Michener Drain Stormwater Baseline Report

October 30, 2018

Project No: EWB-189999

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Revision and Version Tracking

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Paul C. Marsh, P.Eng.
EWA Engineering Inc.
Principal Engineer

Notice:
This report is based on information and data that was available for review as provided. The analysis undertaken is for the purpose stated in the report and is not for use elsewhere.

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1 Introduction

The City of Port Colborne retained Paul Marsh, P.Eng of EWA Engineers Inc. to prepare a Drainage Report under the Drainage Act R.S.O. 1990 for the Michener Drain. The Michener Drain Engineer's Report is prepared as follows:

- Baseline Drainage Report; provides an assessment of current drainage problems and identifies the extent of the drainage area to be serviced by the municipal drain.

- Drain Capacity Assessment Report; provides an assessment of existing capacity through the use of hydrologic and hydraulic modelling which identifies the options for resolving problems and recommends a preferred option to improve drainage.

The final Michener Engineer's Report is composed of the two previous reports along with supporting documentation and final drainage cost estimates and assessment schedule or table.

This report is the Baseline Drainage Report and provides a summary assessment of the existing condition and drainage issues of the Michener Drain. The Baseline Drainage Report presents the current, as of 2018, baseline or reference condition from which all proposed improvements will be reviewed, planned and designed to address. In some cases, a drainage issue may be identified in the Baseline Report but deferred from a specific implementation in the specific Drain Engineer's report. The Baseline Report provides the total needs of the drain works but does not provide specific recommendations on implementation.

There are three Drain Reports being prepared concurrently. Of those drainage projects, there are two that have the Wignell Drain as their outlet and they are:

- Michener Drain, outlets to Wignell at 0+010 North of the Lakeshore East Rd. and proceeds northerly for 1.6km, ending South of the Friendship Trail.

- Port Colborne Drain, outlets to the Wignell at 2+062 South of the Friendship Trail and proceeds northerly for 3.3km ending at or near the Second Concession Road.

The Port Colborne drain originally had an outlet to Lake Erie but was diverted to the Wignell by an Engineer's report. For some number of years, the upper portion has been referred to as a branch of the Wignell Drain but by the preparation of the planned Engineer's Report with a revised Cost Assessment Schedule it will be recognized as the Port Colborne drain with an outlet to the Wignell Drain south of the Friendship Trail. This new Port Colborne Drain Engineer's Report is expected to be prepared in concert with the Wignell Report and the Michener

Drain Report. The following Figure presents the proposed drain names and drainage boundaries. For a more detailed map, refer to Appendix B.

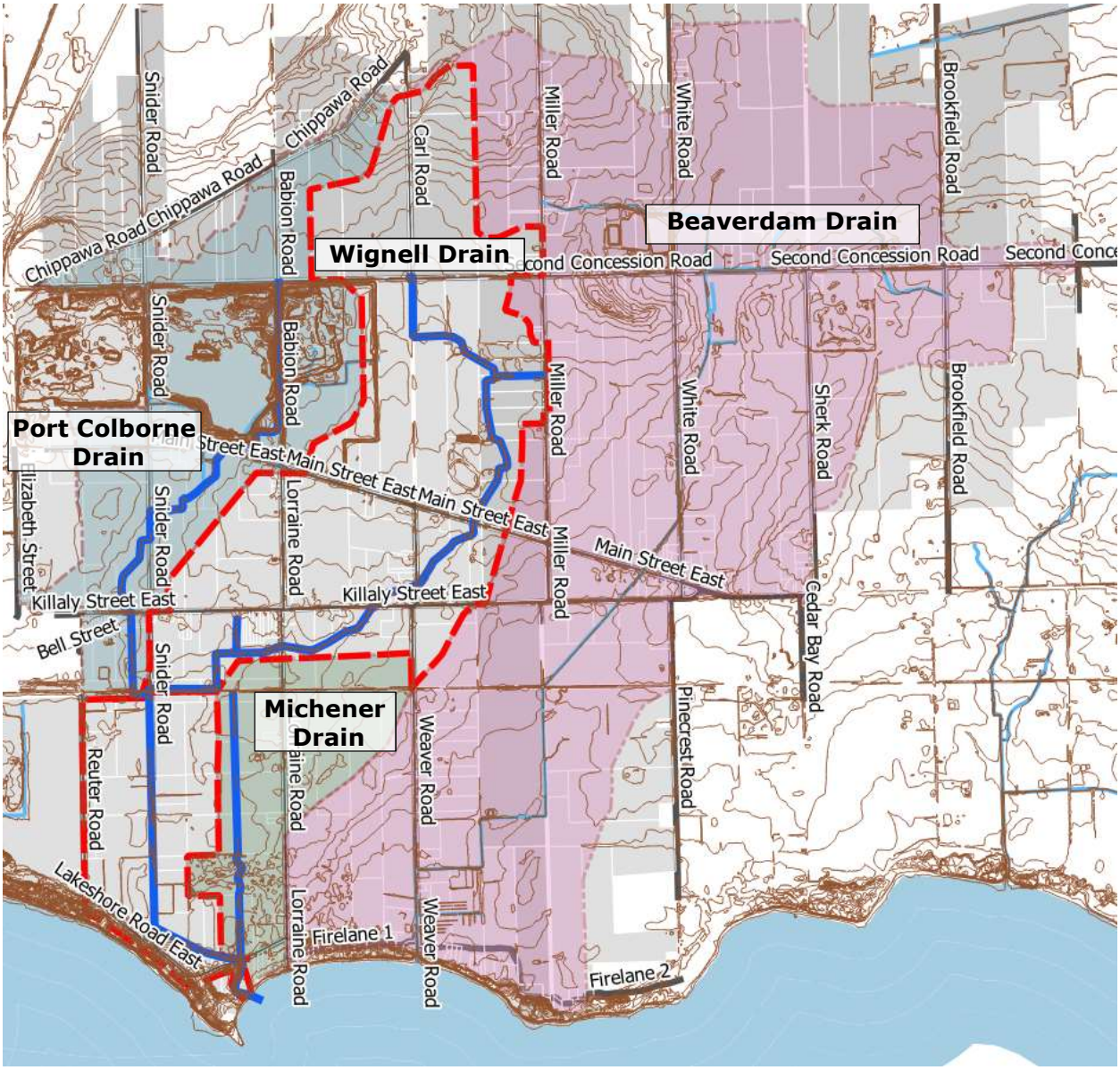


Figure 1 Municipal Drains - Wignell Boundary

1.1 Drain History

The earliest record of the Michener Drain dates back to 1855 in a Judge's notation in the April 26, 1896 judgment in Fredericka Sprock vs. Geo. Ross' Report/Award. A more formal reference under a predecessor act to the Drainage Act dates back to 1875, which was a petition by property owners within area Lots 21 to 26 Con 1 Humberstone, for the deepening of the Wignell Drain.

In the late 1880s to 1900, a few requisitions, petitions and reports were made under the Ditches & Watercourse Act to construct ditches affecting several Con 1 and 2 Humberstone lots. The documentation refers to the constructed ditches as the Port Colborne Drain and Michener Drain. Several reports for the improvement and maintenance works on the Wignell and Michener Drains followed.

The Geo. Ross report dated April 29, 1911 on the Wignell, Michener and Port Colborne Drains calls for enlargement of the Wignell Drain from Lake Erie to Grand Trunk Railroad (GTR), deepening and cleaning the Michener Drain and extending it to the north end of Con 2. The upper portion of the Michener Drain was redirected by a branch; the Port Colborne Drain was extended to Con 3 and re-named as the Wignell Drain. The remainder of the Port Colborne Drain was abandoned. The Wignell and Michener Drains, formerly improved by the Drainage and Watercourse Act, were incorporated under the Municipal Drainage Act.

Starting in 1957 with Casmir Rawski, Cornelius Braakman & J.C. Groetelaars, several petitions were made to construct a flood gate at Lakeshore Bridge on the Wignell/Michener Drain due to the problems associated with flooding of agricultural lands south of CNR (now the Friendship Trail). It was concluded that the existing drain be widened from the CNR south to Lake Erie, and flood control gates be installed on the south side of the existing bridge at Lakeshore Road. The next By-Law, No. 255/73, includes the report on the Wignell Drain low lift pumping station, prepared by C. J. Clarke and Associates, dated February 23rd, 1973. This Report recommended the installation of a 9,000 USGPM pump and appurtenances to the south of the Lakeshore Road control gates. A schedule for those works was included in the report, assessing the cost to five properties, owned by three landowners.

North of the Friendship Trail, the Wignell Drain, was last maintained under an Engineer's report by D. Ingram of R. V. Anderson, dated July 28, 1978. The lower reach, south of the Friendship Trail, was subsequently maintained in 1985, based on the June 21, 1969 C. J. Clarke Engineer's report, along with periodic spot maintenance works thereafter.

Based on the information provided by the municipality, the applicable Engineer's reports for the Michener Drain were prepared by RV Anderson Associates Ltd. Dated July 28, 1978 and adopted through Bylaw #773/89/78. This was subsequently modified by an Engineer's Report prepared by Wiebe Engineering Group Inc. dated November 15, 1996 and titled, "Michener Municipal Drain M-1 Relocation Property Roll No. 4-4-47". Information concerning the report, Appeals and the Tribunal Decision is included in Appendix A.

Previous information and data regarding the Michener Drain was provided to EWA Engineering for review. This information was compiled first by Wiebe Engineering Group (2001) and then by Amec Foster Wheeler (2014). A history of the Michener Drain is provided in Appendix A of this report for reference. Meetings where held as follows:

- Wignell Michener PIC meeting July 15, 2002

- Wignell Michener Site meeting September 19, 2003
- Wignell Michener PIC meeting October 20, 2003
- Wignell Michener PIC meeting October 20, 2004

While the preparation of the Engineer's report for the watershed in entirety was originally assigned to Wiebe Engineering and then subsequently to Amec Foster Wheeler but not completed, 17 years have passed and during that time, the City of Port Colborne has engaged in drainage improvements conducted on an emergency or opportunity basis that are to be included as improvements in the Engineer's Report for the respective drain. Where improvements were performed on the Michener Drain, those works are described in Section 4 Interim Drainage Works of the Baseline report.

1.2 Michener Drain Basics:

The Michener drain serves an area of 133 hectares based on the defined drain boundary, refer to Figure 2. The main branch of the drain is 1725m in length from the drain origin, which is defined as the outlet to the Wignell Drain just north of Lakeshore East.

The watershed boundary is north of the Friendship Trail. with a high point of 178m. The upper portion of the drain is a narrow fringe of drainage area north of the Trail extending eastwards to Weaver Road. The outlet at the lake varies with the change in Lake Levels but the recorded average lake level is given as 174.15. The lake level fluctuates and for the month of May, 2018 has been 174.7m, which is higher than average and influences the water surface profile.

- Watershed average fall (slope) is given as 0.22% or 2.2m per 1000m
- Drain average fall (slope) is given as 0.13% or 1.30m per 1000m

This slope characterises the Michener as low slope or slow watershed. A desirable drainage slope for any open channel swale is typically 0.2% although the average drain slope within Port Colborne is calculated to be 0.143%. The lower portion of the drain is highly influenced by Lake Erie's water elevation with a littoral sand beach influenced outlet.

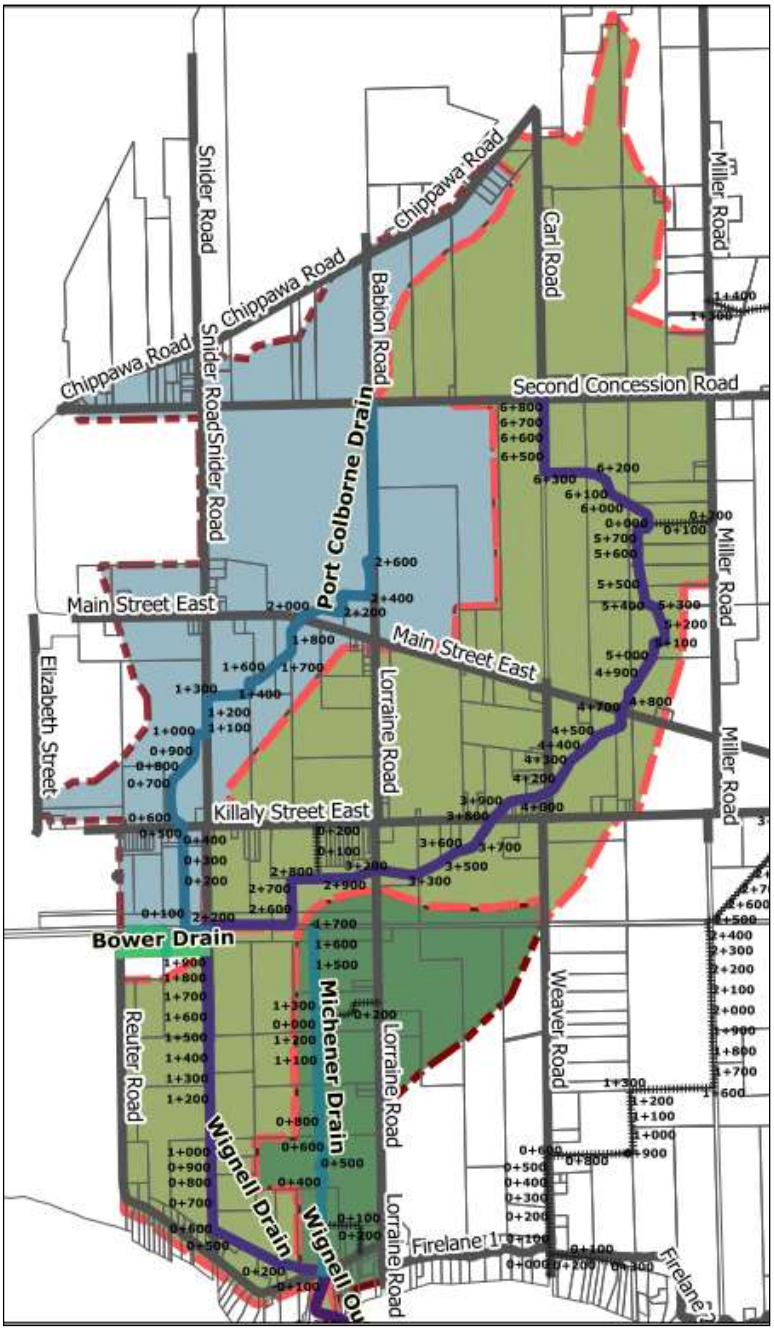


Figure 2 Wignell Drain Watershed with Wignell, Port Colborne and Michener Drains

The Michener drain can be segregated into a few distinct geographic areas.

1. Outlet; this area starts about 0+000 chainage marker and is the outlet to the Wignell. The outlet is influenced by the water surface elevation in the Wignell and is defined by significant vegetation growth for the drain's first 50m.

2. From 0+050 to 0+300 Drain reach to outlet. This portion of the drain lies below the golf course and is a swale with defined banks that runs to the outlet. Bank full or top width is approximately 4m.

3. From 0+300 to 0+695 Golf course; this reach is heavily managed by the golf course. Includes, pumping to reverse flow to irrigation ponds, changed bridge to culvert, vegetation removal, etc.

4. From 0+695 to 1+700 main branch ends; largely agriculture on either side of the drain and the drain is heavily vegetated.

The following figure has the drains and the NPCA supplied Regulated Flood lines, shown in yellow and the Regulated Area limits are shown in pink with grey outline. The flooding between the Wignell Drain and the Michener Drain is extensive in the lower reach of the Wignell and for all of the Michener up to STA 1+500.

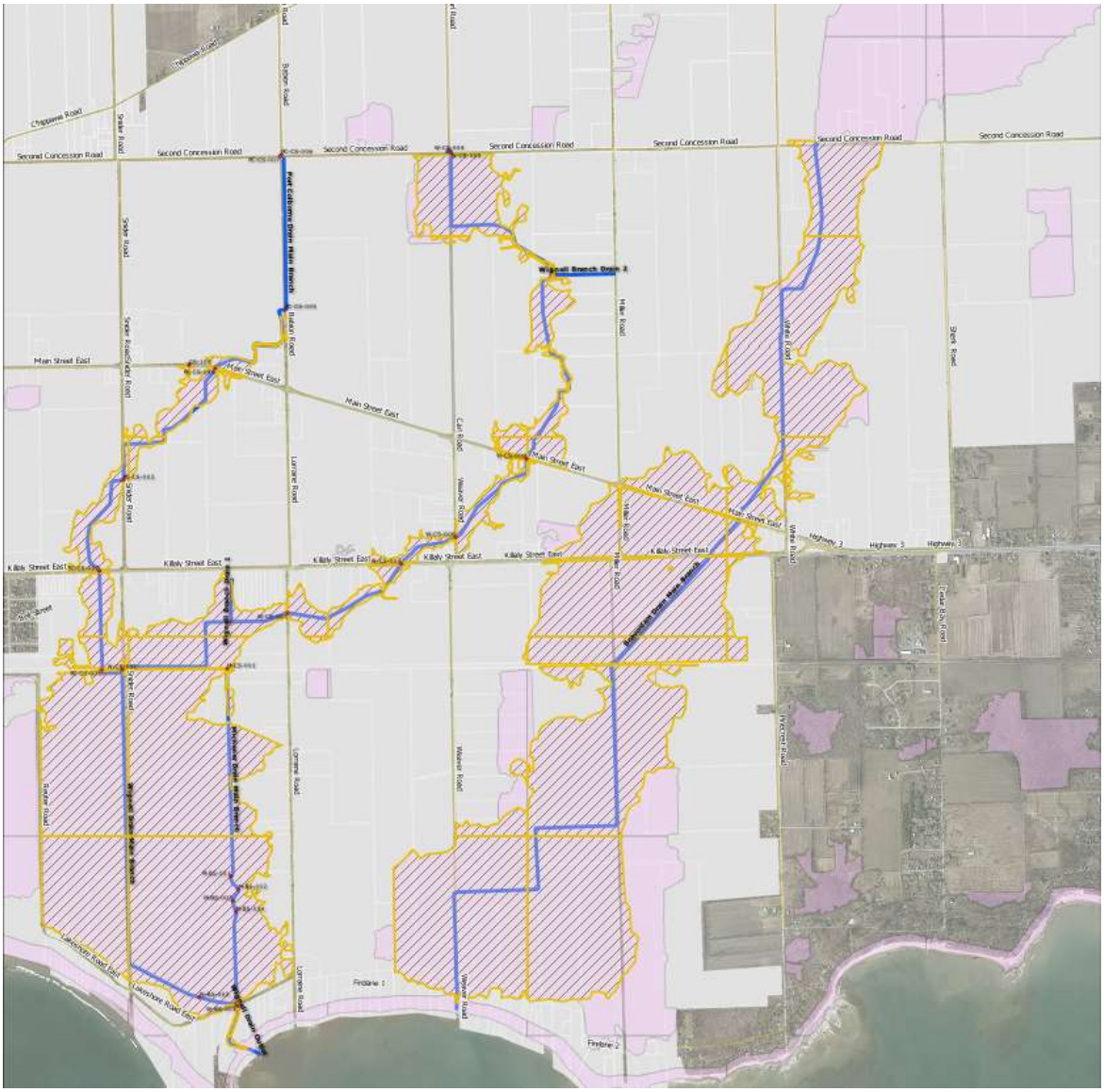


Figure 3 NPCA supplied Regulated Flood limits and Areas

This map and other environmental mapping is provided in Appendix D for reference.

2 Study Approach

All drainage work is legislated by the Provincial Drainage Act.

A one-third agricultural grant is available to all eligible farmlands to help with the cost of drainage repairs and capital projects through the Agricultural Drainage Infrastructure Program (ADIP) managed by the Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA).

Work is done within the guidelines established by the Department of Fisheries and Oceans (DFO) and the Endangered Species Act as established by the Ministry of Natural Resources (MNR).

The Municipal Drainage Act requires a specific process for establishing and making alterations to a Municipal Drain. The Act was prepared with a specific process to be followed. The process for a drainage project improvement under Section 78 of the Act is as follows:

- Under Section 78 of the Act, Council appoints an Engineer to initiate a study and to prepare a report.
- On Site Meeting; notice required by the clerk.
- Preparation of a Preliminary Report
    - Identification of the issues to be improved.
    - The preferred method for improvement.
    - An estimate of the costs for improvement, and
    - The principles for revising, changing or otherwise adjusting the drainage schedule of cost sharing.
- Field Survey
- Detailed Design
- Final Drainage Report Preparation
- Drainage Report Review and Consideration
- Contract Tendering
- Construction
- Post Construction Final Documentation of the Drainage Report

For this report, the following notes are provided for context within the previous work undertaken by Wiebe and Amec Foster Wheeler to establish the purpose and context of the Baseline Drainage Report.

The appointment of the engineer has been completed by Council following the revocation of the assignment to Amec Foster Wheeler, previously appointed to prepare a drainage report.

The onsite meeting has been conducted previously by Amec Foster Wheeler and consultation notes are included in Appendix A. In order to provide those affected by the proposed drainage works, a Public Information Centre (PIC) is planned to provide an update with the focus being on proposed and preferred alternative(s) to address the drainage issues.

The appointed Engineer has conducted a drainage wide site review.

The preliminary Report and Engineer's Drain Report has been segregated into three sub-reports as follows:

1. Baseline Report, presents clear identification of the current drain with particular emphasis on current drain issues that are to be resolved through the improvement works. Also included in this report are environmental criteria and constraints that will or may impact the preferred solution(s).

2. Drain Hydrology and Hydraulics Assessment Report, establishes the current performance of the drain against selected standards.

3. Drain Report, proposed preferred solution including plan & profiles.

The three reports are planned for completion in 2018.

It is planned to have the detailed design and Final Drain Report prepared for consideration before the end of 2018 with tender and construction currently forecast for 2019.

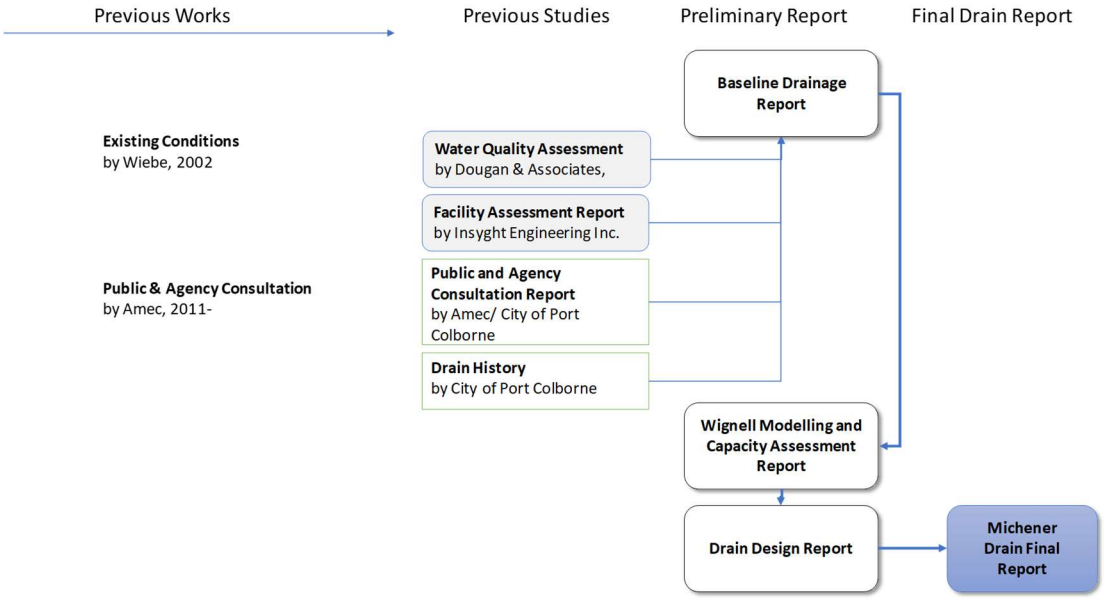


Figure 4 Drain Analysis and Report Methodology

2.1 Methodology

The baseline assessment is performed from site inspections and a technical review of the available data.

The culvert inventory and assessment are preliminary at this time. Depending on the findings, more detailed assessments may be performed.

2.1.1 Drainage Objectives:

The objective of a drain is to provide a clear unobstructed flow with depth to provide adequate private drain connection outlets. The following image exemplifies a traditional "good" drain profile and cross-section with contributary flows from a tile drain connected to the drain.

Figure 5 Example of clear drain

While the figure shows clear and unimpeded flow, the following image shows an obstructed flow.

Figure 6 Vegetation obstructed drain

This flow is obstructed by tree growth within the banks. Bull rushes provide evidence of standing water. The expected performance of the culvert based on this approach is compromised and unlikely to perform as designed or expected.

Figure 7 Dead Ash trees within drain banks

The presence of ash trees allowed to grow within the drain banks previously, which are now dead or dying from the emerald ash borer will provide a source of wood debris that may potentially block the drain and cause backwater or other degradations in performance.

Complete removal of all vegetation may not be a good objective from an environmental benefit or function. While the drain operates best if there are smooth banks and no obstructions to flow, it will continue to operate even with some obstructions to flow. From a drain recovery aspect, improving the drain function while continuing to meet an environmental benefit, the working portion of the drain, the low flow channel should have all trees removed. Approximately the ½ way point up the bank, all trees should be removed, while the upper portion of the bank can maintain a healthy tree. This is modified with a simple approach, that there exists, a working side to provide drain maintenance. In this case where the drain is running adjacent to the road allowance, trees can be accommodated along the upper bank portion provided access for future maintenance is available from the road allowance. Obviously, this does not apply once the drain leaves the road allowance.

It's not desirable from an equipment and drain maintenance view point to have trees within the working allowance created through the Engineer's report. The purpose of the allowance is to provide future maintenance of the drain using suitable equipment working from the preferred side of a drain. However, it is not environmentally sustainable or appropriate to remove all trees from the working allowance. Trees provide several benefits to the function of drains while also posing a risk to drain function depending on type of tree and placement. All trees growing within a constructed drain between the top of banks are to be avoided. Where a mature tree is already established and is an individual tree, it can be accommodated.

New trees can be planted adjacent to a drain following two key criteria:

- The trees are planted back from the top of bank, (the exact distance is determined by tree type and local conditions).

- The trees are planted with adequate space to provide future maintenance. Grouping of planted trees is encouraged given that the spacing of the trees and the arrangement permits future maintenance. This is accomplished by providing an angled approach along the tree edge line to the drain and increasing the tree plant density only as the distance from the drain increases.

From Chatham Kent website, providing advice on tree placement within drain influences.

"Individual hardwood trees may be allowed every 100 feet. Trees of any type shall not be planted within 25' of an existing tile drain (solid tile, wrap joints) or 35' from existing open drain. In certain circumstances where an owner owns property on both sides of the open drain, upon consultation with the Drainage Superintendent, a windbreak may be permitted on one side. On existing drains

where windbreaks exist, costs due to trucking material will be the direct responsibility of the owner and not the upstream ratepayers."

The presence of existing trees on an existing drain does not require a clear cut approach to improving the function of the drain. Trees can be selectively removed to achieve a drain benefit, such as the case with the lower reach of the Wignell drain at Lorraine Road or the Michener Drain north of the golf course.

Figure 8 Selective tree removal

Individual trees, as shown inFigure 8 Selective tree removal, that are currently healthy and with a good expectation for continued good health should be

preserved and protected during construction. Trees that group both side of the drain and create an obstruction to flow are to be removed, (red circle in Figure 9).

Tree Benefits to Drains

While trees can impede flow and through dead limbs or other debris cause problems with backwater effects, there is an overall recognized benefit for trees on a municipal drain. The primary benefit is through soil stabilization by tree roots, although it is not uncommon for a drain under a meander influence to erode the soil from under the tree roots, depending on the species. There are trees, such as willows, whose roots will seek out water and these trees should be avoided along closed conduit drains, as the roots will potentially clog the drain.

There is a recognized benefit from trees to provide shade or canopy to protect the drain with standing water from having a detrimental effect on fish species. While many drains are more likely to be a habitat for warmwater species, there is a real benefit from trees providing shade. As such, there is a stated preferred side for trees based on this benefit, which is the south side and/or west/east side of a north south drain.

2.1.2 Municipal Drains and Environmental Improvements

In the past, Municipal Drains have been created to convert functioning wetlands to functioning farmland. Examples of this can be seen at significant scales in Ontario; Holland Marsh area, Thedford area (former Lake Smith) and throughout Chatham Kent area.

There is an unquestionable contradiction between removing the water to promote farming and retaining the water to support native flora and fauna. The engineering and drainage community have come to appreciate that a straight line to the lake with the highest grade possible to move the most water the fastest off the fields may not be in the best interest of all ratepayers. There is an expectation that drainage can be used to ensure that farming practices are achieved to a reasonable extent on designated lands. However, drainage does not have to negatively impact existing native flora and fauna for the benefit of the community as a whole.

The distinction is made in the pursuit of water management strategies within the Drainage Act and not to just focus on moving water away from farmland for the benefit of landowners. The issue is managing the water cycle through all stages:

- Spring Freshet: snow meltwater runoff potentially with spring rain.
- Summer Convective storm: high intensity sudden but short and not widespread thundershowers.
- Large Air mass precipitation event: longer duration lower intensity but high yield precipitation event.

- Drought: time between precipitation events.

Water management practices change as our understanding of the hydrologic cycle and land management practices improve through research. The following describes past stages of water management practices:

- Pre- 1940 introduction of farming to areas that require drainage to grow crops. From introduction of the drainage act, areas previously identified as bogs, swamps or lakes are drained to provide high quality soil for farming.

- 1950s to 60s sought to move water off the land as quickly as possible, leading to erosion and quality problems as well as environmental degradation.

- 1970s and 80s introduced urban areas to stormwater management ponds which decreased peak runoff but increased erosion and geomorphological forms. Ponds also increased temperature in the resulting runoff as well as changing stream chemistry.

- 1990s to 00s implemented geomorphological assessment of streams to enhance and to mimic natural systems including profile of cold water and warm water streams through modelling of baseflow contributions to runoff and baseflow management. SWM in urban areas with a treatment train approach to water management to address both quantity and quality of runoff.

- 2010 to present features low impact development and soil conservation practices through buffer strips and low tillage practices. Low impact development practices use runoff control techniques to reduce runoff impacts through a watershed as well as controlling through end point practices such as SWM ponds.

The following figure illustrates features associated with a traditional approach to ditching or a typical view of a ditch.

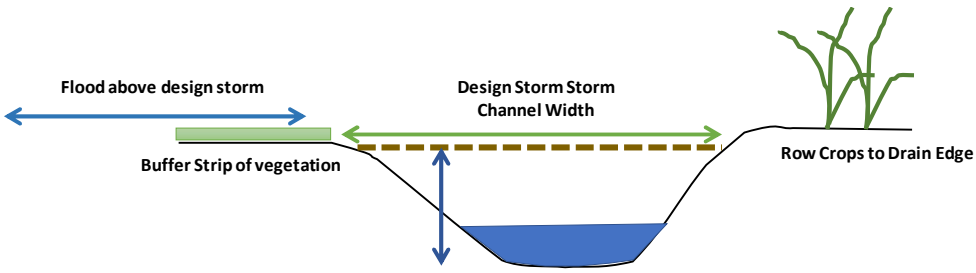


Figure 9 Cross-section ditch view

Figure 10 Trapezoidal Ditching Under Construction

The traditional ditch has the following features:

- A trapezoidal channel design with a bottom width, a depth and a top width that defines the capacity of the ditch.
- The illustration shows a farm use that occurs up to the ditch edge while the opposite bank illustrates a buffer strip of vegetation between the row crops and the ditch top of bank.
- Where the storm exceeds the ditch capacity, the flooding spills out to either side on to the ratepayer lands. The ditch requires an easement equal to the top width of the ditch, which determines the total capacity.

The following figure illustrates a naturalized channel design approach to a ditch or creek channel.

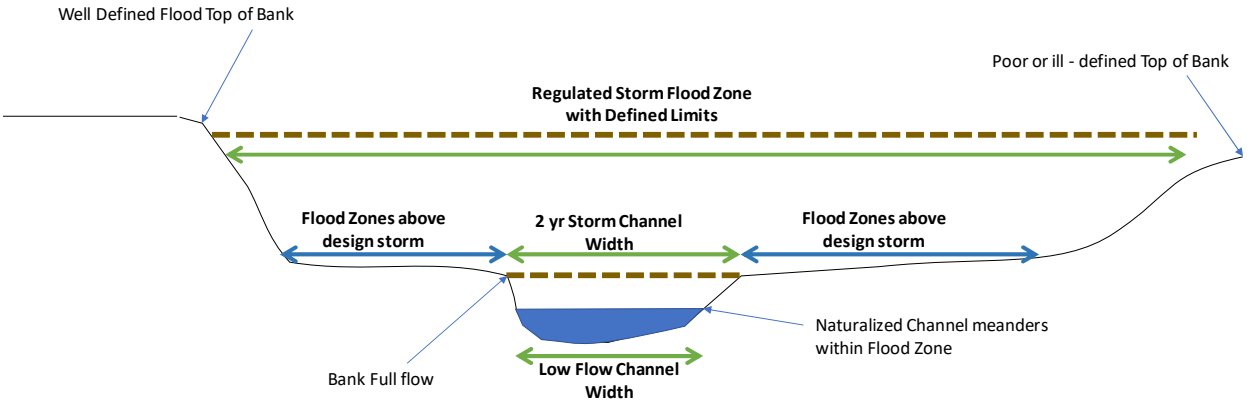


Figure 11 Naturalized Channel cross-section

Figure 12 Naturalized Channel with Pools and Riffles

A naturalized channel design has the following features:

- The natural channel has a pool and riffle design that alternates through a sinusoidal pattern defined by the size, type of watershed and geologic materials composing the watershed.
- The channel is designed to mimic a natural stream that would occur had the creek or stream occurred through geological processes.
- The area above the channel is a flood zone.
- The channel has a specific design capacity while the flood zone has a larger design capacity and the risk to flooding is defined by these capacities.
- Tree and vegetation plantings will grow into a mature canopy that provides shade at the planned locations within the flood zone.

In addition to changes in channel design practice, water management principles have incorporated the function of ponds, wetlands and other detention methods that detain or slow the amount of runoff that is contributing to a peak flow.

The following figure illustrates the modelling and design process for sizing a ditch, channel or stream. The computer model predicts a peak flow (hydrograph) based on a mathematic model of runoff from a specific land use. The ditch is sized to convey the peak flow based on design parameters but significantly influenced by the available grade, slope m/m, for the ditch, channel or stream.

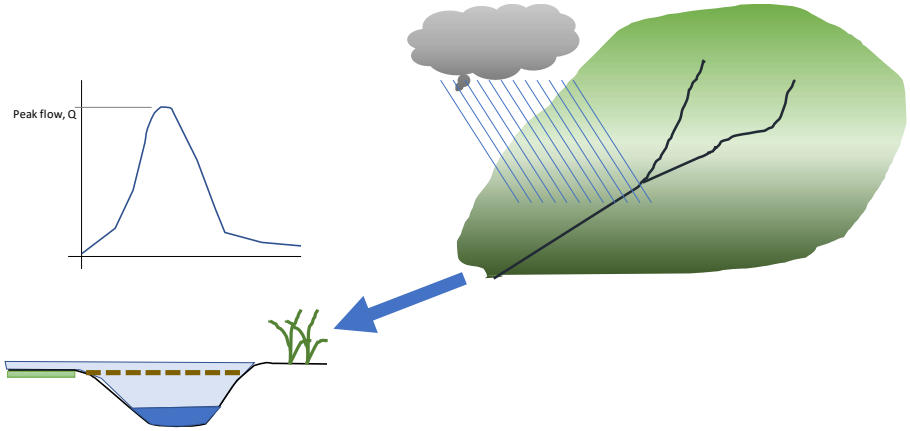


Figure 13 Watershed Typical Predicted Runoff Peak Flow

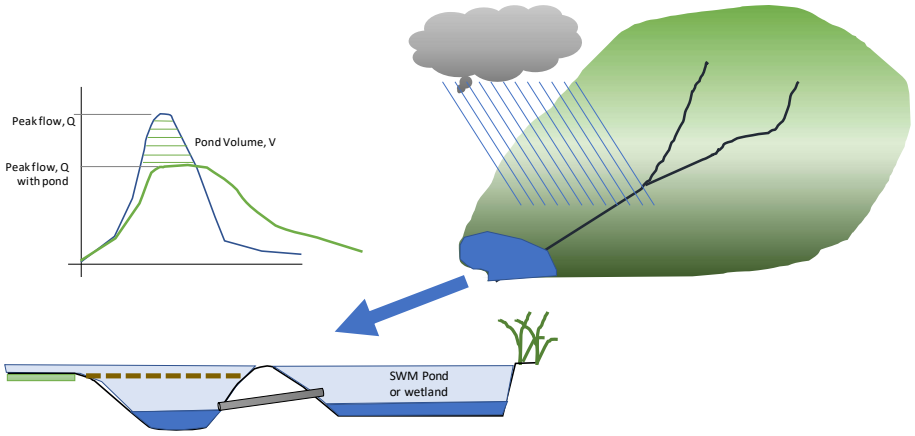


Figure 14 Watershed Typical SWM Pond Runoff Peak Flow

These changes in practice and expectation have resulted in greater analysis requirements during drainage design to assess not only the basic drain performance but it's potential negative or positive impact on the environment. Negative or positive impacts are regulated under various legislation within Canada but the primary bodies that implement the regulations are:

- Government of Canada Fisheries and Oceans (DFO), specifically approvals on culverts to assess potential negative impacts on fish habitats and species. Important to recognize that habitat impacts can be assessed whether the fish species is present in the specific portion of the stream or not.

- Government of Ontario Ministry of Natural Resources (MNR) can assess habitat impacts of proposed projects that affect terrestrial or aquatic habitats.

- Niagara Peninsula Conservation Authority, NPCA is responsible for regulated flood zones, lands within the designated areas.

- Lastly, the Government of Ontario Ministry of Agriculture, Food and Rural Affairs OMAFRA has responsible oversight under the Drainage Act of Ontario

2.2 Document Record

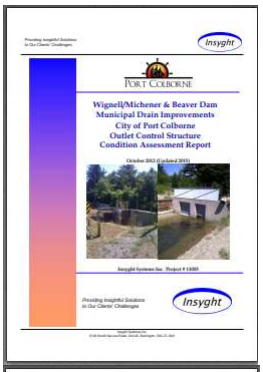
The following is a list of the documents that are relevant to the Michener Municipal Drain.

Memo to file: **Wignell / Michener Abandonments**
Henri Bennemeer, October 11, 2018

Summary of abandonment work by review of existing documents on file.

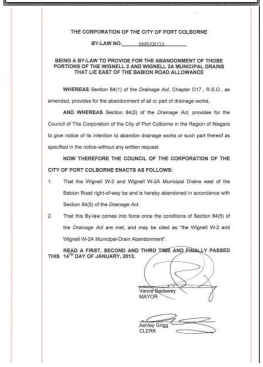
WIGNELL / MICHENER AND BEAVERDAM MUNICIPAL DRAINS WATER QUALITY ASSESSMENT CITY OF PORT COLBORNE
Prepared by: AMEC Environment & Infrastructure / Dougan & Associates Ecological Consulting & Design, February, 2014 (updated November, 2016)

WIGNELL / MICHENER MUNICIPAL DRAIN CITY OF PORT COLBORNE STRUCTURAL REPORT,
Prepared by AMEC Environment & Infrastructure, September 2014



Wignell/Michener & Beaver Dam Municipal Drain Improvements City of Port Colborne Outlet Control Structure Condition Assessment Report,
Prepared by Insyght Systems Inc., March, 2015

Ontario Structure Inspection Manual (OSIM) Bridge Inventory and Appraisal Report, 2012



THE CORPORATION OF THE CITY OF PORT COLBORNE

BY-LAW NO. 5555/02/13

BEING A BY-LAW TO PROVIDE FOR THE ABANDONMENT OF THOSE PORTIONS OF THE WIGNELL 2 AND WIGNELL 2A MUNICIPAL DRAINS THAT LIE EAST OF THE BABION ROAD ALLOWANCE

WHEREAS Section 84(1) of the *Drainage Act*, Chapter D17., R.S.O., as amended, provides for the abandonment of all or part of drainage works,

AND WHEREAS Section 84(2) of the *Drainage Act*, provides for the Council of The Corporation of the City of Port Colborne in the Region of Niagara to give notice of its intention to abandon drainage works or such part thereof as specified in the notice without any written request.

