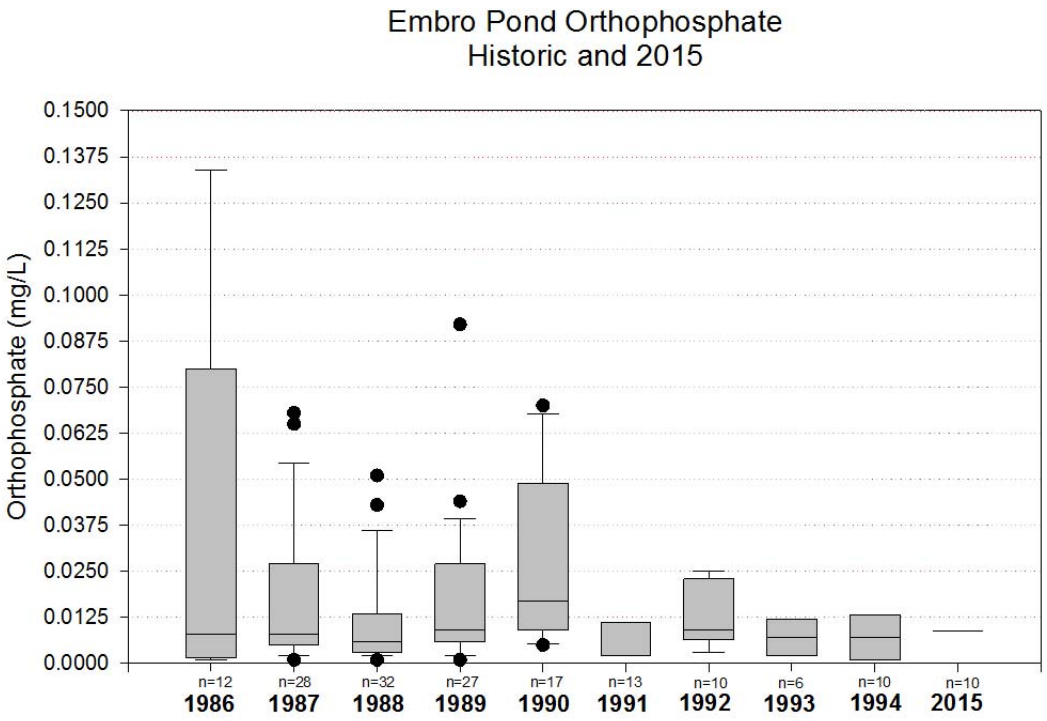


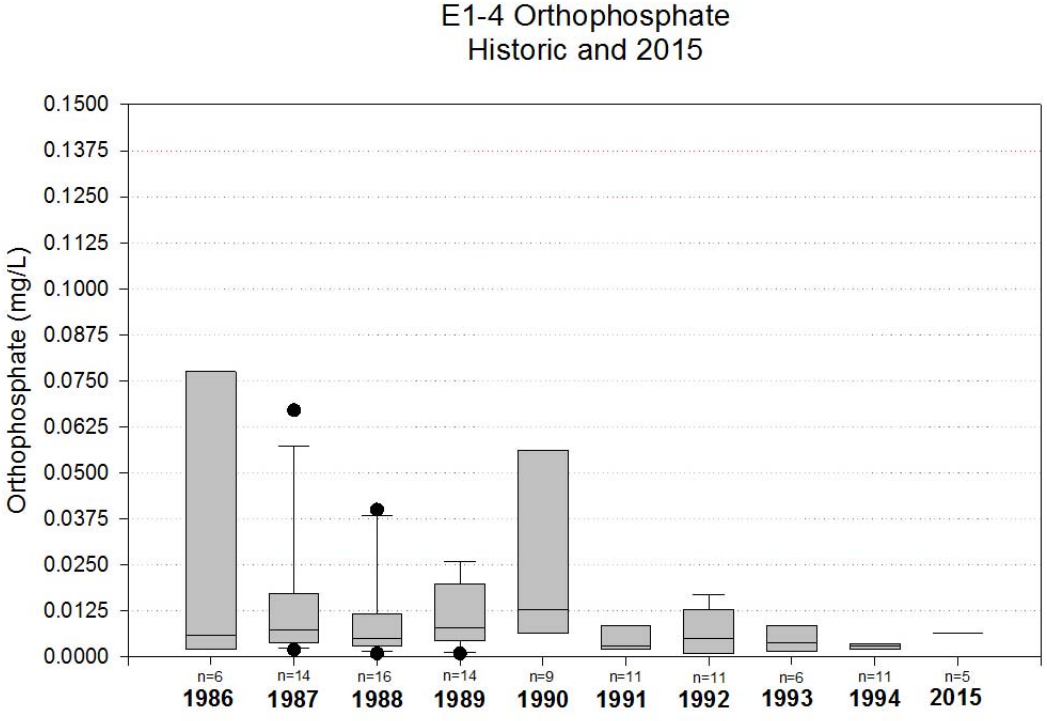


ORTHOPHOSPHATE

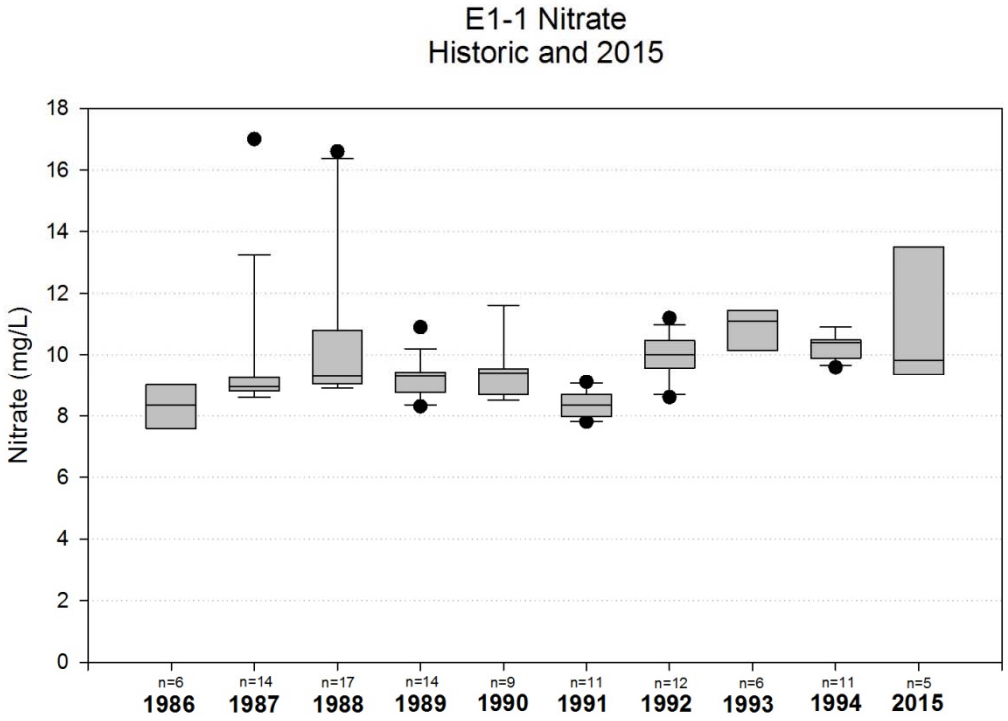


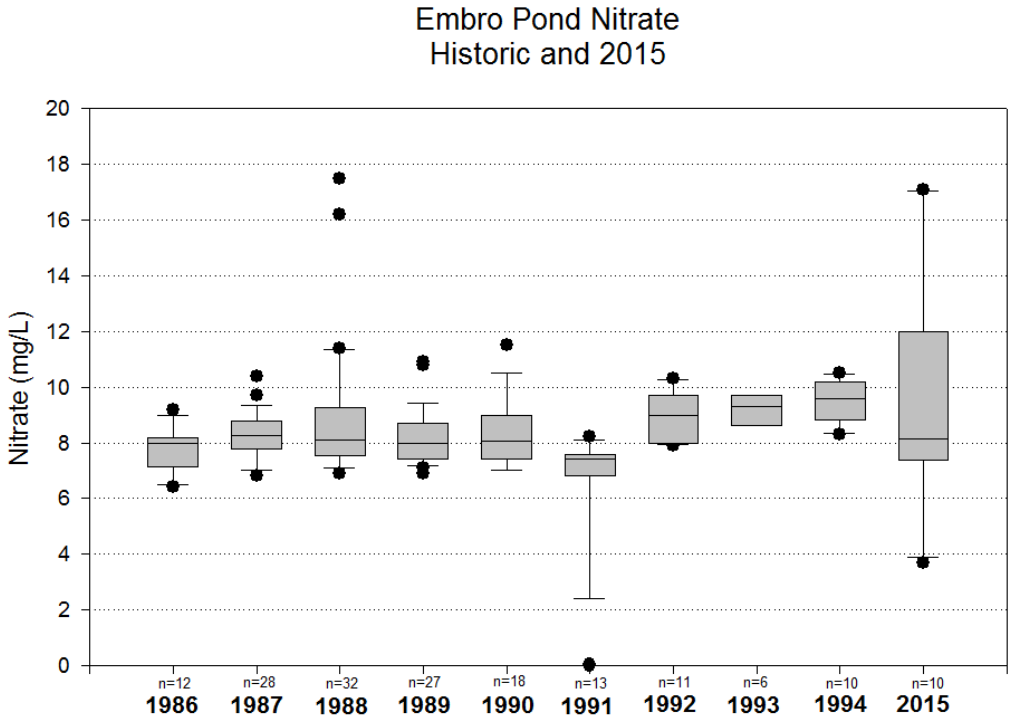
The scale of this graph was adjusted according to the majority of the data for better visual comparison of results and several outliers are not shown on the graph.

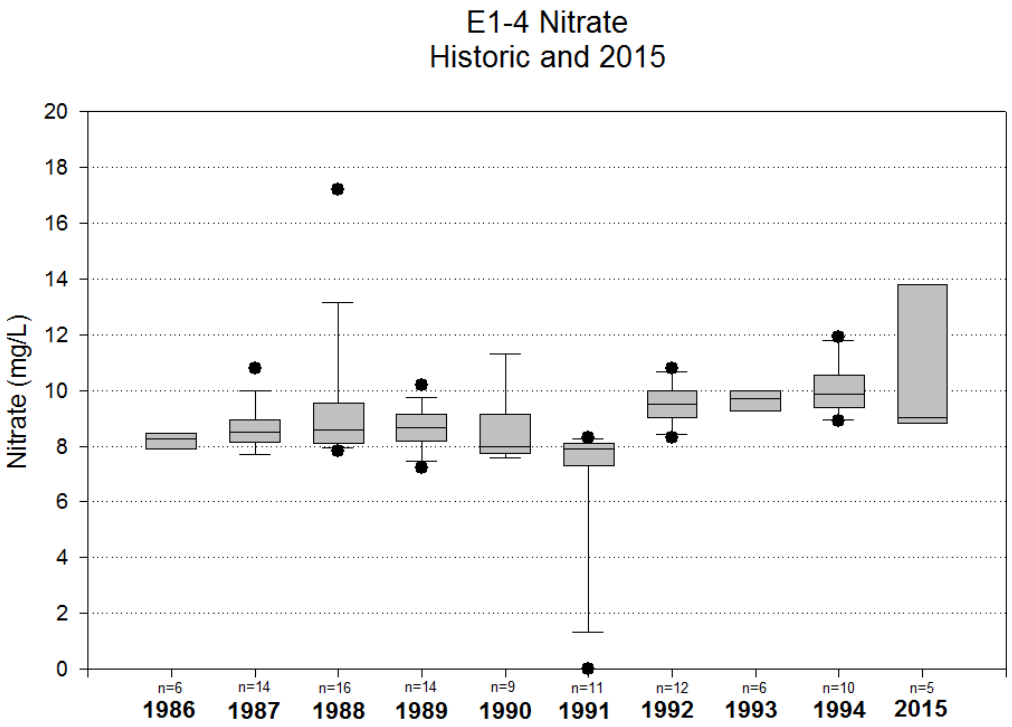

Embro Pond Orthophosphate
Historic and 2015
Orthophosphate (mg/L)
0.1500
0.1375
0.1250
0.1125
0.1000
0.0875
0.0750
0.0625
0.0500
0.0375
0.0250
0.0125
0.0000
n=12 1986
n=28 1987
n=32 1988
n=27 1989
n=17 1990
n=13 1991
n=10 1992
n=6 1993
n=10 1994
n=10 2015


E1-4 Orthophosphate
Historic and 2015
Orthophosphate (mg/L)
0.1500
0.1375
0.1250
0.1125
0.1000
0.0875
0.0750
0.0625
0.0500
0.0375
0.0250
0.0125
0.0000
n=6 1986
n=14 1987
n=16 1988
n=14 1989
n=9 1990
n=11 1991
n=11 1992
n=6 1993
n=11 1994
n=5 2015

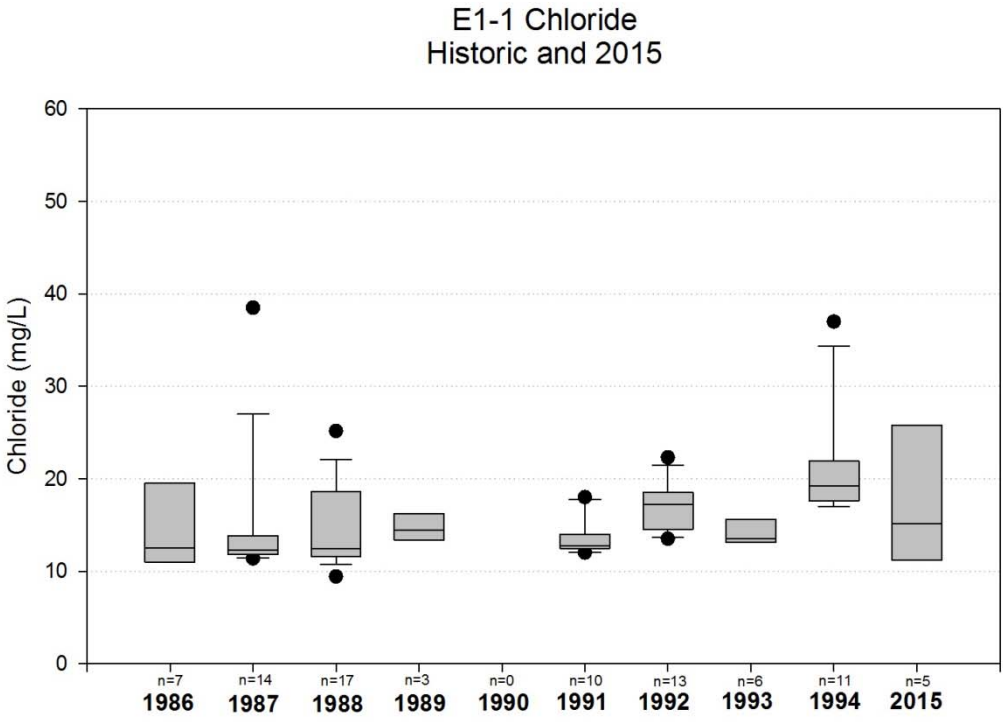
NITRATE

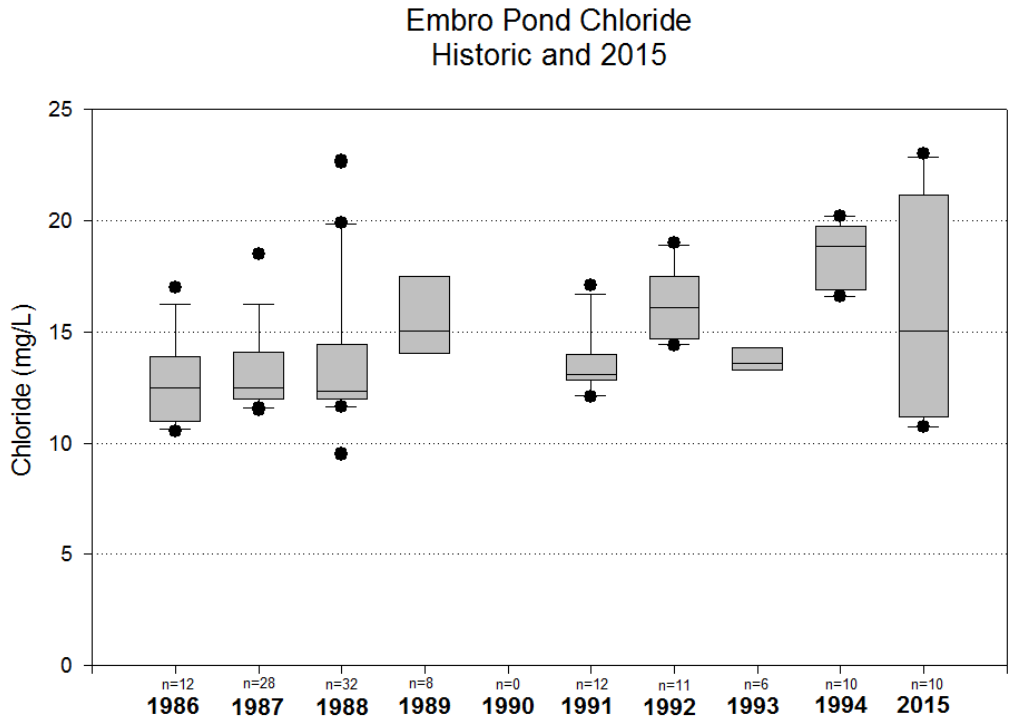

E1-1 Nitrate
Historic and 2015
Nitrate (mg/L)
0
2
4
6
8
10
12
14
16
18
n=6 1986
n=14 1987
n=17 1988
n=14 1989
n=9 1990
n=11 1991
n=12 1992
n=6 1993
n=11 1994
n=5 2015

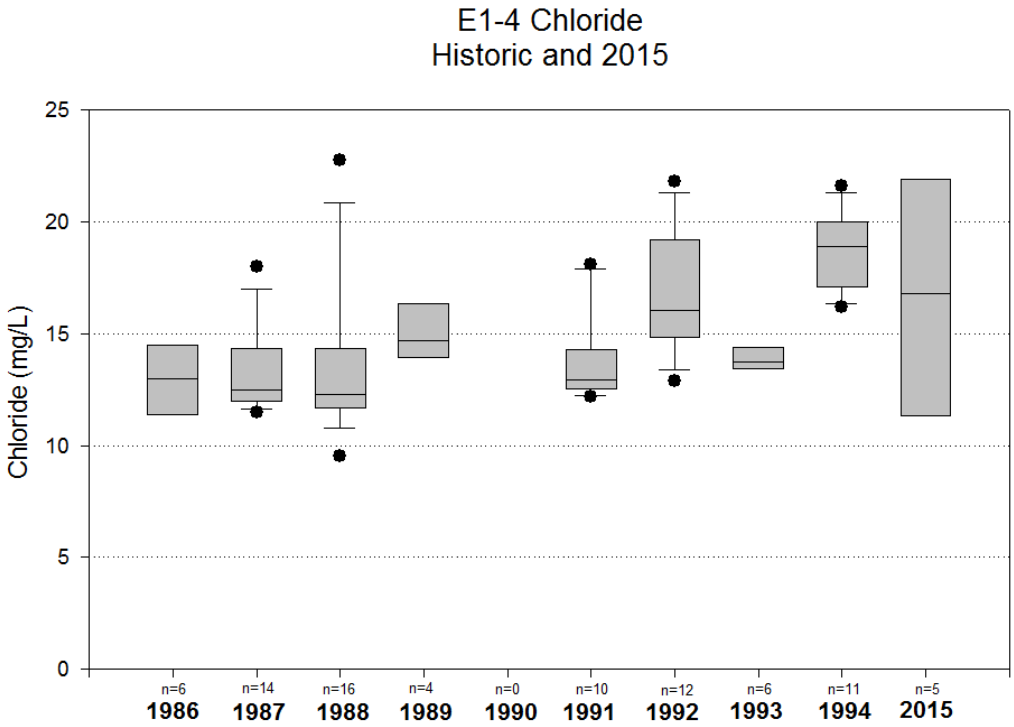

Embro Pond Nitrate
Historic and 2015
Nitrate (mg/L)
0
2
4
6
8
10
12
14
16
18
20
n=12 1986
n=28 1987
n=32 1988
n=27 1989
n=18 1990
n=13 1991
n=11 1992
n=6 1993
n=10 1994
n=10 2015