NOW THEREFORE THE COUNCIL OF THE CORPORATION OF THE CITY OF PORT COLBORNE ENACTS AS FOLLOWS:

1. That the Wignell W-2 and Wignell W-2A Municipal Drains east of the Babion Road right-of-way be and is hereby abandoned in accordance with Section 84(3) of the *Drainage Act*.
2. That this By-law comes into force once the conditions of Section 84(5) of the *Drainage Act* are met, and may be cited as "the Wignell W-2 and Wignell W-2A Municipal Drain Abandonment".

READ A FIRST, SECOND AND THIRD TIME AND FINALLY PASSED THIS 14TH DAY OF JANUARY, 2013.

Vance Badawey
MAYOR

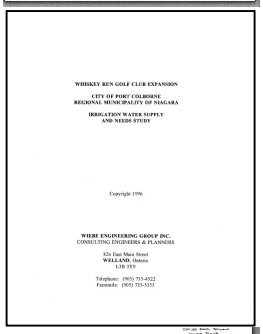
Ashley Grigg
CLERK

City of Port Colborne By-Law 3741/26/99

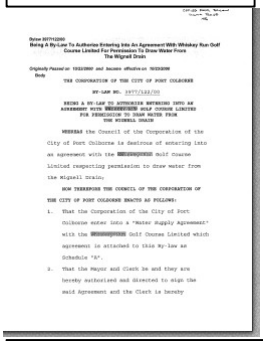
Report on the Wignell Drain Low Lift Pumping Station, City of Port Colborne,
Prepared by CJ Clarke and Associates, 1973

Report on Wignell Drain, Township of Humberstone,
Prepared by CJ Clarke and Associates, 1969

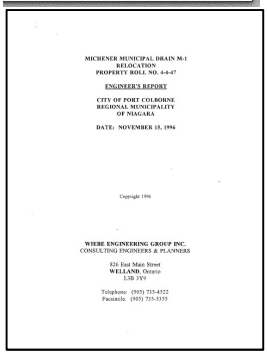
* Plan Profile drawing prepared by CJ Clarke shows a flat or 0 grade drain gradeline from RR ROW to outlet of 572.10 / 174.378m. This is higher than the observed ditch bottom at the time.



Whiskey Run Golf Club Expansion
Irrigation Water Supply and Needs Study
Prepared by Wiebe Engineering Group Inc.
1996

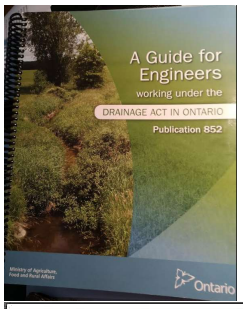


WRGC Irrigation Agreement
By-law No. 3977/122/00
October 23, 2000



Michener Municipal Drain M-1 Relocation Property Roll No. 4-4-47 Engineer's Report
Prepared by Wiebe Engineering Group Inc.
Novermber 15, 1996

Other Reference Works:



Drainage Engineers Guide
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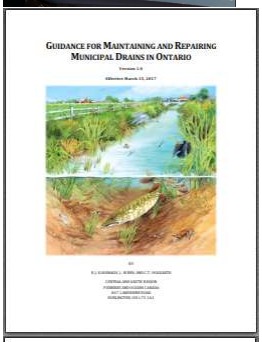
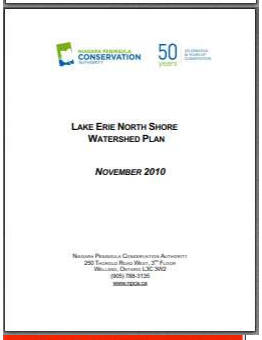
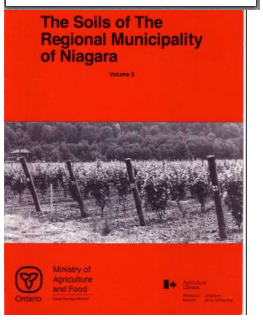


GUIDANCE FOR MAINTAINING AND REPAIRING
MUNICIPAL DRAINS IN ONTARIO
Version 1.0
Effective March 15, 2017
By R.J. KAVANAGH, L. WREN, AND C.T. HOGGARTH
CENTRAL AND ARCTIC REGION
FISHERIES AND OCEANS CANADA



LAKE ERIE NORTH SHORE WATERSHED PLAN
NOVEMBER 2010

NIAGARA PENINSULA CONSERVATION AUTHORITY



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For a complete correspondence record, please refer to Appendix A for a summary listing and reproduction of records.

3 Michener Drain

This section describes the current drain design. The Michener Drain Plan & Profile that is included in Appendix B indicates the profile described on plans from RVA in 1979 as compared to the profile indicated from the most recent survey conducted by Amec Foster Wheeler in 2013. The survey provides good detailed information on the major road crossings but does not provide channel definition survey data except in a few locations. The deficient survey is supplemented using NPCA 1m DEM data, which provides a useful reference view of the generalized slopes and shapes but is not considered accurate enough to profile ditch slope.

The drain provides service to a mix of commercial (blue shape is a golf course) and agriculture as shown in the following figure. The figure is composed from the property zoning to identify agriculture properties; however, not all of the properties zoned for agriculture are currently under cultivation.

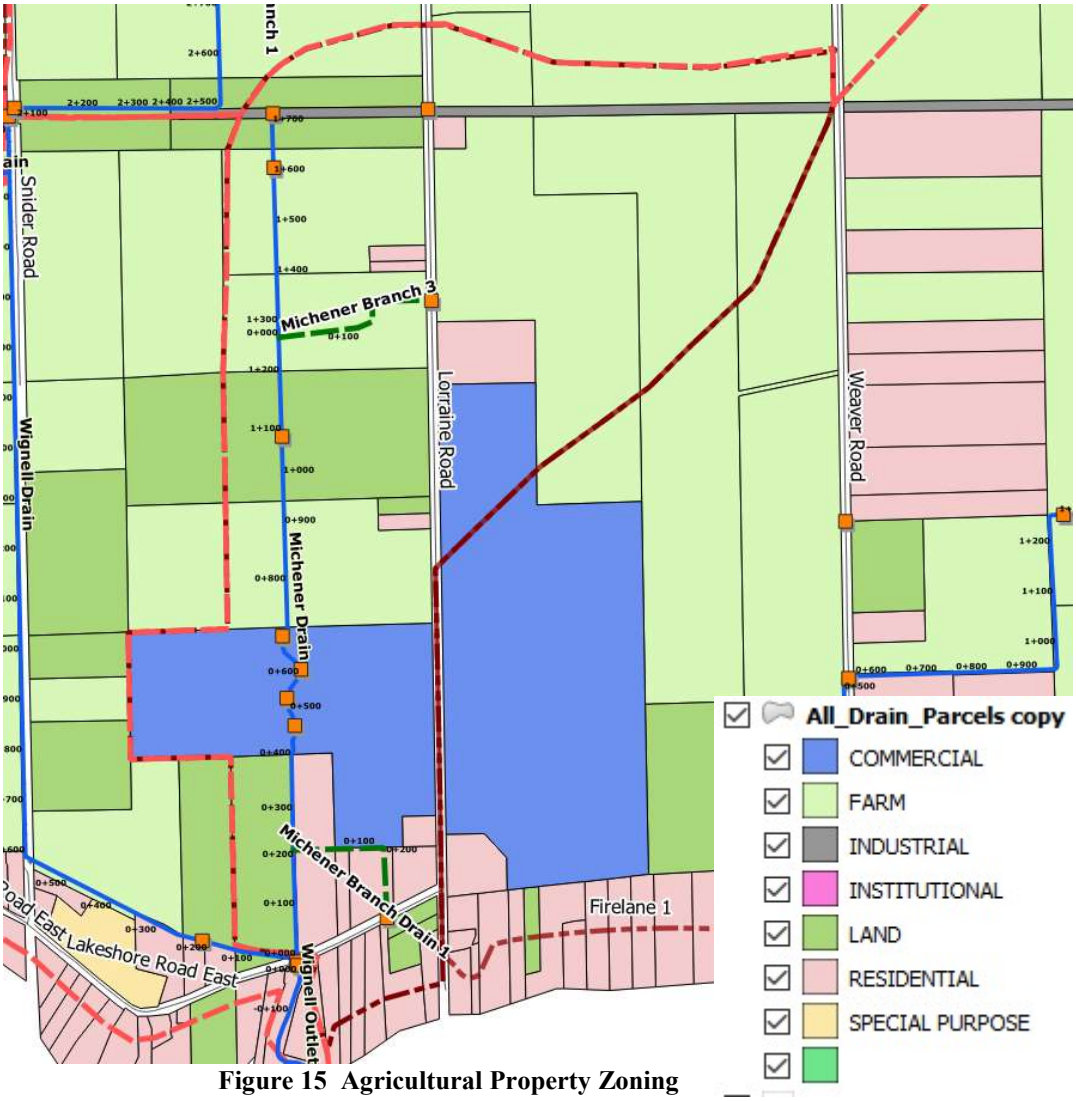


Figure 15 Agricultural Property Zoning

The proposed Drain Structure is for a main drain with branches. Branches can be one of four possible types of branches:

- Municipal Branch Drain connection; forms part of the regulated drain with schedule assessments reflecting area, connection adjacency, etc.
- ROW ditches that connect to the Drain but are not part of the regulated drain.
- Private drain connections that depend on the Municipal Drain but are not part of the Drain. Ideally, each of these will have an established and recognized connection elevation to suit the upstream grade.
- Municipal Drain Features that form part of the drain but are technically ancillary to the drain itself. Examples include:
    - Flood Gate Control structures, including flap gates,
    - Pumping stations,
    - Water Quality control features such as;
        - Stormwater Management Control Ponds,
        - Sediment Basins,
        - Drain related wetlands, and
        - Other runoff quality control measures.
    - Culverts and Bridges.

Generally, the drainage system has a well defined course throughout its length, consisting of natural open water courses, artificially made open ditches, roadside ditches, and roadway and private crossings. Typically, the channel cross-sections are well defined, trapezoidal in shape, with typically steep to almost vertical side slopes in variable depths and lengths.

The four sections defined above are all functioning.

At present the outlet condition appears satisfactory although a direct survey of the outlet grade is not present to indicate the slope of the outlet connection. Plan & Profile Drawings included in Appendix B show the connection based on the NPCA DEM data.

The following photo shows the drain looking south into Section 2 at the southern edge of the golf course.

Figure 16 Michener Drain Looking South to Section 2 STA 0+400

This section is part of the reversing flow that the golf course has established to push water into the irrigation ponds located at the Western edge of the golf

course and south of the Sediment Basin established in the previous engineer's report.

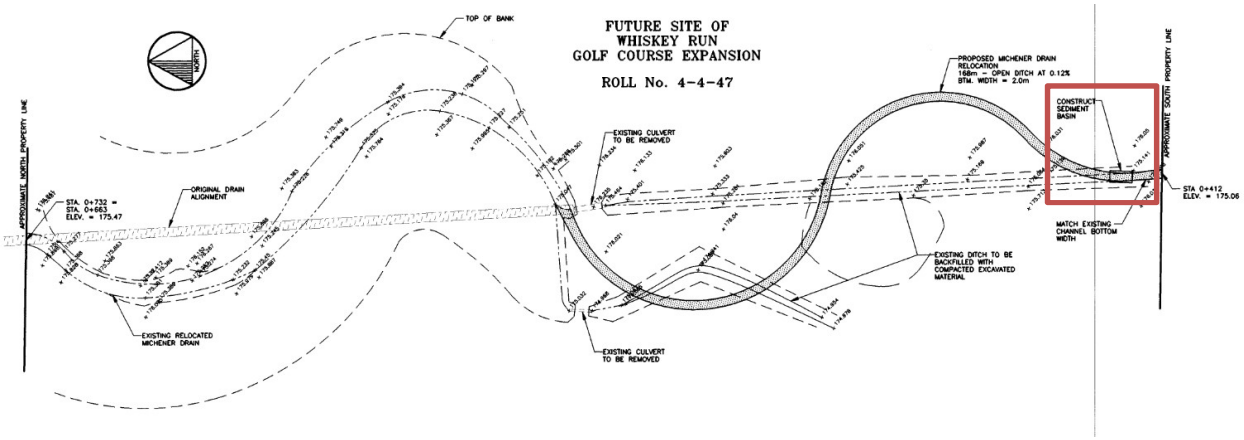


Figure 17 Michener Drain Relocation For WRGC 1996

From a site visit completed on August 16th, 2018 by Paul Marsh, Drainage Engineer, Alana Vander Veen, Acting Drainage Superintendent and Mr. Lou Nieuwland, the following observations were made.

- WRGC has brushed the drain to clear willows and phragmites, bulrushes. Brushing only occurs in a few places where visibility down the fairway is desirable but the drain is occluded at other locations. We traversed the golf course from North to south crossing each of the four bridges. (actually 3 bridges and one culvert). One of the bridges has been converted to a CSP culvert.

- WRGC has removed a previously installed pipe and replaced with an open channel to pass water from the upper level pond by gravity to the irrigation pond located along the western side of the course. This new open channel is fed from the main branch of the Michener by way of a upper pond pumped to a level to run the Michener Drain backwards. The upper level pond is connected to the drain by means of a 100mm cast iron pipe with a valve operated to pass water by gravity backwards up the drain and following the newly graded swale to the irrigation pond.

- South of the last bridge where the sediment detention facility was expected to be seen, WRGC has removed the sedimentation facility that may have previously existed as was shown in the drawing as the ditch has been excavated to an unknown grade to facilitate moving water backwards up the drain from the upper level pond. The spoil pile is haphazardly arranged along the edge of the drain and the excavation is

not to a shape that would meet expectations.

Figure 18 Michener former Sedimentation Facility

- Below the pond pipe connection to the drain, WRCG constructed a temporary (removed in the fall) blockage of the drain by a berm constructed from material removed to direct the flow upstream to the irrigation pond. It was indicated as a regular practice to block the drain and direct all runoff to the irrigation pond. With the relatively limited watershed and runoff rate, WRGC extracts water from the Wignell by pump from the lower pond and pumped to the upper pond by PPTW.

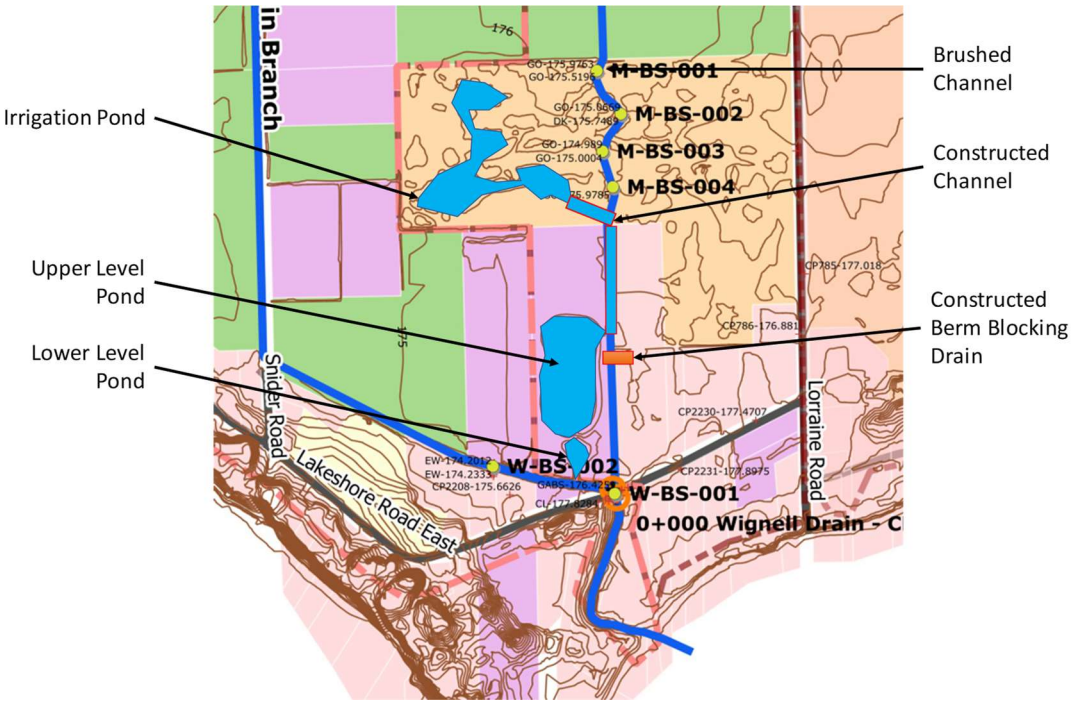


Figure 19 WRGC Water Operations on Michener Drain

The upper portion of the drain, north of the WRGC to the Friendship Trail, section 4 from STA 0+695 to 1+700, is agricultural land but has significant vegetation growth in and through the drain as shown in the following figure looking North.

The figure at right shows that there is significant growth along the drain with mature trees throughout much of the drain.

0+700 to 1+200 agricultural both sides with trees, shrubs and undergrowth in the drain.

1+200 to 1+400 mainly bush lot to the west and lower agricultural practice.

1+400 to 1+700 agricultural both sides with vegetation growth in the drain.

Figure 20 Michener Vegetation view North

As an option to the clear and restore to original cross section that is typical with a municipal drain maintenance practice, the drain can be converted to

a buried pipe with an overflow swale. This is depicted in the following figure with a before and after schematic drawing, (not detailed design).

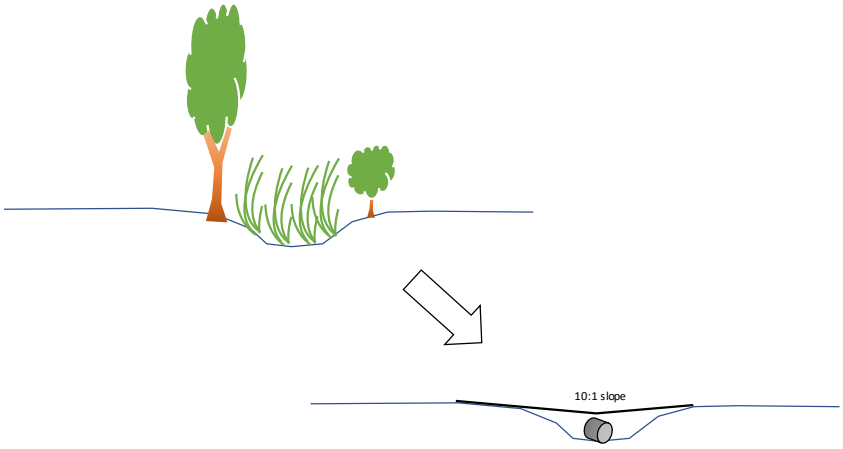


Figure 21 Drain conversion to dual flow capacity

This conversion allows the farmer to work land through the drain over top of the buried pipe and overland swale. The pipe is a common Polyethylene (PE) drainage pipe that is typically not expensive to lay but does require bedding support to ensure it does not collapse. There are additional new PE types of pipe that do not require the same bedding to support but are slightly more expensive.

This could be considered by individual land owners for implementation along the upper Michener Drain from 0+700 to 1+700 and the drain could be kept as a cleared open channel where the farmer chooses not to have the buried pipe with overland swaleoption implemented.

It would be prudent at the lower end of section 4 to implement a controlled flow and sedimentation feature to address overland flow for runoff events larger than the capacity of the buried pipe because of the potential for flow along a row crop field carrying sediment downstream.

3.1 Condition Appraisal

The following describes both the existing open channel condition through the drain but also the structures that are a key feature of the drain.

3.1.1 Condition of Outlet

The Michener drain outlets to the Wignell drain immediately north of Lakeshore Road East Bridge Crossing.

The extremely low grade and ever present static water level in the lower reach of the Wignell drain suggest that flooding in this area is likely to continue without extensive pumping and levies. The NPCA 100 year flood lines also document

the expected extent of flooding impacts in the lower section of the Wignell and Michener drain is extensive, refer to the Flood line shown in Figure 3 and included in Appendix B.

A more detailed analysis of flood impacts will be undertaken in the Wignell Watershed Hydrology and Hydraulics Report.

3.1.2 Channel Condition

The following presents the existing grades assumed to be available based on the survey performed by Amec Foster Wheeler in 2013. These are not the actual grades but results from the survey of inverts at crossings, actual grades may vary along the drain as the survey did not collect ditch grades throughout each reach.

Table 1 Drain Segment Average Grades

DnStream Elev	UpStream Elev	Fall	Dn Stn	Up Stn	Distance	Slope %
174.1723	174.838	**0.6657**	40	485.04	**445.04**	**0.150%**
174.838	174.9565	**0.1185**	485.04	**542.4**	**57.36**	**0.207%**
174.9565	175.0725	**0.116**	542.4	609.81	**67.41**	**0.172%**
175.0725	175.2558	**0.1833**	609.81	691.05	**81.24**	**0.226%**
175.2558	176	**0.7442**	691.05	1100	**408.95**	**0.182%**
176	176.3643	**0.3643**	1100	1732.6	**632.6**	**0.058%**

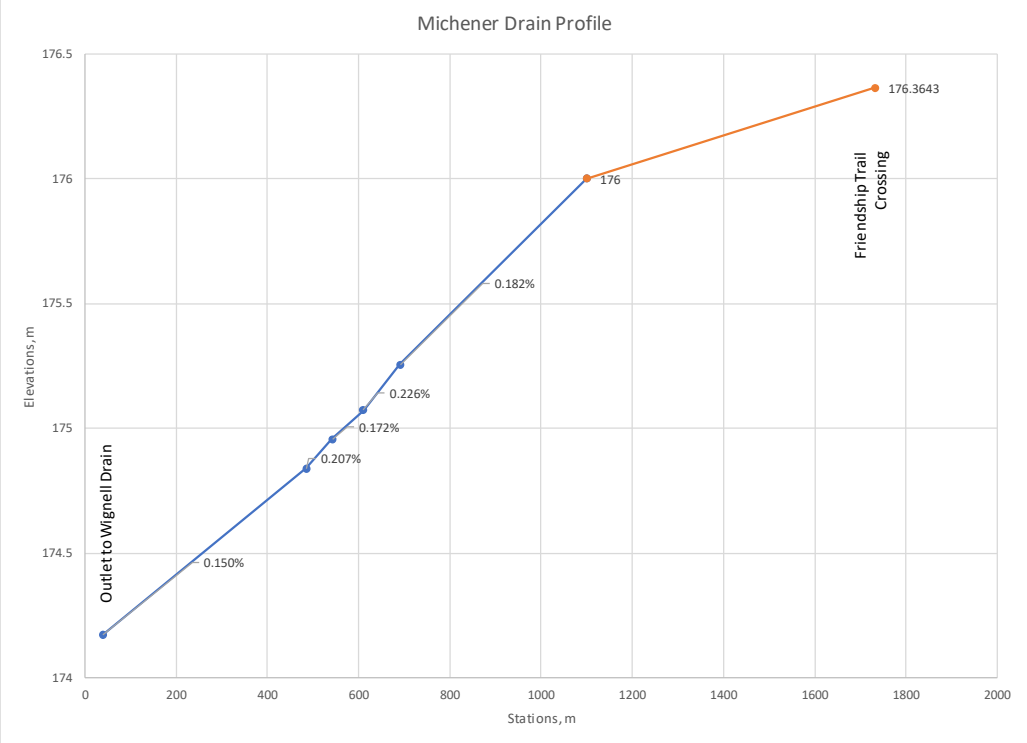


Figure 22 Michener Drain Gradeline Profile

The static water is undesirable and directly influenced by the lake level; however the Michener grade is such that the influence of the static water level is not as pronounced as it is in the Wignell with the flat grade there. The Michener grade is above the Wignell grade at the Friendship trail by station 0+250.

What's visible is the existing trees and other vegetation that occupies the drain top width. Trees within the top of bank to top of bank create obstructions to flows. Also evident is the cultivation up to the edge of the drain without the presence of a buffer zone north side upstream.

Emerald Ash Borer Impacts on Established Ash Trees

The invasive species of ash borer from Asia as decimated Ash trees in southern Ontario. There were significant and numerous opportunistic ash trees that established themselves along the Wignell Drain. These trees are now standing dead with large upper limbs in various stages of decay.

While some trees are showing evidence of re-establishing themselves from the trunk there's no single leader and they are more likely to establish a bush that will eventually be subject to another ash borer infestation.

- **It is necessary to perform a clean up of these standing dead ash trees that occur within the banks of a municipal drain along with the removal of trees that block or create the potential for flow area reductions.**

3.1.3 Wignell Drain Structures

There are 7 crossings on the main drain consisting of bridges, culverts or flow controls. The crossings are shown in the following figure and are listed in the following Table. A larger map showing crossing with labels for cross reference is included in Appendix B.

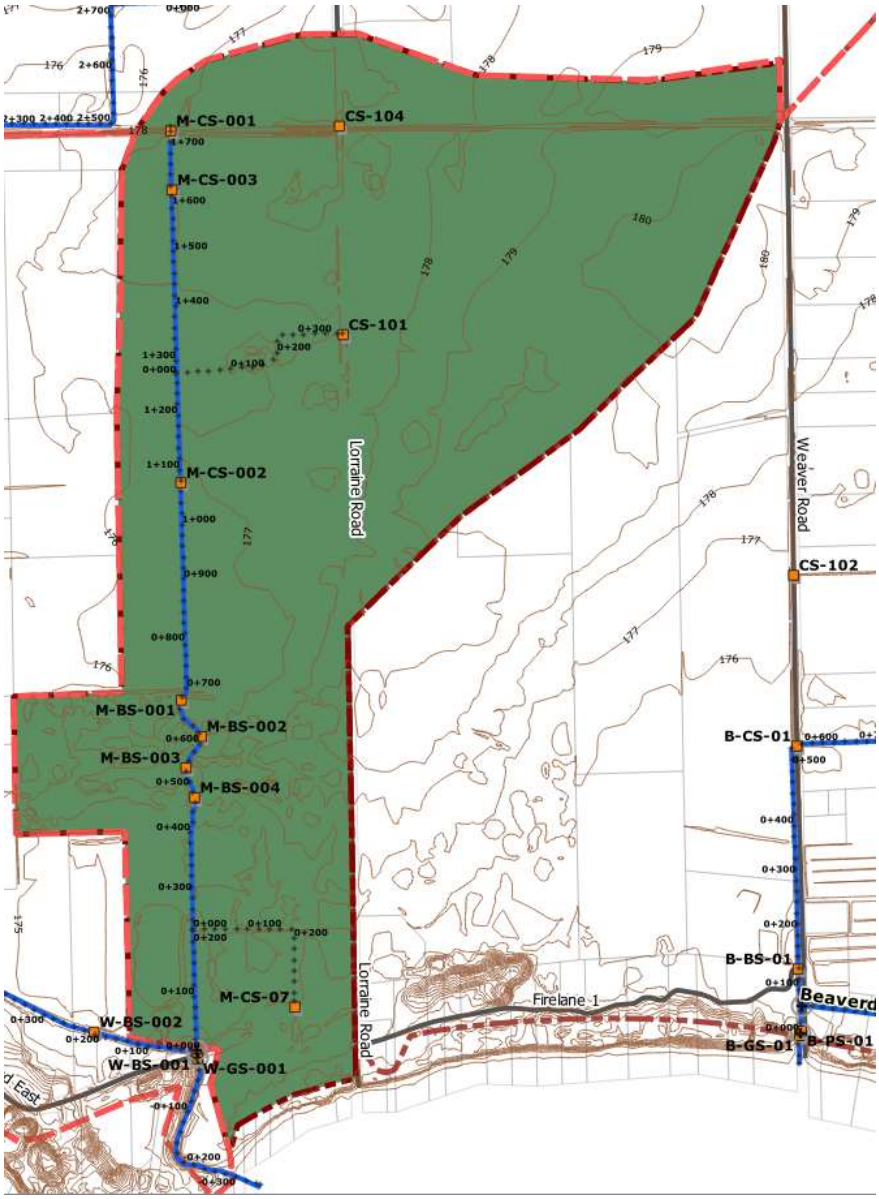


Figure 23 Bridge and Culvert Michener Drain Structures

Four of the seven structures on the Michener Main Drain are golf course crossings and not MTO rated structures consisting of wood structures at the time of the Amec Foster Wheeler survey conducted in 2013.

CS-002 and CS-003 are both farm access structures providing access to the back portion of a farmed property.

CS-001 is the former culvert under the railway that is now a culvert under the Friendship Trail.

Table 2 Michener Crossings

Drain Name	Structure ID	Stucture Name	Description	# of openings	Station	Length, m
Michener Drain	**M-BS-004**	Golf #4	Bridge	1	0+470	3
Michener Drain	**M-BS-003**	Golf #3	Bridge	1	0+527	3
Michener Drain	**M-BS-002**	Golf #2	CSP ?600	1	0+593	3
Michener Drain	**M-BS-001**	Golf #1	Bridge	1	0+672	3
Michener Drain	**M-CS-002**	Private	Concrete Box ?	1	1+073	4.8
Michener Drain	**M-CS-003**	Private	CSP 450	1	1+610	4.6
Michener Drain	**M-CS-001**	Friendship Trail	Concrete 1200	1	1+720	7.6

There are three additional crossings within the Michener catchment that are proposed to be connected to the Drain through the use of a Branch Drain connection. They are:

- M-CS-007 newly replaced culvert crossing Lakeshore Road East that has an existing drain crossing north and then west to outlet on the Michener at STA 0+215
- CS101 is an existing culvert crossing Lorraine Road with an upstream catchment on the East side of the road and an existing swale connection that outlets to the Michener Drain at STA 1+275
- From the Orthophoto a culvert on the North side of the Friendship Trail appears to already exist and would connect upstream area north the Trail to outlet along the swale to the end of the Michener Drain at the M-CS-001 culvert under the Trail STA 1+712

3.2 Overall Drain Performance

The following sections describe the existing Wignell Drain and compliance with accepted design standards and practices.

- Compliance with design objectives; the drain is providing a service to all ratepayers within the watershed on a multi-objective basis that includes both quantity and quality objectives.
- Report on design storm criteria
    - Quantity criteria are considered to be acceptable risk factors:
        - 1 in 2 year flood for channels through agricultural lands.
        - 1 in 5 year flood for channels through residential fringe lands.
        - 1 in 5 year flood of private crossings.
        - 1 in 10 year flood for Port Colborne road crossings.
        - 1 in 25 year flood of Regional Road crossings.
        - MTO crossings are required to meet MTO guidelines for highway crossings, (refer to MTO Highway Drainage Design Standards, January 2008)
    - Quality Objectives include:
        - Suspended Solids and Sediment (often referred to as Total Suspended Solids or TSS) TSS is often related to types of agricultural practices and the presence or absence of drain buffers that reduce direct runoff contributions of TSS. Mitigations through effective design and practices are recommended for implementation in the Design Report.
        - Phosphorous and Nitrogen are nutrients and part of the natural cycle. They are applied to farm land as commercial fertilizers that may runoff and cause excess growth of aquatic plants that affect watershed and receiving water as an ecosystem. Reductions at source is the best practice but practices including the use of wetlands aid in treating excess contributions of these nutrients to the watershed and receiving waters.

Figure 3 NPCA supplied Regulated Flood limits and Areas shows the forecasted regulated flood limits and a map based figure of flood lines is included in Appendix D.

3.2.1 Quantity Issues

From Figure 3 NPCA supplied Regulated Flood limits and Areas, the lower reach has significant distribution of flood limits. Reported flooding complaints or requests for improved drainage are as follows:

- Along Lakeshore Road East there have been flooding complaints lodged and this was addressed with the replacement of a new culvert crossing the road but complaints about the poor drain continue.

- In the past, there were complaints when the Wignell Drain was routed through the Michener Drain in an attempt to seek flood relief on the Wignell; however, this did not succeed and the Wignell was re-routed to the original path.

A more detailed capacity assessment of the drain will be conducted and reported on in the Wignell Watershed Hydrology and Hydraulics Report.

3.2.2 Quality Issues

The Lorraine Bay Community (a.k.a. Lorraine Bay Water Quality Group) identified concerns regarding water quality in Lorraine Bay in 2000, which resulted in that Group retaining the services of Amec Foster Wheeler, to undertake an environmental investigation into the quality of water entering the bay via the Wignell/Michener and Beaver Dam Drains. The previously completed engineering study included a Water Quality Assessment of the Wignell Drain that outlets into Lorraine Bay.

> "The investigation documented in Amec Foster Wheeler's report showed that E.coli counts exceeded Provincial Water Quality Objectives in the drains, near the drain outlets and in Lorraine Bay. Also high Total Phosphorus, Total Kjeldahl Nitrogen concentrations, and bacteria counts were identified throughout the monitoring period. It was concluded that precipitation runoff increases the bacteria in the drains and the bay, thus improvements and/or restoration measures were required in order to improve water quality in the drains and Lorraine Bay.

Completed by Dougan & Associates (Dougan) and included in Appendix C, the study entailed the assessment of existing vegetation and land uses along the Drains, researching possible ecological restoration works to improve water quality in the Drains, assess the costs of the works, and describe opportunities and constraints for water quality improvement measures for each drain based on the field work and research findings.

The report identified the following within the watershed.

> "The field survey recorded a total of 34 reaches, 20 for the Wignell/Michener Drain and 14 for the Beaver Dam Drain. The lands adjacent to the drains were divided into 8 ELC vegetation community types: Agricultural,

Anthropogenic, Coniferous Plantation, Cultural Meadow, Cultural Thicket, Cultural Woodland, Deciduous Forest, Deciduous Swamp and Meadow Marsh.

It was observed that the dominant vegetation communities are agriculture and deciduous swamp, followed by rural residential properties. The drains are directly adjacent to roads in several locations and some parts run through a golf course. The topography was identified as typically very flat except for the remnant dunes along Lake Erie, which were large and rolling.

In terms of natural heritage features, the Wignell/Michener Drain watershed area includes Port Colborne Quarry, a portion of Nickel Beach Marsh PSW, and numerous small woodlot areas, whereas the Beaver Dam Drain watershed includes Humberstone Marsh and Beaver Dam Creek Wetland Complex PSW."

The report recommended the following:

"In general, the specific restoration measures recommended by Dougan & Associates can be summarized into the following categories:

- Buffer plantings;
- Channel modifications;
- Wetland creation; and
- Using existing wetlands during high water events."

The total cost of water quality improvement works proposed for the Wignell/ Michener and Beaver Dam Drains are estimated at $5,105,250. A breakdown of the cost estimate for the restoration work on the Drains is included in Appendix 'E'.

The total cost of buffer planting works based on site preparation and planting of 10 m wide buffer strips along the channel at $100 per meter is $1,018,500. The cost of wetland creation works, including the purchase of an easement is $4,056,000 ($60 per sq.m)."

There are other land uses in the upper reaches of the Wignell, Michener and Port Colborne drain besides agriculture and rural residential lot houses that contribute to the quality of water being discharged to Lake Erie. It is known that the existing Port Colborne Quarry will expand eastward and further impact the flows to the Port Colborne and Wignell Drains. While addressing water quality objectives will be part of the Engineer's report, a Capital Expenditure budget allocation of $5.1M is excessive and much more cost effective solutions that achieve mitigation benefits will be considered.

3.3 Environmental Appraisal

The improvement of the drain should be performed while minimizing or mitigating any negative environmental effects. The existing drain has been functioning in much the same way as it is now for more than 100 years and is proposed to continue to function.

The Port Colborne area including the lands within the Wignell Drain Watershed have historically documented environmental issues. The relevant issues for the Wignell Drain are:

- Risk of contaminated soil in the area adjacent to the Vale Nickel facility.
- Water Quality in the receiving water of Lake Erie.

3.3.1 Ministry of Natural Resources

The recommendation from MNR was to conduct the three activities of:

I. Habitat Inventory

II. Potential SAR on the property

III. SAR Surveys

An inventory of existing vegetation in the riparian zone was compiled by Dougan and Associates, the full report is available upon request. A shortened version, minus the Appendices is included in Appendix C.

3.3.1.1 Species At Risk (SARs)

The following is the information provided by MNR for designated species at risk within the project area.

Table 3 Species at Risk Designation for Port Colborne Area

Species At Risk Designations	
ENDANGERED	
THREATENED	
SPECIAL CONCERN	
EXTIRPATED	
AMPHIBIANS	
Fowler's Toad (*Anaxyrus fowleri*)	Known to Occur
BIRDS	
Barn Owl (*Tyto alba*)	Suspected to Occur
Black Tern (*Childonias niger*)	Known to Occur
Bobolink (*Dolichonyx oryzivorus*)	Suspected to Occur
Cerulean Warbler (*Dendoica cerulea*)	Known to Occur
Chimney Swift (*Chaetura pelagica*)	Suspected to Occur
Common Nighthawk (*Chordeiles minor*)	Suspected to Occur
Least Bittern (*Ixobrychus exilis*)	Known to Occur
Peregrine Falcon (*Falco peregrinus*)	Known to Occur
Short-eared Owl (*Asio flammeus*)	Known to Occur
FISH	
INSECTS	
Monarch Butterfly (*Danaus plexippus*)	Known to Occur

The drainage works, as considered from past works and general construction practices are not forecast to impact bird species in any direct way. There is a clear risk of work in and around the drainage system that could impact amphibians and reptiles and for this we will specify mitigating measures to be implemented during construction.

Those mitigation measures may include:

- Pre-construction survey to confirm that no species at risk are present and/or put at risk through construction. The pre-construction survey will be conducted within a specific time window relative the construction work being undertaken.

- Intervention during construction will occur if a reptile or amphibian is found within the construction site. A qualified person will assess the animal and determine if it is or is not a species at risk and a local re-location effort will occur.

3.3.2 Federal Species at Risk (SAR)

The SAR from the Federal web site listing for Ontario location is provided in Appendix C. Not all species will be likely to occur in the Port Colborne area, and not in the specific habitats of the Wignell, Port Colborne, Michener and

Beaverdam Drains. The contractor will be directed to this information with a requirement to ensure that no species at risk is adversely affected.

3.3.3 Fisheries

The long history of the drains confirms that the works being considered are unlikely to cause a change in environment that is distinctly different from what is currently in existence. Fish have been seen and documented within the Wignell Drain as far north as the Second Concession.

From the DFO website, the following figure does not list any of the drains; Wignell, Beavercreek, Port Colborne or Michener as having Fisheries species at risk. The map does show inventoried streams to the West and East of Port Colborne.

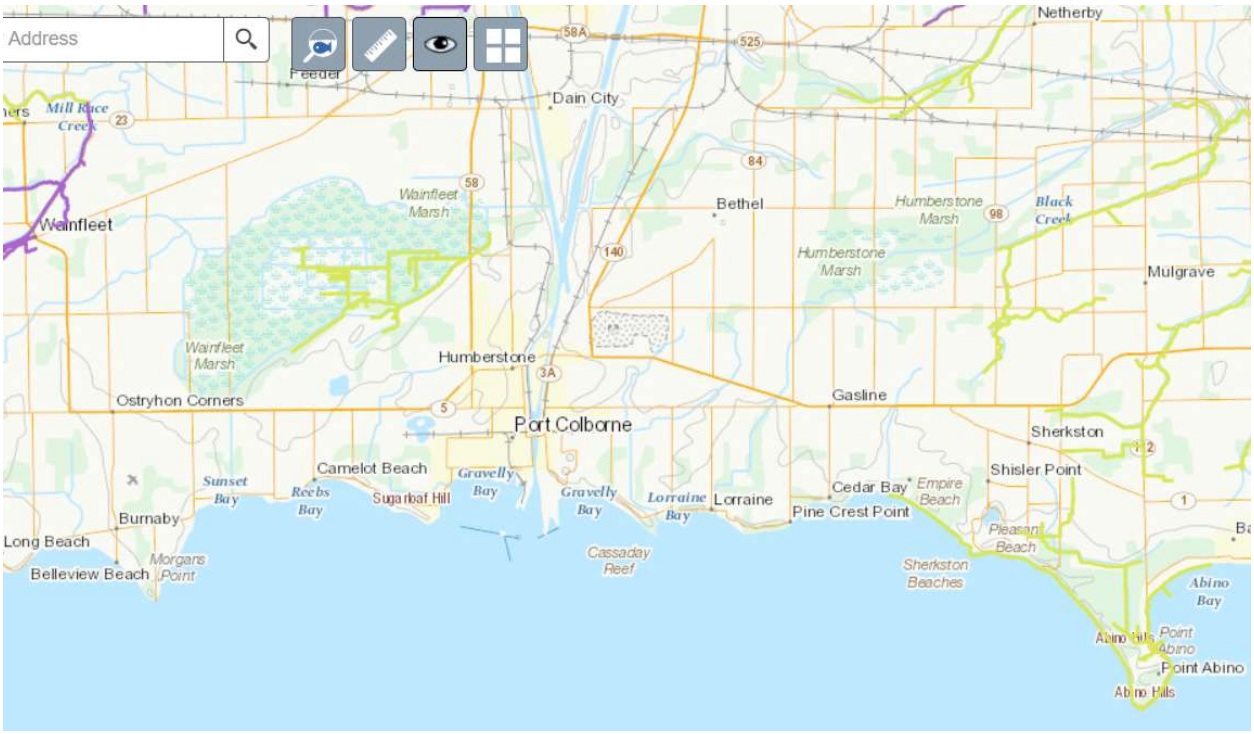


Figure 24 DFO Fisheries at Risk inventory

From this figure, there's no expectation of special measures or requirements to be addressed either by design or during construction for the protection of special significant species. However, suitable construction practices to protect fish in the drains will be implemented. This will focus on downstream sediment impacts as a result of construction to control sediment loading during excavation.

For the proposed works to be undertaken, DFO approval is expected to be required for alteration of waterways.

3.3.4 Migratory Birds Convention Act

The Migratory Birds Convention Act, 1994 (MBCA) provides protection to migratory birds, their eggs and nests. The Act is Federal and administered by Environment Canada and Climate Change Canada (ECCC).

From their website the following identifies two primary consideration for the drain improvement works considered for Wignell.

- General Nesting period mid-March to late August (with regional variations.)
- Exceptions include:
    - Species that may nest earlier, such as Great Blue Heron and American Woodcock in March, or those which may nest later such as Cedar Waxwing, Bohemian Waxwing, Pine Siskin, American Goldfinch, Common Murre and Great Blue Heron until the end of September, or Leach's Storm-Petrel, Fork-tailed Storm-Petrel and Northern Gannet in October;

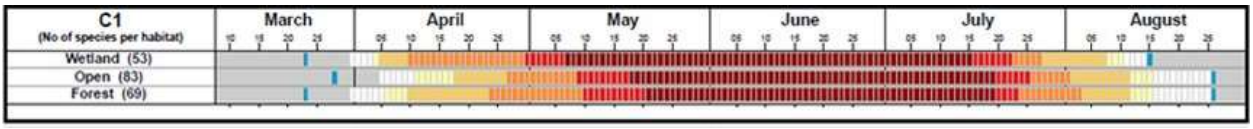


Figure 25 Nesting Period for C1 applicable to Port Colborne

The proposed work of reducing the dead ash within the drain could have a nesting impact if conducted within the general nesting period. Work to remove trees will be schedule outside of the general nesting period and effort to ensure exceptions to the general nesting are not impacted will be made by a qualified person.

Topside vegetation removal; trunk, limbs, branches will occur prior to the general nesting period and preferably during frozen ground conditions. Some vegetation removal could be scheduled after the nesting period for the following construction year; however, preceding construction is preferred. Full removal of the stump will be scheduled with excavations associated with the drainage works.

Warning

The technical information contained in the "General nesting periods of migratory birds in Canada" published on this web site is general information that constitutes advice only. All persons must adhere to all pertinent laws (for example provincial or territorial laws), regulations and permit requirements including but not restricted to the Migratory Birds Convention Act, 1994 (MBCA) and the Migratory Birds Regulations (MBR). It is important to note that some species of birds protected under the MBCA have also been listed in Schedule 1 of the Species at Risk Act (SARA). These species receive protection from both the MBCA and SARA. This information does not provide an authorization for harming or killing migratory birds or for the disturbance, destruction or taking of nests or eggs as prohibited under the MBR. This information does not provide a guarantee that the activities will avoid contravening the MBR or other laws and regulations. This is general information not intended to be relied on as official advice concerning the legal consequences of any specific activity. It is not a substitute for the MBCA, the MBR, or any other legislation.

It is the responsibility of individuals and companies to assess their risk with regards to migratory birds and design relevant avoidance and mitigation measures (see the Specific consideration related to determining the presence of nests and the Guide for Developing Beneficial Management Practices for Migratory Bird Conservation). Since the "General nesting periods of migratory birds in Canada" applies to large geographical areas, it is possible that local nesting periods could have a different starting date and/or duration than published dates due to micro-climatic conditions in specific areas (e.g. high elevation sites or coastal sites) as well as inter-annual variation due to factors such as early spring or cold, wet summer. The technical information published on this web site will be updated as new data become available, which could result in the changing of dates and/or limits of the nesting zones.

Please contact Environment and Climate Change Canada's Wildlife Service office in your region for further technical information.

Ontario Region
Canadian Wildlife Service
Environment and Climate Change Canada
4905 Dufferin Street
Toronto ON
M3H 5T4

3.3.5 Ministry of Environment, Conservation and Parks

Works carried out under the Drainage Act are exempt from seeking an Environmental Compliance Approval (ECA formerly CofA) issued by the MOECP.

Under the Ontario Water Resources Act, 1990 consideration to Water Taking Permits will be reviewed during the design period. Note that there already exist PPTW approvals within the Wignell Watershed for two commercial applicants. Also the discharge of deleterious substances including excess sediment will be given consideration in the design and specifications for construction execution practices to minimize and/or mitigate construction impacts downstream.

Permits to Take Water

The following figure is from the MOE website providing map based review of approved Permits.

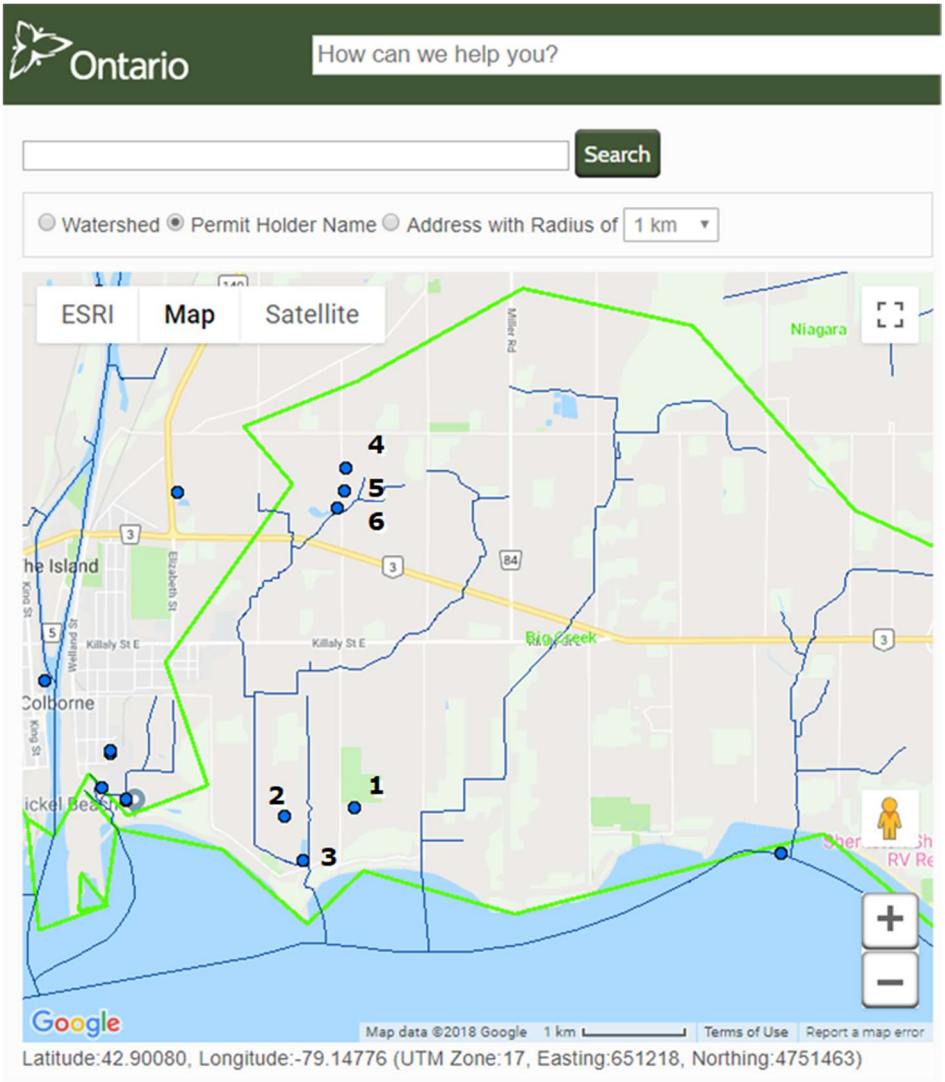


Figure 26 Permits to Take Water

The following are the approved limits for water taking on a per day basis as reported on the MOE Website.

1. Whiskey Run Golf Club Ltd. For Water Supply 22,000 Lpd
2. Whiskey Run Golf Club Ltd. For Commercial Golf Course Irrigation 819,000 Lpd
3. Whiskey Run Golf Club Ltd. For Commercial Other 131,000 Lpd
4. Port Colborne Quarries Inc. For Dewatering 2,052,000 Lpd

5. Port Colborne Quarries Inc. For Dewatering 8,208,000 Lpd

6. Port Colborne Quarries Inc. For Dewatering 8,640,000 Lpd

Observations on PPTW:

- The dewatering of the quarries contributes to flows within the Wignell Watershed through a contribution during pumping operations. This alters the base flow of the Port Colborne / Wignell as pumping typically occurs when a precipitation event is not occurring. Quarry captured water occurs for the quarry area and some upstream areas, which is pumped out at different times based on different operations West or East of Babion Road. Stored water that is pumped is original water that would have flowed into the drain.

- Irrigation for the golf course is consuming water from the Wignell Drain and converting it to evaporation (ponds) or evapotranspiration (grass) and/or possibly returning some through groundwater baseflow although the predominate clay based soil is limiting. Pumping occurs at all times during summer to holding ponds from which water is drawn for irrigation of the golf course lands.

There's no specific monitoring of actual water consumed.

Under the Nutrient Management Act, 2002 a farmer seeking to construct a permanent storage facility is required to identify all drainage tile and piped drains within 15m of perimeter of the permanent nutrient storage facility.

A review of nutrient management within the Watershed and the potential role that the drain may play will be considered in the Hydrologic and Hydraulic Watershed Study.

Regarding the Clean Water Act, 2006 information relevant to the drains is provided by the MOECC's Source Protection Information Atlas. The default view of the area is shown in the following figure.

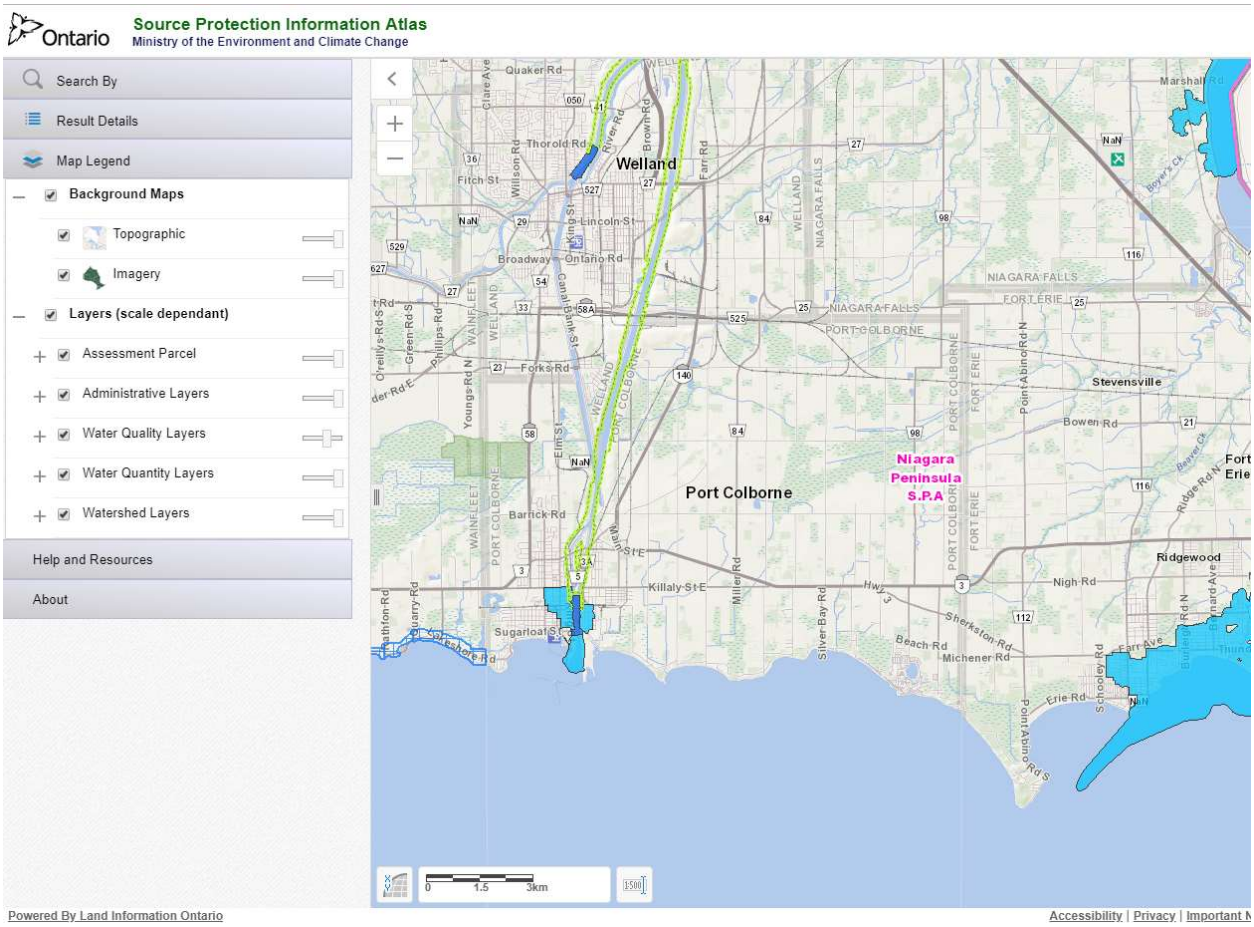


Figure 27 MOECC Source Protection Atlas - default view

The predominate features are the water intakes operated by the RMON.

The following figure shows the Watershed layers to the quaternary level.

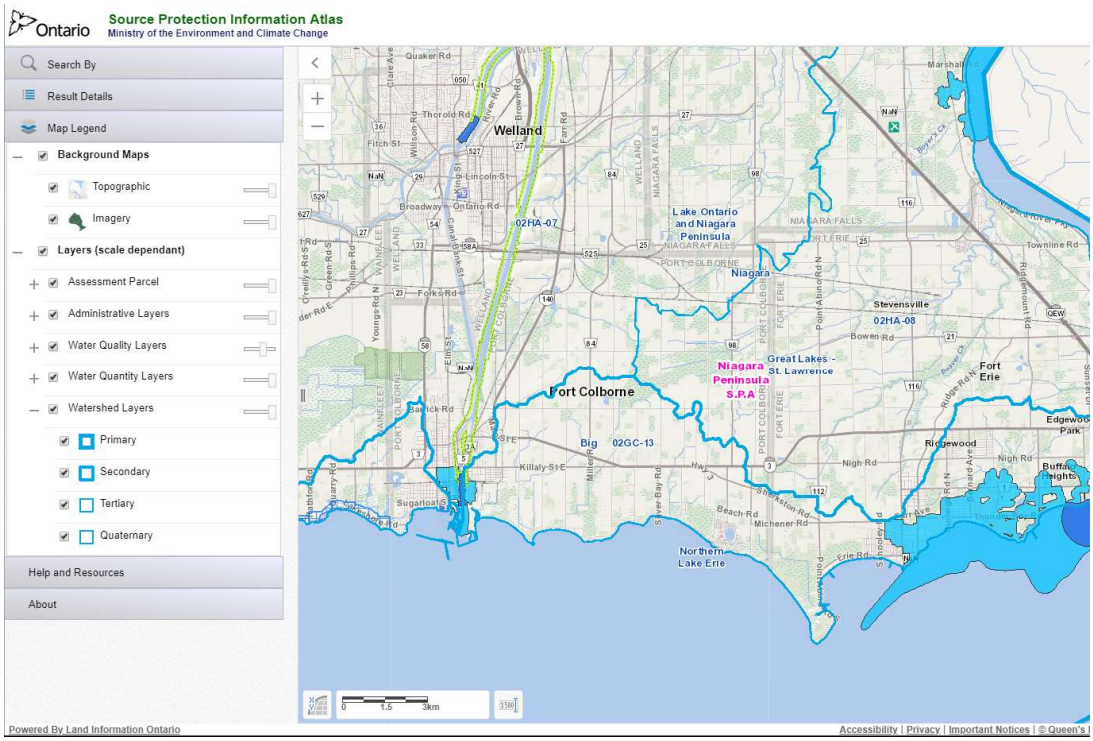


Figure 28 MOECC Source Protection Atlas - Watersheds

The following figure shows highly vulnerable aquifers.

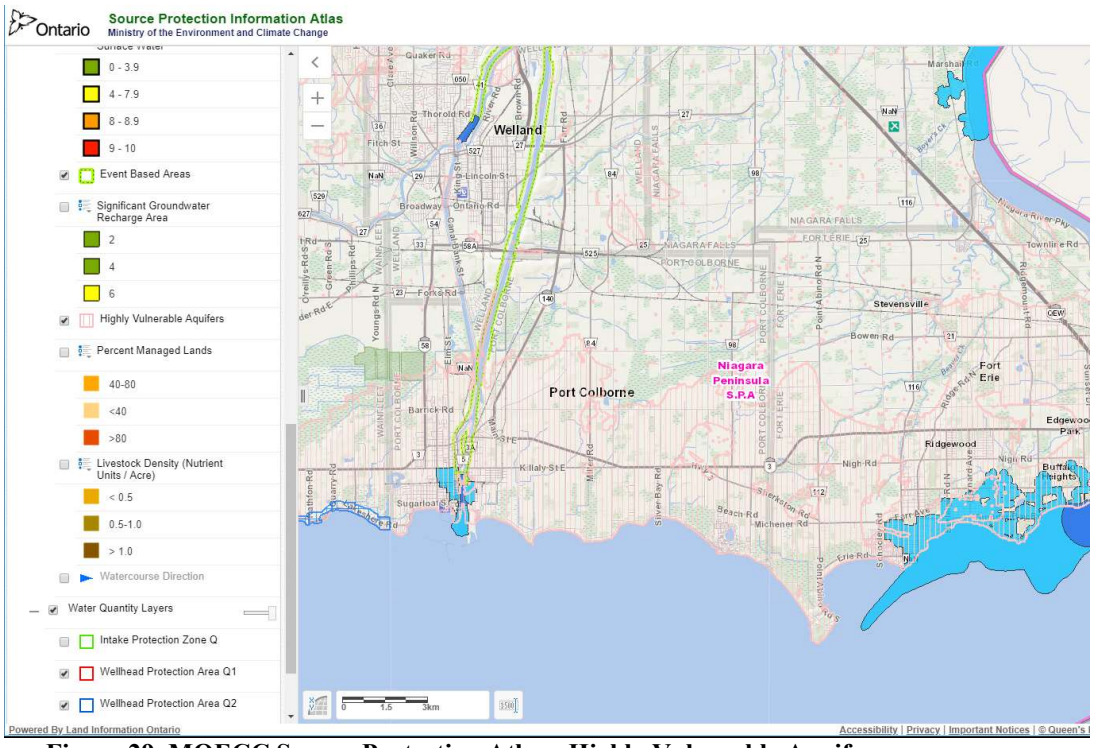


Figure 29 MOECC Source Protection Atlas - Highly Vulnerable Aquifers

The following figure shows the livestock density (Nutrient Units/ Acre)

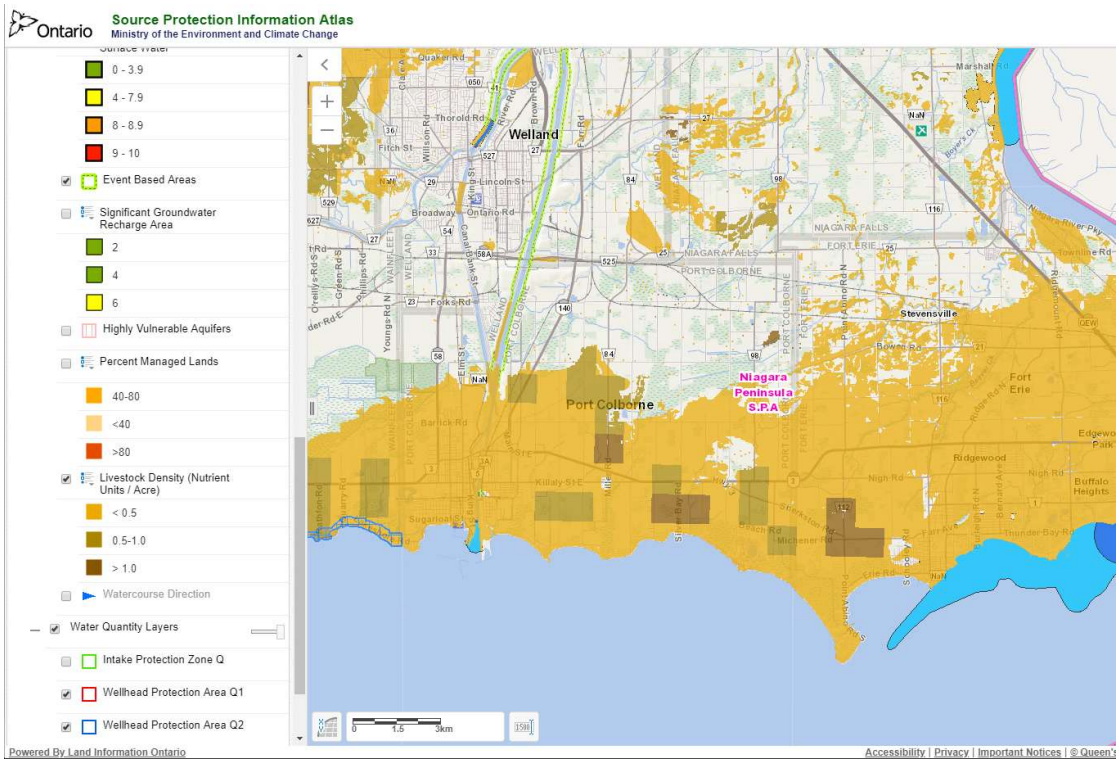
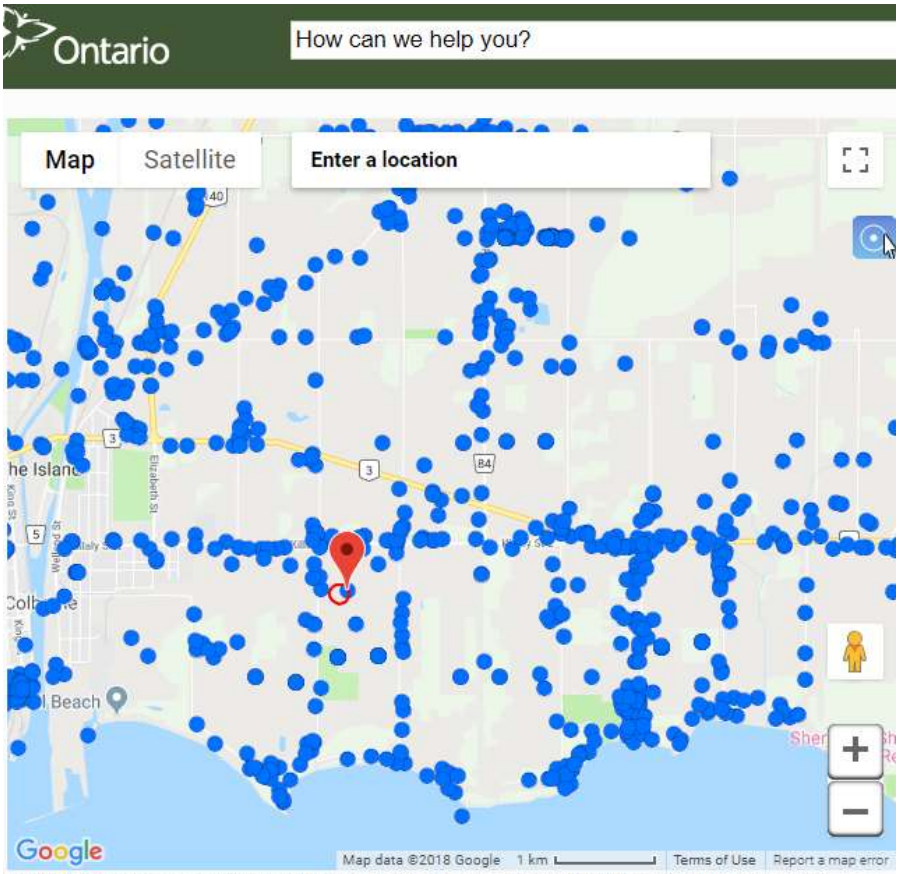


Figure 30 MOECC Source Protection Atlas - Livestock Density

From this information and from previously expressed issues around conveyance of nutrients to Lorraine Bay by the municipal drains, there is a potential concern that should be considered during the design period of the drain improvement. The drain can be engineered to reduce or mitigate the potential negative influences that can occur within the watershed through a variety of hydrologic and hydraulic techniques; however, the best technique is to address at the source.

There are new regulations around the use of excess soil and at risk considerations for use of soils that may be contaminated. Review of the requirements and incorporation of measures into specifications for implementation by the contractor will be addressed in the Engineer's report.

The following figure shows the placement of water well records within the area of drains.



Latitude:42.87811, Longitude:-79.15212 (UTM Zone:17, Easting:650917, Northing:4748935)

Show 100 entries Search:

Well ID	Well Record Information	Well Tag # (since 2003)	Audit #	Contractor Lic#	Well Depth (m)	Date of Completion (MM/DD/YYYY)
6604018	PDF|HTML	N/A	108562	4795	9.8	08/13/1991

Figure 31 Water Well Records

A more detailed analysis of water well records will be conducted during the Hydrologic and Hydraulic analysis; however, the presence of the overlying limestone series Onondaga, that is above a rock series that is very low permeability along with the parent soil material of predominately clay suggests that interactions with local municipal drains are unlikely to be a consideration for negative groundwater effects.

3.3.6 Conservation Authority

Niagara Peninsula Conservation Authority provides control through regulated authority on a variety of environmental areas including the following;

- Wetlands; designated or not.
- Watercourses; including shorelines of the Great Lakes and inland lakes.
- Regulated areas adjacent to wetlands and watercourses.
- Hazardous lands, and
- Other areas that could interfere with the hydrologic function of the wetland.

3.3.7 Cultural Heritage Resources

The drains already exist and cultural heritage impacts may have already been affected by past construction activities. Where a drain is to be moved on to a new path, then a pre-construction investigation will be conducted prior to the start of construction.

During construction in the event that specific artifacts are uncovered by excavation or other works, then a qualified person will be contacted, attend the site and make a determination of the potential significance along with recommending specific measures to continue construction.

3.4 Stakeholders

All ratepayers within the watershed are stakeholders. Additional interests as potential stakeholders as discussed in the following sections.

3.4.1 Navigable Waters

Under the revised legislation, Navigation Protection Act, 1985 (2012 amendments).

The Wignell drain is not listed and specific approval for the works is not considered required with the exception of the outlets to the Lake Erie. Works in and around the Wignell outlet may require application for approval under the Minor Works Order. As regular mechanical maintenance is required to keep the outlet free flowing a standing Minor Work Order should already be in place and a review of this requirement will be referenced under the maintenance section of the Engineer's Report.

3.4.2 Ministry of Transportation

Where drainage works are within an MTO right of way, then an Encroachment permit will be sought.

All work conducted in and around rights of way is to follow the MTO's Book 7 Ontario Traffic Manual – Temporary Conditions to ensure the safety of right of way users during construction.

3.4.3 Potential Utility Conflicts

Utility companies operating in the area were contacted by Amec Foster Wheeler and provided with two maps showing the extent of the works likely to occur with Wignell, Port Colborne and Michener Drains and with the Beaverdam Drain. They responded with Markup plans indicating where potential conflicts may exist. This information will be carried forward and shown on the design drawings. It will be the contractor's responsibility to obtain locates of existing buried infrastructure and to ensure that all required measures to ensure existing infrastructure is protected and not disturbed or disrupted during construction.

3.5 Drainage Needs

Maintenance Activities Performed Under an Existing Engineer's Report may include:

- Brushing of banks
- Bottom cleanout of sediment
- Culvert repairs
- Erosion control
- Catch basin repairs
- Tile flushing

Construction Activities Requiring an Engineer's Report may include:

- Construction of new tile drains
- Construction of new culverts
- Realignment of open ditches
- Wetland restoration projects

- Excavation and brushing of open ditches

For the Michener Drain, the predominate need is to have the drain cross-section area re-established in the upper portion of the drain, above 0+700. There is an opportunity to have a buried pipe municipal drain to allow farming through the single property.

The opportunity to add water quality control features as part of the drain should be investigated and assessed where ever the opportunity is identified. Where such features may require future maintenance, such as sedimentation basins, the Engineer's report is to be explicit on frequency and trigger points for maintenance activities.

A detailed investigation and assessment of the need to re-establish the pumping capacity at the Wignell Control Structure, W-GS-001 should be examined in the Hydrologic and Hydraulic Capacity Assessment Report. Based on preliminary evidence, the removal of the pumps has not indicated an adverse condition at present.

4 Interim Drainage Works

The following works were undertaken.

4.1 Removal of the Sedimentation Basin at 0+400

From the site visit conducted on August 16, 2018 to assess the current function of the sedimentation basin, it was clear that the sedimentation basin shown in the Engineer's report has been removed by the WRGC.

Additional works by the WRGC to facilitate their use of water taking has been engaged but are not recognized in the Engineer's report. The WRGC has retained an engineering company to update their water taking permit submission to the MOE for approval.

5 Michener Drain Baseline Summary

The Michener Drain continues to function and provide service to the residents and businesses within the watershed; however, these services are currently compromised or performing below desired service levels. The following specific sections of the Michener Drain are below service and are to be improved.

1. From the RVA Engineer's Report prepared in 1978 the Plan & Profiles drawings have the original design grade line, see drawings in appendix B.

2. The lower reach of the drain, within 100m of the outlet, appears to be in a satisfactory condition without the need for specific works.

3. The reach of the drain affected by the WRGC requires a review of water taking procedures and a specific design that provides drainage and accommodates the WRGC need for irrigation. Include options for consideration could include the following:

    a. A flow control structure south of the outlet of the upper pond to allow the WRGC to re-direct pumped flow into the irrigation ponds.

    b. A sedimentation basin to replace the basin removed.

    c. Restoration of the drain profile from the works conducted by the WRGC.

4. The upper portion of the drain that crosses farm properties could be converted to a buried drain pipe with an overland swale above that would allow a row crop to be worked through the drain could be implemented if the farm owner supported the cost of the conversion.
   The upper portion does require maintenance to clean, clear and re-establish a drain cross-section suitable for the required flow capacity.

5. Branch Drain #2 providing a drain outlet across the already installed CSP on Lorraine Road should be implemented in the Engineer's Michener Drain Report.

6. Consideration of a Branch Drain along the North side of the Friendship Trail to provide a drain outlet for the existing culvert crossing Loraine Road should be considered or recognized as a roadside ROW ditch that has an outlet in the Michener Drain at the culvert under the Friendship Trail. An option for a Branch Drain on the South side of the Trail could also be considered.

7. Branch Drain #1 providing a drain outlet across the newly install CSP on Lakeshore Road East should be implemented in the Engineer's Michener Drain Report.

8. Hydrology and Hydraulic Analysis to update the original NPCA flood study is recommended but updating the NPCA work is not required for the drain report. The Hydrology and Hydraulic Analysis to be included in the Drainage report will demonstrate the effectiveness of the improvements or suggest additional works.

9. It is recommended the Baseline Report including the Preliminary Plan & Profile drawings be circulated for comment by the relevant authorities;

    a. DFO, Drain Class A – C, E authorization for maintenance and repair

    b. MNR, Species At Risk review

    c. NPCA, Habitat assessment and stream quality improvement recommendations, section 28 of CAA. Regulated Areas review.

Appendix A:
Drain History & Consultation Record

1.1.1 Wignell/Michener Drain

The earliest record of the Michener Drain dates back to 1855 in a Judge's notation in the April 26, 1896 judgment in Fredericka Sprock vs. Geo. Ross' Report/Award. A more formal reference under a predecessor act to the Drainage Act dates back to 1875, which was a petition by property owners within area Lots 21 to 26 Con 1 Humberstone, for the deepening of the Wignell Drain.

In the late 1880s to 1900, a few requisitions, petitions and reports were made under the Ditches & Watercourse Act to construct ditches affecting several Con 1 and 2 Humberstone lots. The documentation refers to the constructed ditches as the Port Colborne Drain and Michener Drain. Several reports for the improvement and maintenance works on the Wignell and Michener Drains followed.

The Geo. Ross report dated April 29, 1911 on the Wignell, Michener and Port Colborne Drains calls for enlargement of the Wignell Drain from Lake Erie to GTR, deepening and cleaning the Michener Drain and extending it to the north end of Con 2. The upper portion of the Michener Drain was redirected by a branch; the Port Colborne Drain was extended to Con 3 and re-named as the Wignell Drain. The remainder of the Port Colborne Drain was abandoned. The Wignell and Michener Drains, formerly improved by the Drainage and Watercourse Act, were incorporated under the Municipal Drainage Act.

Starting in 1957 with Casmir Rawski, Cornelius Braakman & J.C. Groetelaars, several petitions were made to construct a flood gate at Lakeshore Bridge on the Wignell/Michener Drain due to the problems associated with flooding of agricultural lands south of CNR. It was concluded that the existing drain be widened from the CNR south to Lake Erie, and flood control gates be installed on the south side of the existing bridge at Lakeshore Road. The next By-Law, No. 255/73, includes the report on the Wignell Drain low lift pumping station, prepared by C. J. Clarke and Associates, dated February 23rd, 1973. This Report recommended the installation of a 9,000 USGPM pump and appurtenances to the south of the Lakeshore Road control gates. A schedule for those works was included in the report, assessing the cost to five properties, owned by three landowners.

In 1978 according to the Engineer's Report by R.V. Anderson and Associates Limited (By-Law, No.773/89/78), the drain was subdivided into five parts, M-1 and M-2 of the Michener Drain and W-1, W-2 and W-2A of the Wignell Drain, as the present condition of the Wignell/Michener Drain. The report recommended performing repairs to the pump at the outlet of the drain, brushing throughout the drains and removal of silt.

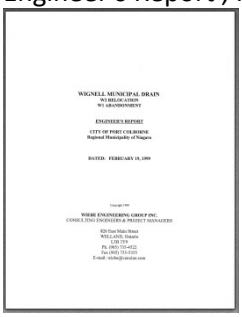
Wiebe Engineering Group Inc. prepared an Irrigation and Water Supply Needs Study for the Whiskey Run Golf Club in September 1996 stating that there was sufficient water in the drain to be taken for its irrigation purposes. Another report written in 1996 outlined works for minor relocation to the portion of the Michener Drain M-1 that ran through the Whiskey Run Golf Club.

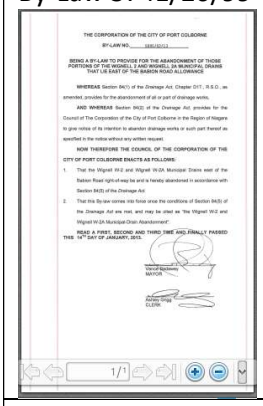
The Engineer's Report dated February 1999, prepared by Wiebe Engineering Group Inc., recommended the relocation of a portion of the W2 Branch located between Highway # 3 and Babion Road, in order to accommodate the final quarry configuration and rehabilitation plan. The

northern portion of Wignell Drain W-1 was to be abandoned as portions of it no longer existed, due to expansion of the Port Colborne Quarry.

The water quality issues of Lorraine Bay were perhaps first brought forward at the time of the Michener Relocation Report in 1997 regarding the Whisky Run Golf Course and then again, or heighted through actions initiated in 2000 by the Lorraine Bay Community (a.k.a. Lorraine Bay Water Quality Group). Further, concerns were brought before the Council of the City of Port Colborne on January 8, 2011, noting that the drains may be responsible for the observed near shore degradation of the water quality in the bay. To that end and more recently, the City of Port Colborne has retained the engineering services of AMEC Environment & Infrastructure to prepare an Engineer's Report, in order to address landowner complaints regarding rural drainage problems, as well as to provide a formal request to improve the water quality of the drains.

The following is a record of correspondence received during the previous design period for the Wignell, Port Colborne, Michener and Beaverdam Drain projects.

Subject / Sender / Date	Notes:
Memo to file: Wignell / Michener Abandonments Henri Bennemeer October 11, 2018	Summary of abandonment work by review of existing documents on file.
Letter from Rankin Construction regarding water influent to quarry. Jan.11, 1999 	"Natural drainage is to the East" request for re-dress.
Wignell Michener Drain Section 65 Report Preapred by: K.Smart Associates Jan. 11, 1999 	"The City of Port Colborne has requested K. Smart Associates Ltd to prepare a report under Section 65(4) of the Drainage Act to address the disconnection of the northeast part of Lot 19, Concession 2 from the Wignell Drain W2 and under Section 65(3) to address the subsequent connection of the northeast part of Lot 19, Concession 2 to the Michener Drain M2 at Carl Road."
Wignell Municipal Drain W2 Relocation W1 Abandonment Engineer's Report , Feb. 19, 1999 	Engineer's report to Council to abandon W1 drain, formerly proceeding north to Second Concession but captured by Port Colborne Quarry works. Report also details relocation of W2.