E1-4 Nitrate
Historic and 2015
Nitrate (mg/L)
0
2
4
6
8
10
12
14
16
18
20
n=6 1986
n=14 1987
n=16 1988
n=14 1989
n=9 1990
n=11 1991
n=12 1992
n=6 1993
n=10 1994
n=5 2015

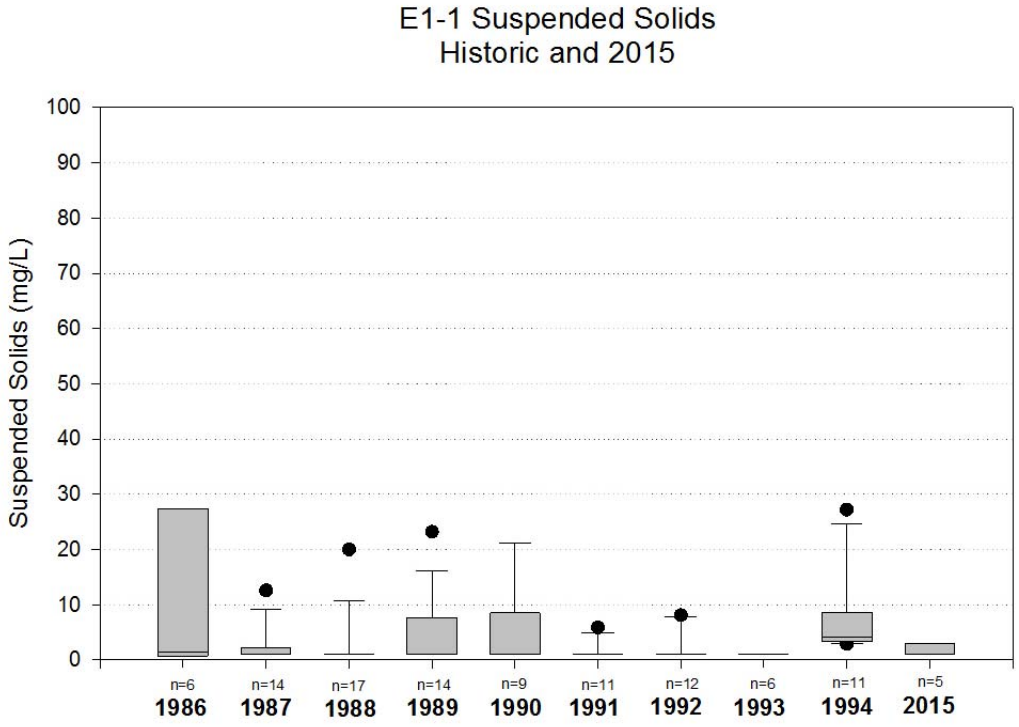
CHLORIDE

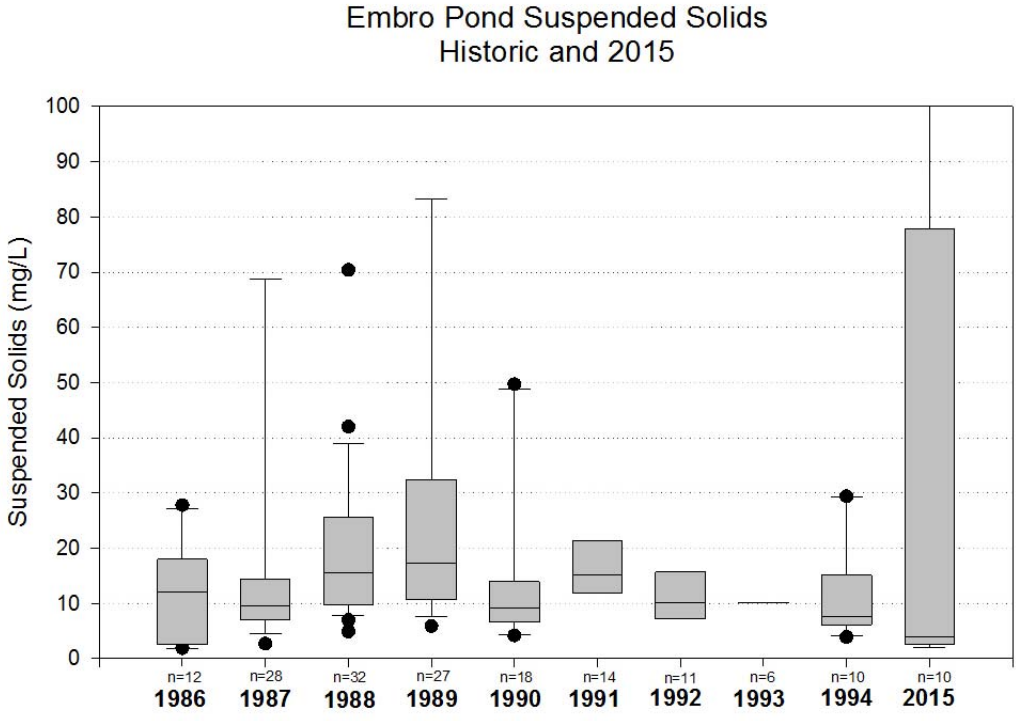

E1-1 Chloride
Historic and 2015
Chloride (mg/L)
0
10
20
30
40
50
60
n=7 1986
n=14 1987
n=17 1988
n=3 1989
n=0 1990
n=10 1991
n=13 1992
n=6 1993
n=11 1994
n=5 2015


Embro Pond Chloride
Historic and 2015
Chloride (mg/L)
25
20
15
10
5
0
n=12
1986
n=28
1987
n=32
1988
n=8
1989
n=0
1990
n=12
1991
n=11
1992
n=6
1993
n=10
1994
n=10
2015

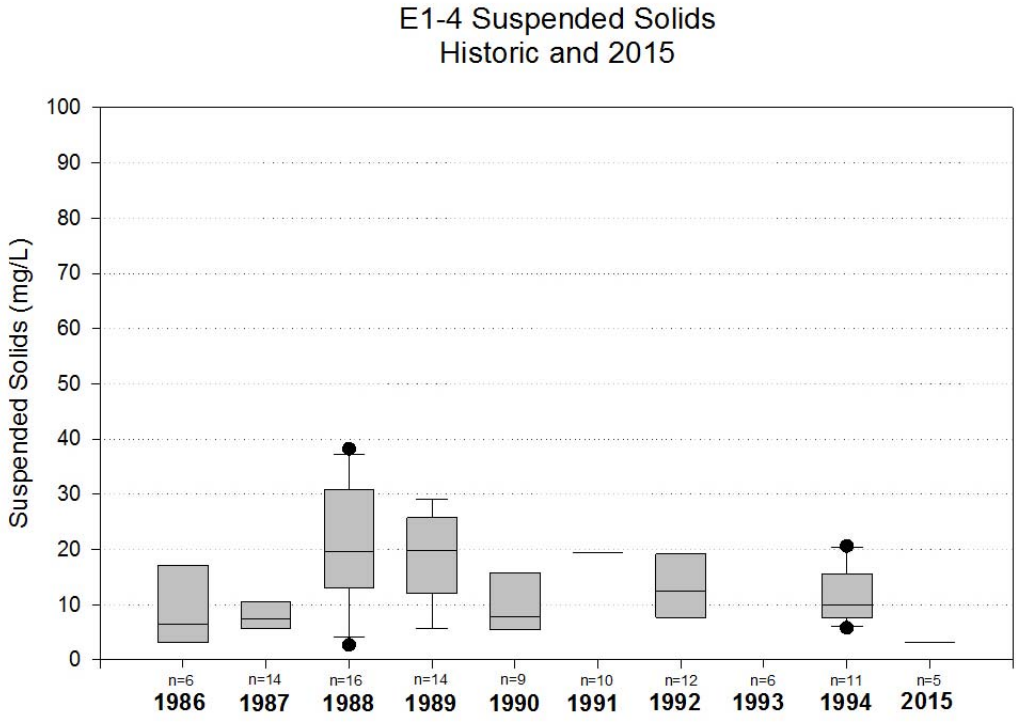

E1-4 Chloride
Historic and 2015
Chloride (mg/L)
25
20
15
10
5
0
n=6
1986
n=14
1987
n=16
1988
n=4
1989
n=0
1990
n=10
1991
n=12
1992
n=6
1993
n=11
1994
n=5
2015

SUSPENDED SOLIDS





The scale of this graph was adjusted according to the majority of the data for better visual comparison of results and several outliers are not shown on the graph.


E1-4 Suspended Solids
Historic and 2015
Suspended Solids (mg/L)
100
90
80
70
60
50
40
30
20
10
0
n=6
1986
n=14
1987
n=16
1988
n=14
1989
n=9
1990
n=10
1991
n=12
1992
n=6
1993
n=11
1994
n=5
2015

Appendix C

Embro Dam Area Fish and Benthic Records

Prepared by UTRCA, Updated October 2016

Appendix C

Updated Oct 13, 2016

Embro Dam Area
Fish and Benthic Records

Contents

Fish diversity upstream of Embro Pond

Species	Status - Global	Can	Ont.	Thames	Thames Distribution	Times Sampled
Blacknose Dace	G5		S5	Abundant	widespread	8
Brook Stickleback	G5		S5	Abundant	widespread	20
Brook Trout (coldwater)	G5T		S5	Uncommon	localized	32
Creek Chub	G5		S5	Abundant	widespread	1
Fathead Minnow	G5		S5	Abundant	widespread	13
Johnny Darter	G5		S5	Abundant	widespread	2
Northern Redbelly Dace	G5		S5	Abundant	locally common	4
White Sucker	G5		S5	Abundant	widespread	21

Fish diversity downstream of Embro Pond

Species	Status - Global	Can	Ont.	Thames	Thames Distribution	Times Sampled
Blacknose Dace	G5		S5	Abundant	widespread	9
Bluegill	G5		S5	Common	localized	1
Bluntnose Minnow	G5		S5	Abundant	widespread	4
Brook Stickleback	G5		S5	Abundant	widespread	3
Brook Trout (coldwater)	G5T		S5	Uncommon	localized	10
Central Stoneroller	G5		S4	Abundant	widespread	5
Common Shiner	G5		S5	Abundant	widespread	8
Creek Chub	G5		S5	Abundant	widespread	8
Fantail Darter	G5		S4	Abundant	widespread	2
Fathead Minnow	G5		S5	Abundant	widespread	6
Golden Shiner	G5		S5	Common	localized	1
Greenside Darter	G5		S4	Abundant	widespread	1
Hornyhead Chub	G5		S4	Abundant	widespread	3
Johnny Darter	G5		S5	Abundant	widespread	6
Northern Hog Sucker	G5		S4	Abundant	widespread	1
Northern Redbelly Dace	G5		S5	Abundant	locally common	6
Rock Bass	G5		S5	Abundant	widespread	1
Rosyface Shiner	G5		S4	Abundant	widespread	2
Smallmouth Bass	G5		S5	Abundant	widespread	2
Striped Shiner	G5		S4	Abundant	widespread	1
White Sucker	G5		S5	Abundant	widespread	9

Embro Dam area fish sampling (2015)

Species (Common Name)		COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Youngsville Drain							
East of 35th Line 2 km North of Road 84			UTM x: 505741	UTM y: 4781834	Source: UTRCA	Site Code MU24	Sample Date 10/9/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Youngsville Drain							
East of 35th Line 1.2 km North of Road 84			UTM x: 506031	UTM y: 4781231	Source: UTRCA	Site Code MU41	Sample Date 5/7/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Embro Pond							
Embro CA, Rd 84			UTM x: 506858	UTM y: 4779995	Source: UTRCA	Site Code MU25	Sample Date 4/15/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Youngsville Drain							
Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791	Source: UTRCA	Site Code MU40	Sample Date 4/15/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791	Source: UTRCA	Site Code MU40	Sample Date 7/8/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Rd 84, Embro C.A., downstream of pond		UTM x: 506879	UTM y: 4779791	Source: UTRCA		Site Code MU40	Sample Date 10/19/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Fantail Darter	*Etheostoma flabellare*				S4	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Golden Shiner	*Notemigonus crysoleucas*				S5	Common	localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Embro Dam area fish sampling (2015)

Species (Common Name)		COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution

Youngsville Drain

East of 35th Line 2 km North of Road 84		UTM x: 505741	UTM y: 4781834	Source: UTRCA		Site Code MU24	Sample Date 10/9/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized

Youngsville Drain

East of 35th Line 1.2 km North of Road 84		UTM x: 506031	UTM y: 4781231	Source: UTRCA		Site Code MU41	Sample Date 5/7/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Embro Pond

Embro CA, Rd 84		UTM x: 506858	UTM y: 4779995	Source: UTRCA		Site Code MU25	Sample Date 4/15/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Youngsville Drain

Rd 84, Embro C.A., downstream of pond		UTM x: 506879	UTM y: 4779791	Source: UTRCA		Site Code MU40	Sample Date 4/15/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Rd 84, Embro C.A., downstream of pond		UTM x: 506879	UTM y: 4779791	Source: UTRCA		Site Code MU40	Sample Date 7/8/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Rd 84, Embro C.A., downstream of pond		UTM x: 506879	UTM y: 4779791	Source: UTRCA		Site Code MU40	Sample Date 10/19/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Fantail Darter	*Etheostoma flabellare*				S4	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Golden Shiner	*Notemigonus crysoleucas*				S5	Common	localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Embro Dam area fish sampling (2009 – 2014)

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA	2007	SRank	Abundanc	Distribution
Youngsville Drain								
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		11/21/2003
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*					S5	Abundant	widespread
White Sucker	*Catostomus commersoni*					S5	Abundant	widespread
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		11/23/2010
Brook Stickleback	*Culaea inconstans*					S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
White Sucker	*Catostomus commersoni*					S5	Abundant	widespread
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		11/27/2012
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
White Sucker	*Catostomus commersoni*					S5	Abundant	widespread
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		11/30/2012
Brook Stickleback	*Culaea inconstans*					S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*					S5	Abundant	widespread
White Sucker	*Catostomus commersoni*					S5	Abundant	widespread
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		11/18/2013
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		11/20/2013
Brook Stickleback	*Culaea inconstans*					S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*					S5	Abundant	widespread
White Sucker	*Catostomus commersoni*					S5	Abundant	widespread
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		11/27/2013
Brook Stickleback	*Culaea inconstans*					S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*					S5	Abundant	widespread
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		11/29/2013
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		12/5/2013
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized
East of 35th Line 2 km North of Road 84		UTM x: 505741		UTM y: 4781834		MU24		12/9/2013
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundanc	Distribution
East of 35th Line 2 km North of Road 84			UTM x: 505741	UTM y: 4781834		MU24	11/12/2014
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 2 km North of Road 84			UTM x: 505741	UTM y: 4781834		MU24	11/17/2014
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
East of 35th Line 2 km North of Road 84			UTM x: 505741	UTM y: 4781834		MU24	11/26/2014
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 2 km North of Road 84			UTM x: 505741	UTM y: 4781834		MU24	12/2/2014
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 2 km North of Road 84			UTM x: 505741	UTM y: 4781834		MU24	12/5/2014
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Youngsville Drain

East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	9/3/2009
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	11/18/2010
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	11/22/2013
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	12/2/2013
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundanc	Distribution
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	10/27/2014
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	11/3/2014
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	11/13/2014
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	12/5/2014
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
East of 35th Line 1.4 km North of Road 84			UTM x: 505996	UTM y: 4781291		MU41	12/12/2014
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Youngsville Drain

Road 84			UTM x: 506759	UTM y: 4780111		837-UT	11/1/1999
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
Road 84			UTM x: 506759	UTM y: 4780111		837-UT	11/12/2010
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Road 84			UTM x: 506759	UTM y: 4780111		837-UT	11/21/2013
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundanc	Distribution
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Road 84			UTM x: 506759	UTM y: 4780111	837-UT		11/25/2013
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
Road 84			UTM x: 506759	UTM y: 4780111	837-UT		11/26/2014
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Youngsville Drain

Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791	MU40		9/3/2009
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	widespread
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Greenside Darter	*Etheostoma blennioides*				S4	Abundant	widespread
Hornyhead Chub	*Nocomis biguttatus*				S4	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
Northern Hog Sucker	*Hypentelium nigricans*				S4	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791	MU40		9/2/2010
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Bluegill	*Lepomis macrochirus*				S5	Common	localized
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	widespread
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
Striped Shiner	*Luxilus chrysocephalus*				S4	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundanc	Distribution
Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791		MU40	11/12/2010
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791		MU40	7/15/2011
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Hornyhead Chub	*Nocomis biguttatus*				S4	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791		MU40	8/28/2012
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Fantail Darter	*Etheostoma flabellare*				S4	Abundant	widespread
Hornyhead Chub	*Nocomis biguttatus*				S4	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
Rosyface Shiner	*Notropis rubellus*				S4	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791		MU40	10/18/2012
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	widespread
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
Rock Bass	*Ambloplites rupestris*				S5	Abundant	widespread
Rosyface Shiner	*Notropis rubellus*				S4	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Rd 84, Embro C.A., downstream of pond			UTM x: 506879	UTM y: 4779791		MU40	6/25/2014
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	widespread
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundanc	Distribution
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Abundant	locally common
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Global Rank (GRANK): Global ranks are assigned by a consensus of the network of natural heritage programs (conservation data centres), scientific experts, and The Nature Conservancy to designate a rarity rank based on the range-wide status of a species, subspecies or variety. The most important factors considered in assigning global (and provincial) ranks are the total number of known, extant sites world-wide, and the degree to which they are potentially or actively threatened with destruction. Other criteria include the number of known populations considered to be securely protected, the size of the various populations, and the ability of the taxon to persist at its known sites. The taxonomic distinctness of each taxon has also been considered. Hybrids, introduced species, and taxonomically dubious species, subspecies and varieties have not been included.
G1 Extremely rare; usually 5 or fewer occurrences in the overall range or very few remaining individuals; or because some factor(s) making it especially vulnerable to extinction.
G2 Very rare; usually between 5 and 20 occurrences in the overall range or with many individuals in fewer occurrences; or because of some factor(s) making it vulnerable to extinction.
G3 Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.
G4 Common; usually more than 100 occurrences; usually not susceptible to immediate threats.
G5 Very common; demonstrably secure under present conditions.