By-Law 3741/26/99  THE CORPORATION OF THE CITY OF PORT COLBORNE BY-LAW NO. 5381/2013 BEING A BY-LAW TO PROVIDE FOR THE ABANDONMENT OF THOSE PORTIONS OF THE WIGNELL 2 AND WIGNELL 2A MUNICIPAL DRAINS THAT LIE EAST OF THE BARON ROAD ALLOWANCE WHEREAS Section 84(1) of the Drainage Act, Chapter D17, R.S.O., as amended, provides for the abandonment of all or part of drainage works; AND WHEREAS Section 84(2) of the Drainage Act provides for the Council of The Corporation of the City of Port Colborne in the Region of Niagara to give notice of its intention to abandon drainage works or such part thereof as specified in the notice without any written request; NOW THEREFORE THE COUNCIL OF THE CORPORATION OF THE CITY OF PORT COLBORNE ENACTS AS FOLLOWS: 1. That the Wignell W-2 and Wignell W-2A Municipal Drains east of the Baron Road right-of-way be and is hereby abandoned in accordance with Section 84(5) of the Drainage Act 2. That this By-law comes into force once the conditions of Section 84(5) of the Drainage Act are met, and may be cited as "the Wignell W-2 and Wignell W-2A Municipal Drain Abandonment" READ A FIRST, SECOND AND THIRD TIME AND FINALLY PASSED THIS 14TH DAY OF JANUARY, 2013. Harold Wells MAYOR Andrew Wright CLERK	City of Port Colborne Bylaw to abandon W1 And relocate W2.
Ontario Drainage Tribunal Decision December 20, 1999  Ontario Drainage Tribunal La Commission de drainage de l'Ontario 10 December 1999 The City of Port Colborne 66 Charlotte Street Port Colborne, ON L3K 3C8 Attention: Ms. Janet Beckett, Clerk Treasurer Dear Ms. Beckett: Re: Wignell, W2 Municipal Drain Attached is a signed copy of the Drainage Tribunal's decision with regard to the Wignell W2 Municipal Drain Please forward copies to your distribution list. Thank you for your assistance before, during and after the hearing. Yours sincerely, Jean Johnson General Manager/Secretary	There were six points in the Tribunals findings: 1. Engineer directed to amend the report and drawings. 2. Revise the drawing to show original and proposed clearly. 3. Actions by clerk. 4. Clerk to provide notification of the change. 5. Report as amended for repair and maintenance. 6. All parties responsible for their own costs.
Drainage Tribunal Decision with respect to the appeal by Bill Walker heard on April 3, 1997 From: Andrew Wright To: Mrs Pat Premi, Deputy Clerk April 11, 1997	• Appeal by Mr. Walker is dismissed. • Engineer's report to be amended to indicate entire channel on Property Roll No. 4-4-47 is to be incorporated as part of the drain. • The cost of the engineer preparation and attendance paid for by Mr. Walker. Not to exceed $3,000. **Point of Information** regarding the Tribunal Hearing and findings, Pollution prohibition removed from Drainage Act Written by Dianne Saxe on March 28, 2011. Posted in Environmental laws - "Ontario has revoked the old pollution prohibition in s. 83 of the Drainage Act, saying it had become redundant: o 'The ministry believes there are more effective tools to communicate the responsibility to protect water resources to those in the industry

	than a section in a statue that is infrequently read by the public. The ministry currently employs many of these, including the award-winning Best Management Practice booklets and Environmental Farm Plan, a number of fact-sheets and presentations to stakeholders. o Further, the local municipality assigns their responsibility for the management of municipal drains to their drainage superintendents. All drainage superintendents must attend a five day course prior to being authorized to serve as a drainage superintendent. Through this course, they are educated about their environmental obligations when performing their work. Drainage superintendents are fully aware that when they encounter polluting connections into municipal drains, they must report to the local office of the Ministry of the Environment. o Striking section 83 from the act does not change the legislative fact that drainage works constructed under the Drainage Act are subject to other legislation such as the Conservation Authorities Act, the Ontario Water Resources Act and the Fisheries Act.' " Relevant documents: - "zoning by-law amendment and fulfill MOE requirements, WRGC had Wiebe Engineering Group Inc. carry out the "Irrigation Water Supply and Needs Study". This study focuses on the Wignell Drain as the supply, by way of an agreement with the City of Port Colborne" H. Bennemeer email Jan 22, 2014

	WRGC Expansion Irrigation Supply Needs Study, Wiebe Engineering Group Inc. 1996 WRGC Irrigation Agreement, circa 2000 Michener Municipal Drain M1 Relocation Report 1996, Wiebe Engineering Group Inc. November 15, 1996
Letter: Beaverdam Municipal Drain Peter Prophet – 1671 Firelane 2, Port Colborne August 29, 2011	Concerns expressed for water quality wrt processing facility. "What I object to is that a poultry processing plant is allowed to discharge large amounts of water upstream and flow through the watershed and eventually discharged into Lorraine Bay at Weaver road. This is water used in the slaughtering and processing of approximately 50,000 chickens daily. This results in brown murky water at the beach and in the bay for extended periods of time in the spring and fall when they discharge the water."
Water quality info Correspondence from LBWQG November 5, 2011	- Water quality data (testing results) - History of The Lorraine Bay Water Quality Group (LBWQG) to 2010 - Niagara Water Quality Protection Strategy, - references to key points
Lake Erie North Shore Watershed Plan NPCA August 24, 2011	
Niagara Peninsula Conservation Authority, Species at Risk Map NPCA January 2012	- Species at Risk mapping - Lake Erie North Shore Watershed Plan - Floodplain Mapping No specific correspondence records identified. Follow up correspondence: Brian Lee blee@npca.ca via niagarapeninsulaca.onmicrosoft.com July 5, 2018 Hi Paul Here is a link to the section of our FTP Site that contain our DEM data: Here you will find the following folders of interest:

	"DTM2010_3kmtiles_dwg": This contains all the .dwg files along with some PDF files that show the tile layout of the data. "DTM2010_gdb" This folder and subfolders contain the DTM information (contours included) in a geodatabase format. This geodatabase is fairly large (so give it time to download). Give this a go to see if QGIS can read geodatabases. Cheers, Brian Brian Lee, B.E.S GIS Analyst Tel (905) 788-3135 | extension 226 **Seek updated info.**
Subject: Wignell/Michener and Beaverdam Drains – proposal for drain maintenance Katherine Yagi SAR Biologist, MNR Niagara Area August 4, 2011 Included list of SAR possible presence in area.	From Guelph District Office, to Lisa Vespi Amec [not dated] but recorded as August 4, 2011 o "Our records indicate the presence of Common Hop Tree and Fowler's Toad within the area of the proposed work." o "Please note that because the province has not been surveyed comprehensively for the presence of species at risk, the absence in the NHIC database of an EO in a particular geographic area does not indicate the absence of the species in that area. Consequently, the presence of an EO is useful to flag the presence of the species in the area, but is not an appropriate tool to determine whether a species is absent from the area, or whether it should be surveyed for or not in a particular area. It is the responsibility of the person engaging in the activity (the proponent) to remain in compliance with the Endangered Species Act, 2007." o "I. Habitat Inventory The District recommends undertaking a comprehensive botanical inventory of the entire area that may be subject to direct and indirect impacts from the proposed activity." o "II. Potential SAR on the property The list of species at risk known to occur in the City of Port Colborne is attached." o "III. SAR surveys

	The District is of the opinion that each species at risk identified under Step II should be surveyed for, regardless of whether or not the species has been previously recorded in the area." Contact if presence of SAR is detected. New contact is: **Elizabeth Reimer** A/Management Biologist Ministry of Natural Resources and Forestry Guelph District - Vineland Field Office P.O. Box 5000, 4890 Victoria Ave. N. Vineland, ON L0R 2E0 Tel: (905) 562-0041
Great Lakes guardian community fund grant application and guide Not dated.	Documentation recorded - Grant application information received. No other correspondence of record.
October 30 CofPC notes Port Colborne Drain Re-alignment documentation	3 map figures
Branch Drain Email exchange June 23, 2015	With respect to my earlier email regarding the overview of the petition process required for the aforementioned drains, please note this will also include potential branch drains from discussions with parties to the award drains mentioned in the terms of reference, ie Port Colborne & Geo. A. Schooley Award Drains in the Wignell/Michener watershed and the Kinsley,Chas. Sherk & David Michener Award Drains in the Beaver Dam watershed. Regards! Henri Bennemeer Drainage Superintendent Various maps documenting potential branch drain arrangements.
2014-01-16 Port Colborne_James Craig Agreement Drain	Documentation on the drain in a variety of files. GPS survey with low accuracy.
2014-01-21 Port Colborne _Wignell Drain_Erosion Protection Works Email dated January 21, 2014	On or about September 15, 2006 an erosion protection works was commissioned as an emergency works by Wiebe Engineering Group Inc. under the Drainage Act, to address concerns raised by several property owners (MacNeil 828

	Lakeshore, Smith 503 Snider and St. Joseph's Cemetery). This work was estimated at the time of tender at $145,000.00. A tender from Rankin Construction Inc. indicates a cost of $148,690.00 excluding G.S.T. to carry out these works by their forces. The work was carried out during the winter of 2007 at a total actual cost of $241,254.46. The Drainage Act requires the Minister's approval before any emergency work can be carried out on a municipal drain (Section 124) prior to the Engineer's (Wiebe) Report being finalized. The Minister's approval was not sought/given for this work. As such, the cost of this work, which can not be billed out as maintenance under the old report/by-law, must be incorporated in the new (AMEC) report, in order for the City to recover this cost. Appended to this email is pertinent documentation, from which a determination can be made to incorporate these works under the new report. Please note the design changes to the concrete block wall asindicated in one of these documents. A copy of the plan has not yet been located but should be in the Wiebe repository of information which you have on CD. The original design drawings are also located in this repository and are noted as PP-2 & XTN-2 dated April 6, 2006. If you are not able to locate these drawings or need further information please contact me.
2014-01-21 Port Colborne_Ramey Drain	For reference Here is the information on the James Craig Agreement Drains. I have not yet been able to walk/chart the more northerly route, as indicated in my earlier email below. Regards! Henri Bennemeer Drainage Superintendent
Beaverdam Drain Water Quality Enhancement Project City of Port Colborne July 27, 2009	A Feasibility Study for the Beaverdam Drain Wetland Restoration Project was prepared by the MNR and issued in October of 2008. The study determined that a wetland restoration project was not suitable/applicable for this location. The study along with a summary document did

	however recommend a Watershed Buffer Restoration Project, which is another MNR program. The goal of this program is to improve downstream water quality primarily by the implementation of upstream buffer restoration and/or through the installation of sediment basins. Report No. 2008-76 was presented to Council on November 10, 2008 authorizing staff to prepare a Request For Proposal (RFP) to hire an Engineer to design sediment traps on the Beaverdam Municipal Drain. A draft RFP was prepared shortly after Council approval which the writer attempted to finalize. Upon review a number of issues surfaced as well as the concerns of the Lorraine Bay Water Quality Group regarding timelines.
Wiebe Meeting documentation Wignell Michener Site meeting September 19, 2003 Wignell Michener PIC meeting July 15, 2002 Wignell Michener PIC meeting October 20, 2003 Wignell Michener PIC meeting October 20, 2004 Email to AMEC dated November 17, 2014	We have on file a CD of Wiebe's records pertaining to this project, which were acquired through legal channels. I can't recall if AMEC has been provided with this information as it may have been considered sensitive at the time. I'm quite sure that I have reviewed all of the text/correspondence records contained in this CD and had made hard copies at the time, for our file. I may need to check this over again as some of the meeting minutes were (if they exist(ed)) were not on file. Regards! Henri Bennemeer Drainage Superintendent
2015-03-27 Insyght_revised report	Outlet Control Structures; Wignell and Beaverdam Condition Assessment Report updated 2015
2015-06-12 Port Colborne Culvert Assessment Report	OSIM report for 2012
RFP Addendum #1 January 12, 2011 Henri Bennemeer Drainage Superintendent	electronic topographic survey file of the Wignell/Michener Drain by Suda & Maleszyk Inc. has been included

	With respect to branch drains, for clarification the investigation will include the incorporation of one or both former railway ditches along the Friendship Trail, as well as the Port Colborne Branch (Reuter Drain) which is located at or near the Friendship Trail, as referenced in Appendix 'A' , a singular distance of 2100 m (Weaver Rd. to Reuter Rd.). Petitions will be initiated by the City at the time of the onsite meeting. There is also one existing award drain, the Geo. A Schooley Award Drain, at Hwy # 3 & Michener Drain M2 that could be a potential branch drain dependent on interest. With respect to branch drains, for clarification the investigation will include the incorporation of one or both former railway ditches along the Friendship Trail, a singular distance of 1600m, the improvement of an existing drainage ditch (James Craig Agreement Drain) that serves as an outlet for the Sherk Road ditches, an approximate distance of 1200 m and the extension of the East Branch Drain from Con Rd. 2 to Brookfield Rd., a distance of Petitions will be initiated by the City and presented at the time of the onsite meeting. There are also three existing award drains, the Kinsley Award (at the market gardening operation) and the Chas. Sherk and David Michener Awards (at Gasline) that could be potential branch drains dependent on interest.

Memo

From: Henri Bennemeer
To: Port Colborne Drainage File
Date: October 11, 2018
Subject: Wignell/Michener Abandonments

The following is a description of the drain abandonments that have taken place on the Wignell, Michener, Port Colborne Drainage areas.

Wiebe Engineering Group Inc. prepared a report dated February 19, 1999 (see attached) to abandon that portion of the Wignell 1 Drain (R. V. Anderson 1978) north of the north limit of Highway # 3, and to realign a portion of the Wignell 2 Drain (R. V. Anderson 1978) between Highway # 3 and Babion Road.

The following information was reviewed for consideration:

- A profile drawing dated March 14, 1914 by Geo. Ross titled "Profile For Improvement Of The Wignell Ditch" shows W1 as defined in the R. V. Anderson report of 1978, extended much further north, to the south end of the Second Concession Road crossing structure.
- A subsequent plan in a report by J. R. Scott dated July 30, 1927 calls for the "Wignell Drain Main Branch" (W1) to be repaired to Sta 165+00, noted as end on the plan, however the plan shows that this drain continues to the south end of the Second Concession Road crossing structure.
- A plan accompanying the report of R. Blake Erwin, dated September 8, 1949, indicates or states that the drain ends at Sta. 166+00, close to that of the repair end of the 1927 report.

Using a common reference point to the 1927, 1949 & 1978 reports, which is the confluence of the W1 & W2 drains, the 1999 Wiebe report references the extent of the drain depicted in the R. V. Anderson report of 1978. **By-Law 3740/26/99, which is the corresponding By-Law for this abandonment, appears to be in order**, as it indicates that the Wiebe report, although not identified as a schedule to the By-Law.

Several properties with the 005 prefix in Lots 21 & 22 had their outlet via the original extent of the W1 Drain circa 1914, 1927 & 1949. Sometime after 1949 the course of the drain was intercepted by quarry expansion and these flows were received onto the quarry floor and pumped to a discharge into W2 at the downstream end of the Babion Road crossing structure, at the time of the abandonment. There appears to be a former diversion channel on quarry property just south of Second Concession Road, which had its discharge via a culvert into the west Babion roadside ditch. The diversion had no status under the Drainage Act R.S.O. 1990.

Although the Wiebe Engineering Group Inc. engineer's report, titled **Wignell Municipal Drain W2 Relocation & W1 Abandonment, dated February 19, 1999, which was adopted by By-Law 3741/26/99** (see attached) indicates that a total station survey of the existing channel and adjacent quarry lands was undertaken, the plan view of the report lacked detail relevant to the Drain. The subsequent Section 51(1) request to the Tribunal to incorporate design changes to the location of the drain, due to the proximity of the existing stockpile of overburden material. The request entailed changing the location specified in the engineer's report to that of relocating the channel closer or at the property line and then having a 6m working corridor between the channel and the existing overburden stockpile. The original design entailed creating a berm along the property line, a 6m working corridor (as stated in the report), the channel, a 6m working corridor and then the existing

overburden stockpile, all within the quarry lands. The corresponding Tribunal decision of December 15, 1999 (see attached) ordered that these changes be incorporated through revisions to plan, profile and cross-section shown on drawing No. 1 dated February 19, 1999 by replacement with drawing No. 1 revision No. 3 dated November 19, 1999. This drawing has been located, which is attached to the By-Law, in the Clerk's file (see attached). Based on Drawing No. 1, revision No. 3 dated November 19, 1999, the design course of the drain has been constructed as specified.

Although the tribunal decision infers that the supplanted portion of this drain is to be abandoned, the Wiebe report does not speak to this. Furthermore By-Law 3741/26/99 makes no mention of any abandonments derived from this report.

This lack of specificity could be interpreted by someone that the abandonments are still outstanding. However, from the material referenced, the drain previously referred to as W2 has been re-aligned and not necessarily abandoned. As such, future Drain Report should address this as a re-alignment rather than abandonment.

There is also one culvert structure that was incorporated into the design during construction, due to encountering a sand lens. There is documentation in the file.

The City, circa 2009 through their roadside ditching program constructed roadside ditching. Sometime earlier, Port Colborne Quarries requested that the City discontinue/reroute the flows from the former upper W1 watershed from the existing crossing under Second Concession Road, which still discharged into the quarry. It is understood that MOE had concerns over the quality of the water entering and exiting the quarry as a result of salt from the City's winter maintenance program. To facilitate this request, the roadside ditch along north side of Second Concession Road and the west side of Babion Road were regraded to divert these flows to the W2 Drain at the Babion Road crossing. During and after the construction of this diversion, the City encountered a number design/performance issues that led to the reconstruction of the Port Colborne Quarry's pump discharge channel, along the west boundary of the quarry, east of the Babion Road allowance. This work took place through negotiations with quarry personal sometime shortly after the ADWQT wetland project, 2016/2017.

Roadside ditching is to be recognized as a stormwater feature that relies on the Drain for an outlet and should be shown in the EWA report.

The following documents are relevant background information to the abandonment of the Wignell W2 & complete abandonment of the Wignell W2A drains, providing a complete, self explanatory chronologic account of all proceedings up to the By-law to abandon the said defined municipal drains.

Therefore this abandonment is complete and not outstanding.

- Wignell Municipal Drain W2 Relocation W1 Abandonment 1999 Weibe Report.pdf)
- 1934_WIGNELL_AERIAL.tif)
- 20170328_WIGNELL_DRAIN_HISTORIC_PC_QUARRY_ROUTING.pdf)
- By-laws: 58950213.pdf)
- Tribunal Hearing.pdf)
- Wignell W2 Plan and Profile.pdf)
- Wignell 2 & 2A Abandonment & Michener 2 Subsequent Connection Report.pdf)

K. SMART ASSOCIATES LIMITED
CONSULTING ENGINEERS AND PLANNERS

85 McINTYRE DRIVE
KITCHENER, ONTARIO N2R 1H6

TELEPHONE (519) 748-1199
FAX (519) 748-6100

January 11, 2013 File No. 10-262

WIGNELL MICHENER DRAIN
SECTION 65 REPORT
City of Port Colborne

BACKGROUND

Port Colborne Quarries Ltd have submitted a request to the City of Port Colborne to have the Wignell Drain W2 and W2A abandoned of status under the Drainage Act on their properties (Roll Number 4-3-156 and 158) in Lot 20 and part of Lot 19, Concession 2 (Humberstone) which is east of Babion Road between Highway 3 and Concession 2 Road.

The northeast portion of Lot 19, Concession 2 (Roll Number 4-3-153-10) owned by Paul Fehrman on the west side of Carl Road is currently defined to be within the upper watershed of the Wignell Drain W2 and has a direct outlet into the Wignell Drain W2 on the west boundary of the parcel. Port Colborne Quarries Ltd have indicated that they have an agreement with Paul Fehrman to construct a drain on the Fehrman property that would provide outlet for the property into the Michener Drain M2 at Carl Road.

The City of Port Colborne has requested K. Smart Associates Ltd to prepare a report under Section 65(4) of the Drainage Act to address the disconnection of the northeast part of Lot 19, Concession 2 from the Wignell Drain W2 and under Section 65(3) to address the subsequent connection of the northeast part of Lot 19, Concession 2 to the Michener Drain M2 at Carl Road.

DRAINAGE HISTORY

The current report applicable to the majority of the Wignell Michener Drain is found in City of Port Colborne Bylaw 773/89/78 adopted on February 26, 1979. The Bylaw adopted a report prepared by D. Ingram P.Eng., R.V. Anderson Associates Limited dated July 28, 1978.

Some modification was made to the Wignell Michener Drain under a report by J. Bryon Wiebe, P.Eng., Wiebe Engineering Group Inc. dated February 19, 1999. The Wiebe report was adopted by City of Port Colborne Bylaw 3741/27/99 on June 14, 1999. The Wiebe report provided for the abandonment of the Wignell Drain W1 north of Highway 3 in Lot 22, Concession 2 and the realignment of the Wignell Drain W2 in Lot 21, Concession 2 between Highway 3 and Babion Road. The Wiebe report included an updated maintenance schedule for the Wignell Drain W2.

The City of Port Colborne has currently appointed AMEC Environment and Infrastructure to prepare an updated report for the Wignell Michener Drain wateshed. This report is still in progress at this time.

AUTHORITY FOR REPORT

In early discussions between AMEC and Port Colborne Quarries Ltd it was felt that the abandonment of the Wignell Drain W2 and W2A and subsequent changes to the watershed boundaries could be dealt with under the AMEC report. However, Port Colborne Quarries Ltd has now determined that they would like to have the Wignell Drain W2 abandoned and the Fehrman property watershed area directed to the Michener Drain M2 prior to the completion of the AMEC report on the Wignell Michener Drain.

Section 65(5) of the Drainage Act states:
No person shall connect to or disconnect from a drainage works without the approval of the council of the municipality.
Therefore, this report is properly authorized under Section 65(3) and Section 65(4) of the Drainage Act.

RECOMMENDATIONS

Michener Drain M2

When the Wignell Drain W2 is abandoned the owner of Roll Number 4-3-158 will complete a berm along the east limits of the property to block any potential drainage from the northeast part of Lot 19, Concession 2 (Roll Number 4-3-153-10) westerly into the Wignell Drain W2. The owner of Roll Number 4-3-158 will then construct a drain on the northeast part of Lot 19, Concession 2 to provide outlet for this parcel easterly into the Michener Drain M2 on the east side of Carl Road.

The following observations are made with respect to the above described connection to the Michener Drain M2:

- Currently there is a culvert under Carl Road at the head of the Michener Drain M2 so it thus appears that portions of the northeast part of Lot 19, Concession 2 (Roll Number 4-3-153-10) may already be draining easterly into the Michener Drain M2 and not westerly into the Wignell Drain W2.
- The watershed area upstream of the head of the Michener Drain M2 at Carl Road is currently approximately 130ha. The addition of approximately 12ha from Roll Number 4-3-153-10 into the head of the Michener Drain M2 represents less than a 10% increase in the watershed area and this increase will not have an impact on the downstream drainage capacity of the Michener Drain M2.
- Also, the peak flow from the 12ha to be added will pass through the Michener Drain M2 long before the peak flow from the existing upstream watershed reaches the Carl Road culvert since the travel length for the existing watershed to the north is approximately 1.5km as compared to a 200m travel length for the lands to be connected.

The connection of the Wignell Drain W2 watershed area on Roll Number 4-3-153-10 to the Michener Drain M2 will not adversely impact the Michener Drain M2 and the connection can therefore be approved.

Since the subsequent connection is an internal connection within the Wignell Michener Drain watershed no assessment is required to be levied to Roll Number 4-3-153-10 for the connection to the Michener Drain M2.

The report being prepared by AMEC will be providing a new maintenance schedule for the Michener Drain M2 which can take into account the change in the Michener Drain M2 watershed as outlined above.

In the event that the City would be required to undertake maintenance work and levy the cost on the Michener Drain M2 prior to the completion of the AMEC report then the maintenance assessment schedule in the 1978 report for Michener Drain M2 shall be amended by adding $325 to the assessment for Roll Number 4-3-153-10.

Wignell Drain W2

The City of Port Colborne will proceed with the abandonment of the Wignell Drain W2 and W2A east of Babion Road under Section 84 of the Drainage Act following the acceptance of this report. When the Wignell Drain W2 is abandoned the owner of Roll Number 4-3-158 will complete a berm along the east limits of the property to block any potential drainage from the northeast part of Lot 19, Concession 2

(Roll Number 4-3-153-10). The owner of Roll Number 4-3-158 will then construct a drain on the northeast part of Lot 19, Concession 2 to provide outlet for this parcel into the Michener Drain M2 on the east side of Carl Road. Therefore the disconnection of the Roll Number 4-3-153-10 from the Wignell Drain W2 can be approved.

The report being prepared by AMEC will be providing a new maintenance schedule for the Wignell Drain W1 and W2 which can take into account the change in the Wignell Drain watershed in the northeast part of Lot 19, Concession 2 and the portions of the Wignell Drain that have been abandoned.

For the Wignell Drain W1 no adjustment can be made to the assessments in the 1978 report assessment schedule to reflect the change in watershed since the Wignell Drain W1, W2 and W2A were combined into one assessment schedule and since the Michener Drain M2 outlets into the Wignell Drain W1.

In the event that the City would be required to undertake maintenance work and levy the cost on the remaining Wignell Drain W2 prior to the completion of the AMEC report then the maintenance assessment schedule in the 1999 report for Wignell Drain W2 shall be amended by deleting the assessment to Roll Number 4-3-153-10 with the remaining assessments used to prorate the cost.

WATERSHED PLAN
A copy of the Wignell Michener Drain watershed is included with the report to illustrate the change in watershed noted above.

ENGINEERING COST
Report Preparation
Review background information and 1978 and 1999 reports, discussion with Drainage Superintendent, prepare report

Total Report Preparation	$ 600
Net HST (1.76%)	10
Total Engineering Cost	**$ 610**

ASSESSMENT
The total Engineering cost for this report shall be assessed to Roll Number 4-3-158.

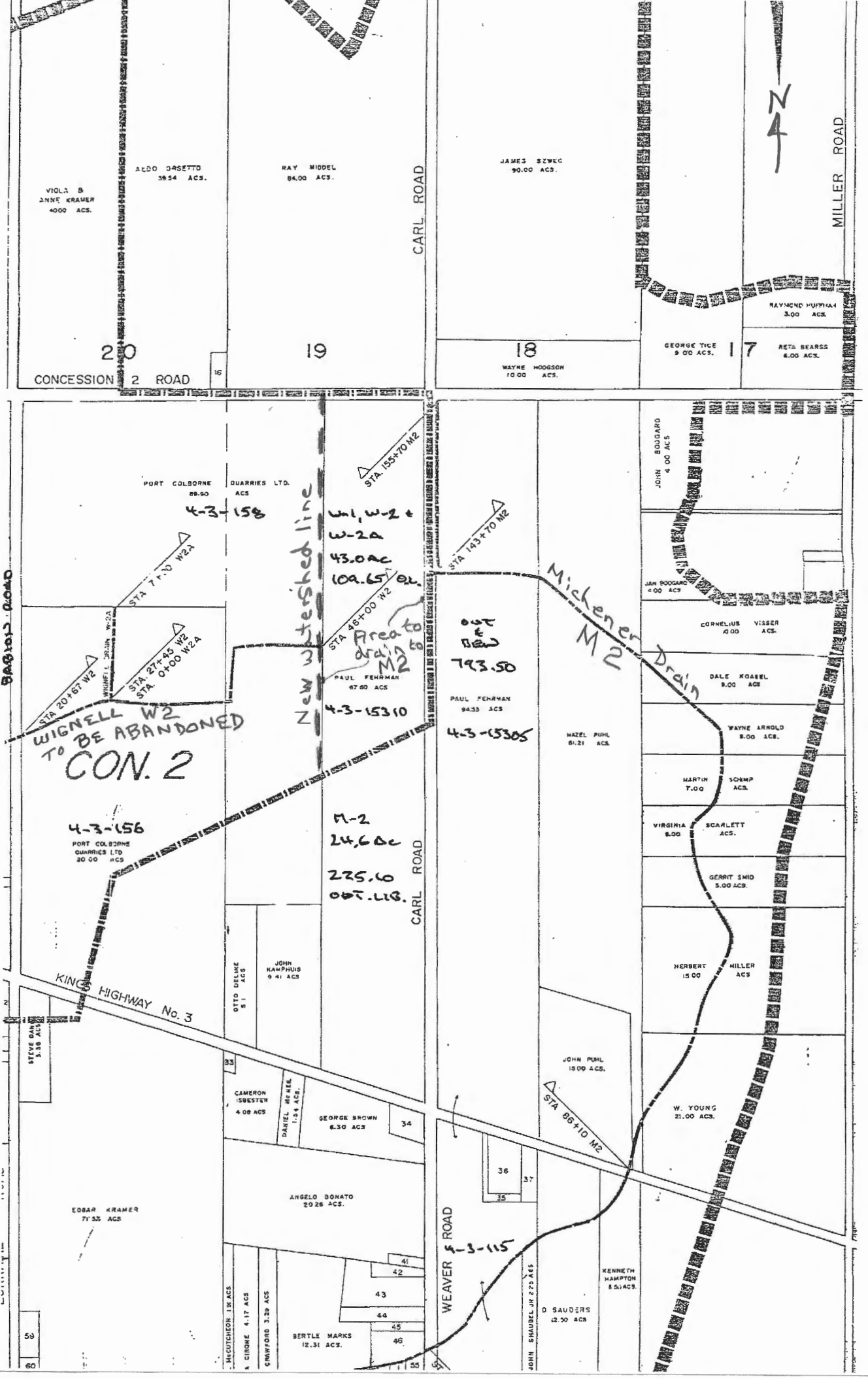
PROCEEDINGS FOR THIS REPORT
In accordance with Section 65(8) of the Drainage Act a copy of this report shall be sent to Roll Number 4-3-158 and 4-3-153-10.

In accordance with Section 65(5) of the Drainage Act the Council of the City of Port Colborne should approve this report by resolution if in agreement with the recommendations in the report.

The maintenance assessment provisions of this report shall apply until such time as the new report on the Wignell Michener Drain being prepared by AMEC is adopted by bylaw.
This report does not alter the specifications for drain maintenance or the extent of the drains from either the 1978 or 1999 drain reports.

All of which is respectfully submitted.
K. SMART ASSOCIATES LIMITED

John Kuntze, P. Eng.


CONCESSION 2 ROAD
CARL ROAD
MILLER ROAD
WEAVER ROAD
KING'S HIGHWAY No. 3
BARTLETT ROAD
20
19
18
17
16
VIOLA & ANNE KRAMER 40.00 ACS.
ALDO DARSETTO 38.54 ACS.
RAY MIDDEL 84.00 ACS.
JAMES SZWEC 90.00 ACS.
WAYNE HODGSON 10.00 ACS.
GEORGE TICE 9.00 ACS.
RAYMOND PURDAM 3.00 ACS.
RETA BEARSS 6.00 ACS.
PORT COLBORNE QUARRIES LTD. 89.90 ACS
4-3-158
W1, W-2 & W-2A
43.0 Ac
109.65 Rd.
STA 155+70 M2
STA 143+70 M2
STA 7+10 W2A
STA 46+00 W2
STA 27+45 W2
STA. 0+00 W2A
STA 20+67 W2
WIGNELL DRAIN W-23
New 3 watershed line
Area to drain to M2
OUT to BED
793.50
PAUL FEHRMAN 67.50 ACS
4-3-15310
PAUL FEHRMAN 94.33 ACS
4-3-15305
Michener Drain M2
WIGNELL W2 TO BE ABANDONED
CON. 2
4-3-156
PORT COLBORNE QUARRIES LTD 20.00 ACS
M-2
24.6 Ac
225.60
OUT. LIB.
JOHN BOOGARD 4.00 ACS
JAN BOOGARD 4.00 ACS
CORNELIUS VISSER 10.00 ACS.
DALE KOABEL 9.00 ACS
WAYNE ARNOLD 8.00 ACS.
MARTIN SCHIMP 7.00 ACS.
VIRGINIA SCARLETT 8.00 ACS.
GERRIT SMID 5.00 ACS.
HERBERT MILLER 15.00 ACS
HAZEL PUHL 61.21 ACS.
JOHN PUHL 15.00 ACS.
W. YOUNG 21.00 ACS.
STA 86+10 M2
4-3-115
OTTO DELUWE 5.1 ACS
JOHN KAMPHUIS 9.41 ACS
STEVE DANKO 5.38 ACS
CAMERON ISBESTER 4.08 ACS
DANIEL MCNEIL 1.54 ACS.
GEORGE BROWN 6.30 ACS
ANGELO BONATO 20.26 ACS.
EDGAR KRAMER 71.32 ACS
MCCUTCHEON 1.36 ACS
A. CIRONE 4.17 ACS
CRAWFORD 3.29 ACS
BERTLE MARKS 12.31 ACS.
JOHN SHAUDEL JR 2.25 ACS
D. SAUDERS 42.50 ACS
KENNETH HAMPTON 8.51 ACS.
33
34
35
36
37
41
42
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44
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46
55
59
60

WIGNELL MUNICIPAL DRAIN
W2 RELOCATION
W1 ABANDONMENT

ENGINEER'S REPORT

CITY OF PORT COLBORNE
Regional Municipality of Niagara

DATED: FEBRUARY 19, 1999

WIEBE ENGINEERING GROUP INC.
CONSULTING ENGINEERS & PROJECT MANAGERS

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CITY OF PORT COLBORNE
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CITY OF PORT COLBORNE

1.0 INTRODUCTION

The following is our report on the Wignell Municipal Drain, particularly relating to a) the relocation of the Wignell W2 Drain on Property Roll No. 4-4-115 owned by the Port Colborne Quarries Limited, and b) the abandonment of a portion of Wignell Drain W1, also on Property Roll No. 44-115.

A written request from Port Colborne Quarries Limited dated March 31, 1998 was forwarded to the City of Port Colborne requesting that an Engineer's Report be prepared under the provisions of the Drainage Act, for the relocation of part of the Wignell Drain (W2) situated on their property.

Another written request from Port Colborne Quarries Limited dated October 2, 1998 was forwarded to the City of Port Colborne requesting *"that the Wignell Drain W2A be abandoned; the Wignell W2 Drain, east of Babion Road be abandoned; and the Wignell Drain W1, north of Highway No. 3 be abandoned"*. Subsequent to that request, Port Colborne Quarries Limited have advised that they are requesting that only the abandonment of a portion of Wignell Drain W1 be addressed in this report. Abandonment of portions of other Wignell Drains on their property, may be considered in the future.

1.1 Authority to Prepare Report

Operational Services Division - Director's Report #98-32 recommended that Wiebe Engineering Group Inc. be appointed to prepare a report under the provisions of the Drainage Act for the requested relocation. That recommendation was approved by the City of Port Colborne Council on May 11, 1998. We were also directed by the City of Port Colborne to address the written request for the abandonment of portions of the Wignell Drain in the same report. This report has been prepared pursuant to Sections 78(1) and 84 of the Drainage Act.

1.2 Description of the Report Requirements

The purpose of this report is to design the relocation of a portion of the Wignell W2 Drain on Property Roll No. 4-4-115 and to assess the costs. The relocation has been requested by the property owner so as to incorporate the drain into the final quarry configuration and subsequent rehabilitation plan. We are also to address the abandonment of portions of the Wignell W1 Drain.

According to Section 84(1) of the Drainage Act, the municipality is to notify all owners assessed for the drainage works, when a request for abandonment of a drainage works is filed. Any of those owners may, within ten days of that notification, give notice to the City Clerk that they require the report of an Engineer to be made on the proposed abandonment. If no such written notice is provided to the Clerk, the municipality may, through by-law, abandon the drainage works without the report of an Engineer. In this case, the municipality has decided to have the proposed abandonment examined and included in the same report as the proposed relocation.

This report includes the plan and profile for the proposed relocation; description of the proposed works and abandonments; and revised assessment schedule for Wignell W2 Drain, recognizing the adjustments necessary to account for the increased channel length, as well as changes in the drainage area, and changes to properties within the drainage area.

1.3 History of the Drainage Area

Based on the information provided by the municipality, the applicable Engineer's Report for this drain was prepared by R. V. Anderson Ltd., dated July 28, 1978, and adopted through By-law #773/89/78. Prior to that, improvements were undertaken in 1949 under Township of Humberstone By-law 903, and in 1959 as a result of an Engineer's Report prepared by C. J. Clark.

1.4 Limits of Drain Relocation

This report deals with the relocation of a portion of the Wignell W2 Municipal Drain on Property Roll No. 4-4-115 between the north limit of the Highway No. 3 right-of-way and the west limit of the Babion Road right-of-way. All remaining portions of the drain will continue to be maintained according to the 1978 Engineer's Report and By-law.

1.5 Request for Abandonment

Section 84(1) of the Drainage Act stipulates that a written request for abandonment must represent no less than three-quarters of the area assessed for **benefit** on a drainage works, as shown in the by-law under which the drainage works exists. The current By-law for the drainage works in question is #773/89/78, which adopts the Engineer's Report prepared by R. V. Anderson Ltd., dated July 28, 1978.

The Repair Assessment Schedule attached to that report covered all three Wignell Drains (W1, W2, and W2A) in one schedule. We have reviewed that schedule and determined that the following properties were assessed for Benefit **on the portions of drains being examined for abandonment**.

Owner	Lot/Con.	Acreage In Drainage Area	Roll No.
Port Colborne Quarries	22/2	50.0	4-115
Port Colborne Quarries	22/2	24.97	4-111
Jack Hellinga	22/2	20.3	4-110

We have determined that Port Colborne Quarries Limited owns 78% of the lands assessed for Benefit on the portion of the Wignell W1 Drain that is to be abandoned. Therefore the request from Port Colborne Quarries Limited meets or exceeds the requirements of Section 84(1) of the Drainage Act and is considered an adequate request for abandonment.

1.6 Limits of Abandonments

The portion of the Wignell W1 Municipal Drain that has been examined for abandonment is from the north limit of the Highway No. 3 right-of-way (original Station 67+41') to the upstream limit of the drain (original Station 83+00') at the line between Lots 21 and 22, Concession 2.

2.0 NOTICES AND MEETINGS

2.1 Notice of On-Site Meeting

As required under Section 9 of the Drainage Act, our firm conducted an on-site meeting on July 29, 1998 at 4:30 p.m. to discuss the proposed drain relocation. All owners of land which outlets into Drain W2, upstream of Babion Road, were provided with a notice of this meeting. No public utilities will be affected by the proposed relocation, and therefore, were not invited to the site meeting. We understand that the Niagara Peninsula Conservation Authority and Ministry of Natural Resources were notified by the City of Port Colborne on April 1, 1998 of the request for relocation.

The site meeting was attended by four landowners. The proposed relocation was described to those landowners, as well as the general procedures of the Drainage Act. The landowners were advised that all costs associated with the preparation of the Engineer's Report and proposed construction would be assessed to the owner requesting the relocation, Port Colborne Quarries Limited.

2.2 Notice of Abandonment

As required under Section 84(1) of the Drainage Act, a "*Notice of Abandonment of Drainage Works*", dated November 9, 1998 was sent to all owners of land assessed for the drainage works. The drainage works, or parts thereof, intended to be abandoned were described in the notice as:

Wignell Drain W2A in Lot 20, Concession 2
Wignell Drain W2 in Lot 19 and Lot 20, Concession 2
Wignell Drain W1 North of Highway #3, in Lot 22, Concession 2

As previously noted, Port Colborne Quarries Limited has since advised that only the abandonment of a portion of Wignell Drain W1 is to be considered at this time.

The "*Notice Requiring Report*" was also provided to the landowners so that they had an opportunity to require the report of an Engineer on the proposed abandonment. The covering letter from the municipality that accompanied the Notice urged landowners to submit any concerns regarding the abandonment to the City Clerk within ten days of the date of the notice.