COSEWIC Status: The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses species for their consideration for legal protection and recovery (or management) under the Species at Risk Act (SARA).
Extinct: A wildlife species that no longer exists.
Extirpated: A wildlife species no longer existing in the wild in Canada, but exists elsewhere.
Endangered: A wildlife species facing imminent extirpation or extinction.
Threatened: A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern: A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk: A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient: A category that applies when the available information is insufficient (a) to resolve a wildlife species' eligibility for assessment or (b) to permit an assessment of the wildlife species' risk of extinction.
References: http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=1 https://www.registrelep-sararegistry.gc.ca/sar/index/default_e.cfm?stype=speciesindex=1cosid=common=scientific=population=taxid=3locid=0desid= 0schid=0desid2=0 http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.pdf http://www.cosewic.gc.ca/eng/sct5/index_e.cfm (current to September 2009)

Provincial Rank (SRANK): Provincial (or Subnational) ranks are used by the Natural Heritage Information Centre to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario. By comparing the global and provincial ranks, the status, rarity, and the urgency of conservation, needs can be ascertained. The NHIC evaluates provincial ranks on a continual basis and produces updated lists at least annually. The NHIC welcomes information which will assist in assigning accurate provincial ranks.
S1 Extremely rare in Ontario; usually 5 or fewer occurrences in the province or very few remaining individuals; often especially vulnerable to extirpation.
S2 Very rare in Ontario; usually between 5 and 20 occurrences in the province or with many individuals in fewer occurrences; often susceptible to extirpation.
S3 Rare to uncommon in Ontario; usually between 20 and 100 occurrences in the province; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances. Most species with an S3 rank are assigned to the watch list, unless they have a relatively high global rank.
S4 Common and apparently secure in Ontario; usually with more than 100 occurrences in the province.
S5 Very common and demonstrably secure in Ontario.
S? Unranked, or, if following a ranking, rank uncertain (e.g. S3?). S? species are thought to be rare in Ontario, but there is insufficient information available to assign a more accurate rank.
SE Exotic; not believed to be a native component of Ontario's flora

Embro Dam area benthic water quality sampling summary

	DATE	FBI	QUALITY
Youngsville Drain upstream of dam Accessed from 35th Line 1.2 km north of Rd 84			
Site code: MU24 UTM X Coordinate: 506031 UTM Y Coordinate: 4781231			
	11/21/2003	6.11	Fairly Poor
Youngsville Drain upstream of dam Oxford Road 84 North of Embro CA			
Site code: MU26 UTM X Coordinate: 506776 UTM Y Coordinate: 4780094			
	7/9/2008	6.04	Fairly Poor
	5/5/2015	5.82	Fairly Poor
	9/23/2015	6.06	Fairly Poor
Youngsville Drain downstream of dam Embro C.A., below dam			
Site code: MU40 UTM X Coordinate: 506879 UTM Y Coordinate: 4779791			
	9/29/2010	5.81	Fairly Poor
	5/5/2015	5.84	Fairly Poor
	9/23/2015	6.37	Fairly Poor

Embro Dam area benthic sampling data (2003 – 2015)

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Youngsville Drain upstream of pond	**Accessed from 35th Line 1.2 km north of Rd 84**			
	Site code: MU24	UTM X: 506031	UTM Y: 4781231	
Sampled - 11/21/2003				
	REP: 1			
Acariformes	Water Mite	A	8	6
Asellidae	Sow Bug	A	51	8
Baetidae	Small Mayfly	N	14	6
Chironomidae	Midge	L	21	6
Dytiscidae	Predacious Diving Beetle	L	1	5
Elmidae	Riffle Beetle	L	1	5
Hydroptilidae	Micro-caddisfly	L	1	6
Limnephilidae	Northern Caddisfly	L	5	4
Nematoda	Thread Worm	A	1	5
Oligochaeta	Aquatic Worm	A	11	8
Physidae	Pouch Snail	A	1	8
Pisidiidae	Fingernail Clam	A	1	6
Simuliidae	Black Fly	L	85	5
Tipulidae	Crane Fly	L	3	4
Turbellaria	Flatworm	A	1	6
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**6.11**
Youngsville Drain upstream of pond	**Oxford Road 84 North of Embro CA**			
	Site code: MU26	UTM X: 506776	UTM Y: 4780094	
Sampled - 7/9/2008				
	REP: 1			
Acariformes	Water Mite	A	4	6
Baetidae	Small Mayfly	N	1	6
Ceratopogonidae	Biting Midge	L	4	6
Chironomidae	Midge	L	276	6
Corixidae	Water Boatmen	A	18	5
Dytiscidae	Predacious Diving Beetle	L	2	5
Elmidae	Riffle Beetle	L	1	5
Haliplidae	Crawling Water Beetle	L	2	5
Leptoceridae	Long-horned Caddisfly	L	1	4
Nematoda	Thread Worm	A	3	5
Oligochaeta	Aquatic Worm	A	22	8
Pisidiidae	Fingernail Clam	A	2	6
Simuliidae	Black Fly	L	1	5
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**6.04**
Sampled - 5/5/2015				
	REP: 1			
Acariformes	Water Mite	A	26	6
Asellidae	Sow Bug	A	11	8
Baetidae	Small Mayfly	N	9	6
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	P	19	6
Chironomidae	Midge	L	160	6
Dytiscidae	Predacious Diving Beetle	L	1	5
Elmidae	Riffle Beetle	A	4	5
Elmidae	Riffle Beetle	L	20	5
Empididae	Dance Fly	L	9	6

Glossiphoniidae	Leech	A	1	8
Hydropsychidae	Net-spinning Caddisfly	L	9	5
Hydroptilidae	Micro-caddisfly	L	1	6

Taxonomic Name	**Common Name**	**Life Stage**	**# in Subsample**	**Biotic Index**
Lepidostomatidae	*Lepistomatid* Caddisfly	L	7	1
Limnephilidae	Northern Caddisfly	L	2	4
Oligochaeta	Aquatic Worm	A	13	8
Perlidae	Stonefly	N	9	3
Simuliidae	Black Fly	L	5	5
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**5.82**

Sampled - 9/23/2015

REP: 1

Acariformes	Water Mite	A	21	6
Asellidae	Sow Bug	A	18	8
Baetidae	Small Mayfly	N	20	6
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	L	226	6
Chironomidae	Midge	P	16	6
Elmidae	Riffle Beetle	L	5	5
Hydropsychidae	Net-spinning Caddisfly	L	9	5
Hydroptilidae	Micro-caddisfly	L	1	6
Hydroptilidae	Micro-caddisfly	P	3	6
Nematoda	Thread Worm	A	1	5
Oligochaeta	Aquatic Worm	A	5	8
Pisidiidae	Fingernail Clam	A	2	6
Simuliidae	Black Fly	L	5	5
Tipulidae	Crane Fly	L	3	4
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**6.06**

Youngsville Drain downstream of dam

Embro C.A., below dam

Site code: MU40 UTM X: 506879 UTM Y: 4779791

Sampled - 9/29/2010

REP: 1

Acariformes	Water Mite	A	7	6
Asellidae	Sow Bug	A	15	8
Baetidae	Small Mayfly	N	2	6
Chironomidae	Midge	P	15	6
Chironomidae	Midge	L	76	6
Elmidae	Riffle Beetle	A	4	5
Elmidae	Riffle Beetle	L	23	5
Empididae	Dance Fly	L	7	6
Gammaridae	Sideswimmer	A	13	6
Hydropsychidae	Net-spinning Caddisfly	L	44	5
Oligochaeta	Aquatic Worm	A	10	8
Pisidiidae	Fingernail Clam	A	16	6
Simuliidae	Black Fly	L	16	5
Tipulidae	Crane Fly	L	9	4
Turbellaria	Flatworm	A	39	6
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**5.81**

Sampled - 5/5/2015

REP: 1

Acariformes	Water Mite	A	3	6
Asellidae	Sow Bug	A	11	8
Baetidae	Small Mayfly	N	1	6
Chironomidae	Midge	L	81	6

Chironomidae	Midge	P	8	6
Elmidae	Riffle Beetle	L	40	5
Elmidae	Riffle Beetle	A	9	5
Empididae	Dance Fly	L	1	6

Taxonomic Name	**Common Name**	**Life Stage**	**# in Subsample**	**Biotic Index**
Gammaridae	Sideswimmer	A	110	6
Hydropsychidae	Net-spinning Caddisfly	L	24	5
Oligochaeta	Aquatic Worm	A	11	8
Philopotamidae	Finger-net Caddisfly	L	1	4
Pisidiidae	Fingernail Clam	A	4	6
Planorbidae	Orb Snail	A	1	6
Simuliidae	Black Fly	P	1	5
Simuliidae	Black Fly	L	4	5
Tipulidae	Crane Fly	L	5	4
Turbellaria	Flatworm	A	6	6
Uenoidae	Caddisfly	L	2	3
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**5.84**

Sampled - 9/23/2015

REP: 1

Acariformes	Water Mite	A	5	6
Asellidae	Sow Bug	A	39	8
Baetidae	Small Mayfly	N	4	6
Chironomidae	Midge	L	57	6
Chironomidae	Midge	P	8	6
Crangonyctidae	Sideswimmer	A	4	6
Elmidae	Riffle Beetle	A	5	5
Elmidae	Riffle Beetle	L	35	5
Gammaridae	Sideswimmer	A	14	6
Hydropsychidae	Net-spinning Caddisfly	L	11	5
Oligochaeta	Aquatic Worm	A	67	8
Philopotamidae	Finger-net Caddisfly	L	8	4
Pisidiidae	Fingernail Clam	A	3	6
Simuliidae	Black Fly	L	4	5
Tipulidae	Crane Fly	L	10	4
Turbellaria	Flatworm	A	53	6
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**6.37**

Benthic Samples were obtained using a Rapid Bioassessment Protocol developed by the United States Environmental Protection Agency and modified by Dr. Robert Bailey of the University of Western Ontario Zoology Department. A representative section of stream is selected, incorporating a riffle if present, and sampled by moving upstream along a diagonal transect, dislodging and capturing invertebrates with a .5 mm mesh "D"- frame net. Samples are preserved in the field and analyzed in the lab to randomly select a 100 bug subsample which is identified to the Family taxonomic level.

The biotic index is a value assigned to benthic invertebrate taxa indicating their pollution sensitivity and tolerance on a scale from 0 to 10. Lower numbers indicate pollution sensitivity and high numbers tolerance. A value of -1 indicates that no biotic index value has been assigned to these taxa.

The Family Biotic Index is the weighted average of the biotic index and number of bugs in each taxa in the sample. The water quality ranges for the FBI values are as follows: < 4.25 = Excellent; 4.25 - 5.00 = Good; 5.00 - 5.75 = Fair; 5.75 - 6.50 = Fairly Poor; 6.50 - 7.25 = Poor; and > 7.25 = Very Poor.

Report prepared - Monday, November 09, 2015

Appendix D

Embro Conservation Area Vegetation and Bird Inventory

Prepared by UTRCA, Updated October 2016

Appendix D

updated Oct 13, 2016

Embro Conservation Area

Vegetation and Bird Inventory

2015

Vegetation Inventory by: Brenda Gallagher, Vegetation Specialist and Forestry Technician
Bird Inventory by: John Schwindt, Aquatic Biologist
Report by: Cathy Quinlan, Terrestrial Biologist

UPPER THAMES RIVER
CONSERVATION AUTHORITY

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Cover Photo

A Great Blue Heron visits Embro Reservoir, summer 2015. Photo by Cathy Quinlan.

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Executive Summary

This study examines the vegetation and bird 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. It is part of the Embro Dam Class Environmental Assessment.

A three-season botanical inventory was completed in 2015 of 5.4 ha of the Embro CA, within 100 m of the reservoir. Of the 198 plant species found, 31% are non-native, an average number. The overall quality of the terrestrial habitats (Cultural Savanna, Cultural Meadow and Mixed Forest) was assessed as average or moderate. Efforts to plant native trees and tallgrass prairie plants into the CA have added to the diversity of the site. 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.

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.

Thus, no plant Species at Risk or rare or uncommon or sensitive species were found on the land or in the reservoir that require special consideration prior to making changes to the dam and reservoir.

There are no wetlands within the 120 m trigger distance of the Embro CA that need to be considered and, in fact, no wetlands 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 will be unaffected by changes to the dam and reservoir.

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. 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 creek within Embro CA.

In conclusion, there are no sensitive plants, plant communities, birds or wildlife that would be threatened from the changes to the Embro Dam and reservoir environment.

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1.0 Purpose of the Vegetation and Bird Study

This study is a component of a larger Environmental Assessment study on the Embro Dam and Reservoir. The purposes of this study are to:

- document the vegetation communities within Embro Conservation Area (CA) to establish baseline conditions and to flag any unique or rare species that need protection or consideration prior to any potential changes to the CA (i.e., the dam and reservoir), and

- document the bird species that use the aquatic and terrestrial habitats of Embro CA, either year round, seasonally or infrequently, to establish baseline conditions and to flag any unique or rare species that need protection or consideration prior to any potential changes to the CA (i.e., the dam and reservoir).

2.0 Vegetation Inventory

2.1 Methodology

A three-season vegetation inventory was carried out in 2015 on an area within Embro Conservation Area (CA) 100 m from the reservoir. This 5.4 ha area was inventoried by Brenda Gallagher, Vegetation Specialist and Forestry Technician with the Upper Thames River Conservation Authority (UTRCA). The study area did not include the western wooded section of Embro CA or the adjacent Oxford County Forest as they are outside the 100 m buffer around the pond/reservoir. Private properties (farms) to the north and east of the reservoir were not studied as they are not part of the CA and are not in natural cover.

The study area was inventoried in May, again in July and lastly in August. Each season's inventory spanned two field days. Table 1 summarizes the survey effort.

Table 1. Vegetation Survey Dates in 2015

Dates Inventoried	No. Days
May 27, 28	2
July 8, 10	2
August 26, 28	2
Total days	**6**

After walking the entire study area once, the ELC (Ecological Land Classification) vegetation communities were mapped onto 2010 colour orthoimagery. Vascular plant species in each vegetation community were recorded on field sheets. At the end of the study, the plant lists were entered into the UTRCA plant database to produce a full checklist of vascular plants by community. Statistics were generated also.

Aquatic plants in the pond/reservoir were collected and identified by John Schwindt, Aquatic Biologist, when undertaking the fish inventory. Brenda Gallagher also recorded incidental wildlife sightings, especially of birds, amphibians, reptiles and mammals, while undertaking the vegetation inventories.

2.2 Results and Discussion

Figure 1 shows the three ELC vegetation communities plus the pond/reservoir (Shallow Aquatic) for the study area within Embro CA. Table 2 shows the area of each community. ELC communities less than 0.5 ha in size are usually merged with neighbouring vegetation communities, as per Lee *et al*. 1998. A full annotated checklist of vascular plants found in all three terrestrial communities is provided in Appendix A.

Table 2. Area of ELC Vegetation Communities

Com #	ELC Code	Community Description	Area	Terrestrial vs. Aquatic
1	CUS	Cultural Savanna	2.1 ha	4.4 ha (terrestrial)
2	CUM	Cultural Meadow	0.7 ha	
3	FOM	Mixed Forest	1.6 ha	
4	SA	Shallow Aquatic	1.0 ha	1.0 ha (aquatic)
	Total		**5.4 ha**	

Table 3 summarizes the number of species, both native and non-native, as well as MCC (Mean Coefficient of Conservatism) and Average Wetness for each plant community and overall. Descriptions of these parameters are provided in Appendix C. The overall quality of the vegetation in the study area is average. The sections that follow describe the conditions in greater detail for each of the communities.

Table 3. Summary of Plant Statistics

Community Number and ELC		# Species	# Native Species	# Non-native Species	% Non-native Species	MCC	# Species with CC 8-10	Avg Wet-ness	Overall Quality Assessment
1	CUS	168	115	53	32	3.8	4	-0.8	Average
2	CUM	93	61	31	34	3.0	0	-0.8	Moderately Poor
3	FOM	101	77	24	24	3.5	0	0.2	Average
Overall		**198**	**137**	**61**	**31**	**3.8**	**4**	**-0.8**	**Average**

Figure 1. Embro Conservation Area Study Area and ELC Vegetation Communities

2.2.1 Community 1, Cultural Savanna (CUS)

The Cultural Savanna of Community 1 is 2.1 ha in size and encompasses the north part of the CA on both sides of the pond/reservoir. Cultural Savannas have a canopy cover of 25 - 35%. Cultural communities result from, or are maintained by, cultural or anthropogenic-based disturbances (Lee *et al.*, 1998)

This community has a variety of small but different habitats within it. The day-use area has an understory of mowed grass with scattered shade trees (planted over the last 40 years). There are also small naturalized areas of meadow/marsh along the pond's shore and by Rd 84 as well as two planted tallgrass prairie plots. Appendix F provides a short history of the tree and wildflower plantings in Embro CA.

A total of 168 plant species were recorded: 115 native and 53 non-native or adventive species. The number of plant species is relatively large for such a small area, owing to the diversity of micro-habitats within it. The percentage of non-native plants is 32%, which is about average or moderate for the Upper Thames watershed. The site is disturbed by past land use changes and day-use activities.

The MCC (Mean Coefficient of Conservatism) is 3.8, an average or moderate score. There is a slight predominance of wetland plants in this community (Average Wetness is -0.8).

Mature trees in the overstory include Silver Maple, Red Pine, White Birch with some Black Cherry and Sugar Maple (see Appendix B). The younger trees include Sugar Maple, Red Oak, Burr Oak, with some Silver Maple. In the naturalized areas, there are raspberries, dogwoods, and Choke Cherry.

Photo 1. Community 1 – View looking south from Rd 84 at the small meadow and treed areas on the north side of the reservoir/pond.

Photo 2. Community 1 – Cultural Savanna, showing the day use area of spaced shade trees and the pavilion west of the reservoir

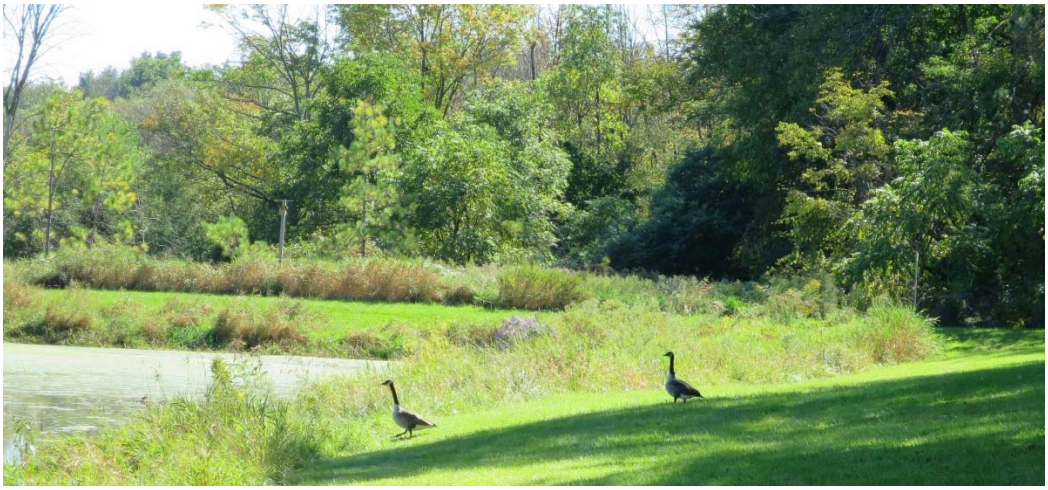


Photo 3. Community 1 (lawn and pond fringe) meets Community 2 at the far side of the reservoir (behind bird box).

2.2.2 Community 2, Cultural Meadow (CUM)

The Cultural Meadow of Community 2 is located on the south or downstream side of Embro Reservoir on both sides of the Youngsville Drain. It is 0.7 ha in size. Cultural meadows area open areas characterized by grasses and flowers with tree cover ≤25% and shrub cover ≤25% and resulting from or maintained by cultural anthropogenic-based disturbances (Lee et al, 1998).

A total of 92 species were recorded, 61 native and 31 non-native. The percentage of non-native species (34%) is average or moderate and reflects the natural and human disturbances this community experiences. The MCC score is 3.0, a moderately poor to average score.

Some trees have been planted or have naturalized and include ashes, willows, Black Cherry, Black Walnut and White Elm. The herbaceous layer was dominated by Joe Pye-weed, jewelweeds, asters, goldenrods, teasels, thistles, milkweeds, and grasses (see Appendix B).

Photo 3. Community 2 – Riparian area along Youngsville Drain downstream of Embro Dam.

Photo 4. Community 2 – Trail through the grasses and trees

2.2.3 Community 3, Mixed Forest (FOM)

The mixed forest of Community 3 is 1.6 ha but is part of a larger wooded area that extends west towards Embro Creek and the Oxford County Forest. Under the Ecological Land Classification (ELC) system, mixed forests have conifer (evergreen) tree species >25% and deciduous tree species >25% of canopy cover. The coniferous trees were planted about 50 years ago. The older deciduous trees have self-seeded in, while younger trees were planted by the UTRCA a few years ago to infill amongst dying Red Pines.

A total of 101 species were recorded from the community, 77 native species and 24 non-native species. The percent of non-native plants (24%) is relatively low, which indicates the habitat is moderately good. The MCC score is 3.5, an average to moderately poor score.

Dominant overstory tree species include Red Pine (in decline), Black Cherry, Silver Maple and Sugar Maple (see Stand Descriptions in Appendix B). The understory trees include ashes, Black Cherry, Black Walnut, and apple. Common shrubs include raspberries and Choke Cherry.

The forest is young to mid age, having been planted by the UTRCA post 1961. In 2010/2011 the conifer plantations were thinned by the UTRCA to remove dying pines and to encourage hardwood forest regeneration. In addition, 2100 native hardwood seedlings were planted between the rows (see history in Appendix F).

Photo 6. Community 3 of pines and other deciduous species west of the reservoir.

2.2.4 Community 4, Shallow Aquatic (SA)

The Embro Pond/Reservoir is classified as Shallow Aquatic with standing water <2 m depth and a low percentage of emergent vegetation, and floating-leaved macrophytes. The pond has silted in over the years and is likely 0.5 m deep on average today and the bottom substrate is very soft.

Duckweed and algae float on the surface of this shallow aquatic community. Four rooted aquatic species were identified by John Schwindt and these are listed in Table 4.

Table 4. Aquatic Plant Species in Embro Reservoir

Common Name	Scientific Name	Exotic Status	SRank	SARO	Sensitivity
Broad-leaved Arrowhead	*Sagittaria latifolia*		S5		Non-sensitive
Broad Waterweed	*Elodea Canadensis*		S5		Non-sensitive
Curly-leaved Pondweed	*Potamogeton cirspus*	SE			Non-sensitive
Slender Pondweed	*Potamogeton pusillus* ssp. *pusillus*		SU		Non-sensitive

Because there is good water clarity and a surplus of nutrients in the water, there is a heavy growth of these pondweeds and waterweeds, and smaller amounts of arrowheads. It is estimated that 50% of the pond/reservoir volume is filled with aquatic vegetation. This vegetation does provide good cover for fish species that are adapted to ponds. Other sections of the Embro Environmental Assessment discuss the fisheries.

There are very few wetland emergent plants growing along the edges of the pond. The Pond contours don't seem to favour these plants (e.g., steep sided). As well, the pond is kept at the same elevation all year with no drawdowns that would expose mudflats and promote colonization of species such as cattails and rushes. Any shoreline vegetation is included in Community 1.

Photo 7. Community 4 – Floating Duckweed on the surface, pondweeds and waterweeds under the surface and beggarticks on the shore. Photo by Cathy Quinlan, Sept 2015

Photo 8. Community 4 – View of Embro Pond/Reservoir in Sept. 2015, looking east.

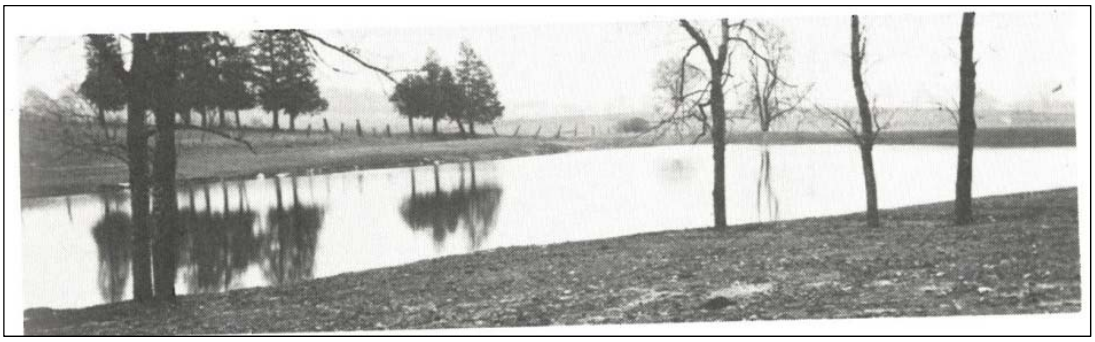


Photo 9. Historical photo of Embro Pond shortly after construction in the 1960s. Source: *Twenty Five Years of Conservation on the Upper Thames Watershed 1947 – 1973*, published by the UTRCA.

2.2.5 Plants with High Coefficient of Conservatism (CC) Scores

Plants with a CC score of 8, 9 or 10 are considered more specialized in habitat or condition and conserve themselves to very specific environments, usually unaltered communities. Plants with low CC scores are considered generalist species that are found in a wide variety of habitats, including disturbed sites.

Table 5 summarizes the four plant species that had a CC score of 8, 9 or 10, all found in Community 1 in the planted tallgrass prairie plots. These plots were planted in 2007 and 2010 by the UTRCA, Embro Pond Community Association, and local school groups. They planted 2800 native wildflowers and grasses to add diversity to the site (see Appendix F).

Table 5. Plant Species with high CC Scores

Common Name	Scientific Name	CC Score	Community	Comments
Butterfly-weed	*Asclepias syriaca*	8	1	planted
Tall Coreopsis	*Coreopsis tripteris*	9	1	planted
Gray-headed Coneflower	*Ratibida pinnata*	9	1	planted
Indian Grass	*Sorgahastrum nutans*	8	1	planted

2.2.6 Plants with Species at Risk (SAR) Designations

There are no plant species-at-risk in the study area. Appendix B lists the various species-at-risk categories.

2.2.7 Plant species with Provincial Ranking (SRANK) of S1, S2 or S3

Four plant species were found that have a SRank of S1, S2 or S3 (very rare to rare to uncommon). Table 6 summarizes the list of species. All of these species were planted in the tallgrass prairie plots. These plantings should not be negatively affected by any potential changes to the dam and reservoir as they are on higher ground and are not reliant on the pond ecosystem.

Table 6. Plant species with SRanks of S1 to S3

Common Name	Scientific Name	SRank	Community	Comments
Tall Coreopsis	*Coreopsis tripteris*	S2	1	planted
Gray-headed Coneflower	*Ratibida pinnata*	S3	1	planted
Giant Ironweed	*Vernonia gigantea*	S1?	1	planted
Culver's Root	*Veronicastrum viginicum*	S2	1	planted

3.0 Bird Survey and Incidental Wildlife

3.1 Methodology

A three-season bird survey was undertaken in 2015 by John Schwindt, Aquatic Biologist with the UTRCA who has years of birding experience with the Breeding Bird Atlas and Christmas Bird Count. Incidental bird observations were made by Brenda Gallagher while she was undertaking the botanical inventories. Brenda is also an experienced birder.

Table 7 summarizes the dates of each of their visits. John Schwindt focused his efforts on the spring and early summer to capture the spring migration and breeding seasons. Approximately four hours were spent each time, with particular effort around the pond. Brenda Gallagher also spent six days at Embro CA from May to late August.

Table 7. Bird Survey Dates in 2015

Season	John Schwindt	Brenda Gallagher
Early Spring	April 22	
Spring	May 5, 14, 26	May 27, 28
Summer	June 24	July 8, 10
Late Summer		Aug 26, 28
12 days total	**6 days total**	**6 days total**

3.2 Results

A total of 40 bird species were seen by John Schwindt and Brenda Gallagher on their separate visits to the study area in Embro CA from April to August, 2015. Appendix D provides a full list of the bird species recorded. One exotic or introduced species was seen (European Starling). Of the 39 native species:

- 28 are **common breeding species** in Oxford County,
- 9 are **common permanent residents** in Oxford County,
- 1 is an **uncommon permanent resident** in Oxford (Red-bellied Woodpecker), and
- 1 is a **common breeding** species in Oxford but **Threatened** in Ontario (Barn Swallow).

The Barn Swallow is a common breeding species found throughout southern Ontario but there was no breeding evidence at Harrington CA. Barn Swallow is listed as Threatened by SARO (Species at Risk in Ontario), meaning the species lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening it.

According to the Ministry of Natural Resources and Forestry (http://www.ontario.ca/page/barn-swallow), Barn Swallows often live in close association with humans, building their cup-shaped mud nests almost exclusively on human-made structures such as open barns, under bridges and in culverts. Barn Swallows have experienced a significant decline since the mid-1980s. While there have been losses in the number of available nest sites, such as open barns, and in the amount of foraging habitat in open agricultural areas, the causes of the recent population decline are not well understood. This bird's nests are often destroyed when old buildings in rural areas are demolished or fall down. Massive pesticide spraying of fields can also reduce the insect population barns swallows need for food.

The Red-bellied Woodpecker, an uncommon breeder in Oxford County, was seen in the mixed forest (Community 3). There is anecdotal evidence this species is more common than reported.

Of the 40 bird species recorded, none are exclusively pond dwellers. Species such as Canada Goose, Mallard, Great Blue Heron, and Wood Duck, feed in or by standing water but these species utilize rivers and streams as well. The pond does support some small fish species and amphibians (Green Frogs), which are suitable for Great Blue Herons. Other fish-eating birds such as Osprey or Belted Kingfishers were not seen.

The pond provides habitat for a few resident ducks and geese. A family of Wood Ducks was seen. They are cavity nesters so they likely nested in a tree nearby, and used the pond to raise their ducklings. A family of Canada Geese was seen also and they likely nested on the shores of the pond. Both of these waterfowl are common species.

Very few species of waterfowl were seen using the pond/reservoir in the spring migration period. The pond/reservoir does not appear to be important for waterfowl staging perhaps because the pond is small and isolated from other ponds or wetlands in the vicinity.

Most of the birds seen are forest birds, likely attracted to the area by the larger Oxford County Forest adjacent to the Embro CA. Nesting boxes installed by the community and UTRCA seem to be fairly well used but are in disrepair.

Photo 12. Indigo Buntings were seen nesting in the mixed forests near the parking lot of Embro CA, May 2015. Photo by Brenda Gallagher.

Photo 12. Male Tree Swallow in a nest box at Embro in Community 2. Photo by Brenda Gallagher.

Photo 13. Kingbirds were seen in Community 1 and feeding over the pond.

3.3 Other Wildlife Sightings

Brenda Gallagher recorded incidental wildlife seen while undertaking the botanical inventories. Appendix E lists the six insect species, three herptiles and three mammal species seen, all of which are common to abundant in our area.

The Monarch and Snapping Turtle are both designated as Special Concern (SC) under SARO (Species at Risk in Ontario). "Special Concern" means the species lives in the wild in Ontario, is not endangered or threatened, but may become threatened or endangered due to a combination of biological characteristics and identified threats. Special concern species do NOT receive species or habitat protection, however.

The **Snapping Turtle** spends most of its life in water and was seen in the Embro Reservoir. They prefer shallow waters so they can hide under the soft mud and leaf litter with only their noses exposed to the surface to breathe (http://www.ontario.ca/page/snapping-turtle). In summer, females travel overland in search of a suitable nesting site, usually gravelly or sandy areas along streams. The long-lived adults are killed primarily by cars on roads and intentional persecution. Turtle eggs in nests around urban and agricultural areas are subject to predators such as raccoons and Striped Skunks. The possible removal of the Embro Dam and Reservoir may impact individual turtles that use the pond, but they are just as likely to re-establish in the restored creek. See Section 5 for further discussion.

The **Monarch butterfly** uses three different types of habitat over its life cycle. The caterpillars feed on milkweed plants and are confined to meadows and open areas where milkweed grows. The adults can be found in more diverse habitats where they feed on nectar from a variety of wildflowers. Monarchs spend the winter in Oyamel Fir forests in central Mexico. The largest threat to Ontario Monarchs is habitat loss and fragmentation at overwintering sites in central Mexico where forests are being logged. Widespread pesticide and herbicide use throughout the Monarch's range may also limit recovery. The planting of tallgrass prairie plots in Embro is a positive step for this species. As well, there is a lot of milkweed in Communities 1 and 2. The removal of the Embro Dam and Reservoir will not impact this species or their food plants.

The Green Frog has a strong affiliation to permanent water bodies and it may be impacted by the loss of the pond/reservoir. However, it is a common species with no population threats at this time.

3.4 Other Species at Risk Records within 2 km of the Study Area

Within 1.5 km of the study area there are records of Bobolink (S4B, Threatened) and Barn Swallow (S4B, Threatened). The Bobolink uses prairies and large open meadows, so it is unlikey to be found in the Embro CA which has too much tree cover. The Barn Swallow was seen in the study area and is discussed in Section 3.2.

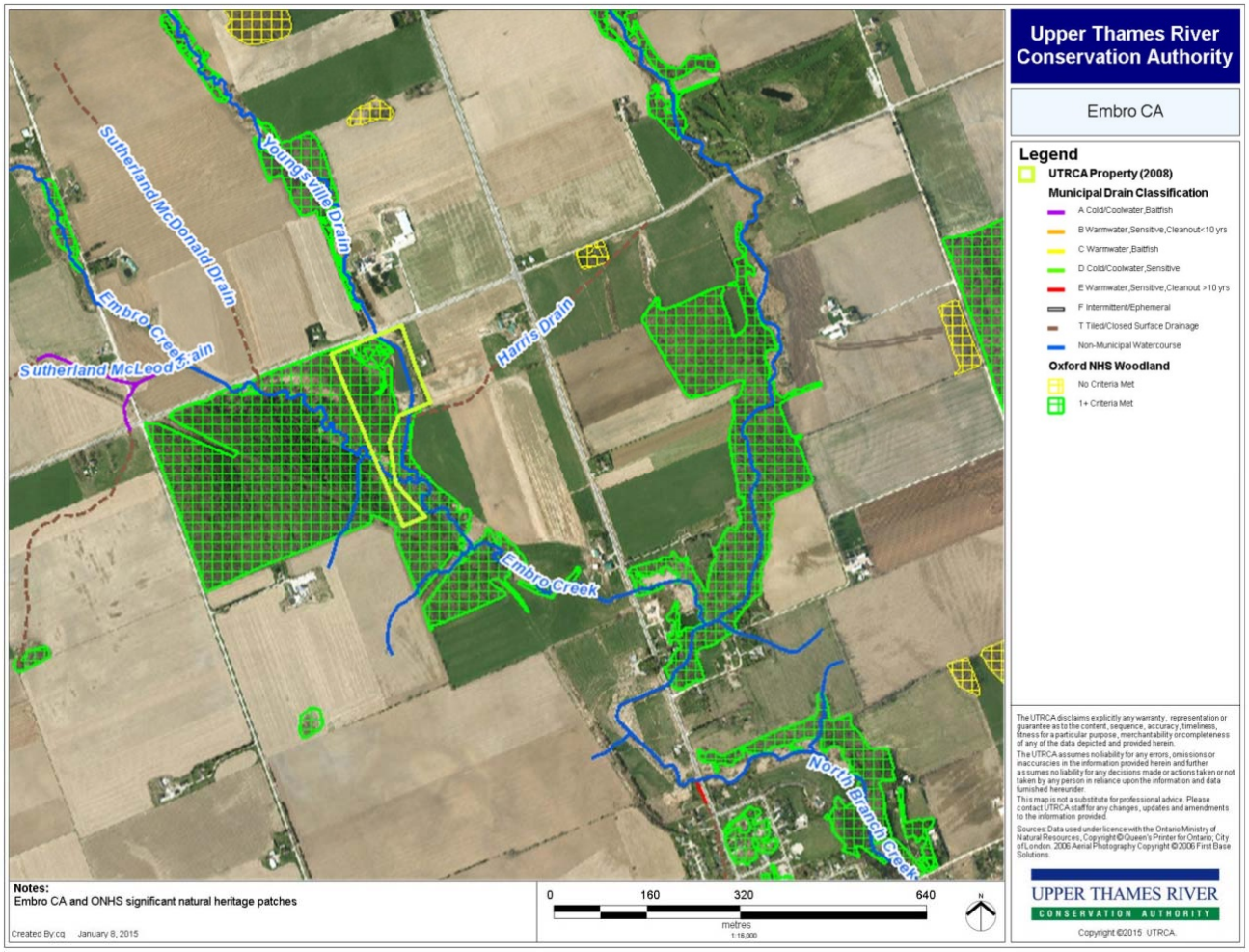
4.0 Significant Natural Heritage Features

4.1 Oxford Natural Heritage Study (ONHS)

The Oxford Natural Heritage Study (Oxford County 2006) identified significant woodland features in the county based on a set of ecological criteria. Figure 2 shows the significant features identified in and around Embro CA. The woodlands of Embro CA are part of a larger woodland feature that includes the Oxford County Forest and adjacent riparian woodlands downstream, considered significant on the county landscape.

The ONHS did not include meadows, marshes, ponds or manicured parkland (e.g., mowed lawn areas). Thus the pond/reservoir and open shoreline habitats around Embro Pond were excluded from the significant natural heritage features. The next iteration of the ONHS study planned for 2016 will include meadows, marshes and ponds as part of the natural features so more of the CA may be identified as significant if it meets the size criteria.