2.2.1 Response From Landowners

One written response was received by the municipality, from Paul A. Fehrman, dated November 12, 1998. The City's Drainage Superintendent, Mr. Rene Landry, also spoke with, either by telephone or in person, four other landowners; Mr. Huffman, Mr. Mascitelli, Mr. Hellinga, and Mr. Schooley. Generally, none of the responding landowners expressed concerns over the proposed abandonment, but did want assurance that the present drainage patterns would not be negatively impacted by the proposed abandonment.

3.0 FIELD INVESTIGATION

3.1 Description of Field Work

The field work undertaken on this project included the following:

- a total station topographic survey of the existing channel and adjacent lands on Property Roll No. 4-4-115, between Highway No. 3 and Babion Road;
- the total station survey was tied to the datum of the original design by level survey;
- a field investigation was undertaken.

4.0 RELOCATION DESIGN

4.1 Design Grade, Bottom Width

The proposed relocation will match into the design grade at both the south and east limits of the property. However, the design grade will be revised to accommodate the longer channel length through this property. The downstream limit of the relocation is located at original Station 0+797' (0+243m) with a channel bottom elevation of 587.12' (178.953m). The upstream limit of the relocation is located at original Station 2+034' (0+620m) at an elevation of 591.00'

(180.137m). The channel was originally constructed at a design grade of 0.30%. The total length of relocated channel is 476m, at a design grade of 0.25%. The channel will follow a more meandering route than the original, and will be approximately 93m longer than the original, straighter, alignment. The original channel was designed with a bottom width of 3.0' (0.9m) and side slopes of 1.5 horizontal to 1 vertical. The relocated channel is to have a design bottom width of 0.9m and 1.5:1 side slopes.

4.2 Description of Proposed Work

The proposed work consists of the removal of existing earth stockpiles in the area of the drain relocation, and the excavation of the relocated channel. All excavated material will be reused elsewhere on the same property. Channel banks are to be revegetated as described in the following Section 6.2. All construction is to be undertaken under the supervision of the City's Drainage Superintendent, or his designated representative.

The proposed work is illustrated on the enclosed Drawing No. 1.

4.3 Cross Culverts

No cross culverts exist along the portion of drain to be relocated, and no new culverts are proposed under this report. If, in the future, the property owner requests a cross culvert, it shall be sized by a qualified Engineer. The cost of supplying and installing such culvert is to be charged completely to the landowner requesting this culvert. Future maintenance costs of such a culvert would be charged 50% directly to the landowner involved and 50% to upstream landowners. Maintenance of that culvert would be limited to the pipe and backfill, and placement of rip rap and filter fabric at each end, if required for erosion protection. The municipality will not undertake maintenance of any headwalls constructed by the landowner.

5.0 ABANDONMENT DETAILS

As the requirements of the Drainage Act for abandonment have been met, we recommend that the portion of the Wignell W1 Drain described in the previous Section 1.6 be abandoned.

Therefore the municipality will no longer be compelled to arrange the maintenance or repair of those portions of the drain that have been abandoned, as required by Section 74 of the Drainage Act. This also means that there will no longer be assessments to the upstream lands and roads **for those portions of the drain that have been abandoned**. Portions of the drains that are still governed by either the previous by-law (773/89/78) and Engineer's Report (July 28, 1978), or this Engineer's Report are to be maintained according to the requirement of the Drainage Act, and assessed to upstream roads and lands according to the applicable Maintenance or Repair Assessment Schedule. The abandoned drains will continue to exist as watercourses, but without the designation of a "Municipal Drain".

6.0 EROSION AND SEDIMENT CONTROL

Erosion and sediment control measures are to be applied in order to reduce or eliminate sedimentation of the channel and deterioration of the quality of water.

6.1 Buffer Strips

It is recommended that a 5 metre wide vegetated buffer strip be maintained along both sides of the drain to limit erosion and control the transportation of silt into the drain.

6.2 Revegetation

All exposed soil areas within 5 metres of the drain, including the ditch banks are to be seeded as quickly as possible, preferably on the same day of excavation. The recommended seed mixture, applied at a rate of 90kg per hectare is as follows:

Creeping Red Fescue	45 kg
Perennial Rye Grass	18 kg
Birdsfoot Trefoil	27 kg
	90 kg per hectare

It is recommended that mulch and fertilizer be applied to ensure the establishment of the vegetative cover.

6.3 Erosion Protection

In the future, the municipality has authority to undertake the placement of rip rap at erosion prone areas of the drain, as maintenance, and the costs shall be assessed to all upstream landowners.

Where surface flow of water from adjacent lands is directed into the drain, the landowner shall ensure that measures are taken to prevent bank erosion. A rock shute spillway or rip rap sluiceway complete with filter fabric underlay should be utilized.

6.4 Sediment Basin

A sediment basin consisting of an area of overexcavation is to be constructed and maintained during construction at the downstream limit of excavation. Silt collected from this basin is to be excavated and levelled adjacent to the channel once the depth of silt reaches 300mm. The basin is to remain after construction and form part of the drain. A silt fence is to be installed at the downstream limit of the sediment basin, during construction. Once the channel has stabilized, the silt fence is to be removed.

6.5 Spoil Material

Excavated spoil material is to be placed a sufficient distance from the top of bank to ensure that sediment does not enter the drain and revegetated preferably on the day of levelling.

7.0 COSTS

7.1 Allowances

Allowances were granted under the previous report, and therefore, no further allowances are to be granted under this report.

7.2 Assessment of Costs

All costs associated with the construction of this project are to be assessed directly to Property Roll No. 4-4-115. We understand that construction will be arranged by the landowner, and will be paid by the landowner. All costs associated with the preparation of this report are also to be assessed entirely to Property Roll No. 4-4-115.

Normally a report on a drain relocation would only reapportion the existing assessment schedule, to account for any change in channel length, and the resulting change in maintenance costs. However, this report includes a completely new Maintenance Schedule for several reasons. The 1978 Report provided only one assessment schedule for all three branches of the Wignell Drain; W1, W2, and W2A. It is current practice to include individual assessment schedules for each drain or branch, allowing the municipality to undertake maintenance on each branch independently of the others. Also, a new report was prepared on the Indian Creek Municipal Drain in 1997. The limits of the Indian Creek watershed were updated and revised, based on the drainage patterns at that time. Since the watershed for the Indian Creek abuts that of the Wignell, there are some revisions necessary to the north limit of the Wignell watershed to match that of Indian Creek. The limits of the watershed for the Wignell W2 have been established based on 1:2,000 topographic base mapping, in conjunction with the previously established Indian Creek watershed, and are illustrated on the enclosed Drainage Plan. Inconsistencies in property areas were noted in the original assessment schedule, and have been corrected according to the most recent property information available. Information used for the preparation of the Maintenance Schedule has been provided by the City of Port Colborne. The enclosed Maintenance Schedule for the Wignell W2 Drain is to be used for all future maintenance undertaken on this drain.

8.0 WORKING SPACE

8.1 General

As per Section 63 of the Drainage Act, the total working space required will include the top width

of the drain, and 6 metres on each side of the drain, measured from the top of bank. Generally, maintenance will take place from one side of the drain, however, if it appears that it will be more practical and cost effective at certain locations along the drain, work may be undertaken from both sides.

8.2 Spoil

Spoil from the construction of the relocated drain shall be disposed of elsewhere on Property Roll No. 4-4-115. Spoil from future maintenance is to be levelled adjacent to the drain. Should the landowner require that all, or a portion of future spoil be trucked away from their property, rather than levelled adjacent to the drain, the cost of trucking spoil away shall be assessed totally to the landowner requesting same.

9.0 SUMMARY

Based on the above report, it is respectively recommended that the City of Port Colborne adopt this report through bylaw under authority of the Drainage Act. At that time the portion of the Wignell W1 Drain, north of the Highway No. 3 right-of-way shall be abandoned. The municipality will no longer be responsible for the maintenance of that drain or part thereof. Maintenance will no longer be assessed to the contributing lands of the drain or part thereof that has been abandoned.

The design included in this report shall apply to the portion of the Wignell W2 Drain between Highway No. 3 and Babion Road. The design included in the 1978 Report shall apply to the remaining downstream portion of the Wignell W2 Drain. The Maintenance Schedule in this report shall apply to all future maintenance on the entire Wignell W2 Drain.

The design included in the 1978 Report shall continue to apply to the portions of the Wignell W1 Drain that has not been abandoned, that is, from its outlet at original Station 0+00, to the north side of the Highway No. 3 right-of-way. The Repair Assessment Schedule in the 1978 Report shall continue to apply to the Wignell W1 Drain. The design and Repair Assessment Schedule from the 1978 Report shall continue to apply to the Wignell W2A Drain.

WIEBE ENGINEERING GROUP INC.
Consulting Engineers and Project Managers
per:

J. Bryon Wiebe, P. Eng.
Consulting Engineer

Cam M. Milne, C.E.T.
Project Manager

DATED: February 19, 1999

APPENDIX 'A'

Wignell Drain - W1
Repair Assessments

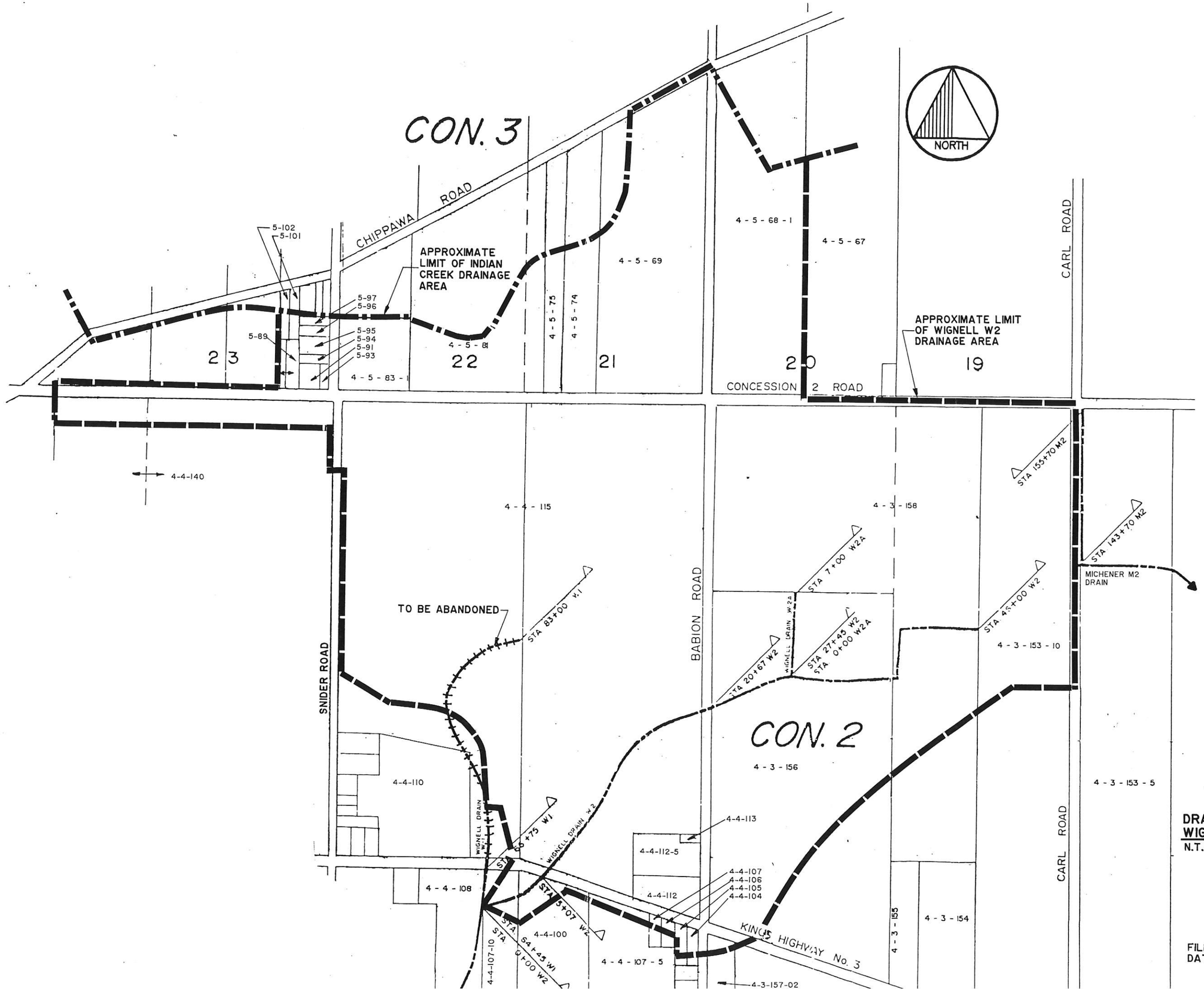
CITY OF PORT COLBORNE
WIGNELL W2 MUNICIPAL DRAIN
MAINTENANCE SCHEDULE

February 19,1999
File No. 9758

CON.	LOT OR PART LOT	ASSESSMENT ROLL NO.	APPROXIMATE AREA AFFECTED (ha)	OWNERS	MAINTENANCE ASSESSMENT (%)	NET** ASSESSMENT (%)
3	23	040 00510200	0.14	R. JOHNSON	0.0436	0.0436
3	23	040 00510100	0.14	Z. SOVEGJARTO	0.0436	0.0436
3	23	040 00508900	0.40	G. BEAULIEU	0.1246	0.1246
3	23	040 00509700	0.15	CITY OF PT. COLBORNE	0.0467	0.0467
3	23	040 00509600	0.15	K. MARTIN	0.0467	0.0467
3	23	040 00509500	0.30	W. & C. PROVENCAL	0.0934	0.0934
3	23	040 00509400	0.15	J. & F. STEFAN	0.0467	0.0467
3	23	040 00509100	0.38	M. & S. GARNER	0.1183	0.1183
3	23	040 00509300	0.11	V. PASCUZZI	0.0343	0.0343
3	22	040 00508301	2.45 *	M. & A. HENDERSON	0.763	0.5087
3	21–22	040 00508100	5.06 *	G. & N. PROULX	1.4949	0.9966
3	21	040 00507500	1.22 *	P. & A. DIMARIA	0.3332	0.2221
3	21	040 00507400	2.37 *	M. WHEATLEY	0.5512	0.3675
3	21	040 00506900	14.58 *	G. BABION	4.5406	3.0271
3	20	040 00506801	11.18 *	B. & R. STEELE	2.9586	1.9724
2	23–24	040 00414000	2.75	PT. COLBORNE QUARRIES LTD.	2.5166	2.5166
2	21–22	040 00411500	73.12	PT. COLBORNE QUARRIES LTD.	48.9964	48.9964
2	22	040 00410710	0.42 *	A. & R. SANTARELLA	0.0075	0.005
2	21	040 00411300	0.07	D. MICHAEL	0.0218	0.0218
2	21	040 00411205	1.21	R. & E. BILLY	0.3768	0.3768
2	21	040 00411200	1.21	P. & T. KINZIE	0.3768	0.3768
2	21	040 00410000	0.88	INCO LIMITED	0.0651	0.0651
2	21	040 00410705	0.18 *	R. STARK	0.0188	0.0125
2	21	040 00410700	0.06	A. CITRIGNO	0.0063	0.0063
2	21	040 00410600	0.05	J. WICKES	0.0052	0.0052
2	21	040 00410500	0.05	M. SOUDER & D. FISHER	0.0052	0.0052
2	21	040 00410400	0.14	J. & C. HUFFMAN	0.0147	0.0147
2	20	040 00315702	0.30	R. & J. PHILLIPS	0.0314	0.0314
2	20	040 00315600	25.50	PT. COLBORNE QUARRIES LTD.	9.5948	9.5948
2	19–20	040 00315800	31.46	PT. COLBORNE QUARRIES LTD.	11.8374	11.8374
2	19	040 00315310	12.60 *	P.& A. FEHRMAN	2.6374	1.7583
					87.7516	
CITY OF PORT COLBORNE ROADS						
	CHIPPAWA ROAD				0.1930	0.1930
	CONCESSION 2 ROAD				5.1205	5.1205
	SNIDER ROAD				0.8491	0.8491
	BABION ROAD				5.0393	5.0393
	SUBTOTAL – CITY OF PORT COLBORNE ROADS				11.2019	
MINISTRY OF TRANSPORTATION						
	HIGHWAY NO. 3				1.0465	1.0465
	SUBTOTAL – MINISTRY OF TRANSPORTATION ROADS				1.0465	
SUBTOTAL – ROADS					12.2484	
TOTAL ASSESSMENTS – WIGNELL W2 DRAIN					100.0000	

* indicates agricultural land
** net amount is calculated by subtracting government subsidy (where applicable)

WIEBE ENGINEERING GROUP INC.
CONSULTING ENGINEERS
& PROJECT MANAGERS
BRANTFORD – WELLAND



DRAINAGE PLAN
WIGNELL W2 DRAIN
N.T.S

FILE: 9758
DATE: FEBRUARY 19, 1999

René

Ontario Drainage Tribunal
1 Stone Road West
Guelph, Ontario N1G 4Y2
Tel: (519) 826-3433 Fax: (519) 826-4232

La Commission de drainage de l'Ontario
1, rue Stone ouest
Guelph, Ontario N1G 4Y2
Tél: (519) 826-3433 Téléc: (519) 826-4232

20 December 1999

TheCity of Port Colbourne
66 Charlotte Street
Port Colbourne, ON
L3K 3C8

Attention: Ms. Janet Beckett, Clerk Treasurer

Dear Ms. Beckett:

Re: Wignell W2 Municipal Drain

Attached is a signed copy of the Drainage Tribunal's decision with regard to the Wignell W2 Municipal Drain

Please forward copies to your distribution list.

Thank you for your assistance before, during and after the hearing

Yours sincerely,

John Johnston
General Manager/Secretary

The Ontario Drainage Tribunal
1st Floor NW, 1 Stone Road West
Guelph, Ontario N1G 4Y2
Tel: (519) 826-3433 Fax: (519) 826-4232

La Commission de drainage de l'Ontario
1e étage NO, 1, rue Stone ouest
Guelph (Ontario) N1G 4Y2
Tél: (519) 826-3433 Téléc: (519) 826-4232

IN THE MATTER OF THE DRAINAGE ACT R.S.O. 1990, CHAPTER D.17, AS AMENDED.

AND IN THE MATTER OF:

An application to the Ontario Drainage Tribunal by the City of Port Colborne requesting a modification to City By Law No. 3741/27/99 concerning the **Wignell W2 Municipal Drain in the City of Port Colborne.**

Before:

John Taylor, Vice-Chair; Herb Todgham, Vice-Chair; Gertrude Levac, Member.

DECISION OF THE TRIBUNAL

This application was considered by the Tribunal on December 14, 1999 under Sub-Section 51(1) of the *Drainage Act* (the Act). Sub-Section 51(1) is as follows:

51. (1) On any appeal or reference to the Tribunal under this Act, the Tribunal shall hear and determine the matter and, where not so provided, may make such order and direct such things to be done as are authorized by this Act or as it considers proper to carry out the purposes of this Act.

The Background

By report dated February 19, 1999, Wiebe Engineering recommended to the City of Port Colborne the relocation of a portion of the Wignell W2 Drain and the abandonment of a portion of the drain that is being supplanted by the proposed new work. All of the proposed work is being undertaken on lands owned by Port Colborne Quarries Ltd. and entirely at the cost of Port Colborne Quarries Ltd.

In general terms, the proposed work will allow the existing drain to be relocated within the lands operated as a quarry so the drainage will fit into the final quarry configuration and subsequent rehabilitation plan. After the By-law was passed, but prior to the construction, Port Colborne asked that the work be relocated on their property to reduce the amount of earth that had to be moved. The original proposal had a berm constructed along the quarry property line and the

drain constructed on the quarry side of the berm. When the owners were investigating the work necessary to construct the drain, they determined that a large amount of fill material would have to be moved and asked that the drain be relocated to the boundary line with the berm material on the quarry side of the berm. This proposal has been discussed with the adjacent owners and none have objected to the work. The City of Port Colborne circulated a notice to all personas assessed on this portion of the Wignell W2 Drain informing them of the proposal and requesting any concerns or appeals to be filed with the City Clerk by November 26, 1999. No concerns were filed with the Clerk.

In general terms this will have the effect of:

1. The three meter high berm will be relocated north and west of the new channel, as opposed to east or south as originally proposed.

2. The new channel will be located immediately inside the property line of Port Colborne Quarries Ltd., as opposed to inside the berm as originally proposed.

3. The channel in the south east corner of the property of Port Colborne Quarries Ltd. (Roll Number 4-4-115) is relocated closer to the boundary line of property Roll Number 4-4-112-05 than originally proposed.

4. None of the verbiage of the report needs to be changed to accomplish these changes, it is only necessary to amend the plan and profile to show the revised location and cross section of the work.

ORDER OF THE TRIBUNAL

After careful consideration the Tribunal decided to use its authority under Section 51 of the *Drainage Act* and approve the requested amendments to By Law No. 3741/27/99 but to do so on terms. Therefore the Tribunal orders that:

1. The engineer is directed to amend the report, dated February 19, 1999, by replacing Drawing No. 1 with revised drawing Number 1, dated February 19, 1999, Revision Number 3, finally revised November 19, 1999.

2. The revised drawing is to show the original recommended alignment "x" out with the revised alignment clearly marked.

3. The Clerk of the City of Port Colborne is to replace Drawing Number 1 with the revised drawing Number 1, dated February 19, 1999, Revision Number 3, finally revised November 19, 1999, in By Law No. 3741/27/99, and place a copy of this decision in the file with the By Law.

4. To avoid confusion in the future, the Clerk is to send a copy of revised Drawing Number 1 to all persons who received a copy of the original engineer's report along with a notice to remove the drawing originally sent with the report, discard it and replace it with drawing Number 1, dated February 19, 1999, Revision Number 3, finally revised November 19, 1999.

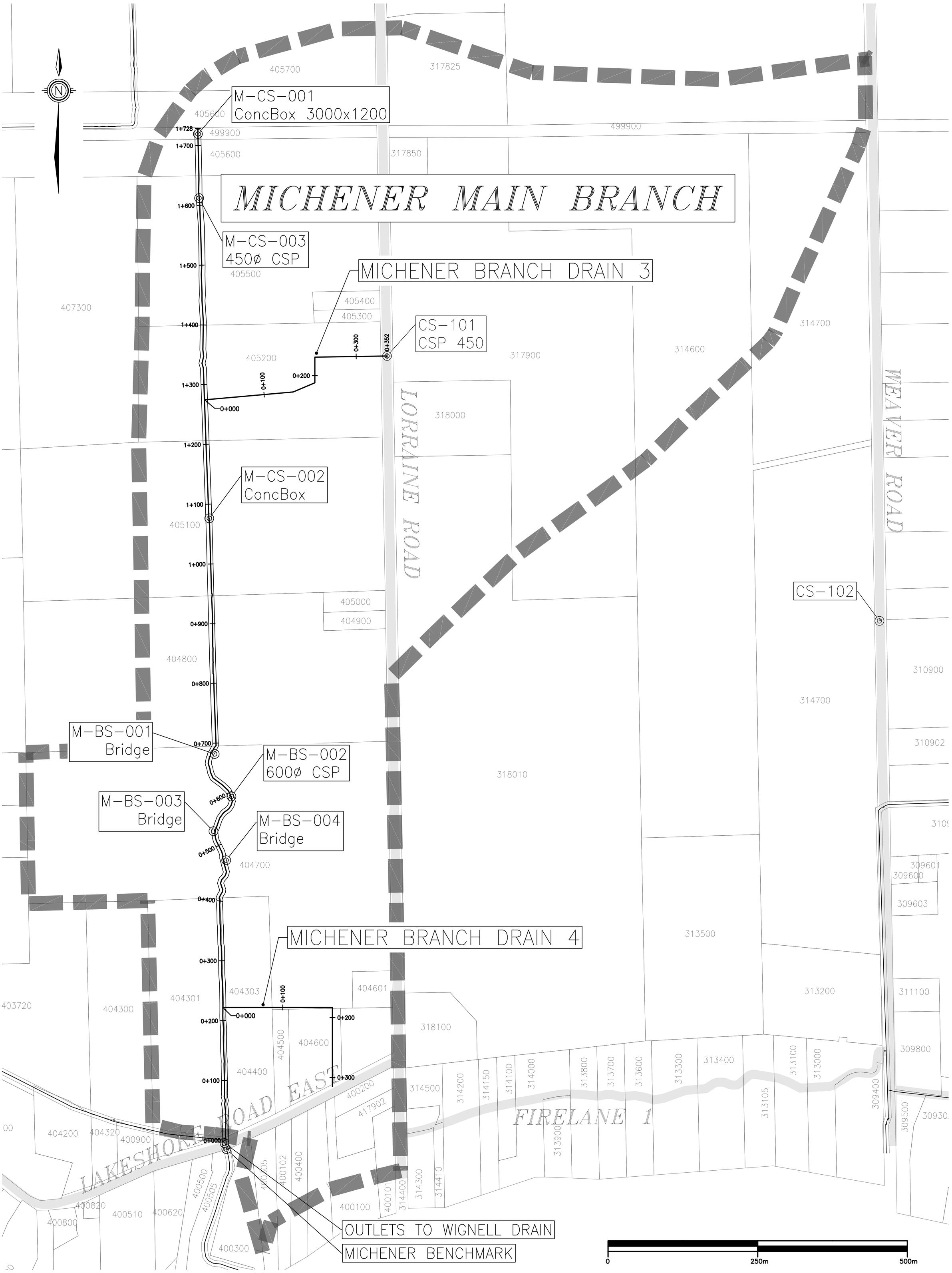
5. The report, dated February 19, 1999, together with the revised drawing Number 1, dated February 19, 1999, Revision Number 3, finally revised November 19, 1999, will henceforth define this portion of the Wignell W2 Drain for purposes of repair and maintenance under the Act.

6. It is ordered that there be no order as to costs and all parties are responsible for their own costs. Attention is drawn to Section 73 of the Act.

John Taylor
Vice-Chair
Dated at Hawkesbury, Ontario this 15th day of December, 1999.

Appendix B:

Drain Drawings and Figures



NOTES:

1. DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED
2. CATCHMENT BOUNDARIES ARE BASED ON THE NPCA DIGITAL ELEVATION MODEL (DEM) 2010
3. SPECIFIC POINTS IN THE SURFACE ARE BASED ON THE FOLLOWING SURVEYS:
   - DRAIN CROSSINGS & SPOT CHANNELS AMEC SURVEY, 2013
   - AS CONSTRUCTED SURVEY BY CofPC, 2016 STATION 0+000–1+940
   - SUPPLEMENTARY SURVEY BY CofPC, 2018
   - WEIBE ENGINEERING SURVEY, 2008

PLAN VIEW LEGEND:

- DRAINAGE AREA BOUNDARY
- DRAIN CENTERLINE
- PROPOSED DRAIN CENTERLINE
- 0+000 DRAIN CHAINAGE
- W-CS-001 ConcBox — STRUCTURE I.D. / STRUCTURE DESCRIPTION

NO.	REVISION DESCRIPTION	DATE
1	ISSUED FOR BASELINE REPORT	OCT/03/2018

MICHENER DRAIN PLAN

Paul C. Marsh, P.Eng. Principal Engineer
EWA Engineering Inc.
84 Main Street, Unionville, Ontario
L3R 2E7
647.400.2824 **www.ewaeng.com**

Automated Engineering Technologies Ltd.
91A Duke Street , Guelph, Ontario N1E 5L1 (519)821-8644
397 Romeo Street S., Stratford, ON, N5A 4V1 (519)273-9318 WEB: www.autoengtech.on.ca

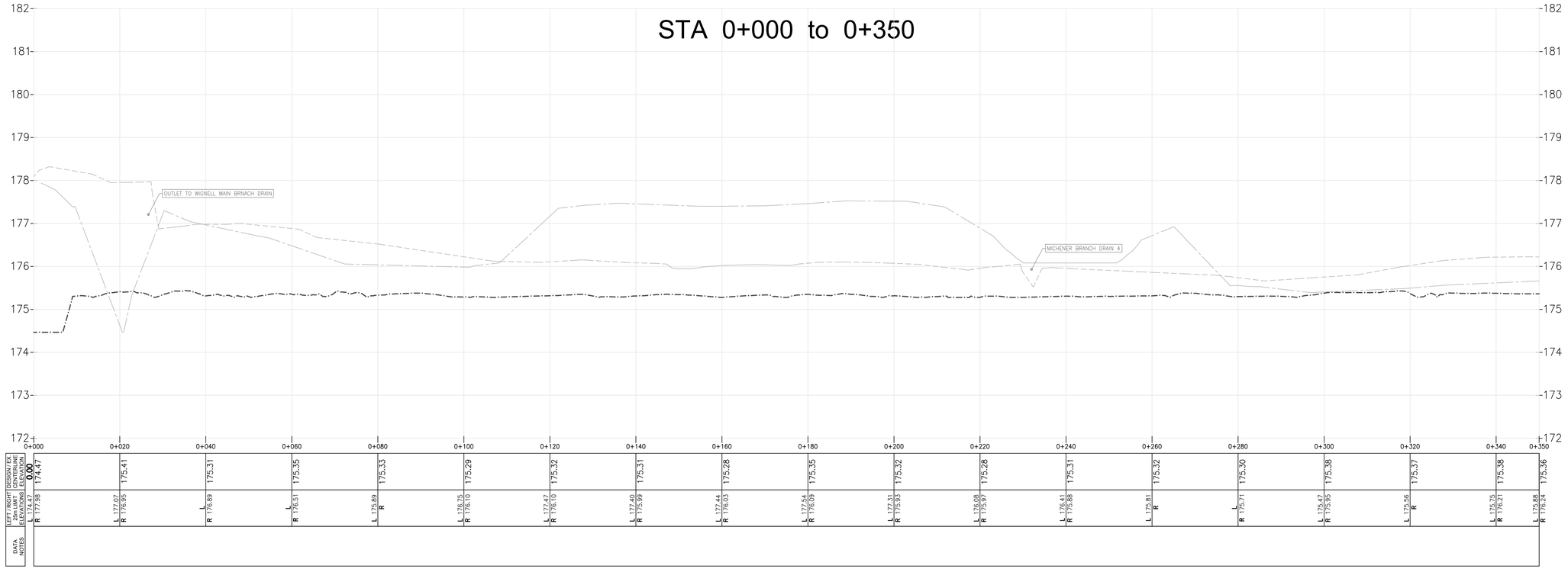
City of Port Colborne

Michener Municipal Drain

DRAWN BY :	APPROVED BY :	PROJECT NO. :	DRAWING NO. :
DAC	PCM	183927	M.PLAN
DESIGNED BY :	DATE :	SCALE :	
–	2–Oct–18	F.T.P.	

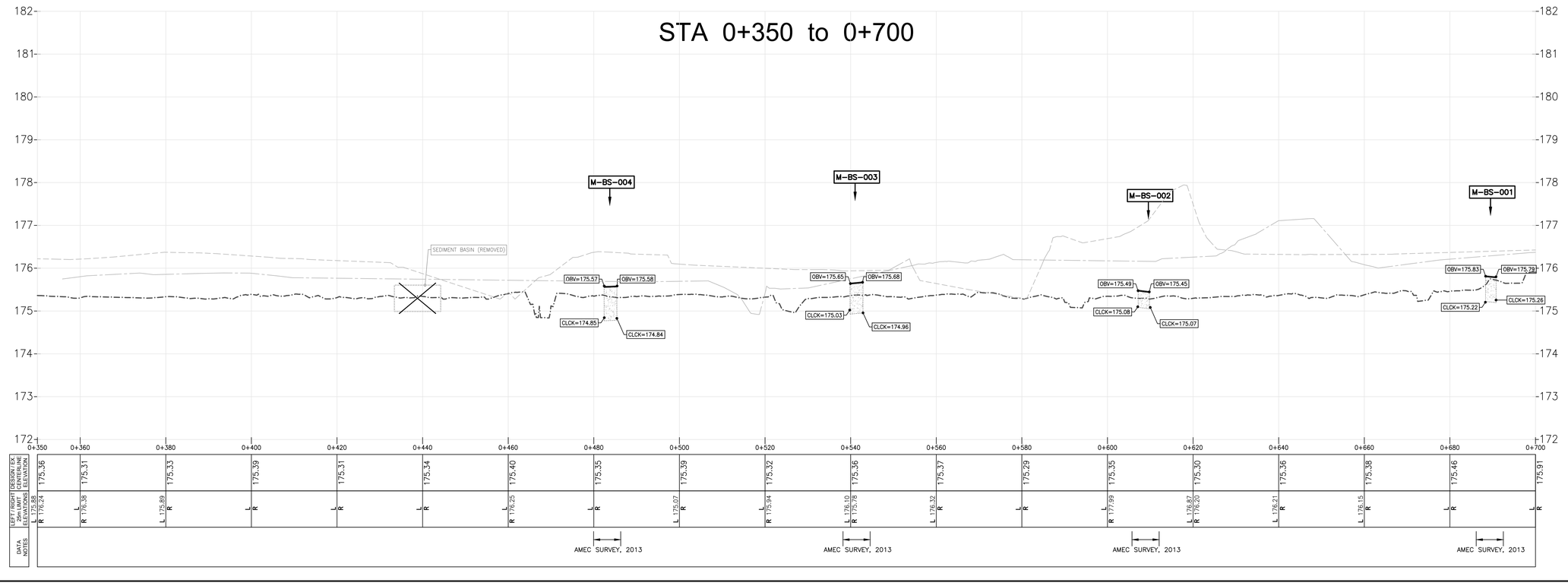
MICHENER DRAIN GRADE PROFILE

STA 0+000 to 0+350



	0+000	0+020	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+180	0+200	0+220	0+240	0+260	0+280	0+300	0+320	0+340	0+350
DESIGN/ EX CENTERLINE ELEVATION	174.47	175.41	175.31	175.35	175.33	175.29	175.32	175.31	175.28	175.35	175.32	175.28	175.31	175.32	175.30	175.38	175.37	175.38	175.36
LEFT / RIGHT 25m LIMIT ELEVATIONS	177.98 R	177.07 L 176.95 R	L 176.89 R	L 176.51 R	175.89 L R	176.75 L 176.10 R	177.47 L 176.10 R	177.40 L 175.99 R	177.44 L 176.03 R	177.54 L 176.09 R	177.31 L 175.93 R	176.08 L 175.97 R	176.41 L 175.88 R	175.81 L R	L 175.71 R	175.47 L 175.95 R	175.56 L R	175.75 L 176.21 R	175.88 L 176.24 R
DATA NOTES																			

STA 0+350 to 0+700



	0+350	0+360	0+380	0+400	0+420	0+440	0+460	0+480	0+500	0+520	0+540	0+560	0+580	0+600	0+620	0+640	0+660	0+680	0+700
DESIGN/ EX CENTERLINE ELEVATION	175.36	175.31	175.33	175.39	175.31	175.34	175.40	175.35	175.39	175.32	175.36	175.37	175.29	175.35	175.30	175.36	175.38	175.46	175.91
LEFT / RIGHT 25m LIMIT ELEVATIONS	175.88 R 176.24 L	L 176.38 R	175.89 L R	L R	L R	L R	L 176.25 R	L R	176.07 L R	L 175.94 R	L 176.10 R 175.78 L	L 176.32 R	L R	L 177.99 R	176.87 L 176.20 R	L 176.21 R	L 176.15 R	L R	L R
DATA NOTES								AMEC SURVEY, 2013			AMEC SURVEY, 2013			AMEC SURVEY, 2013				AMEC SURVEY, 2013	

NOTES:

1. DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED
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   - AS CONSTRUCTED SURVEY BY CofPC, 2016 STATION 0+000–1+940
   - SUPPLEMENTARY SURVEY BY CofPC, 2018

SPATIAL DATA:

DTM DATA FROM NIAGARA PENINSULA CONSERVATION AUTHORITY

- HORIZONTAL DATUM: UTM NAD83–CSRS ZONE 17N
- VERTICAL DATUM: CGVD28–1978
- ACCURACY: ABSOLUTE HORIZONTAL AND VERTICAL POSITIONAL ACCURACIES OF ±0.5m

LEGEND

	EXISTING DRAIN CENTERLINE
	HISTORICAL DRAIN GRADELINE
	PROPOSED DRAIN GRADELINE
	LEFT SURFACE LIMIT
	RIGHT SURFACE LIMIT
	EXISTING DRAIN SECTION
	EXISTING STRUCTURE DETAILS
	ASSUMED EXISTING STRUCTURE DETAILS
OBV=175.00	POINT DATA FROM "DC SURVEY.dwg" AMEC, 2013
	DATA POINT FROM HISTORICAL DESIGN GRADELINE RVA, 1979

NO.	REVISION DESCRIPTION	DATE

PROFILES

THE POSITION OF POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND, WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED.

BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR ANY DAMAGE DONE TO THEM.

CITY OF PORT COLBORNE

MICHENER DRAIN

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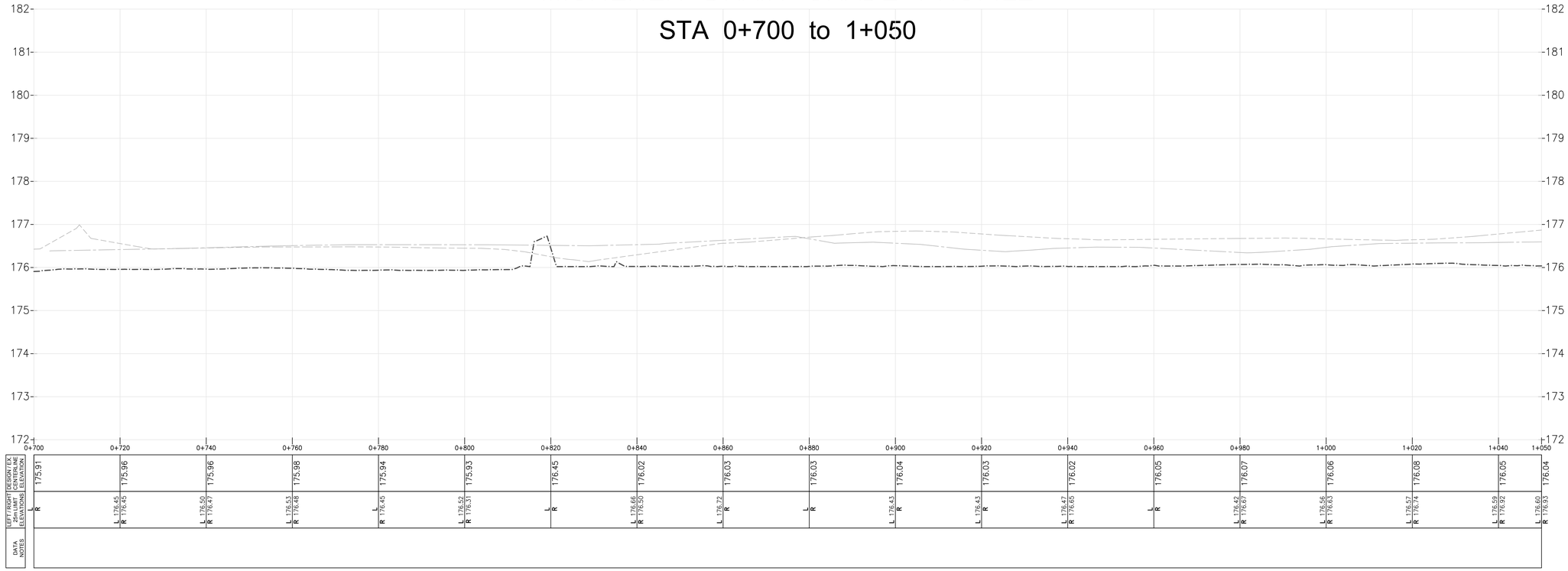
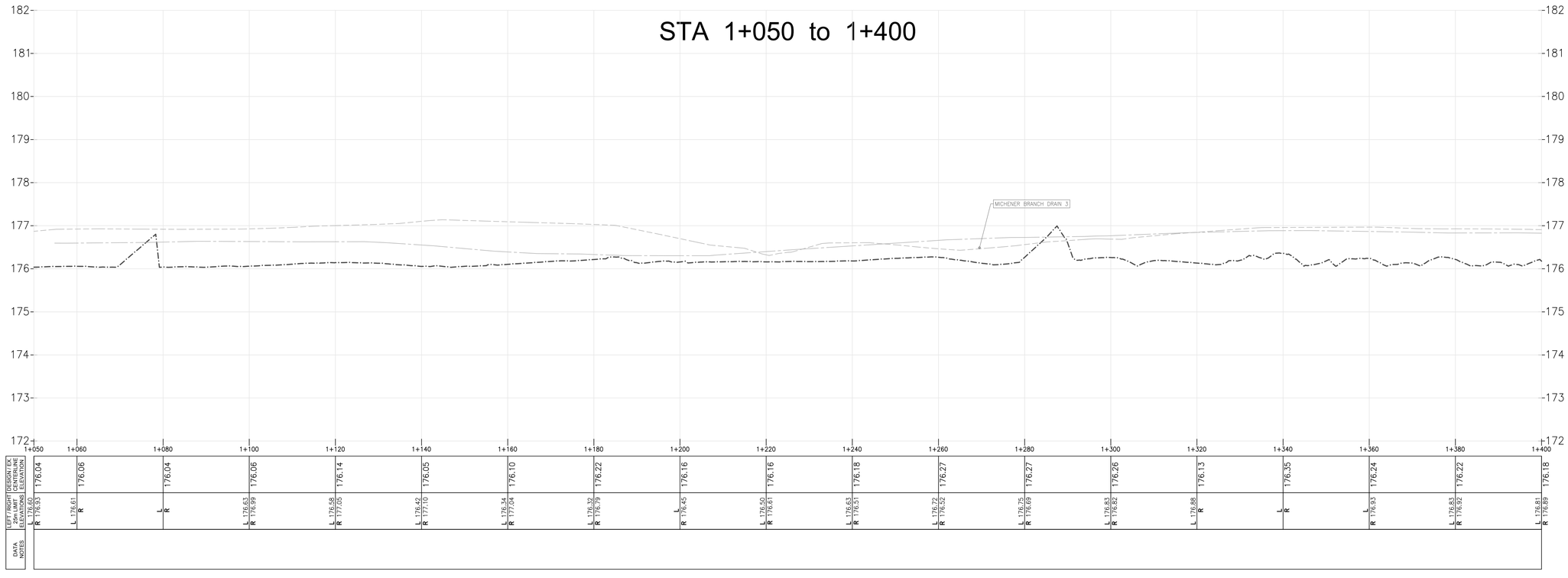
DRAWN BY :	APPROVED BY :	PROJECT NO. :	DRAWING NO. :
DAC	PCM	183927	M.P1
DESIGNED BY :	DATE :	SCALE :	
–	2–Oct–18	1:500	

MICHENER DRAIN GRADE PROFILE

STA 0+700 to 1+050



STA 1+050 to 1+400



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SPATIAL DATA:

DTM DATA FROM NIAGARA PENINSULA CONSERVATION AUTHORITY

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- ACCURACY: ABSOLUTE HORIZONTAL AND VERTICAL POSITIONAL ACCURACIES OF ±0.5m

LEGEND

	EXISTING DRAIN CENTERLINE
	HISTORICAL DRAIN GRADELINE
	PROPOSED DRAIN GRADELINE
	LEFT SURFACE LIMIT
	RIGHT SURFACE LIMIT
	EXISTING DRAIN SECTION
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CITY OF PORT COLBORNE

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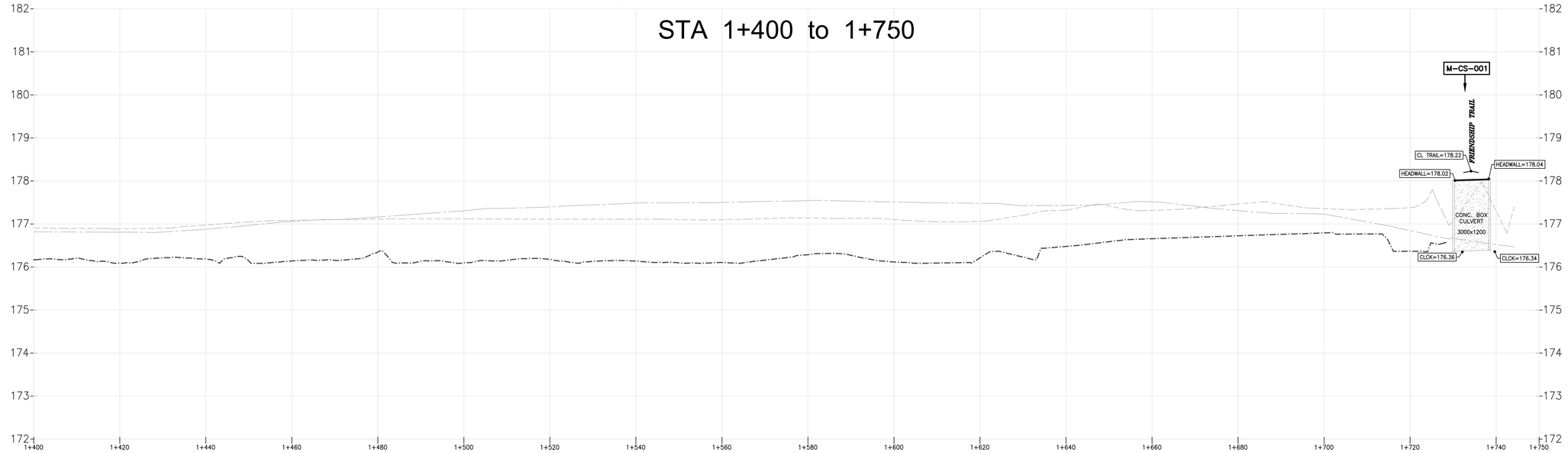
DRAWN BY :	APPROVED BY :	PROJECT NO. :	DRAWING NO. :
DAC	PCM	183927	M.P2
DESIGNED BY :	DATE :	SCALE :	
–	2–Oct–18	1:500	

MICHENER DRAIN GRADE PROFILE

STA 1+400 to 1+750



	1+400	1+420	1+440	1+460	1+480	1+500	1+520	1+540	1+560	1+580	1+600	1+620	1+640	1+660	1+680	1+700	1+720	1+740	1+750
DESIGN/ EX. CENTERLINE ELEVATION	176.18	176.09	176.19	176.14	176.35	176.09	176.18	176.14	176.11	176.29	176.12	176.21	176.48	176.66	176.72	176.79	176.37		
LEFT / RIGHT 25m LIMIT ELEVATION	L 176.81 R 176.89	L 176.84 R 176.95	L R 177.07	L 177.18 R 177.13	L R 177.13	L 177.41 R	L 177.45 R	L 177.50 R 177.09	L 177.50 R 177.15	L 177.51 R 177.13	L 177.47 R 177.05	L 177.46 R 177.32	L 177.52 R 177.31	L 177.34 R	L 177.24 R 177.38	L 176.84 R 177.36	L 177.84 R 177.87	L R	L R
DATA NOTES																			

MICHENER BRANCH DRAIN 3

STA 0+000 to 0+352

	0+000	0+020	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+180	0+200	0+220	0+240	0+260	0+280	0+300	0+320	0+340	0+352
EXISTING CENTERLINE ELEVATION	176.10	176.71	176.64	176.67	176.80	177.21	176.97	176.87	176.44	176.52	176.88	176.90	176.68	176.69	176.71	176.73	176.75	176.76	177.30

MICHENER BRANCH DRAIN 4

STA 0+000 to 0+350

	0+000	0+020	0+040	0+060	0+080	0+100	0+120	0+140	0+160	0+180	0+200	0+220	0+240	0+260	0+280	0+300	0+320	0+340	0+350
EXISTING CENTERLINE ELEVATION	175.31	176.00	175.73	175.82	175.72	175.53	176.29	176.52	176.42	176.10	176.35	176.25	176.22	176.19	176.17	176.49			

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	HISTORICAL DRAIN GRADELINE
	PROPOSED DRAIN GRADELINE
	LEFT SURFACE LIMIT
	RIGHT SURFACE LIMIT
	EXISTING DRAIN SECTION
	EXISTING STRUCTURE DETAILS
	ASSUMED EXISTING STRUCTURE DETAILS
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DAC	PCM	183927	M.P3
DESIGNED BY :	DATE :	SCALE :	
–	2–Oct–18	1:500	

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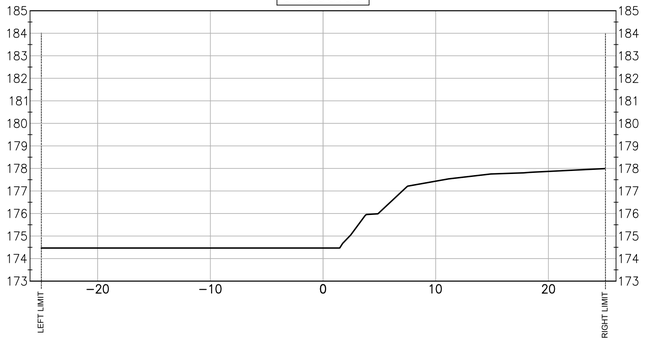

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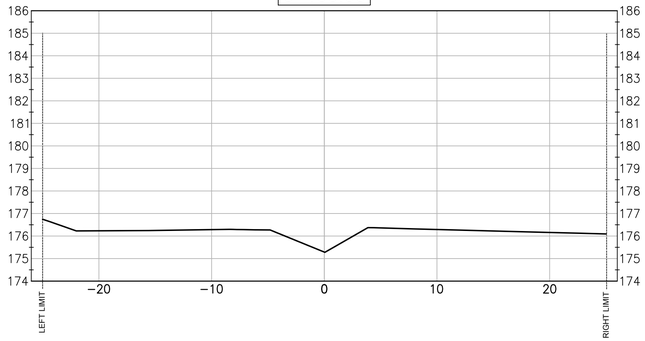

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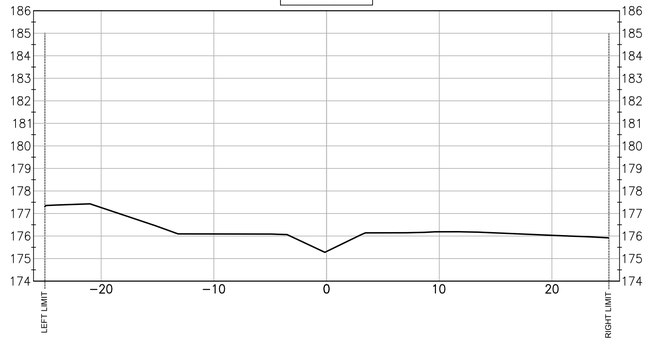

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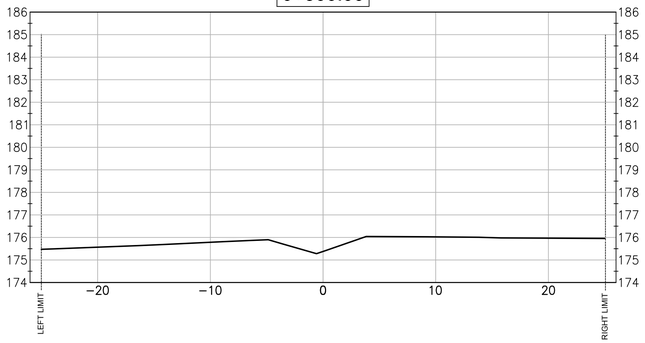

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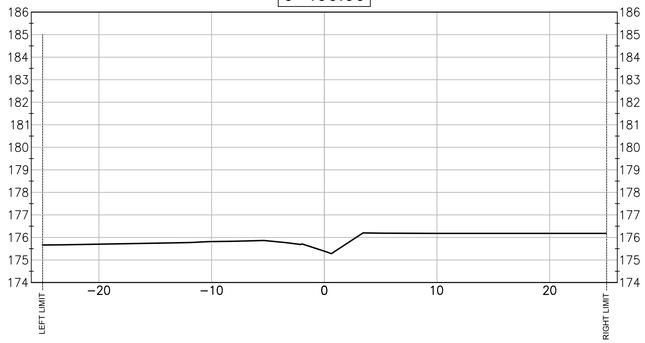

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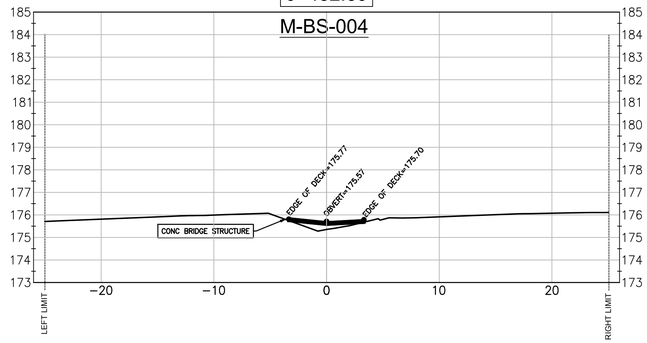

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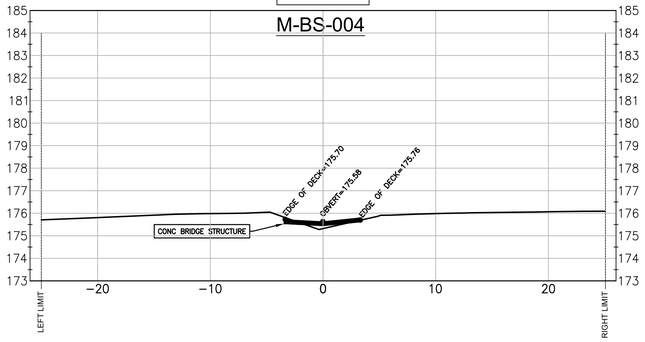

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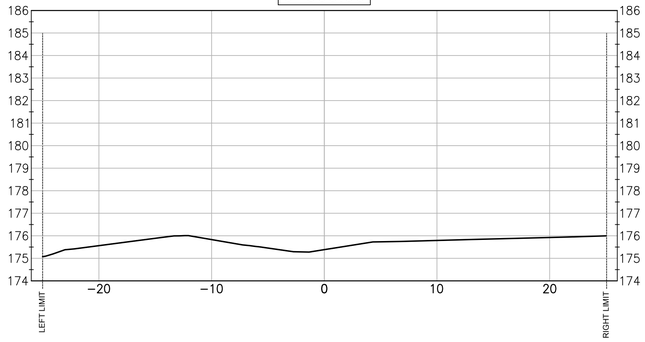

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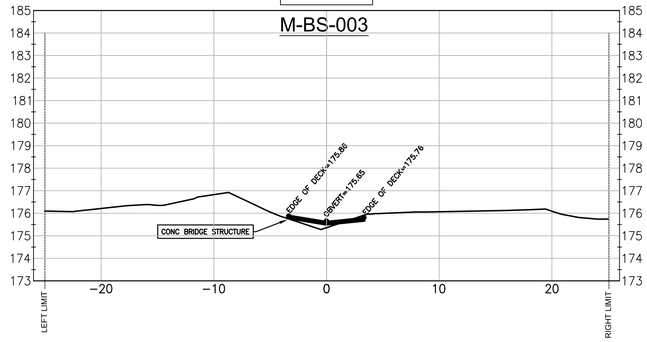

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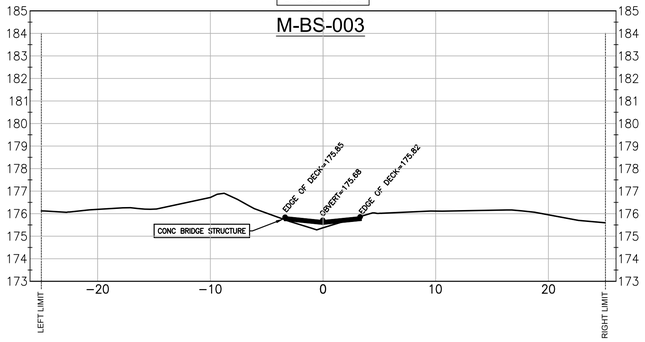

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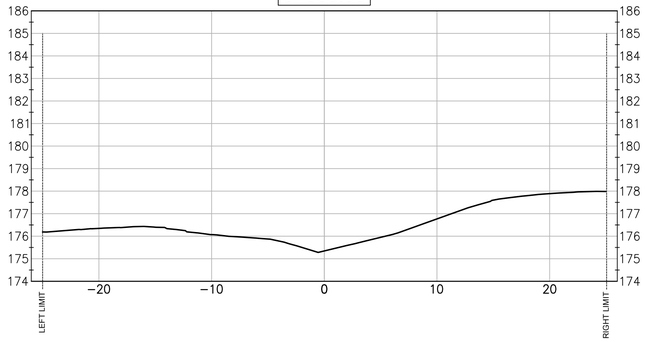

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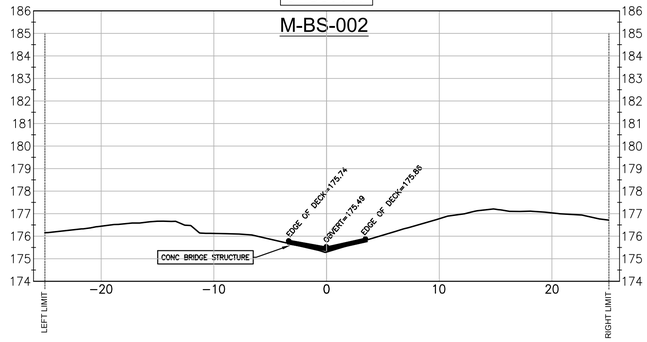

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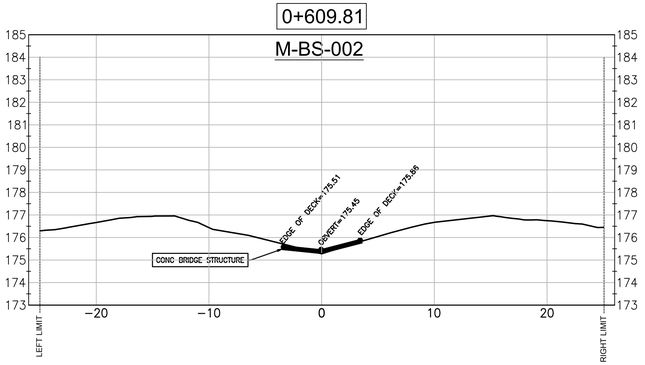

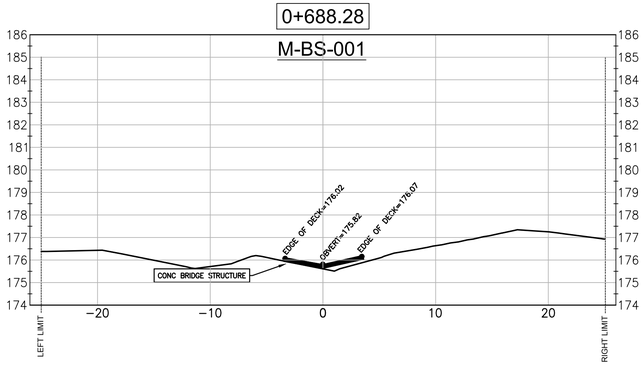

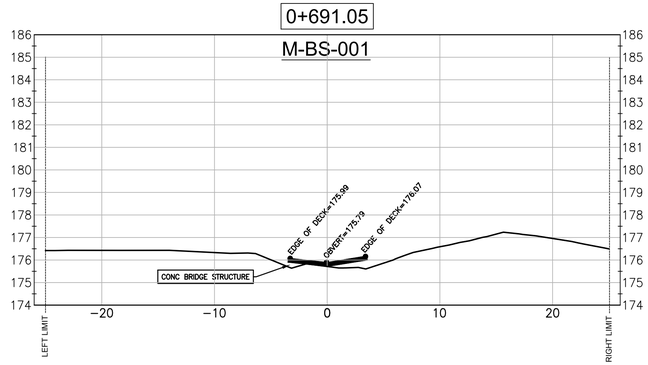

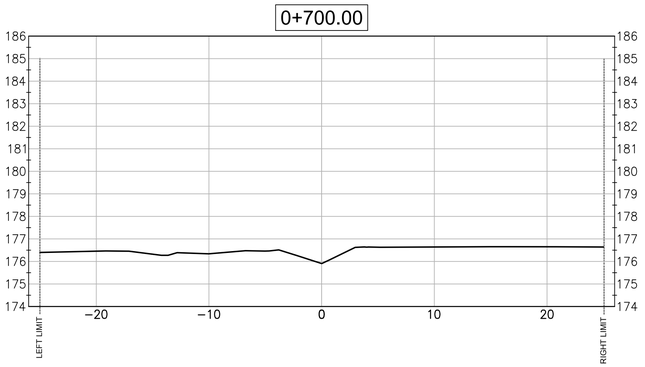

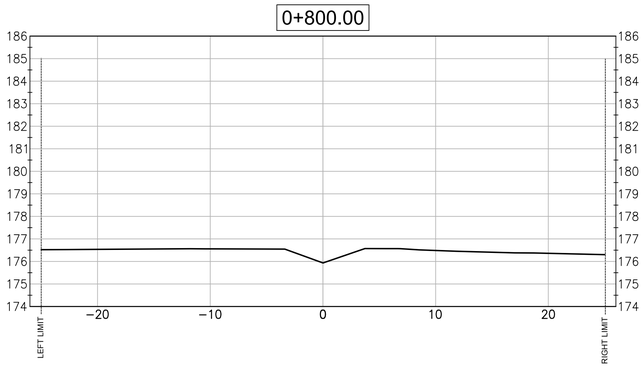

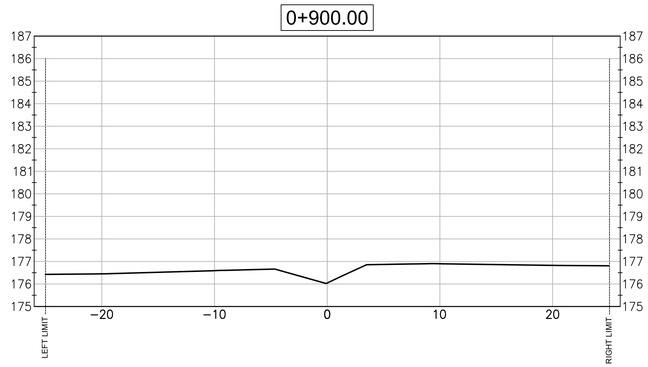

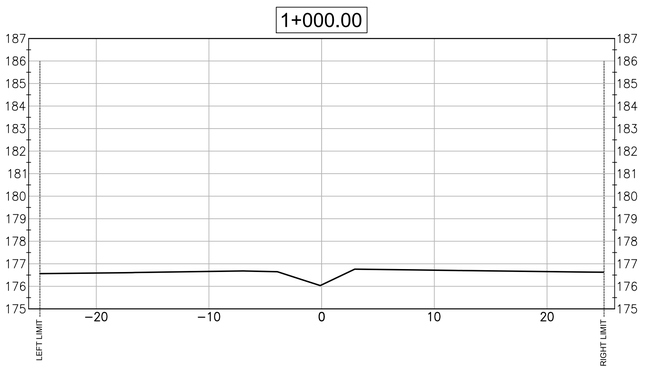

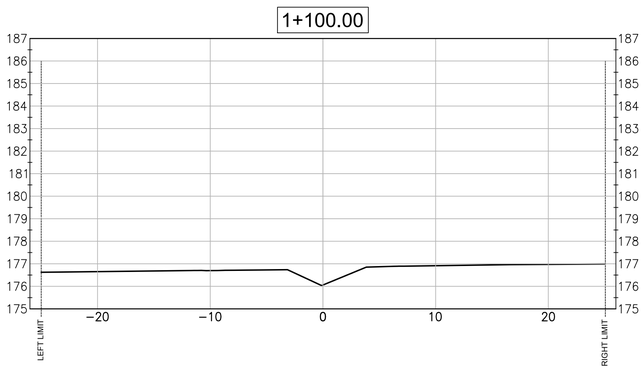

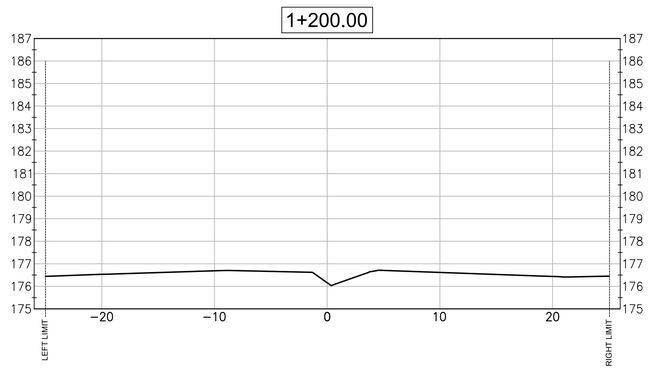

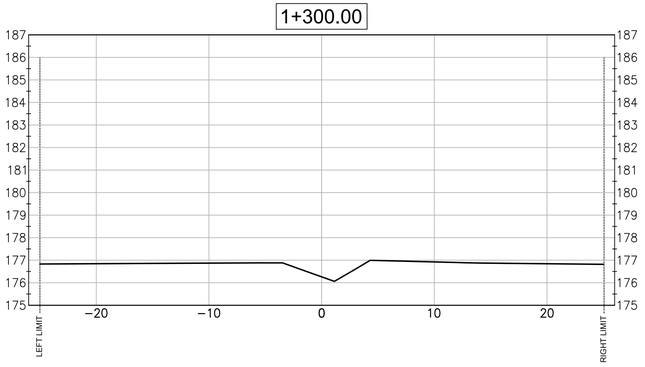

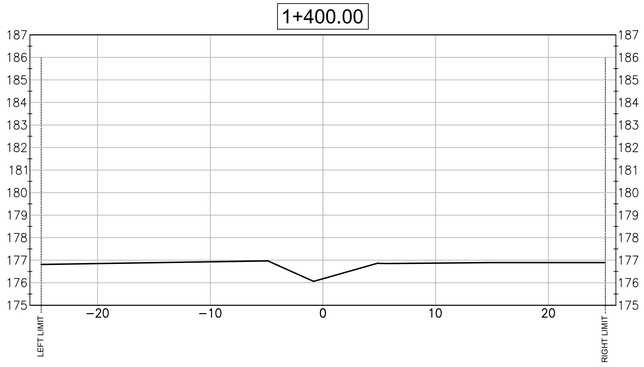

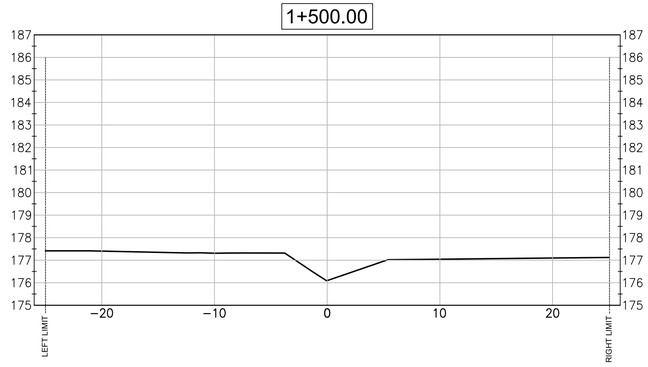

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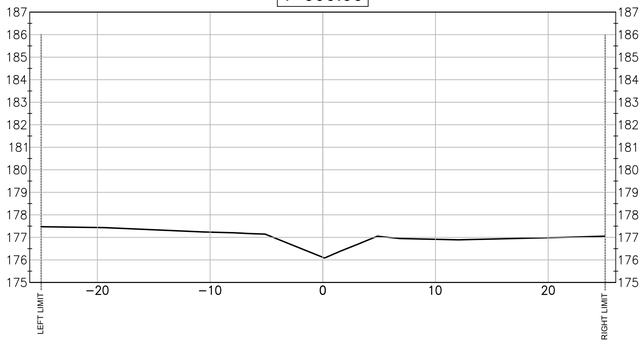

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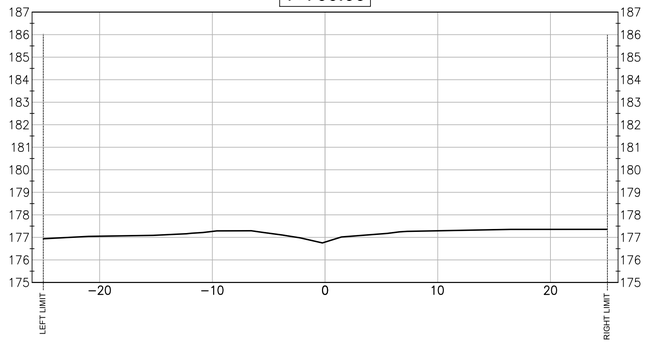

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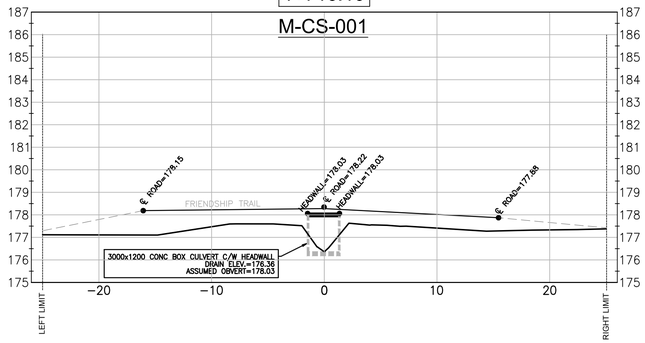

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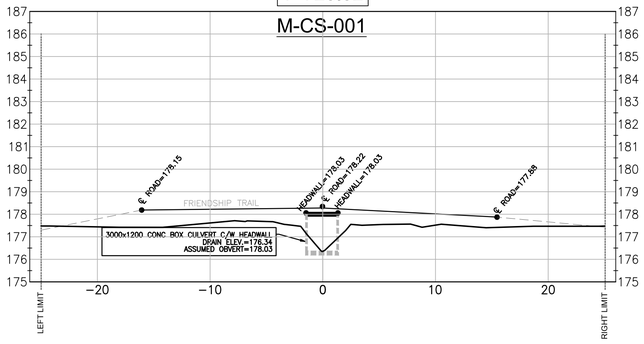

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Appendix C:

Relevant Reports

Ontario Structure Inspection Manual - Inspection Form

Structure:	7 :	*Lorraine Road*	0.24 km South of Killaly Street East

Historical Data

Year Built:	*1960*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

The culvert is in good condition.

There is an overgrowth of vegetation at the east end of the culvert.

The gabion baskets should be checked periodically for stability and slope protection.

There is no significant change since the last inspection in 2009.

Next Detailed Visual Inspection:

Structure:	7 : *Lorraine Road*	0.24 km South of Killaly Street East

Element Group:	*Culverts*	Length:	*3.6*
Element Name:	*Inlet / Outlet Components*	Width:	*12.2*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs:

Comments / Recommended Work:
There is some minor spalling.

Vegetation should be cleared from the culvert area.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	75%
Good:	25%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
The foundation is not visible for inspection, however, it appears to be in stable condition.

Ontario Structure Inspection Manual - Inspection Form

Structure:	7 :	*Lorraine Road*	0.24 km South of Killaly Street East

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Retained Soil System*		Count:
Element Type:	*Gabion Baskets*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		*It appears that some gabion baskets are missing stone, and as a result over time, has deformed and shifted. However, the gabion baskets are still providing adequate support for slope stability at this time.*
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: *6*
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:	75%	
	Good:	25%	
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Structure 7 : *Lorraine Road*	0.24 km South of Killaly Street East

Photographs

Roadway over the structure - Looking south

The west end of the structure

Structure	7	:	*Lorraine Road*	0.24 km South of Killaly Street East

Photographs

View of the interior of the structure, from the west end

View of the interior of the structure, from the east end

Ontario Structure Inspection Manual - Inspection Form

Structure: 8 : *Weaver Road* — 1.56 km South of Killaly Street East

Inventory Data

Structure Name: *Beaver-dam Drain Lot 19*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Weaver Road*

Structure Location: *1.56 km South of Killaly Street East*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed:

# of Lanes: *1*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *6*

Structure Type: *Poured-In-Place Concrete Arch*

Interchange Number:

Total Deck Length: *4.3* (m)

Interchange Structure Number:

Overall Str. Width: *3.1* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *3* (m)

Detour Length Around Bridge: km

Skew Angle: *0* (Degrees)

Direction of Structure: *North-South*

No. of Spans: *1*

Span Lengths: *3.7* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-06*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *19 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	8 :	*Weaver Road*	1.56 km South of Killaly Street East

Historical Data			
Year Built:	*1920*	Last Inspection:	*2009*
Rehab History / Notes:			

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

The embankment at the northwest corner should be checked periodically for erosion and slope protection.

There is no significant change since the last inspection in 2009.

Next Detailed Visual Inspection:

Ontario Structure Inspection Manual - Inspection Form

Structure:	8 :	*Weaver Road*	1.56 km South of Killaly Street East

Element Group:	*Culverts*		Length:	*4.3*
Element Name:	*Inlet / Outlet Components*		Width:	*3.1*
Location:			Height:	
Material:	*Concrete*		Count:	
Element Type:			Total Quantity:	
Environment:	*Moderate*		Limited Inspection:	
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:			
	Good:	60%		
	Fair:	30%		
	Poor:	10%		
Performance Deficiencies:		None		
Maintenance Needs:		None		

Element Group:	*Decks*		Length:	
Element Name:	*Top / Wearing Surface*		Width:	
Location:			Height:	
Material:	*Asphalt Wearing Surface*		Count:	
Element Type:			Total Quantity:	
Environment:	*Moderate*		Limited Inspection:	*Yes*
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:			
	Good:	50%		
	Fair:	50%		
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Element Group:	*Foundations*		Length:	
Element Name:	*Foundation*		Width:	
Location:			Height:	
Material:	*Concrete*		Count:	
Element Type:			Total Quantity:	
Environment:	*Severe*		Limited Inspection:	*Yes*
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:	50%	*The foundation is not visible for inspection,*	
	Good:	50%	*however, it appears to be in stable condition.*	
	Fair:			
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Ontario Structure Inspection Manual - Inspection Form

Structure:	8 :	*Weaver Road*	1.56 km South of Killaly Street East

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Concrete*		Count:
Element Type:	*Concrete Wall / Wingwall*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		*Concrete has broken away from the bottom of the northwest wingwall, allowing for erosion at the embankment.*
	Good:		
	Fair:	75%	
	Poor:	25%	
Performance Deficiencies:		15	
Maintenance Needs:		13	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: 3
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:	*Barriers*		Length:
Element Name:	*Barriers / Railings*		Width:
Location:			Height:
Material:	*Concrete*		Count:
Element Type:	*Wall*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:	25%	
	Fair:	75%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Structure 8 : *Weaver Road*	1.56 km South of Killaly Street East

Photographs

Roadway over the structure - Looking west

View of the structure, from the south side

Structure	8	:	*Weaver Road*	1.56 km South of Killaly Street East

Photographs

Concrete has deteriorated and broken away, at the northwest wing wall

View of the structure, from the north side

Ontario Structure Inspection Manual - Inspection Form

Structure:	9	:	*Weaver Road*	1.24 km South of Killaly Street East

Inventory Data

Structure Name: *Beaver-dam Drain Lot 18 & 19*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Weaver Road*

Structure Location: *1.24 km South of Killaly Street East*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed: *60* km/h

# of Lanes: *2*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *7*

Structure Type: *Rectangular Concrete Structure*

Interchange Number:

Total Deck Length: *4.8* (m)

Interchange Structure Number:

Overall Str. Width: *16.8* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *6* (m)

Detour Length Around Bridge: km

Skew Angle: *L-30* (Degrees)

Direction of Structure: *West-East*

No. of Spans: *1*

Span Lengths: *4.4* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-06*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *19 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	9 :	*Weaver Road*	1.24 km South of Killaly Street East

Historical Data

Year Built:	*1964*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:	X		

Special Notes:
There is no significant change since the last inspection in 2009.

Next Detailed Visual Inspection:

Ontario Structure Inspection Manual - Inspection Form

Structure:	9 :	*Weaver Road*	1.24 km South of Killaly Street East

Element Group:	*Culverts*	Length:	*4.8*
Element Name:	*Inlet / Outlet Components*	Width:	*16.8*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:

Units	
Exc.:	25%
Good:	75%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
There is minor spalling on the surface.

A utility cable is affixed to the east end of the culvert.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
The foundation is not visible for inspection, however, it appears to be in stable condition.

Structure:	9 :	*Weaver Road*	1.24 km South of Killaly Street East

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Concrete*		Count:
Element Type:	*Retaining Wall / Blocks*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:	25%	*There appears that minor settlement of the concrete blocks at the southeast corner has occurred, but has stabilized.*
	Good:	75%	
	Fair:		
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: *6*
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:	75%	
	Good:	25%	
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:	*Barriers*		Length:
Element Name:	*Barriers / Railings*		Width:
Location:			Height:
Material:	*Steel*		Count:
Element Type:	*Guide Rail*		Total Quantity: *1*
Environment:	*Severe*		Limited Inspection:
Protection System:	Galvanized		
Condition Data:	Units		Comments / Recommended Work:
	Exc.:	75%	
	Good:	25%	
	Fair:		
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Structure 9 : *Weaver Road*	1.24 km South of Killaly Street East

Photographs

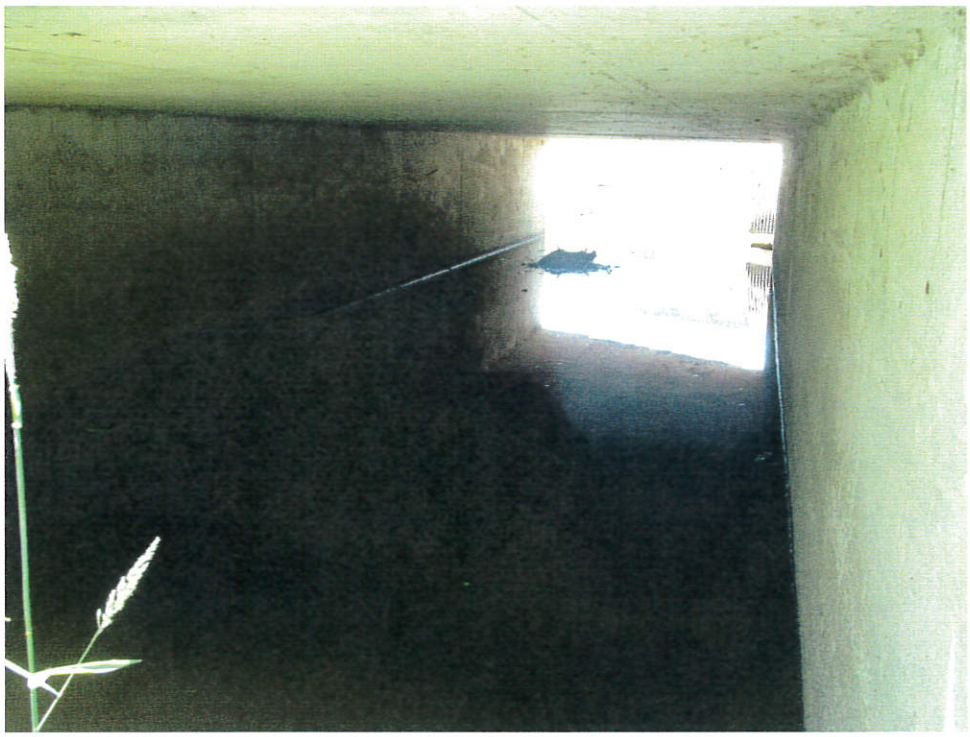
Roadway over the structure - Looking south

The east end of the structure

Structure 9 : *Weaver Road*	1.24 km South of Killaly Street East

Photographs

Concrete block retaining wall at the southeast corner of the structure



Viewing the interior of the structure from the east end

Structure 9 : *Weaver Road*	1.24 km South of Killaly Street East

Photographs

The west end of the structure

The west end of the structure

Ontario Structure Inspection Manual - Inspection Form

Structure:	10 :	*Lakeshore Road East*	0.30 km West of Lorraine Road

Inventory Data

Structure Name: *Wignell Drain Lot 21*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Lakeshore Road East*

Structure Location: *0.30 km West of Lorraine Road*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed: *40* km/h

# of Lanes: *1*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *5*

Structure Type: *Composite Bridge*

Interchange Number:

Total Deck Length: *6.3* (m)

Interchange Structure Number:

Overall Str. Width: *4.8* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *3.4* (m)

Detour Length Around Bridge: km

Skew Angle: (Degrees)

Direction of Structure: *North-South*

No. of Spans: *1*

Span Lengths: *5.4* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-06*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *19 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	10 :	*Lakeshore Road East*	0.30 km West of Lorraine Road

Historical Data

Year Built:	*1950*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

On the south (downstream) side of the structure, there are two floodgates with a bypass, as well as a submersible pump, and a pump control shed. (In 1993, the facility had 2 submersible pumps.)