Figure 2. Significant Woodland Patches near Embro CA, ONHS 2006

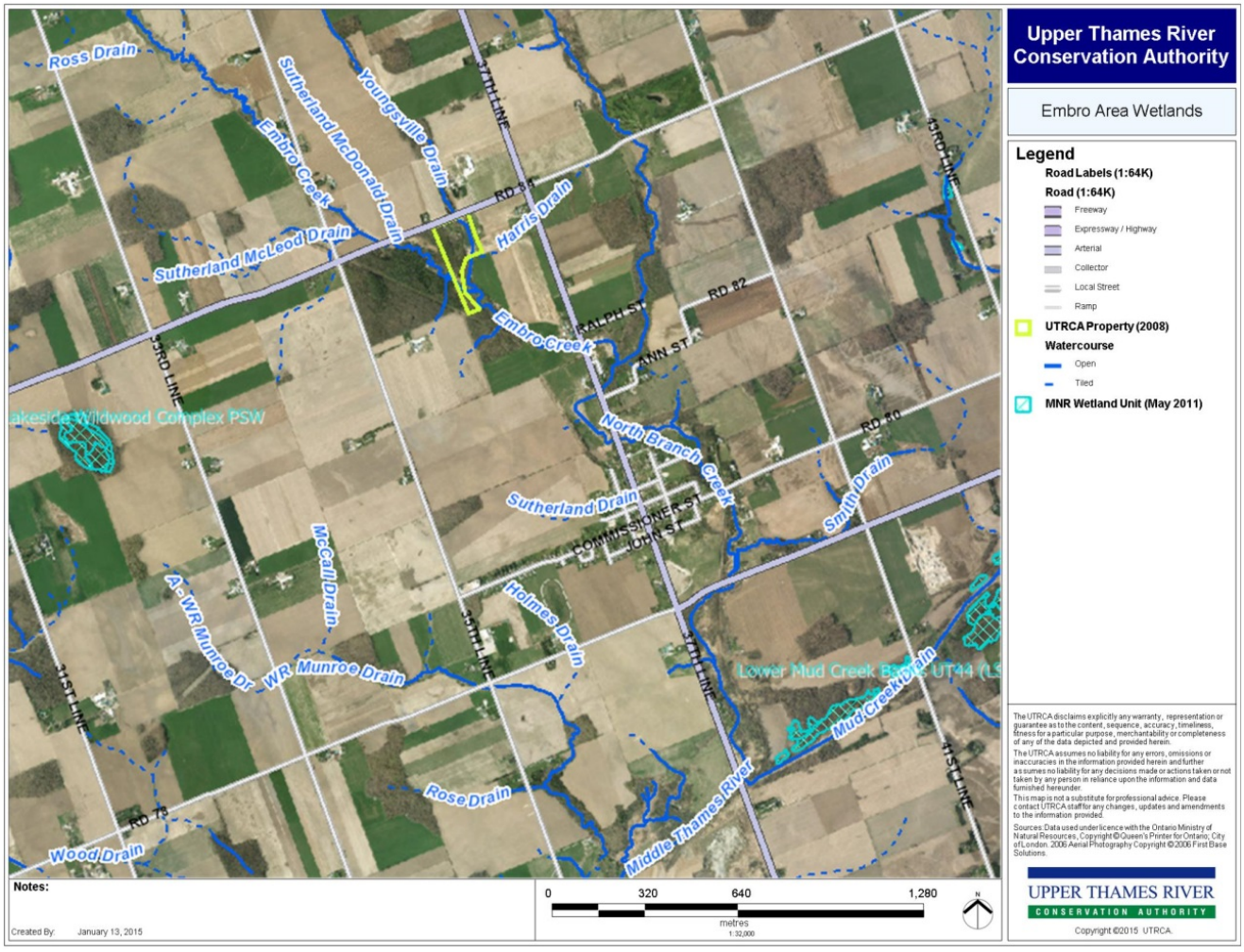


4.2 Wetlands

Figure 3 shows there are no evaluated or unevaluated wetlands within the 120 m trigger distance of Embro CA.

The nearest wetland, approximately 1.5 km to the west, is a small portion of the Lakeside Wildwood Wetland Complex (Provincially Significant Wetland), but it is not connected hydrologically to Embro CA. Approximately 4 km downstream of the North Branch Creek is the Lower Mud Creek Banks Wetland (Locally Significant Wetland), but it not hydrologically connected either.

Figure 3. Harrington Area Wetlands (Lakeside Wildwood Complex)



5.0 Summary and Conclusions

5.1 Vegetation

The vegetation within Embro Conservation Area is quite diverse owing to the mix of habitats including manicured parkland, pond edge, naturalized plots and maturing mixed forest plantation. Efforts to plant more native plants in Embro CA over the years have added to the diversity of the vegetation cover.

While the diversity of plants is quite large for a small site, the overall quality of the three vegetation communities ranges from average to moderately poor. The overall percentage of non-native species is 31% (24 - 34% range), which is about average and expected for a small, disturbed area. Community 3, Mixed Forest, had the lowest percentage of non-native species (24%) and is naturalizing quite well as a result of natural processes and thinning and planting by the UTRCA.

The Embro Pond/Reservoir supports only three native rooted aquatic plant species (pondweeds and waterweeds). They are prolific and occupy approximately half of the water volume due to good water clarity and a surplus of nutrients. All of the species are common.

There are very few emergent plants growing along the edges of the pond, possibly due to the steep sidedness of the reservoir and the constant water level that does not expose mudflats. By comparison, shallow natural ponds often fill in with wetland plants over time. Most of the plants that grow along the edge of Harrington pond/reservoir also grow along the shores of Harrington Creek and nearby creeks and rivers and wetlands and are not uncommon in our area. Therefore, no unique plants are seen as a result of the reservoir.

No plant species at risk was found in the study area. Four plants with a high Conservatism of Conservation score were found, all tallgrass prairie species that were planted in the plots. Four plant species with SRanks of S1-S3 were found as well, but these species are also all planted tallgrass prairie species. The prairie plots should be unaffected by the potential reservoir to creek restoration project.

5.2 Birds and Wildlife

Forty bird species were seen in the study area. Of the 39 native species, 37 are common breeding or permanent residents of Oxford County. One uncommon permanent resident, the Red-bellied Woodpecker, was seen in mixed forest community and should be unaffected by the dam/reservoir work.

One Threatened bird species was seen, Barn Swallow. While Barn Swallows are common breeders in Oxford County, their overall population has been declining and may be attributed to loss of barns and human structures, pesticide spraying of fields that reduce insect populations. Since they were not seen breeding in Embro CA (they use old buildings) and are habitat generalists, there is no special action that needs to be taken to protect them if any changes are made to the Embro dam/reservoir.

Most of the native birds seen are forest birds, likely attracted to the area by the larger Oxford County Forest adjacent to Embro CA. As such, they will be unaffected by changes to the dam/reservoir.

The pond/reservoir does provide habitat for a few resident ducks and geese as a family of Wood Ducks and Canada Geese were seen, both common species. The reservoir does not appear to be important for waterfowl staging during spring migration, likely because of the pond's small size and isolation from other ponds or wetlands in the vicinity.

Six insect species, three herpitles and three mammal species were seen, all of which are common in our area.

The Monarch butterfly is a species of Special Concern and was seen in the study area. The abundance of milkweeds in the naturalized portions of the Embro CA is a positive element for this species. This insect will not be affected by the restoration of the creek, as long as the wildflower areas are left intact or re-planted.

The Snapping Turtle is a species of Special Concern and it was seen in the reservoir. Special concern species do not receive species or habitat protection. They are likely to re-establish along the restored creek if the reservoir is decommissioned

The Green Frog, a common species, does has affinity to permanent water bodies and they are present in the reservoir. They may be affected by changes to the reservoir.

If the dam and reservoir are to be decommissioned, the timing is important to protect wildlife. The reservoir should be drawn down slowly in the summer, allowing hibernating frogs and turtles time to move out of the pond sediments and into surrounding stream habitats. These species will likely re-establish in the restored creek.

5.3 Conclusions

This report examines the vegetation and bird/wildlife of a 5 ha study area within Embro CA to flag any rare or sensitive species that might be impacted if changes to the Embro Dam and reservoir are undertaken.

No rare or sensitive plant species will be affected by any proposed restoration work. No plant species-at-risk or species of Special Concern 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.

There are no wetlands within the 120 m trigger distance of the Embro CA that need to be considered.

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 will be unaffected by changes to the dam and reservoir.

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. 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 creek within Embro CA.

Photo 13. Youngsville Drain downstream of the dam

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Appendices

A. Annotated Checklist of Vascular Plants for the Embro CA Study Area

B. Stand Descriptions

C. Descriptive Indices for Vegetation Communities

D. Bird Sightings at Embro CA, 2015

E. Animal Sightings (Incidental)

Appendix A. Annotated Checklist of Vascular Plants for the Embro CA Study Area

Scientific Name	Common Name	Native or Adv-entive	Weed	CC	Cwet	SARO	Srank S1-S3	Com 1	Com 2	Com 3
Acer rubrum	Red Maple	N		4	0			x	x	x
Acer saccharinum	Silver Maple	N		5	-3			x		x
Acer saccharum	Black Maple	N		7	3			x		
Acer saccharum	Sugar Maple	N		4	3			x	x	x
Achillea millefolium	Yarrow	A	-1					x	x	
Agrimonia gryposepala	Agrimony	N		2	2			x	x	x
Alliaria petiolata	Garlic Mustard	A	-3					x	x	x
Amelanchier sp	Serviceberry species	N		5	3			x		x
Anemone canadensis	Canada Anemone	N		3	-3			x	x	
Angelica atropurpurea	Angelica	N		6	-5			x		x
Anthriscus sylvestris	Wild Chervil	A	-2					x		
Apocynum cannabinum	Indian Hemp	N		3	0					x
Arctium minus	Common Burdock	A	-2					x	x	x
Arisaema triphyllum	Jack-in-the-pulpit	N		5	-2			x		x
Aronia melanocarpa	Chokeberry	N		7	-3			x		
Asclepias syriaca	Common Milkweed	N		0	5			x	x	
Asclepias tuberosa	Butterfly-weed	N		8	5			x		
Athyrium filix-femina var. *angustum*	Northeastern Lady Fern	N		4	0					x
Bellis perennis	English Daisy	A	-1					x		
Berberis vulgaris	Common Barberry	A	-2					x		
Betula papyrifera	Paper Birch	N		2	2			x		
Bidens cernua	Nodding Beggarticks	N		2	-5			x		
Bidens frondosa	Devil's Beggarticks	N		3	-3			x		
Boehmeria cylindrica	False Nettle	N		4	-5			x		
Bromus inermis	Smooth Brome	A	-3					x	x	
Caltha palustris	Marsh-marigold	N		5	-5				x	

Scientific Name	Common Name	Native or Adv-entive	Weed	CC	Cwet	SARO	Srank S1-S3	Com 1	Com 2	Com 3
Carex cristatella	Crested Sedge	N		3	-4			x		
Carex lacustris	Lake Sedge	N		5	-5			x	x	
Carex stricta	Tussock Sedge	N		4	-5			x	x	
Carex vulpinoidea	Fox Sedge	N		3	-5			x		
Carya cordiformis	Bitternut Hickory	N		6	0			x		x
Celtis occidentalis	Common Hackberry	N		7	1					x
Centaurea jacea	Brown Knapweed	A	-1					x		
Cerastium fontanum	Mouse-eared Chickweed	A	-1					x		
Chelone glabra	Turtlehead	N		7	-5			x	x	
Cichorium intybus	Chicory	A	-1					x		
Cicuta bulbifera	Bulb-bearing Water-hemlock	N		5	-5			x		
Cicuta maculata var. *maculata*	Spotted Water-hemlock	N		6	-5			x		
Circaea canadensis	Enchanter's-nightshade	N		3	3			x	x	x
Cirsium arvense	Canada Thistle	A	-1					x	x	
Cirsium vulgare	Bull Thistle	A	-1					x		
Coreopsis tripteris	Tall Coreopsis	N		9	0		S2	x		
Cornus alternifolia	Alternate-leaved Dogwood	N		6	5			x	x	x
Cornus amomum	Silky Dogwood	N		5	-4			x	x	x
Cornus racemosa	Grey Dogwood	N		2	-2					x
Cornus stolonifera	Red-osier Dogwood	N		2	-3			x	x	x
Crataegus sp.	Hawthorn species	N		4	5			x	x	x
Dactylis glomerata	Orchard Grass	A	-1					x	x	x
Daucus carota	Wild Carrot	A	-2					x		
Desmodium canadense	Showy Tick-trefoil	N		5	1			x		
Dipsacus fullonum	Teasel	A	-1					x	x	
Doellingeria umbellata var. *umbellata*	Flat-topped White Aster	N		6	-3			x		
Dryopteris carthusiana	Spinulose Wood Fern	N		5	-2					x

Scientific Name	Common Name	Native or Adv-entive	Weed	CC	Cwet	SARO	Srank S1-S3	Com 1	Com 2	Com 3
Dryopteris clintoniana	Clinton's Wood Fern	N		7	-4			x		x
Echinocystis lobata	Wild Cucumber	N		3	-2			x	x	x
Elymus repens	Quack Grass	A	-3					x		
Elymus virginicus var. *virginicus*	Virginia Wild-rye	N		5	-2			x		
Epilobium ciliatum	Willow-herb	N		3	3			x	x	x
Epilobium hirsutum	Great Hairy Willow-herb	A	-2					x	x	
Equisetum arvense	Field Horsetail	N		0	0			x	x	x
Erechtites hieracifolius	Pilewort	N		2	3					x
Erigeron annuus	Daisy Fleabane	N		0	1			x	x	x
Erigeron philadelphicus	Philadelphia Fleabane	N		1	-3			x	x	
Euonymus europaeus	Spindle-tree, European Euonymus	A	-1							x
Euonymus obovatus	Running Strawberry-bush	N		6	5					x
Eupatorium perfoliatum	Boneset	N		2	-4				x	x
Euthamia graminifolia	Grass-leaved Goldenrod	N		2	-2			x	x	x
Eutrochium maculatum var. *maculatum*	Spotted Joe-Pye-weed	N		3	-5			x	x	x
Fagus grandifolia	American Beech	N		6	3					x
Fragaria vesca	Woodland Strawberry	N		4	4					x
Fragaria virginiana	Wild Strawberry	N		2	1			x	x	x
Frangula alnus	Glossy Buckthorn	A	-3					x	x	x
Fraxinus americana	White Ash	N		4	3			x	x	x
Fraxinus pennsylvanica	Red/Green Ash	N		3	-3			x	x	x
Galium asprellum	Rough Bedstraw	N		6	-5			x	x	
Galium mollugo	Wild Madder	A	-2					x	x	x
Galium palustre	Marsh Bedstraw	N		5	-5			x		
Geranium	Herb Robert	A	-2					x	x	x

Scientific Name	Common Name	Native or Adv-entive	Weed	CC	Cwet	SARO	Srank S1-S3	Com 1	Com 2	Com 3
robertianum										
Geum aleppicum	Yellow Avens	N		2	-1			x	x	x
Geum canadense	White Avens	N		3	0			x	x	x
Geum laciniatum	Cut-leaved Avens	N		4	-3			x		
Glechoma hederacea	Gill-over-the-ground	A	-2					x	x	x
Helianthus divaricatus	Woodland Sunflower	N		7	5			x		
Heliopsis helianthoides	Ox-eye	N		3	5			x		
Hesperis matronalis	Dame's Rocket	A	-3					x		x
Hypericum perforatum	Common St. John's-wort	A	-3							x
Impatiens capensis	Spotted Touch-me-not	N		4	-3			x	x	x
Inula helenium	Elecampane	A	-2					x		
Juglans nigra	Black Walnut	N		5	3			x	x	x
Juncus tenuis	Path Rush	N		0	0			x		
Juniperus communis	Common Juniper	N		4	3			x		
Leersia oryzoides	Rice Cut Grass	N		3	-5			x		
Lemna minor	Common Duckweed	N		2	-5			x		
Leonurus cardiaca	Motherwort	A	-2					x	x	
Linaria vulgaris	Butter-and-eggs	A	-1						x	
Lindera benzoin	Spicebush	N		6	-2					x
Lobelia siphilitica	Great Lobelia	N		6	-4			x		
Lonicera tatarica	Tartarian Honeysuckle	A	-3					x		x
Lycopus americanus	American Water-horehound	N		4	-5			x	x	
Lycopus uniflorus	Bugleweed	N		5	-5			x		
Lysimachia ciliata	Fringed Loosestrife	N		4	-3			x		x
Lysimachia nummularia	Moneywort	A	-3					x		x
Maianthemum stellatum	Starry False Solomon's-seal	N		6	1					x
Malus pumila	Apple	A	-1					x	x	x
Medicago lupulina	Black Medick	A	-1					x	x	
Mentha arvensis	Field Mint	N		3	-3			x	x	

Scientific Name	Common Name	Native or Adv-entive	Weed	CC	Cwet	SARO	Srank S1-S3	Com 1	Com 2	Com 3
Mentha x *piperita*	(M. *aquatica* X M. *spicata*)	A	-1					x		
Monarda fistulosa var. *fistulosa*	Wild Bergamot	N		6	3			x		
Oenothera biennis	Hairy Yellow Evening-primrose	N		0	3			x	x	
Onoclea sensibilis	Sensitive Fern	N		4	-3			x		x
Oxalis stricta	European Wood-sorrel	N		0	3			x		x
Parthenocissus inserta	Virginia Creeper	N		3	3			x	x	x
Persicaria lapathifolia	Pale Smartweed	N		2	-4			x		
Phalaris arundinacea	Reed Canary Grass	N		0	-4			x	x	
Phleum pratense	Timothy	A	-1					x	x	
Phragmites australis ssp. *australis*	Common Reed	A	-3					x		
Picea abies	Norway Spruce	A	-1							x
Picea glauca	White Spruce	N		6	3			x	x	
Pilea pumila	Clearweed	N		5	-3					x
Pinus resinosa	Red Pine	N		7	3			x	x	x
Pinus strobus	White Pine	N		4	3			x		x
Plantago lanceolata	English Plantain	A	-1					x		
Plantago major	Common Plantain	A	-1					x	x	
Plantago rugelii	Rugel's Plantain	N		1	0			x	x	x
Poa pratensis ssp. *pratensis*	Kentucky Bluegrass	N		0	1			x	x	
Populus tremuloides	Trembling Aspen	N		2	0					x
Potentilla norvegica	Rough Cinquefoil	N		0	0					x
Prunella vulgaris ssp. *lanceolata*	Heal-all	N		1	0			x	x	x
Prunus avium	Sweet Cherry	A	-2					x		
Prunus serotina	Wild Black Cherry	N		3	3			x	x	x
Prunus virginiana	Choke Cherry	N		2	1			x		x
Quercus macrocarpa	Bur Oak	N		5	1			x		x
Quercus rubra	Red Oak	N		6	3			x		x

Scientific Name	Common Name	Native or Adv-entive	Weed	CC	Cwet	SARO	Srank S1-S3	Com 1	Com 2	Com 3
Ranunculus acris	Common Buttercup	A	-2					x	x	x
Ranunculus hispidus var. *caricetorum*	Hispid Buttercup	N		7	0			x		
Ranunculus repens	Creeping Buttercup	A	-1					x		
Ratibida pinnata	Gray-headed Coneflower	N		9	5		S3	x		
Rhamnus cathartica	Common Buckthorn	A	-2					x	x	x
Rhus typhina	Staghorn Sumac	N		1	5			x	x	x
Ribes americanum	Wild Black Currant	N		4	-3			x	x	x
Ribes cynosbati	Prickly Gooseberry	N		4	5			x		x
Ribes rubrum	Garden Red Currant	A	-2					x	x	x
Robinia pseudoacacia	Black Locust	A	-3					x		x
Rosa multiflora	Multiflora Rose	A	-3							x
Rubus allegheniensis	Common Blackberry	N		2	2			x		x
Rubus idaeus ssp. *strigosus*	Wild Red Raspberry	N		0	-2			x	x	x
Rubus occidentalis	Black Raspberry	N		2	5			x	x	x
Rudbeckia hirta var. *pulcherrima*	Black-eyed Susan	N		0	3			x		
Rudbeckia laciniata	Cut-leaved Coneflower	N		7	-4			x		
Rumex crispus	Curly Dock	A	-2					x		
Rumex obtusifolius	Bitter Dock	A	-1					x		x
Sagittaria latifolia	Common Arrowhead	N		4	-5			x		
Salix alba	White Willow	A	-2					x	x	
Salix bebbiana	Bebb's Willow	N		4	-4				x	
Salix euxina	Crack Willow	A	-3						x	
Sambucus canadensis	Common Elder	N		5	-2			x	x	x
Sambucus racemosa	Red-berried Elder	N		5	2			x		x
Schedonorus pratensis	Meadow Fescue	A	-1					x	x	
Scirpus atrovirens	Dark Green	N		3	-5			x		

Scientific Name	Common Name	Native or Adv-entive	Weed	CC	Cwet	SARO	Srank S1-S3	Com 1	Com 2	Com 3
	Bulrush									
Scirpus pendulus	Nodding Bulrush	N		3	-5			x		
Solanum dulcamara	Climbing Nightshade	A	-2					x	x	x
Solidago altissima ssp. *altissima*	Late Goldenrod	N		1	3			x	x	x
Solidago canadensis var. *canadensis*	Canada Goldenrod	N		1	3			x	x	x
Sonchus arvensis ssp. *arvensis*	Perennial Sow-thistle	A	-1					x	x	
Sonchus oleraceus	Annual Sow-thistle	A	-1					x		
Sorghastrum nutans	Indian Grass	N		8	2			x		
Spiraea alba	Meadowsweet	N		3	-4				x	
Symphyotrichum lanceolatum ssp. *lanceolatum*	Panicled Aster	N		3	-3			x	x	x
Symphyotrichum lateriflorum	Calico Aster	N		3	-2			x	x	x
Symphyotrichum novae-angliae	New England Aster	N		2	-3			x	x	x
Symphyotrichum puniceum	Purple-stemmed Aster	N		6	-5			x		
Symplocarpus foetidus	Skunk-cabbage	N		7	-5			x	x	x
Syringa vulgaris	Common Lilac	A	-2					x		
Taraxacum officinale	Common Dandelion	A	-2					x	x	x
Thalictrum pubescens	Tall Meadow-rue	N		5	-2			x	x	
Thuja occidentalis	White Cedar	N		4	-3			x		
Tilia americana	Basswood	N		4	3					x
Toxicodendron rydbergii	Rydberg's Poison Ivy	N		0	0			x		x
Tragopogon pratensis	Yellow Goat's-beard	A	-2						x	
Trifolium repens	White Clover	A	-1					x	x	
Tussilago farfara	Coltsfoot	A	-2					x	x	x
Typha latifolia	Common Cattail	N		3	-5				x	
Ulmus americana	American Elm	N		3	-2				x	x
Urtica dioica ssp. *gracilis*	Stinging Nettle	N		2	-1			x	x	

Scientific Name	Common Name	Native or Adv-entive	Weed	CC	Cwet	SARO	Srank S1-S3	Com 1	Com 2	Com 3
Verbascum thapsus	Common Mullein	A	-2					x		
Verbena hastata	Blue Vervain	N		4	-4			x		
Verbena urticifolia	White Vervain	N		4	-1			x	x	x
Vernonia gigantea	Giant Ironweed	N		6	0		S1?	x		
Veronica officinalis	Common Speedwell	A	-2					x		x
Veronica peregrina ssp. *peregrina*	Purslane Speedwell	N		0	-4			x		
Veronica serpyllifolia ssp. *serpyllifolia*	Thyme-leaved Speedwell	A	-1					x		
Veronicastrum virginicum	Culver's root	N		7	0		S2	x		
Viburnum lentago	Nannyberry	N		4	-1			x	x	x
Viburnum opulus ssp. *Trilobum*	Highbush-cranberry	N		5	-3			x		x
Vicia cracca	Cow Vetch	A	-1						x	
Viola canadensis var. *canadensis*	Canada Violet	N		6	5					x
Viola cucullata	Marsh Violet	N		5	-5			x		x
Vitis riparia	Riverbank Grape	N		0	-2			x	x	x
TOTAL			**-108**	**520**	**-104**					
COUNT		**198**	**61**	**137**	**137**	**0**	**4**	**168**	**93**	**101**
MEAN / AVERAGE			**-1.8**	**3.8**	**-0.8**					

	Over-all	By Community		
Adventive Species	**61**	**53**	**31**	**24**
Native Species	**137**	**115**	**61**	**77**
Total Species	**198**	**168**	**92**	**101**
% Adventive Species	**31**	**32**	**34**	**24**
Avg Weediness	-1.8	-1.8	-1.7	-2.1
Mean Coefficient of Conservatism (MCC)	**3.8**	**3.8**	**3.0**	**3.5**
# species with CC 8-10	**4**	4	0	0
Avg Wetness	-0.8	-0.8	-0.8	0.2
# Species with SARO	4	4	0	0
# Species with SRANK S1-S3	4	4	0	0

Appendix B. Stand Descriptions

Community 1

Canopy:	Silver Maple (>25 m tall, 25-60% cover) > Red Pine > White Birch
Sub-Canopy:	Sugar Maple (2-10 m tall, 10-25% cover) = Red Oak = Burr Oak > Silver Maple
Understory:	Raspberries (1-2 m tall, 0-10% cover) >> dogwoods = Choke Cherry
Ground Layer:	Grasses

Community 2

Canopy:	Green Ash (10-25 m tall, 10-25% cover) = willows > Black Walnut = Black Cherry
Sub-Canopy:	Red Pine (2-10 m tall, 10-25% cover) = Black Walnut > American Elm = Green Ash
Understory:	Dogwoods (1-2 m tall, 1-10% cover) = raspberries

Community 3

Canopy:	Red Pine (10-25 m tall, >60% cover) > Black Cherry = Silver Maple > Sugar Maple
Sub-Canopy:	White Ash (10-25 m tall, >60% cover) > Black Cherry = apples >> Black Walnut
Understory:	American Elm (2-10 m tall, >60% cover) >> Choke Cherry = Black Cherry = raspberries

Appendix C. Descriptive Indices for Vegetation Communities

Descriptive indices such as Mean Conservatism Coefficient (MCC), Floristic Quality Index (FQI) and Wetness Index (CW) can decrease the variability that is caused by misidentification of species (Coles-Ritchie *et al*. 2004). This is because similar dominant species are often ecological equivalents, in that they are found in similar habitats and perform similar ecosystem functions. For this reason, taxonomic differences, which can be difficult to identify in the field, may not be important when trying to understand the functioning of the riparian ecosystem (Coles-Ritchie *et al*. 2004). Descriptive indices have the advantage of minimizing the influence of differences in species that are unimportant for the index. The most useful indices are those with many gradations that are based on scientific information about vegetation.

Code and Measure	Description	Examples
CC **Coefficient of Conservatism**	Each native plant species is assigned a coefficient of conservatism (CC) score between 0 and 10 using the floristic quality assessment system for southern Ontario (Oldham *et al*., 1995) CCs represent an estimated probability that a plant species is likely to occur in a landscape relatively unaltered from what is believed to be pre-European settlement conditions (DNR Wisconsin 2001). Higher CCs are given to plants more specialized in habitat or condition and conserve themselves to very specific environments and communities (i.e., fidelity to a habitat).	0 to 3: Plants found in a wide variety of plant communities, including disturbed sites 4 to 6: Plants that typically are associated with a specific plant community but tolerate moderate disturbance. Most woodland species fall in this category 7 to 8: Plants associated with a plant community in an advanced successional stage that has undergone minor disturbance. 9 to 10: Plants with a high degree of fidelity to a narrow range of synecological parameters or habitat specialists.
MCC **Mean Conservatism Coefficient**	MCC is used as a measure of the pristiness or lack of disturbance of a site (Oldham *et al*. 1995). Communities or sites with high MCCs contain more plants unlikely to be found in disturbed habitat. Middlesex Natural Heritage Study (UTRCA 2003) found MCC scores of 3.0 to 5.0 in woodland sites. Burke *et al*. 2007 found MCC scores of 4.1 to 5.3 at 12 woodlots with 75 km of London. ***Formula***: Add all of the CC scores for a particular site or community and then divide by the number of species (native only).	3.0 to 5.0 MNHS, UTRCA 2003 4.1 to 5.3 Burke 2007 3.3 to 3.8 London Dykes (UTRCA 2013) London Subwatershed Study, thresholds for woodland protection: <4.0 low priority 4.0 to 4.5 medium priority >4.5 high priority

Appendix C continued

Number of Conservative Species	The number of plant species with a CC of 8 to 10 gives an indication of site quality and highlights species of concern for management. Dr. Jane Bowls (pers. com) indicated that using CC of 8 to 10 for Conservative Plants is a combination of intuition, convention, experience and data. Species with 0 to 2 CC score are generalists, and 8 to 10 are specialists. The rest are the in-betweens. ***Formula***: Count the number of species with CC score of 8, 9 and 10.	CC scores: 0 to 2 generalist species 3 to 7 in-betweens 8 to 10 specialist species
WEED **Weediness Score**	Each non-native plant species has been assigned a weediness score between -1 and -3, where -1 represents a weed with low invasiveness and a -3 a very invasive species (Oldham *et al*, 1995). The Weediness Score represents an estimated probability that a non-native plant is likely to infest and negatively impact a natural area by displacing native plants.	-1 little or no impact on natural areas -2 occasional impacts on natural areas, generally infrequent or localized -3 major potential impacts on natural areas
MWS **Mean Weediness Score**	The mean weediness score can be used like MCC to measure the representation of weedy adventive (alien) species abundance in a site (Moc 2001). In combination with the percentage of non-native plants, this measure can be used as an indicator of disturbance. Also, it is an indication of the threat to native species from highly invasive adventive species. ***Formula:*** Add all the weediness scores from a particular site or community and divide by the number of non-native species.	-1.0 to -1.6 little or no impact on natural areas -1.7 to -2.3 occasional impacts on natural areas, generally infrequent or localized -2.4 to -3.0 major potential impacts on natural areas **The above is an estimation devised by C. Quinlan at UTRCA using equal divisions between -1 and -3.*
CW (CWet) **Coefficient of Wetness**	Each plant species is assigned a value from -5 to +5 based on the probability of being found in a wetland or not. Usually only native species are used, even though a CW exists for adventive species also.	-5 occurs in wetlands under natural conditions (obligate wetland species) -4 to -2 usually occurs in wetlands, but occasionally found in non-wetlands -1 to 1 equally likely to be occur in wetlands or non-wetlands (facultative) 2 to 4 occasionally occurs in wetlands, but usually occurs in non-wetlands 5 almost never occurs in wetlands under natural conditions (obligate upland)

Code and Measure	Description	Values, Examples, Assessments
WI **Wetness Index (Mean Wetness Coefficient)**	Wetness Index is an assessment of a plant community as to whether it has a predominance of wetland species or not. It is not an indication of site quality. The MNHS 2003 found mean wetness coefficients from individual woodland patches ranged from -2.5 to +2.1. Formula: Add all the CW scores (native species only) from a particular site or community and divide by the number of native species found (Michigan DNR).	Examples: -0.4 to -1.1 London Dykes -2.5 to 2.1 MNHS 2003 woodlands Overall: <0 site has a predominance of native wetland species >0 site has a predominance of native upland species

Provincial (SARO) Status:

The Committee on the Status of Species at Risk in Ontario (COSSARO), an independent committee of experts, considers which plants and animals should be listed as at risk. There are seven categories:

Extinct	A wildlife species that no longer exists
EXT - Extirpated	A wildlife species no longer existing in the wild in Ontario but exists elsewhere
END - Endangered	A wildlife species facing imminent extirpation or extinction in Ontario
THR - Threatened	A wildlife species likely to become endangered if limiting factors are not reversed.
SC – Special Concern	A wildlife species that may become a threatened or endangered species because of a combination of biological characteristics and identified threats.
NAR – Not at Risk	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances
UNK – Data Deficient	A category that applies when the available information in insufficient (a) to resolve a wildlife species' eligibility for assessment of (b) to permit an assessment of the wildlife species' risk of extinction

SRanks – Provincial Ranks

SRANKS are used by the Natural Heritage Information Centre (NHIC) to set protection priorities for rare species and natural communities in Ontario.

SX	Presumed Extirpated	**S1**	Extremely rare in Ontario
SH	Possibly Extirpated (Historical)	**S2**	Very rare in Ontario
SNR	Unranked, or, if following a ranking, rank uncertain (e.g. S3?). S? species are thought to be rare in Ontario but there is insufficient information available to assign a more accurate rank.	**S3**	Rare to uncommon in Ontario
SE	Exotic; not believed to be a native component of Ontario's flora	**S4**	Common and apparently secure in Ontario
SNA	Not Applicable; a conservation status rank is not applicable because the species is not a suitable target for conservation activities (e.g. is exotic or migrant)	**S5**	Very common and demonstrably secure in Ontario
SU	Status unknown		

Appendix D. Bird Sightings at Embro CA, 2015

Common Name	SARO	SRank (S1-S3)	Regional Status	Br	s	S	F	W
American Goldfinch			Common PR	4	C	C	C	C
American Robin			Common BS	4	A	C	A	U
American/Common Crow			Common PR	4	A	C	C	A
Baltimore/Northern Oriole			Common BS	4	C	C	U	
Barn Swallow	THR		Common BS	4	C	C	C	
Black-capped Chickadee			Common PR	4	C	C	C	C
Blue Jay			Common PR	4	C	C	C	C
Brown Headed Cowbird			Common PR	4	C	C	C	U
Canada Goose			Common BS	4	A	C	A	C
Cedar Waxwing			Common BS	4	C	C	C	E
Chipping Sparrow			Common BS	4	C	C	C	O
Common Grackle			Common BS	4	C	C	A	R
Common Yellowthroat			Common BS	4	C	C	C	O
Downy Woodpecker			Common PR	4	C	C	C	C
Eastern Kingbird			Common BS	4	C	C	C	
Eastern Wood-pewee			Common BS	4	C	C	C	
European Starling			Common PR (SE)	4	C	C	C	C
Gray Catbird			Common BS	4	C	C	C	O
Great Blue Heron			Common BS	4	C	C	C	U
Great Crested Flycatcher			Common BS	4	C	C	C	
Hairy Woodpecker			Common BS	4	C	C	C	C
House Wren			Common BS	4	C	C	C	
Indigo Bunting			Common BS	4	C	C	C	
Mallard			Common BS	4	C	C	A	C
Northern Cardinal			Common PR	4	C	C	C	C
Northern Flicker			Common BS	4	C	C	C	R
Northern Rough-winged Swallow			Common BS	4	C	C	C	
Pine Warbler			Common BS	4	C	C	U	
Red-bellied Woodpecker			Uncommon PR	4	U	U	U	U
Red-breasted Nuthatch			Common PR	4	C	U	C	E
Red-eyed Vireo			Common BS	4	C	C	C	
Red-winged Blackbird			Common BS	4	C	C	R	R
Rose-breasted Grosbeak			Common BS	4	C	C	C	
Song Sparrow			Common BS	4	C	C	C	U
Spotted Sandpiper			Common BS	4	C	C	C	
Tree Swallow			Common BS	4	C	C	C	U

Appendix D continued

Common Name	SARO	SRank (S1-S3)	Regional Status	Br	s	S	F	W
Warbling Vireo			Common BS	4	C	C	C	
White Breasted Nuthatch			Common PR	4	C	C	C	C
Wood Duck			Common BS	4	C	U	C	R
Yellow Warbler			Common BS	4	C	C	C	
Total # Common PR			**9**					
Total # Common BS			**29**					
Other			**2**					
TOTAL	1	0	**40**					

NOTES

BS – Breeding Species, PR – Permanent Resident, WR – Winter Resident, SE = Status Exotic

Regional Status based on: Checklist of the Birds of Oxford County, 1st edition, May 2007 by Jeffrey H. Skevington and James M. Holdsworth. Available through The Woodstock Field Naturalists' Club

Br (Breeding Codes)

0 = no evidence of breeding

1 = status uncertain, possibly breeds

2 = formerly bred

3 = sporadically breeds

4 = regularly breeds

Seasonal Codes (relating to bird activities, not calendar dates)

s = Spring; period when a species is migrating to its breeding area

S = summer; the period when a species is nesting

F = Fall; the period when a species is migrating to its wintering area

W = Winter; the period when a species is over-wintering.

Abundance Codes

V = accidental vagrant

O = occasional; very few records; normally absent

R = rare; usually present annually, but seen infrequently

U = uncommon; present in low numbers, unlikely to be found daily without concerted effort

C = common; can be found daily, usually in moderate numbers

A = abundant; found daily in large numbers

E = erratic; numbers highly variable

Appendix E. Animal Sightings (Incidental)

Common Name	SARO	SRank (S1-S3)	Regional Status
Mammals			
Eastern Chipmunk			Common
Grey Squirrel			Common
Red Squirrel			Common
Reptiles and Amphibians			
Reptiles and Amphibians			
Green Frog			Common
American Toad			Common
Snapping Turtle	SC	S3	Common
Insects			
Cabbage White (exotic)			Abundant
Eastern Comma			Common
Eastern Tiger Swallowtail			Common
Monarch	SC	S2N S4B	Common
Red Admiral			Common
Spring Azure			Common

SC – Special Concern (a wildlife species that may become a threatened or endangered species because of a combination of biological characteristics and identified threats.

S2N S4B: N = Non-breeding, B = Breeding

Appendix F. History of Embro CA and Tree Planting Programs

From: 25 Years of Conservation on the Upper Thames Watershed 1947 – 1973, UTRCA.

In 1958 development began on the Embro CA with the replacement of the old dam with a new 300 feet wide structure and a lake (600 feet long and 300 feet wide). To provide a suitable recreation area, 14 acres of the Oxford County Forest and 7 ac of the Charles Harris property were purchased. The area embraces 21 acres. The official opening was Oct 26, 1959. In 1968 existing recreation area expanded to better accommodate the general public.

Embro Conservation Area.

From: Managed Forest Tax Incentive Program Report, UTRCA 2007

Approximately 14 acres of the 21 acre conservation area is in tree cover, some of it mixed plantation and some natural woodland.

Prior to UTRCA ownership in 1961, approximately 8 acres of plantation and woodland were part of the Oxford County Forest and these trees were established between 1947 and 1957. An additional 7 acres were purchased to create the Conservation Area and much of that was planted to trees by the UTRCA in subsequent years.

In 1997 the UTRCA assisted the Embro Pond Community Association (who took over management of the CA in 1993) with shade tree planting around the pond. In 2007, an additional 80 trees were planted by students under the UTRCA's Communities for Nature Program. In 2007 and in 2010, 2800 native wildflowers and grasses were planted in a plot along the laneway (Mud Creek 2012 Watershed Report Card).

In 2010/2011 the conifer plantations were thinned by the UTRCA to encourage hardwood forest regeneration. As well, 2100 native hardwood seedlings were planted between the rows. The project was funded by Oxford County and the Clean Water Project. Trail enhancements were carried out in 2012.