There are large cracks on the west abutment wall.
The abutments should be monitored for signs of further deterioration.

The steel rails are in fair condition with some minor rusting.
It is recommended to sand and re-paint the rails as part of a maintenance program, or to replace.

There is no significant change in the structure since the last inspection in 2009.

Next Detailed Visual Inspection:

Structure:	10 :	*Lakeshore Road East*	0.30 km West of Lorraine Road

Element Group:	*Beams*	Length:	*6.3*
Element Name:	*Girders*	Width:	*4.8*
Location:		Height:	
Material:	*Steel*	Count:	
Element Type:		Total Quantity:	*11*
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Concrete, with Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Abutments*	Length:	
Element Name:	*Bearings*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	25%
Fair:	75%
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

The abutments appear to be in fair condition. There are large cracks on the west abutment wall. The abutments should be monitored for signs of further deterioration.

Structure:	10 : *Lakeshore Road East*	0.30 km West of Lorraine Road

Element Group:	*Foundations*		Length:	
Element Name:	*Foundation*		Width:	
Location:	*Footing*		Height:	
Material:	*Concrete*		Count:	
Element Type:			Total Quantity:	
Environment:	*Severe*		Limited Inspection:	*Yes*
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:		*The foundation is not visible for inspection, however, it appears to be in stable condition.*	
	Good:	50%		
	Fair:	50%		
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Element Group:	*Streams & Embankments*		Length:	
Element Name:	*Slope Protection*		Width:	
Location:			Height:	
Material:	*Concrete / Retained Soil System*		Count:	
Element Type:	*Conc. Wall / Gabion Baskets*		Total Quantity:	
Environment:	*Severe*		Limited Inspection:	
Protection System:				
Condition Data:	Units	All	Comments / Recommended Work:	
	Exc.:			
	Good:	50%		
	Fair:	50%		
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Element Group:	*Approaches*		Length:	
Element Name:	*Approaches*		Width:	*3.4*
Location:	*West / East*		Height:	
Material:	*Asphalt*		Count:	
Element Type:			Total Quantity:	
Environment:	*Severe*		Limited Inspection:	
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:	25%		
	Good:	75%		
	Fair:			
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Structure:	10 :	*Lakeshore Road East*	0.30 km West of Lorraine Road

Element Group:	*Barriers*		Length:
Element Name:	*Barriers / Railings*		Width:
Location:	*North / South sides*		Height:
Material:	*Steel*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		*The steel rails are in fair condition with some minor rusting. It is recommended to sand and re-paint the rails as part of a maintenance program, or to replace the rails.*
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Structure	10	:	*Lakeshore Road East*	0.30 km West of Lorraine Road

Photographs

Roadway over the structure - Looking west

The south side of the structure

Structure	10	:	*Lakeshore Road East*	0.30 km West of Lorraine Road

Photographs

The east wall of the structure

The west wall of the structure

Structure	10	:	*Lakeshore Road East*	0.30 km West of Lorraine Road

Photographs

The underside of the structure

Large cracks on the north end of the west abutment wall

Ontario Structure Inspection Manual - Inspection Form

Structure:	12 :	*Second Concession*	0.16 km East of White Road

Inventory Data

Structure Name: *Beaver-dam Drain Lot 14*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Second Concession*

Structure Location: *0.16 km East of White Road*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed:

# of Lanes: *2*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *14*

Structure Type: *Concrete Culvert with inclined legs*

Interchange Number:

Total Deck Length: *3.6* (m)

Interchange Structure Number:

Overall Str. Width: *19* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *5.8* (m)

Detour Length Around Bridge: km

Skew Angle: *R-40* (Degrees)

Direction of Structure: *North-South*

No. of Spans: *1*

Span Lengths: *3.2* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-07*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *21 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	12 :	*Second Concession*	0.16 km East of White Road

Historical Data

Year Built:	*1960*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:	X		

Special Notes:

Water floods adjacent lands in this area during periods of intense rainfall.

There is no significant change since the last inspection in 2009.

Next Detailed Visual Inspection:

Structure:	12 :	*Second Concession*	0.16 km East of White Road

Element Group:	*Culverts*	Length:	*3.6*
Element Name:	*Inlet / Outlet Components*	Width:	*19*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:

Units	
Exc.:	20%
Good:	60%
Fair:	20%
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

A utility cable is affixed to the south end of the culvert.

There is a crack along the length of the west wall through which water is infiltrating.

There is minor spalling at the north end.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

The foundation is not visible for inspection, however, it appears to be in stable condition.

Structure:	12 :	*Second Concession*	0.16 km East of White Road

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Retained Soil System*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: *5.8*
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:	25%	
	Good:	75%	
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Structure 12 : *Second Concession*	0.16 km East of White Road

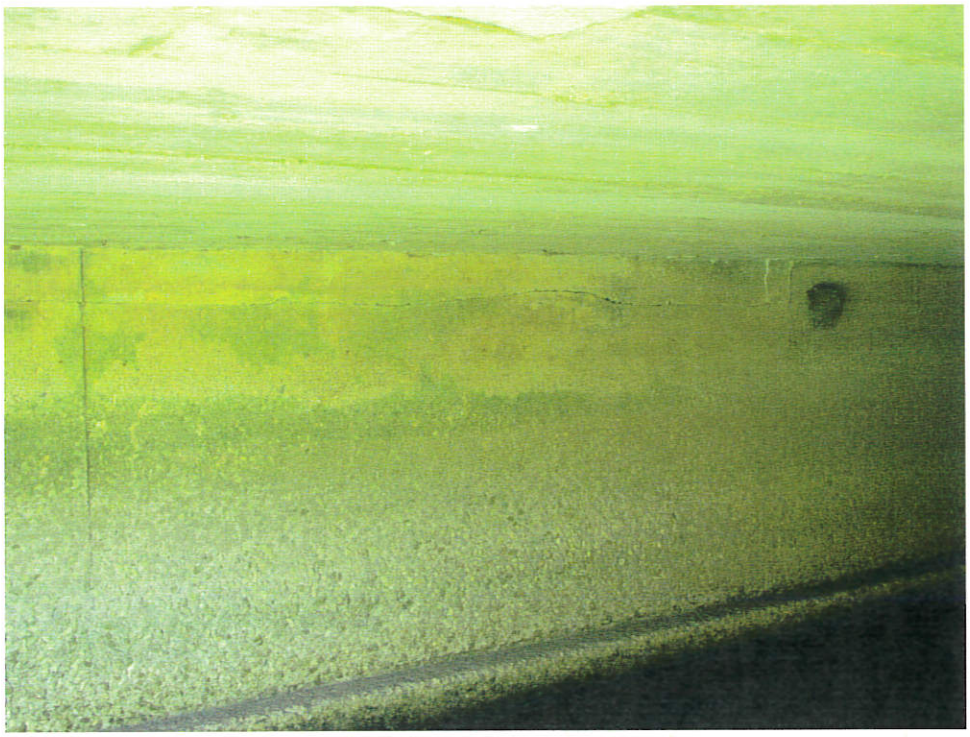
Photographs

Roadway over the structure - Looking west

The north end of the structure

Structure	12	:	*Second Concession*	0.16 km East of White Road

Photographs



The east wall of the structure

The underside of the structure

Structure	12	:	*Second Concession*	0.16 km East of White Road

Photographs

The south end of the structure

Viewing the interior of the structure, from the south end

Ontario Structure Inspection Manual - Inspection Form

Structure:	14 :	*Weaver Road*	0.09 km North of Killaly Street East

Inventory Data

Structure Name: *Mitchener M2 Lot 18*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Weaver Road*

Structure Location: *0.09 km North of Killaly Street East*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed:

# of Lanes: *2*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *8*

Structure Type: *Rectangular Concrete Structure*

Interchange Number:

Total Deck Length: *2.9* (m)

Interchange Structure Number:

Overall Str. Width: *8.5* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *5.5* (m)

Detour Length Around Bridge: km

Skew Angle: (Degrees)

Direction of Structure: *West-East*

No. of Spans: *1*

Span Lengths: *2.5* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection:	*2012-06-06*
Inspector:	*Simon Ip*
Others In Party:	*Sean Ip*
Weather:	*Clear*
Temperature:	*19 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	14 :	*Weaver Road*	0.09 km North of Killaly Street East

Historical Data

Year Built:	*1930*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

It appears that there were two castings for this culvert. The major portion on the east end was cast around 1930, and the west end was cast around 1950.

There is notable separation of the concrete wall at the southeast corner of the structure.

Next Detailed Visual Inspection:

Structure:	14 :	*Weaver Road*	0.09 km North of Killaly Street East

Element Group:	*Culverts*	Length:	*2.9*
Element Name:	*Inlet / Outlet Components*	Width:	*8.5*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	50%
Fair:	50%
Poor:	

Performance Deficiencies: None

Maintenance Needs:

Comments / Recommended Work:
There is an overgrowth of vegetation on the east end of the culvert which should be cleared.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
There is a crack between the deck and the south wall, on the west end of the structure.

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
There is a crack at the footing at the southeast corner of the structure.

Structure:	14 :	*Weaver Road*	0.09 km North of Killaly Street East

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Concrete*		Count:
Element Type:	*Broken Concrete / Blocks*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		*Broken concrete sidewalk has been used for side slope protection on the west side. Concrete blocks have been used on the east side.*
	Good:	75%	
	Fair:	25%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: *5.5*
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		*There is some minor settlement of asphalt at the southeast corner of the structure.*
	Good:	75%	
	Fair:	25%	
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Structure 14 : *Weaver Road*	0.09 km North of Killaly Street East

Photographs

Roadway over the structure - Looking north

The west end of the structure

Structure	14	:	*Weaver Road*	0.09 km North of Killaly Street East

Photographs

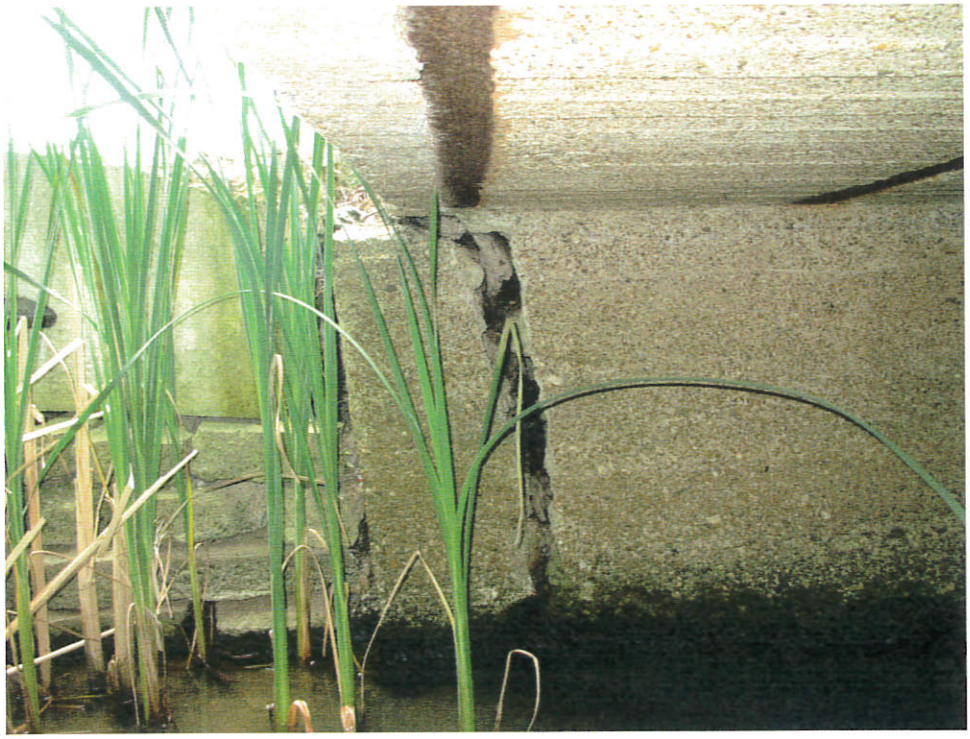
Cracking at the southwest corner of the structure

Viewing the interior of the structure from the west end

Structure	14	:	*Weaver Road*	0.09 km North of Killaly Street East

Photographs

The east end of the structure



Cracking at the footing at the southeast corner of the structure

Ontario Structure Inspection Manual - Inspection Form

Structure:	15 :	*White Road*	1.00 km North of Highway 3

Inventory Data

Structure Name: *Beaver-dam Drain Lot 14 & 15*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *White Road*

Structure Location: *1.00 km North of Highway 3*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed:

# of Lanes: *2*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *15*

Structure Type: *Rectangular Concrete Structure*

Interchange Number:

Total Deck Length: *2.9* (m)

Interchange Structure Number:

Overall Str. Width: *7.2* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *5* (m)

Detour Length Around Bridge: km

Skew Angle: (Degrees)

Direction of Structure: *West-East*

No. of Spans: *1*

Span Lengths: *2.4* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-07*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *21 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	15 :	*White Road*	1.00 km North of Highway 3

Historical Data

Year Built:	*1950*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

Water floods adjacent lands in this area during periods of intense rainfall.

There seems to be some minor erosion occurring in the area of the culvert. The embankments, especially on the east side, should be monitored frequently for stability and signs of further erosion.

For safety, installation of a guide rail along the east side of the road is recommended.

Next Detailed Visual Inspection:

Ontario Structure Inspection Manual - Inspection Form

Structure:	15 :	*White Road*	1.00 km North of Highway 3

Element Group:	*Culverts*	Length:	*2.9*
Element Name:	*Inlet / Outlet Components*	Width:	*7.2*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:	Units
Exc.:	
Good:	25%
Fair:	75%
Poor:	
Performance Deficiencies:	13
Maintenance Needs:	

Comments / Recommended Work:
Some cracking is evident on the headwalls.

There is an overgrowth of vegetation on the west end of the culvert which should be cleared.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:	Units
Exc.:	
Good:	100%
Fair:	
Poor:	
Performance Deficiencies:	None
Maintenance Needs:	None

Comments / Recommended Work:

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:	Units
Exc.:	
Good:	100%
Fair:	
Poor:	
Performance Deficiencies:	None
Maintenance Needs:	None

Comments / Recommended Work:
The foundation is not visible for inspection, however, it appears to be in stable condition.

Structure:	15 : *White Road*	1.00 km North of Highway 3

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Retained Soil System*		Count:
Element Type:	*Grassed Embankment*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		*The embankments should be monitored frequently for stability and signs of further erosion.*
	Good:	25%	
	Fair:	75%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: 5
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:	*Barriers*		Length:
Element Name:	*Barriers / Railings*		Width:
Location:			Height:
Material:	*Steel / Wood*		Count:
Element Type:	*3-Cable Guide on Posts*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		*The 3-cable guide on posts should be rehabilitated or replaced.*
	Good:		
	Fair:	75%	*For safety, installation of a guide rail along the ease side of the road is recommended.*
	Poor:	25%	
Performance Deficiencies:		None	
Maintenance Needs:		None	

Structure	15	:	*White Road*	1.00 km North of Highway 3

Photographs

Roadway over the structure - Looking south

Roadway over the structure - Looking north

Structure 15 : *White Road*	1.00 km North of Highway 3

Photographs

The east end of the structure

Viewing the interior of the structure from the east end

Structure 15 : *White Road*	1.00 km North of Highway 3

Photographs

The underside of the structure

The west end of the structure

Ontario Structure Inspection Manual - Inspection Form

Structure:	7 :	*Lorraine Road*	0.24 km South of Killaly Street East

Historical Data

Year Built:	*1960*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

The culvert is in good condition.

There is an overgrowth of vegetation at the east end of the culvert.

The gabion baskets should be checked periodically for stability and slope protection.

There is no significant change since the last inspection in 2009.

Next Detailed Visual Inspection:

Structure:	7 : *Lorraine Road*	0.24 km South of Killaly Street East

Element Group:	*Culverts*	Length:	*3.6*
Element Name:	*Inlet / Outlet Components*	Width:	*12.2*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs:

Comments / Recommended Work:
There is some minor spalling.

Vegetation should be cleared from the culvert area.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	75%
Good:	25%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
The foundation is not visible for inspection, however, it appears to be in stable condition.

Ontario Structure Inspection Manual - Inspection Form

Structure:	7 :	*Lorraine Road*	0.24 km South of Killaly Street East

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Retained Soil System*		Count:
Element Type:	*Gabion Baskets*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		*It appears that some gabion baskets are missing stone, and as a result over time, has deformed and shifted. However, the gabion baskets are still providing adequate support for slope stability at this time.*
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: *6*
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:	75%	
	Good:	25%	
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Structure 7 : *Lorraine Road*	0.24 km South of Killaly Street East

Photographs

Roadway over the structure - Looking south

The west end of the structure

Structure	7	:	*Lorraine Road*	0.24 km South of Killaly Street East

Photographs

View of the interior of the structure, from the west end

View of the interior of the structure, from the east end

Ontario Structure Inspection Manual - Inspection Form

Structure: 8 : *Weaver Road* — 1.56 km South of Killaly Street East

Inventory Data

Structure Name: *Beaver-dam Drain Lot 19*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Weaver Road*

Structure Location: *1.56 km South of Killaly Street East*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed:

# of Lanes: *1*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *6*

Structure Type: *Poured-In-Place Concrete Arch*

Interchange Number:

Total Deck Length: *4.3* (m)

Interchange Structure Number:

Overall Str. Width: *3.1* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *3* (m)

Detour Length Around Bridge: km

Skew Angle: *0* (Degrees)

Direction of Structure: *North-South*

No. of Spans: *1*

Span Lengths: *3.7* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-06*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *19 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	8 :	*Weaver Road*	1.56 km South of Killaly Street East

Historical Data			
Year Built:	*1920*	Last Inspection:	*2009*
Rehab History / Notes:			

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

The embankment at the northwest corner should be checked periodically for erosion and slope protection.

There is no significant change since the last inspection in 2009.

Next Detailed Visual Inspection:

Ontario Structure Inspection Manual - Inspection Form

Structure:	8 :	*Weaver Road*	1.56 km South of Killaly Street East

Element Group:	*Culverts*		Length:	*4.3*
Element Name:	*Inlet / Outlet Components*		Width:	*3.1*
Location:			Height:	
Material:	*Concrete*		Count:	
Element Type:			Total Quantity:	
Environment:	*Moderate*		Limited Inspection:	
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:			
	Good:	60%		
	Fair:	30%		
	Poor:	10%		
Performance Deficiencies:		None		
Maintenance Needs:		None		

Element Group:	*Decks*		Length:	
Element Name:	*Top / Wearing Surface*		Width:	
Location:			Height:	
Material:	*Asphalt Wearing Surface*		Count:	
Element Type:			Total Quantity:	
Environment:	*Moderate*		Limited Inspection:	*Yes*
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:			
	Good:	50%		
	Fair:	50%		
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Element Group:	*Foundations*		Length:	
Element Name:	*Foundation*		Width:	
Location:			Height:	
Material:	*Concrete*		Count:	
Element Type:			Total Quantity:	
Environment:	*Severe*		Limited Inspection:	*Yes*
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:	50%	*The foundation is not visible for inspection,*	
	Good:	50%	*however, it appears to be in stable condition.*	
	Fair:			
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Ontario Structure Inspection Manual - Inspection Form

Structure:	8 :	*Weaver Road*	1.56 km South of Killaly Street East

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Concrete*		Count:
Element Type:	*Concrete Wall / Wingwall*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		*Concrete has broken away from the bottom of the northwest wingwall, allowing for erosion at the embankment.*
	Good:		
	Fair:	75%	
	Poor:	25%	
Performance Deficiencies:		15	
Maintenance Needs:		13	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: 3
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:	*Barriers*		Length:
Element Name:	*Barriers / Railings*		Width:
Location:			Height:
Material:	*Concrete*		Count:
Element Type:	*Wall*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:	25%	
	Fair:	75%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Structure 8 : *Weaver Road*	1.56 km South of Killaly Street East

Photographs

Roadway over the structure - Looking west

View of the structure, from the south side

Structure	8	:	*Weaver Road*	1.56 km South of Killaly Street East

Photographs

Concrete has deteriorated and broken away, at the northwest wing wall

View of the structure, from the north side

Ontario Structure Inspection Manual - Inspection Form

Structure:	9	:	*Weaver Road*	1.24 km South of Killaly Street East

Inventory Data

Structure Name: *Beaver-dam Drain Lot 18 & 19*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Weaver Road*

Structure Location: *1.24 km South of Killaly Street East*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed: *60* km/h

# of Lanes: *2*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *7*

Structure Type: *Rectangular Concrete Structure*

Interchange Number:

Total Deck Length: *4.8* (m)

Interchange Structure Number:

Overall Str. Width: *16.8* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *6* (m)

Detour Length Around Bridge: km

Skew Angle: *L-30* (Degrees)

Direction of Structure: *West-East*

No. of Spans: *1*

Span Lengths: *4.4* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-06*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *19 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	9 :	*Weaver Road*	1.24 km South of Killaly Street East

Historical Data

Year Built:	*1964*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:	X		

Special Notes:
There is no significant change since the last inspection in 2009.

Next Detailed Visual Inspection:

Ontario Structure Inspection Manual - Inspection Form

Structure:	9 :	*Weaver Road*	1.24 km South of Killaly Street East

Element Group:	*Culverts*	Length:	*4.8*
Element Name:	*Inlet / Outlet Components*	Width:	*16.8*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:

Units	
Exc.:	25%
Good:	75%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
There is minor spalling on the surface.

A utility cable is affixed to the east end of the culvert.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
The foundation is not visible for inspection, however, it appears to be in stable condition.

Structure:	9 :	*Weaver Road*	1.24 km South of Killaly Street East

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Concrete*		Count:
Element Type:	*Retaining Wall / Blocks*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:	25%	*There appears that minor settlement of the concrete blocks at the southeast corner has occurred, but has stabilized.*
	Good:	75%	
	Fair:		
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: *6*
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:	75%	
	Good:	25%	
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:	*Barriers*		Length:
Element Name:	*Barriers / Railings*		Width:
Location:			Height:
Material:	*Steel*		Count:
Element Type:	*Guide Rail*		Total Quantity: *1*
Environment:	*Severe*		Limited Inspection:
Protection System:	Galvanized		
Condition Data:	Units		Comments / Recommended Work:
	Exc.:	75%	
	Good:	25%	
	Fair:		
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Structure 9 : *Weaver Road*	1.24 km South of Killaly Street East

Photographs

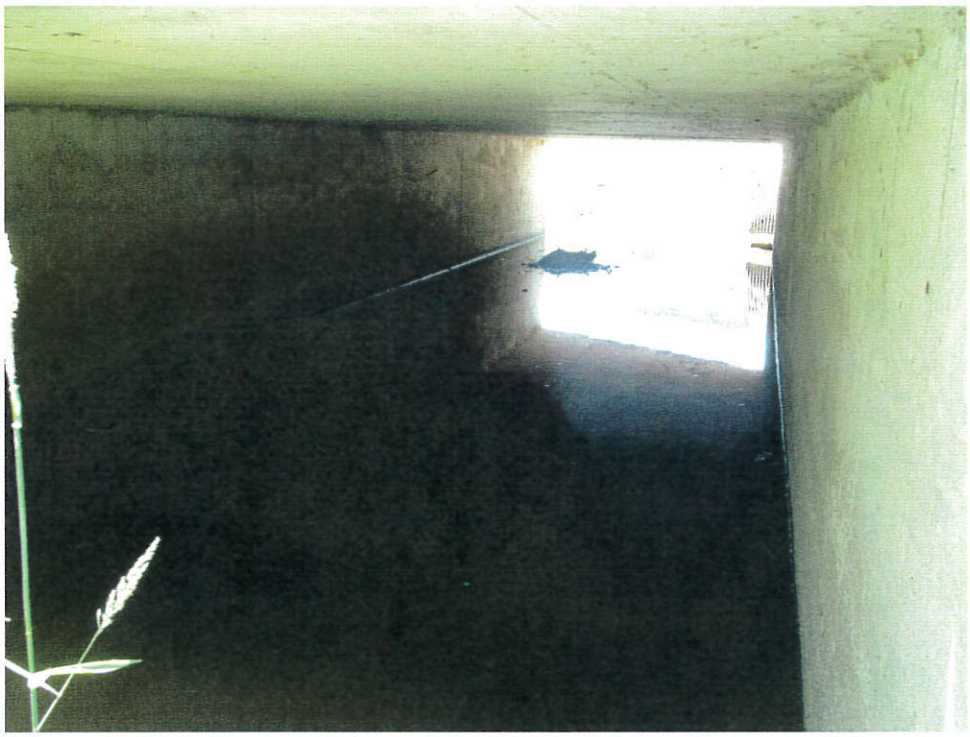
Roadway over the structure - Looking south

The east end of the structure

Structure 9 : *Weaver Road*	1.24 km South of Killaly Street East

Photographs

Concrete block retaining wall at the southeast corner of the structure



Viewing the interior of the structure from the east end

Structure 9 : *Weaver Road*	1.24 km South of Killaly Street East

Photographs

The west end of the structure

The west end of the structure

Ontario Structure Inspection Manual - Inspection Form

Structure:	10 :	*Lakeshore Road East*	0.30 km West of Lorraine Road

Inventory Data

Structure Name: *Wignell Drain Lot 21*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Lakeshore Road East*

Structure Location: *0.30 km West of Lorraine Road*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed: *40* km/h

# of Lanes: *1*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *5*

Structure Type: *Composite Bridge*

Interchange Number:

Total Deck Length: *6.3* (m)

Interchange Structure Number:

Overall Str. Width: *4.8* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *3.4* (m)

Detour Length Around Bridge: km

Skew Angle: (Degrees)

Direction of Structure: *North-South*

No. of Spans: *1*

Span Lengths: *5.4* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-06*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *19 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	10 :	*Lakeshore Road East*	0.30 km West of Lorraine Road

Historical Data

Year Built:	*1950*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

On the south (downstream) side of the structure, there are two floodgates with a bypass, as well as a submersible pump, and a pump control shed. (In 1993, the facility had 2 submersible pumps.)

There are large cracks on the west abutment wall.
The abutments should be monitored for signs of further deterioration.

The steel rails are in fair condition with some minor rusting.
It is recommended to sand and re-paint the rails as part of a maintenance program, or to replace.

There is no significant change in the structure since the last inspection in 2009.

Next Detailed Visual Inspection:

Structure:	10 :	*Lakeshore Road East*	0.30 km West of Lorraine Road

Element Group:	*Beams*	Length:	*6.3*
Element Name:	*Girders*	Width:	*4.8*
Location:		Height:	
Material:	*Steel*	Count:	
Element Type:		Total Quantity:	*11*
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Concrete, with Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Abutments*	Length:	
Element Name:	*Bearings*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	25%
Fair:	75%
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

The abutments appear to be in fair condition. There are large cracks on the west abutment wall. The abutments should be monitored for signs of further deterioration.

Structure:	10 : *Lakeshore Road East*	0.30 km West of Lorraine Road

Element Group:	*Foundations*		Length:	
Element Name:	*Foundation*		Width:	
Location:	*Footing*		Height:	
Material:	*Concrete*		Count:	
Element Type:			Total Quantity:	
Environment:	*Severe*		Limited Inspection:	*Yes*
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:		*The foundation is not visible for inspection, however, it appears to be in stable condition.*	
	Good:	50%		
	Fair:	50%		
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Element Group:	*Streams & Embankments*		Length:	
Element Name:	*Slope Protection*		Width:	
Location:			Height:	
Material:	*Concrete / Retained Soil System*		Count:	
Element Type:	*Conc. Wall / Gabion Baskets*		Total Quantity:	
Environment:	*Severe*		Limited Inspection:	
Protection System:				
Condition Data:	Units	All	Comments / Recommended Work:	
	Exc.:			
	Good:	50%		
	Fair:	50%		
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Element Group:	*Approaches*		Length:	
Element Name:	*Approaches*		Width:	*3.4*
Location:	*West / East*		Height:	
Material:	*Asphalt*		Count:	
Element Type:			Total Quantity:	
Environment:	*Severe*		Limited Inspection:	
Protection System:				
Condition Data:	Units		Comments / Recommended Work:	
	Exc.:	25%		
	Good:	75%		
	Fair:			
	Poor:			
Performance Deficiencies:		None		
Maintenance Needs:		None		

Structure:	10 :	*Lakeshore Road East*	0.30 km West of Lorraine Road

Element Group:	*Barriers*		Length:
Element Name:	*Barriers / Railings*		Width:
Location:	*North / South sides*		Height:
Material:	*Steel*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		*The steel rails are in fair condition with some minor rusting. It is recommended to sand and re-paint the rails as part of a maintenance program, or to replace the rails.*
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Structure	10	:	*Lakeshore Road East*	0.30 km West of Lorraine Road

Photographs

Roadway over the structure - Looking west

The south side of the structure

Structure	10	:	*Lakeshore Road East*	0.30 km West of Lorraine Road

Photographs

The east wall of the structure

The west wall of the structure

Structure	10	:	*Lakeshore Road East*	0.30 km West of Lorraine Road

Photographs

The underside of the structure

Large cracks on the north end of the west abutment wall

Ontario Structure Inspection Manual - Inspection Form

Structure:	12 :	*Second Concession*	0.16 km East of White Road

Inventory Data

Structure Name: *Beaver-dam Drain Lot 14*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Second Concession*

Structure Location: *0.16 km East of White Road*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed:

# of Lanes: *2*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *14*

Structure Type: *Concrete Culvert with inclined legs*

Interchange Number:

Total Deck Length: *3.6* (m)

Interchange Structure Number:

Overall Str. Width: *19* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *5.8* (m)

Detour Length Around Bridge: km

Skew Angle: *R-40* (Degrees)

Direction of Structure: *North-South*

No. of Spans: *1*

Span Lengths: *3.2* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-07*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *21 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	12 :	*Second Concession*	0.16 km East of White Road

Historical Data

Year Built:	*1960*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:	X		

Special Notes:

Water floods adjacent lands in this area during periods of intense rainfall.

There is no significant change since the last inspection in 2009.

Next Detailed Visual Inspection:

Structure:	12 :	*Second Concession*	0.16 km East of White Road

Element Group:	*Culverts*	Length:	*3.6*
Element Name:	*Inlet / Outlet Components*	Width:	*19*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:

Units	
Exc.:	20%
Good:	60%
Fair:	20%
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

A utility cable is affixed to the south end of the culvert.

There is a crack along the length of the west wall through which water is infiltrating.

There is minor spalling at the north end.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	50%
Good:	50%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:

The foundation is not visible for inspection, however, it appears to be in stable condition.

Structure:	12 :	*Second Concession*	0.16 km East of White Road

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Retained Soil System*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: *5.8*
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:	25%	
	Good:	75%	
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Structure 12 : *Second Concession*	0.16 km East of White Road

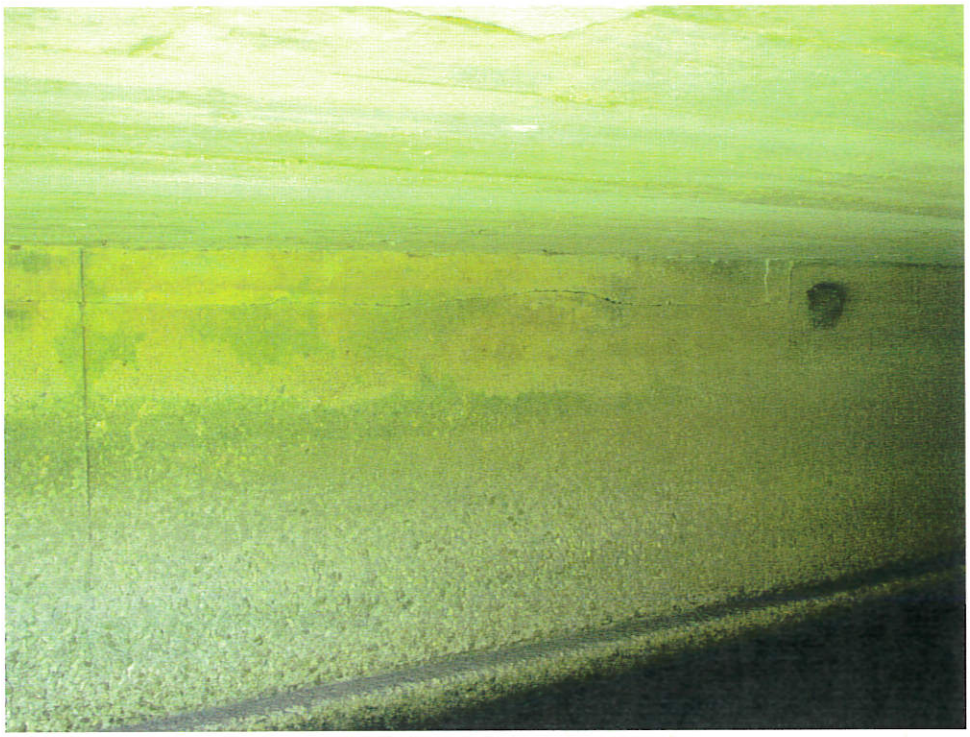
Photographs

Roadway over the structure - Looking west

The north end of the structure

Structure	12	:	*Second Concession*	0.16 km East of White Road

Photographs



The east wall of the structure

The underside of the structure

Structure	12	:	*Second Concession*	0.16 km East of White Road

Photographs

The south end of the structure

Viewing the interior of the structure, from the south end

Ontario Structure Inspection Manual - Inspection Form

Structure:	14 :	*Weaver Road*	0.09 km North of Killaly Street East

Inventory Data

Structure Name: *Mitchener M2 Lot 18*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *Weaver Road*

Structure Location: *0.09 km North of Killaly Street East*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed:

# of Lanes: *2*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *8*

Structure Type: *Rectangular Concrete Structure*

Interchange Number:

Total Deck Length: *2.9* (m)

Interchange Structure Number:

Overall Str. Width: *8.5* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *5.5* (m)

Detour Length Around Bridge: km

Skew Angle: (Degrees)

Direction of Structure: *West-East*

No. of Spans: *1*

Span Lengths: *2.5* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection:	*2012-06-06*
Inspector:	*Simon Ip*
Others In Party:	*Sean Ip*
Weather:	*Clear*
Temperature:	*19 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	14 :	*Weaver Road*	0.09 km North of Killaly Street East

Historical Data

Year Built:	*1930*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

It appears that there were two castings for this culvert. The major portion on the east end was cast around 1930, and the west end was cast around 1950.

There is notable separation of the concrete wall at the southeast corner of the structure.

Next Detailed Visual Inspection:

Structure:	14 :	*Weaver Road*	0.09 km North of Killaly Street East

Element Group:	*Culverts*	Length:	*2.9*
Element Name:	*Inlet / Outlet Components*	Width:	*8.5*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	50%
Fair:	50%
Poor:	

Performance Deficiencies: None

Maintenance Needs:

Comments / Recommended Work:
There is an overgrowth of vegetation on the east end of the culvert which should be cleared.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
There is a crack between the deck and the south wall, on the west end of the structure.

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:

Units	
Exc.:	
Good:	100%
Fair:	
Poor:	

Performance Deficiencies: None

Maintenance Needs: None

Comments / Recommended Work:
There is a crack at the footing at the southeast corner of the structure.

Structure:	14 :	*Weaver Road*	0.09 km North of Killaly Street East

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Concrete*		Count:
Element Type:	*Broken Concrete / Blocks*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		*Broken concrete sidewalk has been used for side slope protection on the west side. Concrete blocks have been used on the east side.*
	Good:	75%	
	Fair:	25%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: *5.5*
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		*There is some minor settlement of asphalt at the southeast corner of the structure.*
	Good:	75%	
	Fair:	25%	
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:			Length:
Element Name:			Width:
Location:			Height:
Material:			Count:
Element Type:			Total Quantity:
Environment:			Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:		
	Fair:		
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Structure 14 : *Weaver Road*	0.09 km North of Killaly Street East

Photographs

Roadway over the structure - Looking north

The west end of the structure

Structure	14	:	*Weaver Road*	0.09 km North of Killaly Street East

Photographs

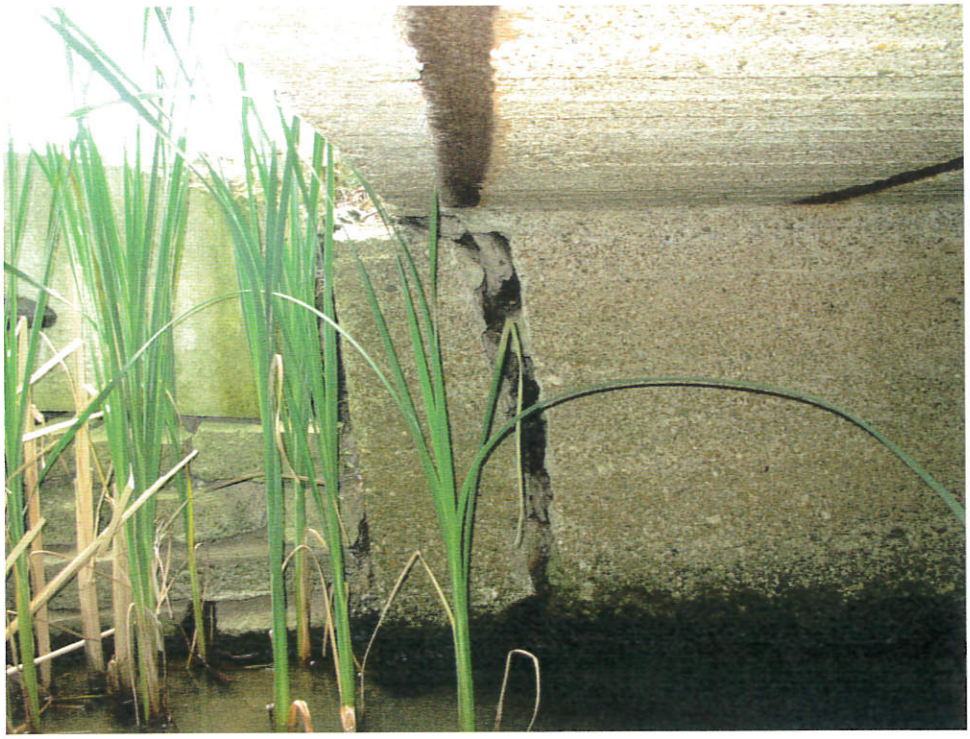
Cracking at the southwest corner of the structure

Viewing the interior of the structure from the west end

Structure	14	:	*Weaver Road*	0.09 km North of Killaly Street East

Photographs

The east end of the structure



Cracking at the footing at the southeast corner of the structure

Ontario Structure Inspection Manual - Inspection Form

Structure:	15 :	*White Road*	1.00 km North of Highway 3

Inventory Data

Structure Name: *Beaver-dam Drain Lot 14 & 15*

Main Hwy/Road #:

Crossing Type: *Non-Navig. Water*

Hwy/Road Name: *White Road*

Structure Location: *1.00 km North of Highway 3*

Latitude:

Longitude:

Owner: *City of Port Colborne*

Heritage Designation: *NSD*

MTO Region:

Road Class:

MTO District:

Posted Speed:

# of Lanes: *2*

Old County:

AADT: % Trucks:

Geographic Twp.:

Inspection Route Sequence: *15*

Structure Type: *Rectangular Concrete Structure*

Interchange Number:

Total Deck Length: *2.9* (m)

Interchange Structure Number:

Overall Str. Width: *7.2* (m)

Min. Vertical Clearance: m

Total Deck Area: (sq.m)

Special Routes:

Roadway Width: *5* (m)

Detour Length Around Bridge: km

Skew Angle: (Degrees)

Direction of Structure: *West-East*

No. of Spans: *1*

Span Lengths: *2.4* (m)

Fill On Structure: (m)

Field Inspection Information:

Date of Inspection: *2012-06-07*

Inspector: *Simon Ip*

Others In Party: *Sean Ip*

Weather: *Clear*

Temperature: *21 deg. C*

Ontario Structure Inspection Manual - Inspection Form

Structure:	15 :	*White Road*	1.00 km North of Highway 3

Historical Data

Year Built:	*1950*	Last Inspection:	*2009*

Rehab History / Notes:

Additional Investigations Required:	Priority		
	None	Normal	Urgent
Detailed Deck Condition Survey:	X		
Non-Destructuve Delamination Survey of Asphalt-Covered Deck:	X		
Substructure Condition Survey:	X		
Detailed Coating Condition Survey:	X		
Underwater Investigation:	X		
Fatigue Investigation:	X		
Seismic Investigation:	X		
Structure Evaluation:	X		
Monitoring of Deformations, Settlements and Movements:		X	

Special Notes:

Water floods adjacent lands in this area during periods of intense rainfall.