Appendix E

Borehole Logs and Site Maps (Extracted from: Embro Dam Embankment Stability Assessment)

Prepared by Naylor Engineering Associates,

September 2008

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 1

Ground Elevation: *48.89 m*

Project: *Embro Dam Embankment Stability Assessment*

Job No.: *7607G1*

Location: *County Road 16, Township of Zorra, Ontario*

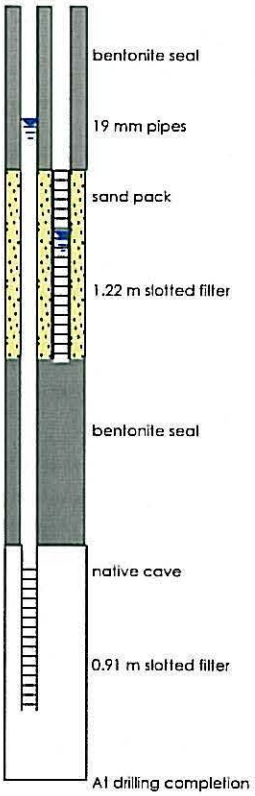
Drill Date: *June 9, 2008*

Depth (m)	Description	Symbol	Elevation (m)	Sample Number	Sample Type	N-Value
0.00	Ground Elevation		48.89			
	FILL: dark brown silt cobbles and boulders, pieces of brick, some topsoil, very moist					
1.00			48.00	1	SS	6
	SILT TILL: loose brown sandy silt, some gravel, saturated			2	SS	4
2.00			47.00			
	CLAY TILL: hard grey silty clay, trace sand and fine gravel, APL			3	SS	23
3.00			46.00			
	DTPL			4	SS	26
4.00	***SILT TILL:*** very dense grey sandy silt, some gravel, moist		45.00	5	SS	30\150mm
5.00				6	SS	35
	Borehole terminated at 5.03 m		44.00			
6.00			43.00			
7.00			42.00			

Dynamic Cone (X) 20 40 60 80
Standard Penetration (●) 20 40 60 80

Shear Strength (PP) kPa (▲) 50 100 150 200
Shear Strength (FV) kPa (■) 50 100 150 200

WP WL
Water Content (%) 10 20 30



Groundwater Observations and Standpipe Details

At drilling completion wet cave at 3.51 m

June 16, 2008
Upper standpipe water level at 1.51 m (Elev. 47.38 m)

Lower standpipe water level at 0.78 m (Elev. 48.11 m)

Reviewed by: *DK*
Drill Method: *Solid Stem Auger*
Notes:

Field Tech.: *RM*
Sheet: *1 of 1*
Drafted by: *SM (01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 2

Ground Elevation: *50.04 m*

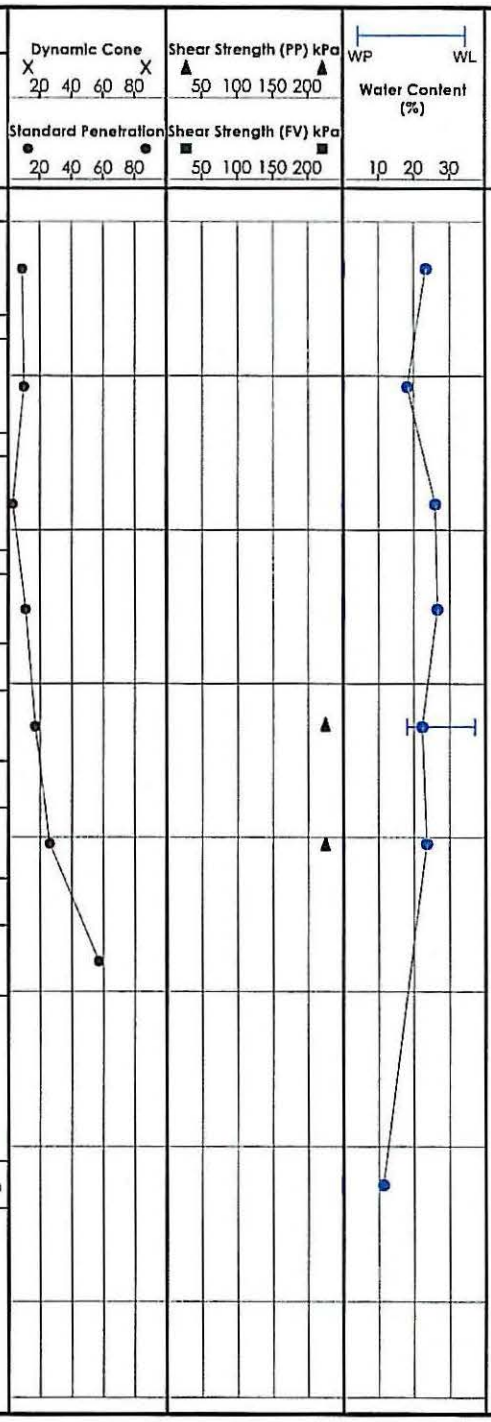
Project: *Embro Dam Embankment Stability Assessment*

Job No.: *7607G1*

Location: *County Road 16, Township of Zorra, Ontario*

Drill Date: *June 9, 2008*

Depth (m)	Description	Symbol	Elevation (m)	Sample Number	Sample Type	N-Value
0.00	Ground Elevation		50.04			
	FILL: dark brown silt, moist			1	SS	9
	loose brown sandy silt, some gravel, trace clay, very moist to wet					
1.00			49.00	2	SS	10
				3	SS	3
2.00	***SILT:*** loose brown silt, trace clay and sand, wet		48.00			
	CLAY TILL: stiff to hard grey silty clay, trace sand and gravel, APL			4	SS	11
3.00			47.00	5	SS	17
4.00			46.00	6	SS	26
	SILT TILL: very dense to dense sandy silt, some gravel, moist			7	SS	57
5.00			45.00			
6.00			44.00	8	SS	16\150mm
	Borehole terminated at 6.40 m					
7.00			43.00			



Groundwater Observations and Standpipe Details

At drilling completion wet cave at 5.94 m

June 16, 2008
Upper standpipe dry

Lower standpipe water level at 1.45 m (Elev. 48.59 m)

Reviewed by: *DK*

Drill Method: *Solid Stem Auger*

Notes:

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *SM (01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 3

Ground Elevation: *50.01 m*

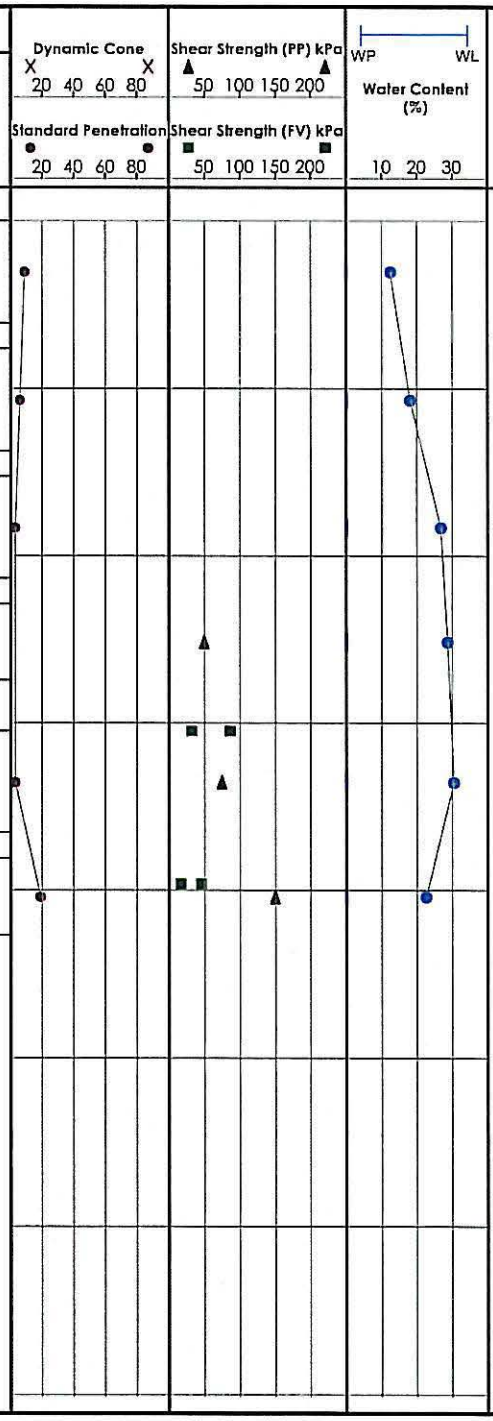
Project: *Embro Dam Embankment Stability Assessment*

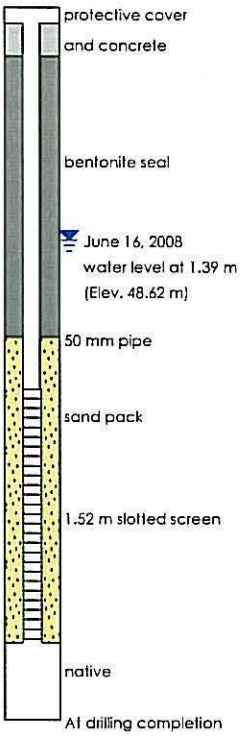
Job No.: *7607G1*

Location: *County Road 16, Township of Zorra, Ontario*

Drill Date: *June 9, 2008*

Depth (m)	Description	Symbol	Elevation (m)	Sample Number	Sample Type	N-Value
0.00	Ground Elevation		50.01			
	FILL: dark brown silt, (topsoil), moist			1	SS	9
	loose brown silt, and sand, some clay and gravel, very moist to wet					
1.00			49.00	2	SS	6
				3	SS	3
2.00	**SILT TILL:** soft mottled brown clayey silt, trace sand and gravel, APL		48.00			
	CLAY: soft mottled brown silty clay, WTPL			4	TW	
3.00			47.00			
	trace organics			5	SS	3
4.00	**CLAY TILL:** very stiff grey silty clay, trace sand and gravel, APL		46.00	6	SS	19
	Borehole terminated at 4.27 m					
5.00			45.00			
6.00			44.00			
7.00			43.00			





Reviewed by: *DK*

Drill Method: *Solid Stem Auger*

Notes:

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *SM (01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 4

Ground Elevation: *49.95 m*

Project: *Embro Dam Embankment Stability Assessment*

Job No.: *7607G1*

Location: *County Road 16, Township of Zorra, Ontario*

Drill Date: *June 10, 2008*

Depth (m)	Description	Symbol	Elevation (m)	Sample Number	Sample Type	N-Value
0.00	Ground Elevation		49.95			
	FILL: dark brown silt, moist;			1	SS	13
	compact brown sandy silt, some gravel, trace clay, moist					
1.00	***SILT:*** stiff brown silt, some clay, some sand, APL		49.00	2	SS	8
				3	TW	
2.00	grey sandy silt, moist		48.00			
	PEAT: black amorphous peat, WTPL			4	SS	*
3.00			47.00	5	SS	8
	CLAY TILL: grey silty clay, trace sand and gravel, WTPL					
4.00	hard, APL		46.00	6	SS	23
	SILT TILL: dense brown silt, some sand and gravel, moist			7	SS	37
5.00			45.00			
6.00	very dense brown sandy silt, some gravel, moist		44.00	8	SS	35\150mm
	Borehole terminated at 6.40 m					
7.00			43.00			

Dynamic Cone (X) 20 40 60 80 — Standard Penetration ● 20 40 60 80

Shear Strength (PP) kPa ▲ 50 100 150 200 — Shear Strength (FV) kPa ■ 50 100 150 200

Water Content (%) WP WL 10 20 30

108%

Groundwater Observations and Standpipe Details

- protective cover and concrete
- June 16, 2008 water level at 1.12 m (Elev. 48.83 m)
- 19 mm pipe
- bentonite seal
- native cave
- 1.52 m slotted screen
- At drilling completion wet cave at 3.35 m

Reviewed by: *DK*

Drill Method: *Solid Stem Auger*

Notes: **Sampler driving on wood*

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *SM (01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 4A

Ground Elevation: *49.95 m*

Project: *Embro Dam Embankment Stability Assessment*

Job No.: *7607G1*

Location: *County Road 16, Township of Zorra, Ontario*

Drill Date: *June 10, 2008*

Depth (m)	Description	Symbol	Elevation (m)	Sample Number	Sample Type	N-Value
0.00	Ground Elevation		49.95			
	FILL: dark brown silt, moist;			1	SS	13
	compact brown sandy silt, some gravel, moist					
1.00	***SILT:*** stiff brown silt, some clay, trace sand, APL		49.00	2	SS	8
	grey sandy silt, moist			3	TW	
2.00	***PEAT:*** black amorphous peat, WTPL		48.00	4	SS	*
3.00	Borehole terminated at 3.05 m		47.00			
4.00			46.00			
5.00			45.00			
6.00			44.00			
7.00			43.00			

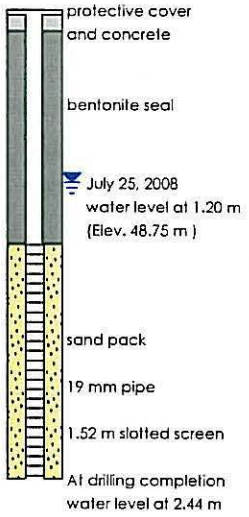
Dynamic Cone (X) 20 40 60 80 — Standard Penetration (●) 20 40 60 80

Shear Strength (PP) kPa (▲) 50 100 150 200 — Shear Strength (FV) kPa (■) 50 100 150 200

Water Content (%) WP — WL; 10 20 30

108%

Groundwater Observations and Standpipe Details



Reviewed by: *DK*

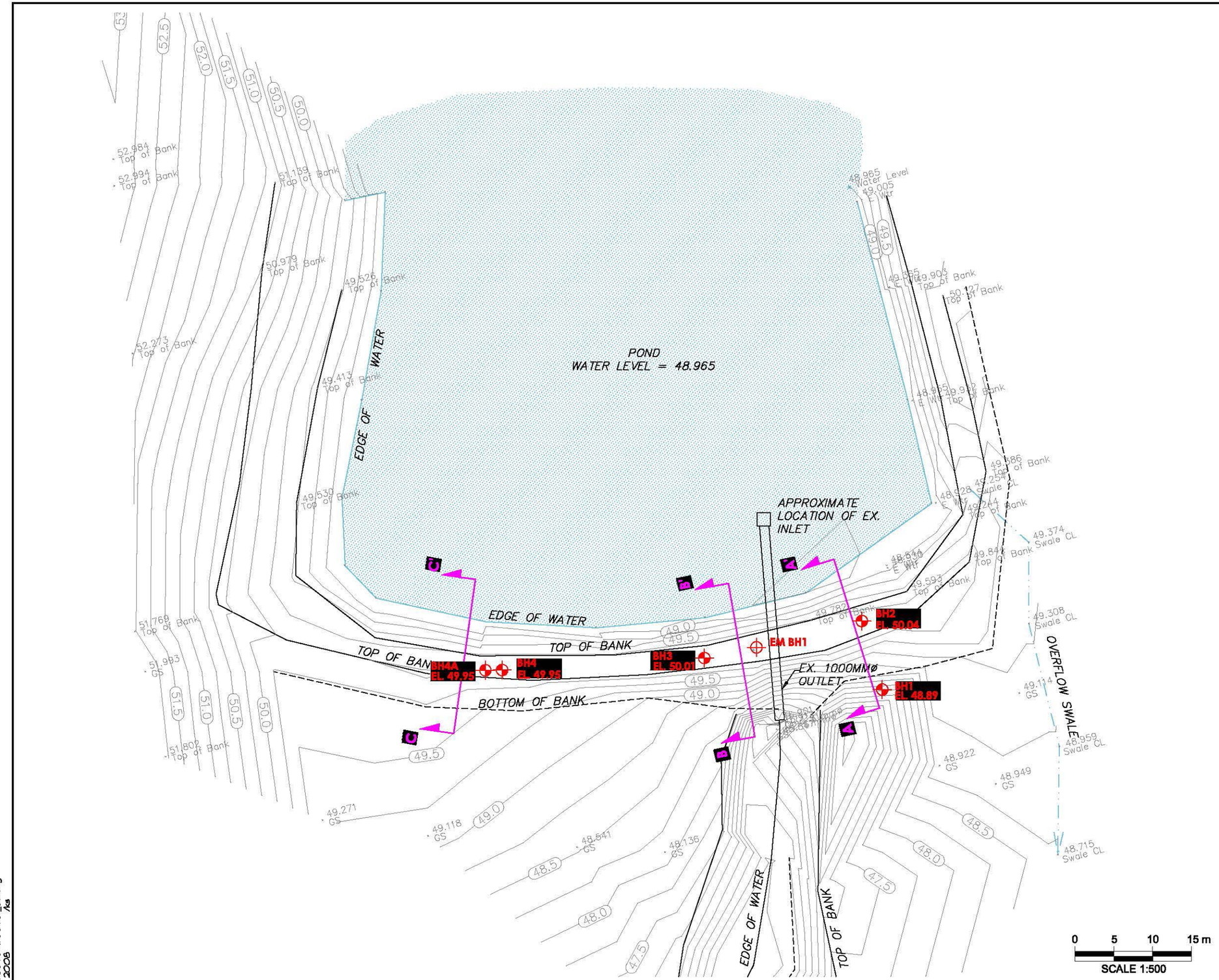
Drill Method: *Solid Stem Auger*

Notes: **Sampler driving on wood. Soil stratigraphy inferred from Borehole 4.*

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *SM (01a)*



Drawing Reference: Base drawing provided by R. J. Burnside Associates Ltd.

F:\7607\7607GN\7607GI_02.dwg
August 5, 2008
ks

No.	Revisions	Date
0	**Report Issued**	**Sept. 2008**
1		
2		
3		

Legend

- Borehole Location (Current Investigation)
- Approximate Borehole Location (Acres International)
- EL.48.89 — Ground Surface Elevation (m)
- A A' — Geologic Cross-Sections (See Drawing No. 3)

Temporary Benchmark
Top centre of concrete base for post at southeast corner of pavillion
Elevation 53.045 m (assumed local datum)

NORTH

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

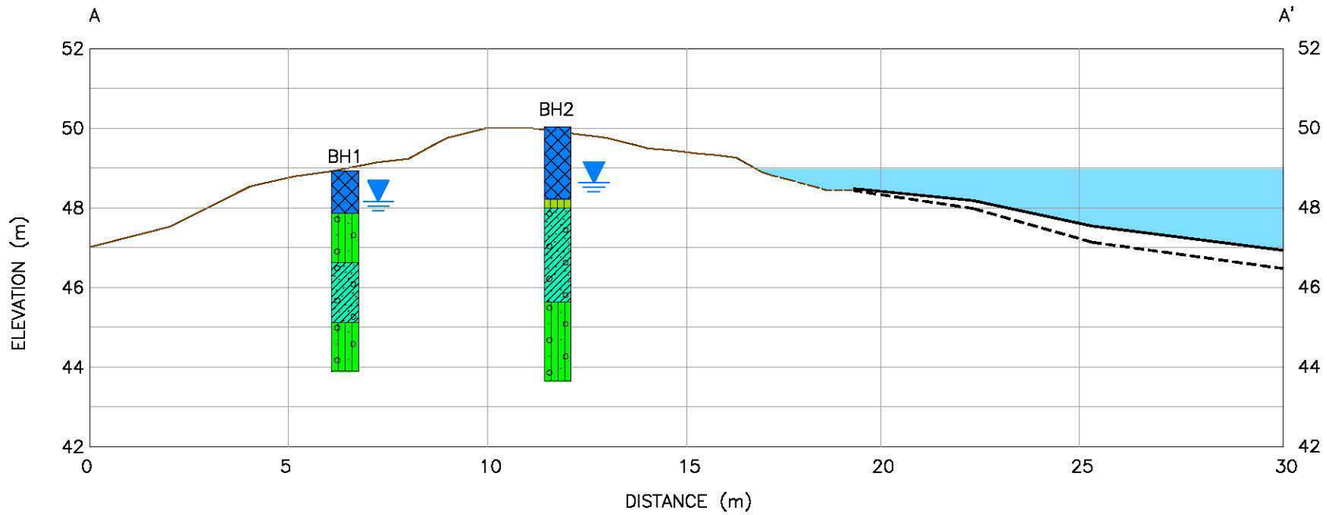
Embro Dam Embankment Stability Assessment

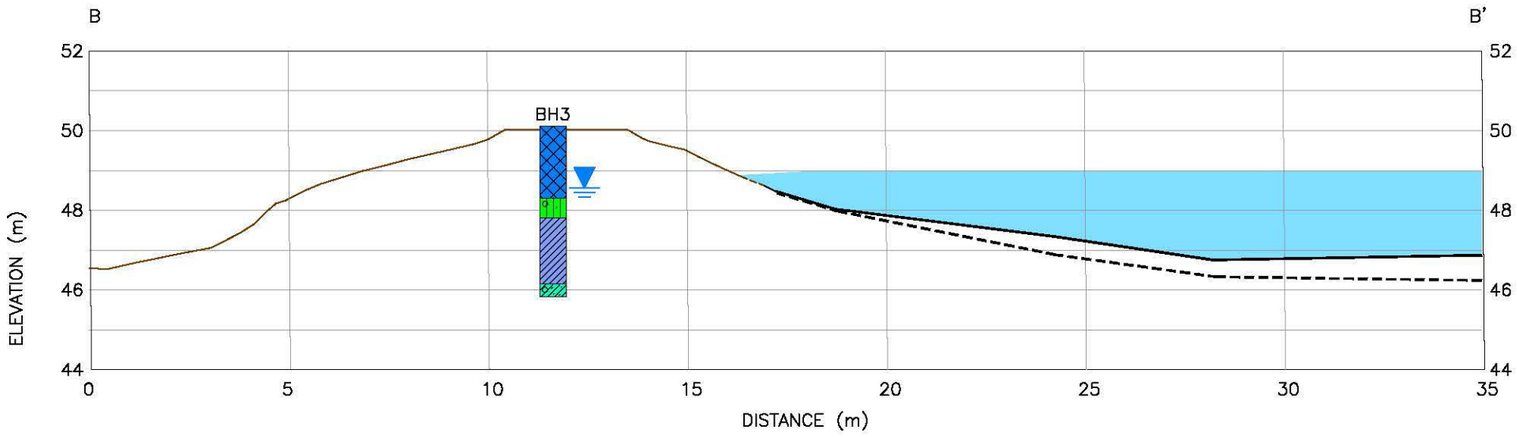
County Road 16

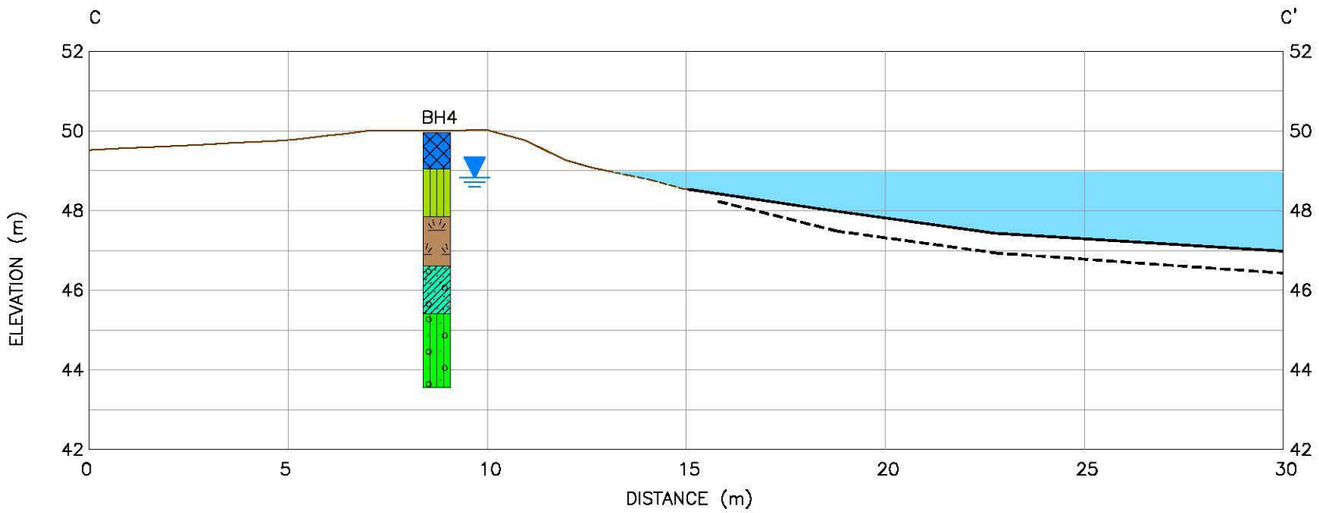
Township of Zorra, Ontario

SITE PLAN

Date	Scale	Job No.	Drawing No.
Sept. 2008	**1:500**	**7607G1**	**2**







No.	Revisions	Date
0	**Report Issued**	**Sept. 2008**
1		
2		
3		

Legend

- Fill
- Peat
- Silt
- Clay Till
- Silt Till
- Clay
- Groundwater Table June 16, 2008
- Existing Grade
- Approximate Top of Sediment (m) (Bottom of Pond)
- Approximate Bottom of Sediment (m)

Notes:

Seasonal fluctuations in groundwater levels would be expected.
The inferred stratigraphy shown on this cross-section is based on the subsurface stratigraphy contacted at the boreholes. The subsurface conditions between the boreholes will vary.

The ground surface under the water is based on depth (to refusal) measurements taken with a steel survey rod.

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Embro Dam Embankment Stability Assessment

County Road 16

Township of Zorra, Ontario

CROSS-SECTIONS A - A', B - B' and C - C'

Date	Scale	Job No.	Drawing No.
Sept. 2008	**1:150**	**7607G1**	**3**

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July 16, 2008 (em) /Aug 5, 2008 (ke)

Appendix F

Fluvial Geomorphology

Prepared by ERI, February, 2017

Upper Thames River Conservation Authority

Embro Dam Class Environmental Assessment Fluvial Geomorphology Report

Updated February 2017

Table of Contents

List of Figures

List of Tables

1. 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. The assessment included both a desktop review and data collection through field investigations; data collection completed by ERI was supplemented by UTRCA's topographic survey of the channel bed profile. Findings from the geomorphic assessment are presented by sub-section in this report.

1.1 Historical Assessment

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 in **Table 1-1;** a collection of historical airphotos of the study area is provided in **Figure 1-1**.

Table 1-1. Observations of change based on historical photo overview.

	Observation
1955	• Embro pond was not yet constructed south of Road 84 and Youngsville Drain meandered • 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.
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).
1989	• Floodplain vegetation west of Youngsville Drain, and north of Road 84, appears to be • Some channel planform development appears to be occurring at the upstream limit of the channel straightening
2000	• A row of trees appears to have been planted to the west of Youngsville Drain, north of Road 84. The row of trees to the east of the watercourse appears to have been extended further • No change in planform configuration is evident in comparison to the 1989 image.
2010	• Vegetation/tree growth north of Road 84 is notable. Portions of Youngsville Drain are obscured from view on the photo. • Overall, no change in planform configuration is evident in comparison to the 2000 image.

Figure 1-1a. Overview of historical channel change along Youngsville Drain in proximity to Embro Pond

1955

1972

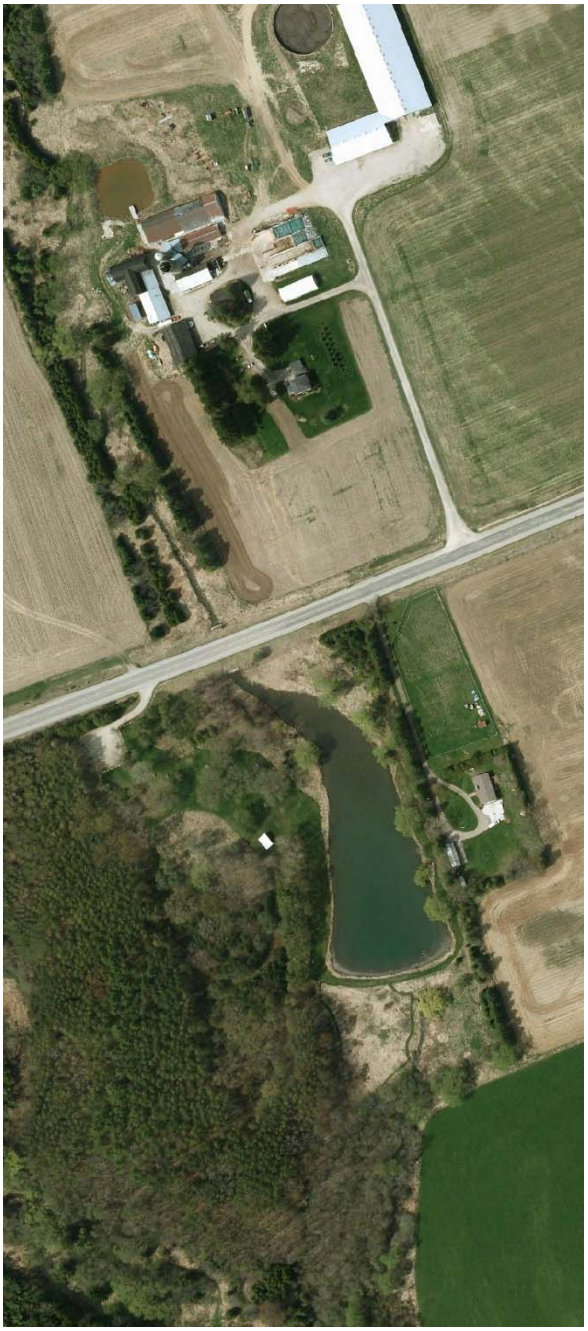
Figure 1-1b. Overview of historical channel change along Youngsville Drain in proximity to Embro Pond

1989

2000

Figure 1-1c. Overview of historical channel change along Youngsville Drain in proximity to Embro Pond

2010



2015

1.2 Existing Conditions

A geomorphic field investigation was undertaken on June 11, 2015 to assess existing conditions along Youngsville Drain, both upstream and downstream of Embro Pond. The field investigation included both reconnaissance level observations and detailed data collection.

During the field assessment, three reaches were identified. Reaches are defined as lengths of channel along which there is relative homogeneity of controlling and modifying influences and thus channel form and processes are similar. A description of dominant channel characteristics is provided by reach below. Although intended for urban watercourses, the Rapid Geomorphic Assessment (RGA) was applied to gain insight into overall channel stability and to identify dominant channel processes. The focus of field data collection/measurements was predominantly upstream of the dam's backwater influence.

The focus of field data collection/measurements was predominantly upstream of the dam's backwater influence and included cross-section profiles and substrate characterization. A topographic survey of the channel bed morphology was undertaken by UTRCA and provided to the ERI team for analysis and integration into the fluvial geomorphic assessment. The reach delineation is demonstrated on **Figure 1-2** the surveyed channel bed profile is illustrated in **Figure 1-3** which includes a profile through Embro Pond based on 2015 water depth mapping provided by the UTRCA.

Figure 1-2. Reach delineation along Youngsville Drain.

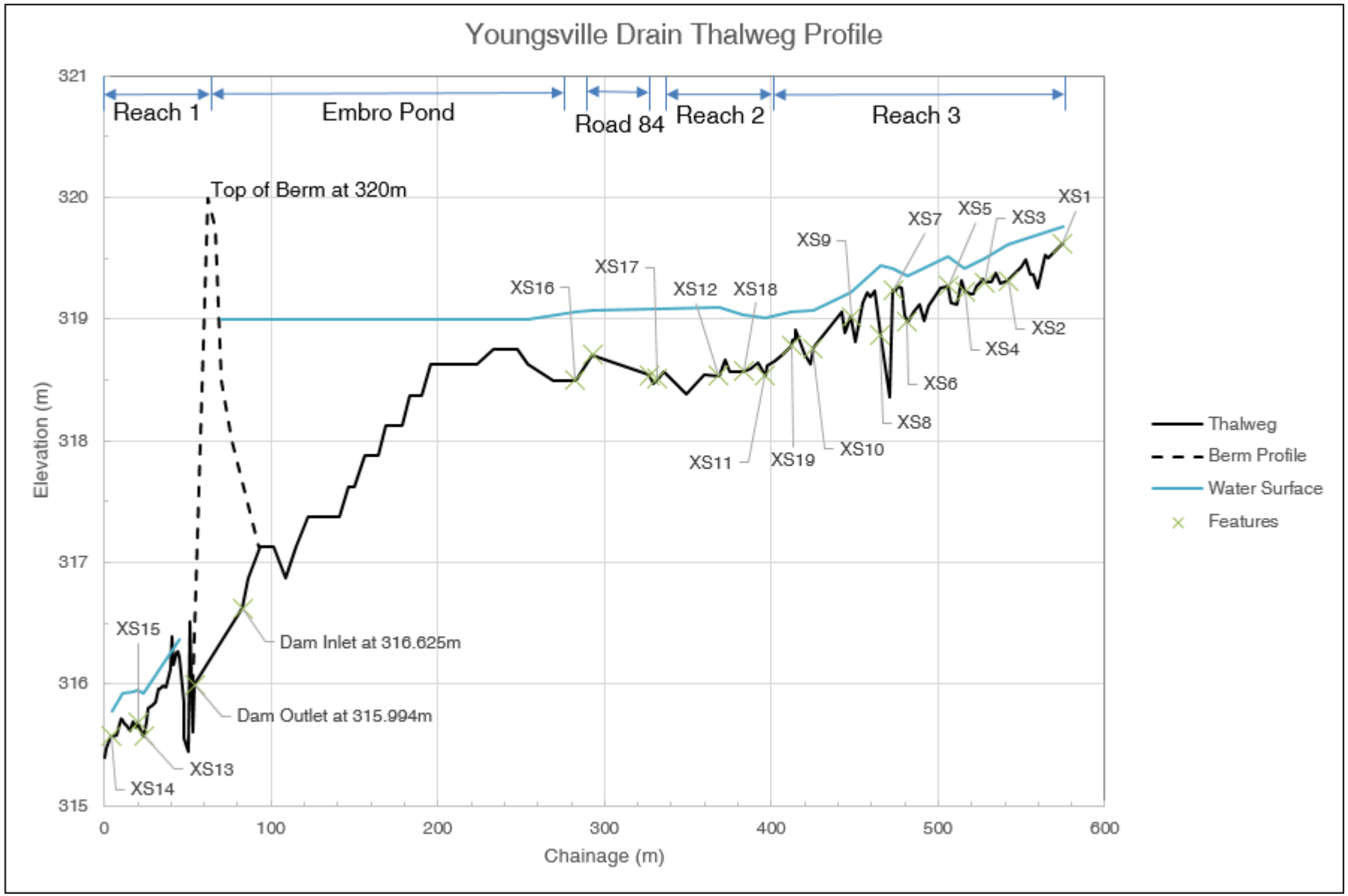


Figure 1-3. Surveyed channel bed profile along Youngsville Drain.

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 reach (**Figure 1-4**). 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. The active channel was ~ 3.70m wide with an average water depth of 0.29m. 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.

A deep pool (0.93 m) occurred within 5 m downstream of the Embro Dam outlet. The dominant bed morphology along the entire reach was riffle/run with shallow pools. A deeper pool where vegetation was overhanging into the watercourse. 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.

View downstream from dam outlet.

Downstream view along creek, towards property line at trees.

Figure 1-4. Reach 1 photos illustrating site conditions

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 (**Figure 1-5**). The backwater conditions extended 85 m upstream of Road 84; the channel was straight. Measurements of channel cross-section parameters and substrate materials were made at two locations within this reach (**Table 1-2**).

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. Average water depth was relatively consistent and ranged from 0.25 – 0.30 m.

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 rooting network of bankside vegetation holds the banks together in ‘clumps’. Undercutting of the banks occurred near the water

surface and was consistently measured as 7 – 8 cm deep. 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.

	
View downstream along Youngsville Drain to Road 84	Substrate materials within the channel and submerged aquatic vegetation growth.
	
Irregular banks with minor undercutting near the water surface. Banks are subjec to hydration processes.	Some bank undercutting was observed along the banks.

Figure 1-5. Reach 2 photos illustrating site conditions.

Table 1-2 . Overview of Reach 2 cross-section parameters.

Parameter	Range	Parameter	Range
BANKFULL		**LOW FLOW WATER**	
Width (m)	3.8	**Width (m)**	3.51
Depth (m)		**Depth (m)**	
Max.	0.66	**Max.**	0.42
Avg.	0.50	**Avg.**	0.27
Width:depth ratio (m/m)	8.0	**Width:depth ratio (m/m)**	13.00
Area (m^2)	1.92	**Area (m^2)**	0.96
Perimeter (m)	6.33	**Wetted perimeter (m)**	3.78
Bank Height (m)	0.38		
Bank undercutting (m)	0.07–0.08		
Bank Vegetation and rooting influence	grasses along both banks		
Floodplain connectivity	well-connected		
Substrate Gradation (mm)			
D90	All substrate consisted of sand and silt sized materials.		
D84			
D50			
D16			
D10			

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 (**Figure 1-6**). 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.

Field data collection was undertaken at ten cross-sections, which included 4 pools and six riffle/run configurations. A summary of cross-sectional characteristics is presented in **Table 1-3**.

Table 1-3. **Overview of Reach 3 cross-section parameters.**

	Riffle		Pool	
	Range	**Average**	**Range**	**Average**
Bankfull				
Width (m)	2.85-4.74	3.90	3.29-5.15	4.09
Depth (m)				
Max.	0.42-0.53	0.44	0.45-0.74	0.56
Avg.	0.33-0.41	0.34	0.31-0.42	0.35
Width:depth ratio (m/m)	8.65-18.05	11.74	9.46-16.82	11.81
Area (m^2)	0.93-1.92	1.33	1.06-1.71	1.44
Perimeter (m)	3.99-6.99	4.96	3.96-5.62	4.64
Low Flow Water				
Width (m)	2.59-3.83	3.28	2.97-4.16	3.34
Depth (m)				
Max.	0.16-0.25	0.21	0.28-0.58	0.40
Avg.	0.11-0.18	0.14	0.18-0.34	0.25
Width:depth ratio (m/m)	14.76-29.24	24.04	9.40-22.88	14.33
Area (m^2)	0.33-0.56	0.46	0.66-1.10	0.83
Wetted perimeter (m)	3.11-4.24	3.53	3.25-4.32	3.76
Substrate Gradation (mm)				
D90	50			
D84	35			
D50	10			
D16	0.5			
D10	0.1			

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 (**Table 1-3**). This reflects the control of grassy and herbaceous bankside vegetation on channel form. Although the average channel depth was similar between pools and riffles, pools attained a somewhat higher depth at both bankfull and low flow stages.

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.

Active drainage channels discharge into the creek.

Channel is well connected to its floodplain

Bank stratigraphy includes a lower unit that provides bedrock control on profile development.

Substrate consisted of cobbles on a gravel-sandy bed

Riparian vegetation includes both grasses/herbaceous plants and trees (cedar/willow)

Figure 1-6. Reach 3 photos illustrating site conditions

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 (**Table 1-3**). The deepest pool evident on **Figure 1-3** 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).

Table 1-4. Channel bed profile characteristics along Reach 3.

		Average
Max. residual pool depth (m)	0.15-0.28 One pool was uncharacteristically deep at 0.87 m	0.33
Pool area (2D along profile) (m^2)	0.28-1.27	0.79
Pool length (m)	8.28-27.48	16.48
Avg. pool depth	0.10-0.32	0.17
Riffle length (m)	4.91-12.35	9.12
Riffle grade (%)	0.39-2.08	1.32
Inter-riffle spacing	16.35-47.01	27.52

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 %. Quantification of riffle and pool parameters, for Reach 3 is provided in **Table 1-4**.

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.