There seems to be some minor erosion occurring in the area of the culvert. The embankments, especially on the east side, should be monitored frequently for stability and signs of further erosion.

For safety, installation of a guide rail along the east side of the road is recommended.

Next Detailed Visual Inspection:

Ontario Structure Inspection Manual - Inspection Form

Structure:	15 :	*White Road*	1.00 km North of Highway 3

Element Group:	*Culverts*	Length:	*2.9*
Element Name:	*Inlet / Outlet Components*	Width:	*7.2*
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	
Protection System:			

Condition Data:	Units
Exc.:	
Good:	25%
Fair:	75%
Poor:	
Performance Deficiencies:	13
Maintenance Needs:	

Comments / Recommended Work:
Some cracking is evident on the headwalls.

There is an overgrowth of vegetation on the west end of the culvert which should be cleared.

Element Group:	*Decks*	Length:	
Element Name:	*Top / Wearing Surface*	Width:	
Location:		Height:	
Material:	*Asphalt Wearing Surface*	Count:	
Element Type:		Total Quantity:	
Environment:	*Moderate*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:	Units
Exc.:	
Good:	100%
Fair:	
Poor:	
Performance Deficiencies:	None
Maintenance Needs:	None

Comments / Recommended Work:

Element Group:	*Foundations*	Length:	
Element Name:	*Foundation*	Width:	
Location:		Height:	
Material:	*Concrete*	Count:	
Element Type:		Total Quantity:	
Environment:	*Severe*	Limited Inspection:	*Yes*
Protection System:			

Condition Data:	Units
Exc.:	
Good:	100%
Fair:	
Poor:	
Performance Deficiencies:	None
Maintenance Needs:	None

Comments / Recommended Work:
The foundation is not visible for inspection, however, it appears to be in stable condition.

Structure:	15 : *White Road*	1.00 km North of Highway 3

Element Group:	*Streams & Embankments*		Length:
Element Name:	*Slope Protection*		Width:
Location:			Height:
Material:	*Retained Soil System*		Count:
Element Type:	*Grassed Embankment*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units	All	Comments / Recommended Work:
	Exc.:		*The embankments should be monitored frequently for stability and signs of further erosion.*
	Good:	25%	
	Fair:	75%	
	Poor:		
Performance Deficiencies:		None	
Maintenance Needs:		None	

Element Group:	*Approaches*		Length:
Element Name:	*Approaches*		Width: 5
Location:			Height:
Material:	*Asphalt*		Count:
Element Type:			Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		
	Good:	50%	
	Fair:	50%	
	Poor:		
Performance Deficiencies:			
Maintenance Needs:			

Element Group:	*Barriers*		Length:
Element Name:	*Barriers / Railings*		Width:
Location:			Height:
Material:	*Steel / Wood*		Count:
Element Type:	*3-Cable Guide on Posts*		Total Quantity:
Environment:	*Severe*		Limited Inspection:
Protection System:			
Condition Data:	Units		Comments / Recommended Work:
	Exc.:		*The 3-cable guide on posts should be rehabilitated or replaced.*
	Good:		
	Fair:	75%	*For safety, installation of a guide rail along the ease side of the road is recommended.*
	Poor:	25%	
Performance Deficiencies:		None	
Maintenance Needs:		None	

Structure	15	:	*White Road*	1.00 km North of Highway 3

Photographs

Roadway over the structure - Looking south

Roadway over the structure - Looking north

Structure 15 : *White Road*	1.00 km North of Highway 3

Photographs

The east end of the structure

Viewing the interior of the structure from the east end

Structure 15 : *White Road*	1.00 km North of Highway 3

Photographs

The underside of the structure

The west end of the structure

WIGNELL / MICHENER MUNICIPAL DRAIN

CITY OF PORT COLBORNE

STRUCTURAL REPORT

Submitted to:
City of Port Colborne
Engineering & Operations

Submitted by:
AMEC Environment & Infrastructure
3215 North Service Road
Burlington, ON L7N 3G2

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

September 2014

Project No.: TP111090

1 INTRODUCTION

AMEC Environment & Infrastructure (AMEC) conducted a visual structural assessment of the Wignell / Michener Drain on August 27, 2012. At present, the Wignell / Michener Drain flows into Lorraine Bay located approximately 3 km east of the Welland Canal on the north shore of Lake Erie. The Wignell / Michener Drain outlet drains to Lake Erie along Lakeshore Road, west of Lorraine Road.

2 DAM STRUCTURE

The Wignell/Michener dam structure is located immediately downstream of the adjacent roadway, independent of the roadway structure and connected by an infill retaining structure (ref. Figure 1.) The main dam structure consists of a cast-in-place concrete rigid frame, consisting of three (3) cells (ref. Figure 2), complete with structural steel sliding gate and appertunances, railings and piping.

Figure 1: Wignell/Michener Drain

The west cell has been infilled with dam equpment. The centre and east cells contain coated steel sliding gates. In general, the dam structure is in good condition, with limited, localized areas that contain minor cracks and concrete spalls (ref. Figure 3.) Localized repairs should be completed to the cracked and spalled concrete at the same time when other work is being comlpeted on the dam structure.

Figure 2: Downstream Elevation

Figure 3: Localized Concrete Spall

3 EMBANKMENT

The upstream embankment is retained by the the adjacent retaining structures, consisting of a cast-in-place concrete wall supporting an overlying gabion basket wall (ref. Figure 4.) The gabion basket wall has been grouted on the top and inside face. Both the conrete and gabion walls appear to be stable with no noted movement of the wall or retained soil behind the walls.

Figure 2: Upstream Embankment

The downstream embankment is similar to that noted at the upstream side of the dam structure. No signs of movement or rotation were noted during our field review. Remedial measures to the embankments are not recommended at this time.

4 RAILINGS AND WALKWAYS

The railings located on the dam structure are substandard and do not meet current code requirements. Further, in general terms railings are noted to be in fair condition (ref. Figure 5.) It is recommended that the railings be replaced with a new, hot-dip galvanized steel railing system. Additionally, fencing around the downstream side of the dam structure should be replaced with a more permanent fencing system when future work is completed.

Figure 3: Railings

A set of steps with a railing have been constructed to provide better access to the dam and pumping equipment.

5 RECOMMENDATIONS

Based on our review, the following recommendations for remediation to the existing drain, in priority as listed below, are as follows:

1. Railing Enhancements: It is recommended that the existing railing system be replaced with a new, hot-dip galvanized steel railing system that is compliant with current code requirements.

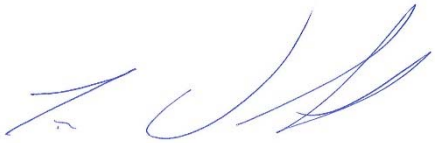
Cost Estimate: $10,000 – 12,000 + HST
Recommended Timing: Within 2 – 5 years

2. Dam Structure Rehabilitation: Localized repairs to the existing concrete on the rigid frame structure.

Cost Estimate: $70,000 - $120,000 + HST
Recommended Timing: Within 5 – 10 years (or when adjacent remedial work completed)

Report prepared by:

AMEC ENVIRONMENT & INFRASTRUCTURE
a division of AMEC Americas Limited



Per: Ben Hunter, P. Eng.
Sr. Structural Eng.
Assistant Office Manager

Tim Winterton, P. Eng.
Project Engineer

APPENDIX A
Photographs

Figure 1: Wignell/Michener Drain

Figure 2: Downstream Elevation

Figure 3: Localized Concrete Spall

Figure 4: Upstream Embankment

Figure 5: Railings: Railings

Providing Insightful Solutions
to Our Clients' Challenges

Wignell/Michener & Beaver Dam Municipal Drain Improvements
City of Port Colborne
Outlet Control Structure
Condition Assessment Report

October 2012 (Updated 2015)

Insyght Systems Inc. Project # 11005

Providing Insightful Solutions
to Our Clients' Challenges

Insyght Systems Inc.
5100 South Service Road, Unit 45, Burlington, ON L7L 6A5

Table of Contents

Section 1 Executive Summary

AMEC Environment & Infrastructure along with Insyght Systems Inc., as part of the AMEC team, was engaged by the City of Port Colborne to evaluate and then report on the current condition of the Wignell / Michener and Beaver Dam Drains.

The scope of Insyghts assignment includes a condition assessment of the electrical systems and components, and mechanical equipment, as well as the type and frequency of regular maintenance and the development of operation & maintenance manuals, and forms part of the overall AMEC report. A visual inspection of each facility was completed to determine if the facilities met the latest codes and regulations governing each discipline. The AMEC report will include other features, such as rationalizing the need for the Wignell / Michener pump station as to land base protection, future land use (return to market gardening) and potential alternatives.

The results of Insyghts detailed review and condition assessment of the mechanical, electrical, and instrumentation equipment, and their associated installation for these two sites are described in this report. A summary of the two facilities general condition has been subdivided into (1) Electrical Systems (2) Mechanical Systems, (3) Maintainability and (4) Code Compliance for simplification and estimation of capital costs.

1.1 Wignell/Michener Drain

The findings in this assessment indicate that the Wignell / Michener Drain facility is generally showing signs of 'wear and tear' and classified as: (1) Electrical Systems: Poor condition, (2) Mechanical Systems: Poor condition and (3) Maintainability: Fair and (4). Code Compliance: Several issues found.

We recommended that the Pump House building and electrical utility feeds and associated distribution be replaced and that the River Pump functionality be incorporated into the Pump House system. The capital cost to complete this work within one project is estimated to be $100,000.00.

1.2 Beaver Dam Drain

The findings in this assessment indicate that the Beaver Dam Drain facility appears to be in reasonably good condition and requires only minimal short-term work, much of which is optional. A summary of the general condition of each inspected area is classified as: (1) Electrical Systems: Fair condition, (2) Mechanical Systems: Good condition and (3) Maintainability: Fair and (4). Code Compliance: Several minor issues found. The capital cost to complete this optional short-term work is estimated to be $8,000.00.

It should be noted that this report reflects the finding and estimated costs associated with the original site inspection and submission of the report in 2012. In 2014 the City decommissioned the Wignell/Michener Drain control building, thus reducing the construction cost of any future upgrade and installation work on the site. We have modified our recommendations and estimated upgrade costs in accordance with this change.

Section 2 Introduction

AMEC Environment & Infrastructure (AMEC) has been engaged by the City of Port Colborne to evaluate and then report on the current condition of the Wignell / Michener and Beaver Dam Drains. This project was initiated by the City of Port Colborne under Operational Services Report 2009-52.

As part of the AMEC team, Insyght provided the necessary expertise relating to the electrical, mechanical, HVAC and SCADA investigation, evaluation, assessment and report preparation for the Wignell / Michener and Beaver Dam pump station and flood gate structures. This investigation includes an evaluation of the integrity of each facility to determine if electrical or mechanical upgrades or repairs are required and to recommend possible improvements. The site inspections were completed on July 25, 2012 and August 2, 2012.

The scope of this assignment includes a condition assessment of the electrical systems and components, and mechanical equipment, as well as the type and frequency of regular maintenance and the development of operation & maintenance manuals, and forms part of the overall AMEC report. A visual inspection of each facility was also completed to determine if the facilities met the latest codes and regulations governing each discipline. The AMEC report will also include rationalizing the need for the Wignell / Michener pump station as to land base protection, future land use (return to market gardening) and potential alternatives.

The result of the site inspections can be reviewed in detail in Sections 2 and 3 of this report. For further reference, the Appendix section of this report includes a photo gallery and brief description of each device / system inspected.

2.1 Project Methodology

To clarify requirements and minimize repetition, the equipment and system evaluation results found in Sections 2 and 3 of this report are based on issue prioritization and current condition. The evaluation criteria for each are identified as follows:

2.1.1 Project Prioritization

The specific issues identified were divided into five categories, which identified their priority rating. The priority rating specifically refers to how quickly we recommend the replacement / upgrade or removal to take place. The five categories are Life & Health Safety, Structural Integrity, Legislative Requirements, Functionality, and Cost effectiveness. These categories are described in further detail as follows:

1. Priority A - Life & Health Safety

Hazardous conditions which cannot be deferred and which could contribute to an accident, severe injury, or loss of life.

2. Priority B - Structural Integrity

Conditions which lead to the deterioration of structural elements of a property, and must be investigated and corrected, if necessary, in order to maintain structural integrity. Failure to do so may lead to unsafe conditions and will eventually render the structural, equipment, or system unsound and physically obsolete.

3. Priority C - Legislative Requirements

Includes all elements, which must be upgraded to comply with current legislation, including Building Codes, Fire Codes, Health and Safety regulations and other governmental mandated regulations.

4. Priority D - Functionality

This category encompasses the electrical and control, monitoring and mechanical elements as required to be maintained in order to protect the value and viability of the asset. Included within this category is the repair or replacement of equipment that has reached the end of its asset life. This work is also deemed necessary in order to prevent the systems from becoming obsolete.

5. Priority E - Cost Effective Upgrades

This category consists of cost-effective upgrades which may lead to the improvement of the operational efficiency of a facility and which have a reasonable payback.

2.1.2 Condition Definition

The following definitions are used throughout this report to describe the condition of the equipment, system or structure. The condition assessment criteria were separated into three categories:

1. Good Condition: Reasonable condition, not requiring capital expenditure;

2. Fair Condition: Deteriorating condition, likely to become "poor" within a few years if not addressed; and

3. Poor Condition: Observable deterioration requiring capital repair.

2.2 Wignell/Michener Drain Overview

The following provides a brief background and general details on the function and design of the Wignell / Michener Drains system.

The Wignell / Michener Drains have been in operation since 1875. There are several reports and by-laws on record, outlining the construction / maintenance history of this drain and petitions from landowners dating from 1875 to 1999.

The Wignell / Michener Municipal Drain consists of three main watercourses that total 13,088m in length, within a watershed of 1,087 ha in area. At present, the upstream point of the Wignell Drain is located just east of Babion Road between Second Concession and Hwy #3, at Rankin Construction Quarry Inc. Portions of the main drain and branches 1, 2 &2a have been abandoned over the years due to quarry activity / expansions. The drain flows southerly into Lorraine Bay, Lake Erie. The Michener Drain is comprised of the Michener Drain M-1 and Michener Drain M-2. The upstream point of the Michener Drain M-2 is located at Carl Road and Second Concession Road. The drain flows southwesterly and intersects the Wignell Drain at Snider Road and the Friendship Trail. The upstream point of the Michener Drain M-1 is at the Friendship Trail just west of 836 Lorraine Road. The drain flows south and intersects with the Wignell Drain upstream of the control structure, at Lakeshore Road E.

The flood control structure, located at the south limit of Lakeshore Road, consists of a concrete dam with three steel gates equipped with gate actuators, a bypass well and well pump and a bypass river pump and associated piping. A well pump and associated controls are housed in a small pump

house, mounted directly above the well structure. A bypass drain pipe under Lakeshore Rd. E. is also in place, which allowed the former owners / operators of the market garden lands to supplement the bypass well pump and river pump, utilizing a portable driven column pump.

The floodgate structure was first petitioned for on November 28, 1957. In correspondence dated January 29, 1958, J.R.Scott, the appointed engineer recommended against a structure under the Drainage Act, in favour of a private scheme which existed on the Beaver Dam Drain (at that time) by way of an agreement with Jas. L. Crane. In compromise, a report by C.J. Clarke dated October 6, 1959 provided for the spoil material from the Wignell Drain to be deposited on the west bank of the drain along Snider Rd., to create a berm to hold back the flood waters from spilling over the banks into the market garden lands / fields.

A subsequent petition filed by Groetelaars Bros. and others dated September 24, 1968 called for the deepening and widening of the Wignell Drain from Lake Erie to the Braakman bend and the construction of a permanent stormgate at the Lakeshore Rd. E. bridge and a temporary floodgate at the CN Railway (Friendship Trail). A report prepared by C. J .Clarke dated June 21, 1969 provided for the widening of the Wignell Drain from the CNR (Friendship Trail) to Lake Erie, for the excavated material to be used for a (the) berm and for the construction of floodgates south of the Lakeshore Road East bridge.

A petition dated January 17, 1973 by Grotelaars Bros., Overholt Bros., and C. Braakman to the Council of the City of Port Colborne was received requesting that a pump works be constructed at the Wignell Drain floodgate structure. A report dated February 23, 1973 by C. J. Clarke provided for a low lift pumping station rated at 10,000 USGPM, located downstream of the control structure, within the existing channel, at the far west storm gate. However, in recent discussions between City and former staff of Sass Manufacturing indicates that this pump may only be capable of delivering around 6,000 UGPM.

Correspondence (petition) dated April 15, 1981 by John Zutt and Tony Schertzing was received, requesting that action be taken to improve the present condition of the Wignell Drain. A May 29, 1981 City Engineer's Report # 81-69 outlined 9 recommendations, one of which was to appoint C. J. Clarke to investigate and prepare the requisite Engineer's report(s). A report dated March 16, 1982 by C. J. Clarke was to provide for a number of the aforementioned recommendations, including an additional pump station of 9,000-10,000 USGPM, for a total of 18,000-20,000 USGPM, however this report was not adopted / acted upon by Council.

Sometime between October 30, 1984 and April 21, 1987, say circa 1985 (re: City Superintendent Report May 24, 1985), the City had two submersible eight inch Grindex Maxi L pumps and associated piping installed on the upstream side of the control structure to augment the existing pump station. The City Superintendent Report indicates that the rated capacity of each pump was to be 12,000 UGPM, however a more recent document (July 6, 2005) in the file indicates a capacity of 230 l/s or approximately 3,450 USGPM.

The Wignell Drain Flood Damage Reduction Study by Acres International circa 1986, a study collaboratively commissioned by the City of Port Colborne and the NPCA, recommends three distinct stages of implementation, one of which involves reinstating the third control gate by removing the existing pump, pump well & building and replacing all pumps with a single high capacity pump. The recommendations of this study do not appear to have been implemented other

than general maintenance of the structure and of the conveyance channel between the Friendship Trail and Lake Erie.

In June 2, 1987, the growers, in collaboration with the City, completed works to accommodate a portable column pump rated at 8,000 UGPM, complete with access ramp and discharge pipe.

2.2.1 Process Control

The City of Port Colborne Operations Department controls the gates and pumps manually from local controls. No remote monitoring capability is currently available. The Operator has four (4) options available to transfer water through the control structure as follows:

1. One or two main gates can be opened and closed at the Operators discretion by activating the gate actuators from the platform above the gates. It should be noted that the third gate was taken out of operation with the advent / construction of the by-pass pump well structure. Upon closer examination this gate has been tack welded in the open position, with the upper portion of the gate having been cut off to allow access to the platform above the intake grate to the pump well. In addition to the fixed position, this gate has been severely compromised by corrosion. It has also not been modified with nylon inserts at the gate slide rails. Nor has the actuator been outfitted with a motor drive. It has been observed that the use of this gate would be a preferred method in holding the intake waters back in order to dewater the well for inspections and or maintenance / repairs. Originally the gates were operated by a hand crank from the platform. The motor drives were added sometime after 1973 based on the fact that the third gate has not been outfitted with a motor drive. The motor driven gate actuators were activated by controls located in the pump house building. The platform was / is only used for maintenance / repair activities;

2. Originally the facility was comprised only of the floodgate structure to hold back floodwaters generated by the lake during wind set up and / or high water level cycles. It became evident that a pump was need to maintain an acceptable market gardening water level upstream of the gates, when the gates were closed, during rainfall events, spring freshets or other instances such as backwater events due to the timing of the gate closing during storm events. As previously mentioned the river pumps were added to augment the well pump capacity. The facility included two river pumps, installed in the upstream channel, which - were used by the Operator to drain the dam's upstream water. Pump 1 and some of its associated piping was subsequently decommissioned and removed from the facility. This pump was removed due to failure. Over time certain parts were removed in order to repair the other pump(s) in this facility and others and subsequently not replaced. This equipment is fed and metered from a separate power supply from the hydro transformer located on the main road. The power supply from the transformer is common to both pump facilities. The more recent river pumps were fed from an intermediate service pole, by splice, which pole was used along with an additional pole in mounting several weather tight cabinets, housing all of the electrical controls and metering for the river pump facility;
3. After there is sufficient water in the Well section of the structure, a gate valve can be opened that will allow the manually controlled Well Pump to dewater the upstream section of the dam. The gate valve is a flap gate which opens on its own. The cable winch was added on the insistence of the market garden operators as they felt the mechanical assist would improve the performance of the pump. The flap gate was required in order to protect the discharge pipe from allowing any backwater surges from the lake to by-pass the floodgates; and

4. As an additional protection, should the first three options fail or be inadequate to control the water within acceptable limits, the Operator (privately operated by the market garden operators.),can use a portable pump to pump the upstream water through a large underground pipe to completely bypass the control structure. Please refer to AMEC report for further details on the condition of this underground pipe.

2.3 Beaver Dam Drain Overview

The following provides a brief background and general details on the function and design of the Beaver Dam Drains system.

The Beaver Dam Drain, which is comprised of a main drain and east and west branches, is located east of the Wignell/ Michener Drain. The Drain has a total length of 9,527 m within a watershed area totaling 1,223 ha. The upstream point of the Main Drain is located at the south end of property address 2767 Third Concession Road or Lot 13 Concession 3 Humberstone. The Drain flows southwesterly to an outlet at the base of Weaver Road, through floodgates into Lake Erie at Loraine Bay.

The control structure, located at the south end of Weaver Road, 60m south of Firelane # 2, consists of a concrete structure containing two gates that allows water to transfer between Lake Erie and the upstream channel. A concrete well structure is also provided that is used by the Operator to collect water and pump water from the upstream channel via the well and mechanical well pump, through discharge piping to Lake Erie when the floodgates are closed.

The Beaver Dam Drain has been in operation since 1885. There are several reports and by-laws on record outlining the maintenance history and petitions from landowners dating from 1885 to 1998.
The earliest record of the control structure lies in an engineering file with regard to a petition dated March 2, 1928 for the repair and improvement of the Beaver dam Drain. Correspondence from J.R. Scott, dated October 10 & 16, 1929 indicates that a structure or wall 60 feet long, double row steel sheet piling, centre filled with concrete with two openings, one 48“ square controlled by a wooden gate to be raised and lowered by one man and the other opening to be controlled by stop logs. The final engineers report for this petition predates this correspondence. Correspondence at a much later date (November 3, 1954) from J. R. Scott related to the control structure, which was in existence at that time, reveals that Mr. Jas. L. Crane had sought and received permission from Council of the day to privately (Correspondence dated November 24, 1955 from J. R. Scott to E. F. Ott, stating that the flood gate structure is not part of the Beaver Dam Municipal Drain works) construct and operate a stop log dam. We surmise that a control structure at the outlet of the Beaver Dam Drain has been in existence since 1930.

Over the next 50 years a number of petitions and requests to improve the control structure were facilitated by Councils of the day. A petition dated February 25, 1957 facilitated the construction of a clay dike along the south side of the drain east of Weaver Road, by way of a letter report by J. R. Scott dated September 6, 1957, regarding Mr. H. C. Schertzing’s concerns. A June 27, 1969 petition for the repair and improvement of the entire length of the Beaver dam Drain and repair of the floodgate structure delved into a similar control structure as the Wignell/ Michener Drain, as evidenced by an application for an ARDA Grant, dated November 2, 1973. An April 19, 1982 City Engineer’s Report # 82-31 outlines the current operation of the stop log gates at that time and the need for modifications. A June 18, 1982 final cost report verifies works carried out by R. J. Gillespie for gate works that are in

place today at a cost of $5,496.14. As with the Wignell / Michener, circa 1985, the Beaver Dam Drain floodgate structure was outfitted with 2 Grindex Maxi L pumps. Three phase 600 volt power was connected from a transformer located at Killaly to the floodgate structure, in lieu of an existing Ontario Hydro line on Miller Road that was dismantled afterwards. These pumps were removed and replaced in 1986 for repairs.

A February 10, 1997 report under Sections 4 & 8 of the Drainage act R.S.O. 1990, by K. Smart Associates Ltd provides for the incorporation of the existing floodgate structure and pumping station and for its rehabilitation and improvement. In addition, it provides for backflow prevention (The product specified was manufactured by Tideflex supplied by Red Valve (NeoValve Canadian distributor) to cross culverts under weaver road to protect lands on the east side from flooding, as a first line of defense. The rehabilitation of the floodgate structure involved placing a concrete floor between the steel wing walls from the control structure face to the south limit of the walls. The concrete floor was placed in order to improve flow & the ability for the channel to self- clean and for erosion protection from storm action and the pump discharge. The date of construction of these wing walls is not known at this time, however we surmise at the same time as the gate modification or the installation of the pump station, circa 1982-1985. The wing walls are constructed from salvaged (Elliot) ship materials consisting of the underside of the ship and sides, an L shape with steel angle bracing from the top of the wall down to the base section. The backfill material keeps the wing wall from falling into the channel. The existing structure was refaced with 150mm of concrete and reinforcing on the lakeside and the top of the wall. To fit the new station in its present location, 18m of existing retaining wall upstream of the structure along Weaver Road was relocated. It is not known at this time when the concrete blocks and guiderail were placed along Weaver Road. We surmise, possibly sometime after May 29, 1981.Also, two stop logs were removed and the openings set to elevation 177.00m, as well as providing two locking devices to hold the gates down during storm events and the repainting the gates. The rehabilitation of the pump station involved complete replacement of the station with a new 3m X 6m X4.6m deep concrete pump reservoir, complete with intake grate facing north and a new 500mm (20”) vertical axial flow Sass pump rated at 20,000 USGPM w / a right angle gearhead for an external power source such as a portable drive on a tractor. The engineer’s report had also called for one of the existing Grindex pumps to remain in place for back up and / or additional capacity, however this was not implemented. Apparently the portable drive became the preferred option as its use was considered infrequent, least costly and less susceptible to power outages.

The control structure currently consists of a dam, gate structure and pump well structure. This facility utilizes a mechanically driven pump to transfer the water from the pump well structure to the lakeside of the dam, via a 24” diameter discharge pipe. Electrical power is used for area lighting only.

As previously mentioned, the earliest record of the Beaver Dam Drain is in an Award by Geo. Ross, dated September 9, 1885, however this report and locals indicate that the drain was in existence long before this time. The concept of some kind of control at the outlet very likely dates back to this time period as well, however it is more likely to have been achieved under a report under the Municipal Drainage Act. The earliest report under this predecessor of the Drainage Act is a report by Geo. Ross dated April 27, 1916. There is no mention in this report of a control structure, however this report indicates that the Beaver Dam Drain had been repaired and improved at various time under the Ditches and Watercourses Act and the Municipal Drainage Act. An inspection report dated May 18, 1910 indicates that an engineer’s report under this legislation may have been prepared for the Beaver

Dam Drain circa 1910. The earliest consideration of constructing a control structure dates back to 1928, when much of the Lake Erie shoreline was being purchased by US interests.

2.3.1 Process Control

The City Operations Department now control the gates and pumps manually from local controls. No remote monitoring capability is currently available. The Ontario Drainage Tribunal had ordered that a remote high water alarm system be installed as part of the drainage works, however this was never implemented. The Operator has two (2) options available to him to transfer water through the control structure as follows:

1. One or two main gates can be opened and closed at the Operators discretion by hand crank gear reduction actuators from the platform above the gates; and

2. The operator can use the river pump via a bypass pipe, located in the Well structure, to dewater the upstream river.

Section 3 Wignell/Michener Drain Dam Evaluation Results

The evaluation has been separated into four (4) subgroups for clarity. (1) Electrical Equipment and Systems, (2) Mechanical Equipment and Systems, (3) Code Compliance, and (4) Maintainability. A detailed description of the evaluation results are presented below. For further details, please refer to the site report and photo gallery included in the appendix section of this report.

3.1 Electrical Equipment & Systems

As part of the electrical review, power distribution, transformers, pump and gate controls, fire and security systems, exterior lighting were inspected. For clarity, the electrical systems have been separated into two areas: (1) Pump House and Well Pump and (2) River Pumps and General Electrical Systems. Our findings are as follows:

3.1.1 Pump House & Well Pump

The pump house is fed overhead from a 600 (575) volt three phase hydro transformer mounted on a pole to the west of the control structure. A metering cabinet and main disconnect switch are installed within the building, along with a splitter / junction box and step down transformer, which feeds the power distribution panel for single phase circuits, such as lighting and the gate actuator motor controls. The main three phase power is connected to the well pump A.C. magnetic reduced voltage starter. For reference the motor was inspected in 1996 by Kaupp Electric at which time the windings were re-dipped / coated. The pump was removed as well and overhauled by R. J. Gillespie at which time the water lubricated bushings were replaced and portions of the body of the pump repaired / replaced. The starter is an obsolete unit well beyond its asset life. Similarly, the 30 HP., 880 RPM. frame size C364T C Flange Brook well pump motor shows significant signs of aging. Due to the poor condition of the pump house building structure and age of the electrical equipment the pump starter and controls, pump motor, and power distribution and lighting within the building is in very poor condition. This equipment needs to be replaced (Priority A, B, C, D, E upgrade).

3.1.2 River Pump

Two Grindex Maxi L pumps were installed in the Wignell Drain to pump water over the control structure from the upstream side to the outlet and lake, to augment the existing well pump facility (It was noted that the reason for the second utility feed was that the river pump add-on was not constructed under the Drainage Act, whereas the existing pump Well facility was, which could not technically be altered without a new engineer's report. The other reason was that there was physically not sufficient room in the existing building to house these additional controls). Only Pump 2 currently remains installed, along with its process piping and electrical power. Pump 1 was removed some time ago along with some of its electrical wiring and conduits. Its process piping remains partially in place. These two pumps are connected to a power panel and control panel that is fed by a separate 600 Volt, 3 phase, 200 amp utility feed, which has been spliced off of the well pump feed at an intermediate hydro pole, between the well pump building and pole mounted transformer located further to west. These two panels are made of steel and mounted on a wooden structure made of power poles and horizontal framing members. The power panel contains the main disconnect and metering equipment. The control panel contains a duplex pump starter control panel and associated control switches. Pump 1 has been disconnected and its control switch removed.

The utility feed cable and pole mounted transformer appear to be in poor condition. The power and control panel structure is also deteriorating and the panels are beginning to rust. Therefore, we consider that this electrical panel structure is in poor condition. The electrical equipment within the panels appear to be in reasonably good condition, however, we expect their conditions to deteriorate rapidly as the structure continues to age. In addition, there was minimal area lighting available that will make it difficult for operations or maintenance staff to work at night should the need arise.

We noted that there is a portable generator power plug installed in the pump house to supply single phase power to the gate actuator motor controls. This appears to be undersized for the application and should be replaced

It appears that the conduit and wiring between the control panel and pumps have been modified several times in the past leaving some of the conduit and wiring in a temporary state. When Pump 1 was removed most of the conduit and wiring remained in place, with its wiring disconnected and made safe and the conduits capped off as required.

The condition of the pump motor itself is currently unknown. However, from a visual inspection, where significant debris had built up around the protective cage and the level of deterioration the motor appear to be in poor condition.

Due to the poor condition of the structure and age of the electrical equipment, the pump starter and controls, pump motor, and power distribution and lighting within the area this system and equipment needs to be replaced (Priority A, B, C, D, E upgrade).

3.1.3 Conclusion and Recommendation

As indicated earlier the electrical systems for both the Pump House & Well Pump and River Pump systems are in poor condition and do not meet current building and municipal codes and regulation. Therefore, we recommend replacing and upgrading the Pump House & Well Pump system and the demolition and removal of the River Pump system, which we suggest is the most cost effective method of upgrading the facility to the current functional requirements and reduces the required

operating and maintenance work to a more manageable level. Further evaluation will be required to determine the rated capacity of the structure and pump sizes based on any future design upgrade.

3.2 Mechanical Equipment & Systems

The mechanical review includes a visual inspection of the slide gate, flap gate and pump mechanisms, and process piping and ventilation systems for the (1) equipment associated with the dam structure and (2) equipment associated with the River Pumps. Our findings are as follows:

3.2.1 Dam Structure Equipment

The general gate mechanisms, gates and slide rails appear to be in reasonably good condition, but may need some minor maintenance to ensure that they remain in good working order. It was noted that several of the gate slide rails have been recently replaced with nylon inserts, which will allow the gates to slide more efficiently. City staff indicated that repair work was carried out by R. J. Gillespie circa 2005. A request for Quotation 2004-1Q, was put out in December of 2004 to have these inserts installed. The bracing referred to in the comments to item 2.1.1 had only been carried ou on the centre gate. The east gate was outfitted with the same bracing under the 2004 quotation / works.

The Well pump and discharge gate winch mechanism appeared to be in fair condition, but will need regular maintenance to ensure that they function as designed. Further detailed inspection of the pump drive shaft and impeller is suggested, as it appears that the equipment has not to be exercised in some time.

No heating or ventilation systems have been installed in the pump house, which has contributed to the aging and wear of the electrical and mechanical control systems located within this structure. This issue will need to be addressed as part of the facility upgrade strategy (Priority A, B, C, D, E upgrade).

3.2.2 River Pump Equipment

As indicated in previous sections Pump 1 and some of its associated piping have been removed. Pump 2 appeared to be in poor condition with a significant buildup of debris surrounding the pump housing and considerable signs of wear and weather related aging. Some of the process piping has been abandoned and left disconnected other process piping appears to be in reasonably good condition. This equipment needs to be replaced (Priority A, B, C, D, E upgrade).

3.2.3 Conclusion and Recommendation

As indicated earlier the mechanical systems for both the Pump House & Well Pump and River Pump systems are in poor condition and do not meet current building and municipal codes and regulations. We therefore recommend replacing and upgrading the Pump House & Well Pump system and the demolition and removal of the River Pump system. We expect that this option will be the most cost effective method of upgrading the facility to the current functional requirements, and it will reduce required operating and maintenance to a more manageable level.

3.3 Code Compliance (Visual Inspection)

The Code Compliance review considered infractions associated with the building code, fire/life safety, health/safety, TSSA and ESA issues. The issues found during the inspection are addressed below.

We noted several ESA and electrical code issues with both the Section 3 Wignell/Michener Drain Dam Pump House equipment, including incoming utility feeder, and the River Pump power system and control structure. ESA indicated that this service does not meet current code requirements, in that it is far too low and accessible. They also expressed concern over the condition of the insulation. An inspection by staff found that only the outer wrap indicating the colour code of the wiring had been compromised. We also noted that the Section 3 Wignell/Michener Drain Dam River Pump System has TSSA issues due to its current semi-permanent installation and piping configuration. Additionally, the guardrails on the top of the control/floodgate structure appear to be installed too close together inhibiting the operator's access to the dam slide gate mechanism.

Due to their lifecycle and deteriorating condition of the Wignell/Michener Drain Dam equipment, much of the Pump House systems, River Pump power and control system equipment, and area lighting needs to be replaced. (Priority A, B, C, D, E upgrade).

3.4 Maintainability

This section considers the current maintenance and inspection program, available maintenance documentation and records, accessibility, and the ongoing maintenance requirements and repairs.

The Wignell/Michener Drain Dam facility is an unmanned structure, used sporadically when weather related events threaten the lower reaches of the watershed. As such we understand that there are only occasional inspections taking place and no regular monthly exercising program for the equipment.

During our site visit we noted that there was minimal "as built" Wignell/Michener Drain Dam documentation and few equipment shop drawings available for review. No maintenance or operational data was available. However, there was significant historical data available compiled by the City that have been prepared by various city engineers and consulting engineering companies over the life of the structure. This information includes correspondence, design briefs' engineering reports and studies that has been compiled by the City, that chronicles the complete evolution of this facility from which future detailed design concepts can be developed.

Over the years, the Wignell/Michener Drain flood control facility has been upgraded and modified several times, in what would appear to be on an ad hoc basis and as the need arose. This has caused a number of maintenance and operational related issues as these additions were not necessarily well planned or consistent with the original concept of the control structure. In some cases the equipment is generally inaccessible to carry out regular maintenance inspections and in others the equipment is well beyond its operating asset life. In addition, there are two utility feeds to the facility, which is unusual and most likely not required. Further, the 1973 Report indicates that there was limited engineering investigation behind the initial sizing of the pump. The 1982 Report recommended doubling the pump capacity, which is what the City may have followed through, when it attempted to address the rising lake levels with the installation of the Grindex Maxi L pumps. The growers followed shortly after in collaboration with the City, with a portable pump rated at 8,000 USGPM.

Other schemes were also being considered, along with the findings of the Wignell Flood Damage Reduction Study. It is not known at this time why the 1982 Report was not adopted by Council. It appears that much of the heightened awareness diminished after lake levels receded and once the market garden lands were retired from production.

3.4.1 Conclusion and Recommendation

Some of the issues that reduced the operating life of the facility are due to the lack of regular monthly inspections and equipment exercise, along with maintaining concise monthly equipment operating and maintenance records and repair data and the availability of O & M manuals.

We recommend that a regular maintenance program be considered, consisting of the following:

1. Monthly maintenance inspection to be conducted where all equipment is exercised and any minor issues and required general maintenance addressed;

2. Monthly operating and maintenance logs to be maintained; and

3. An Operations & Maintenance Manual to be prepared containing a library of shop drawings, contract drawings, regular maintenance requirements and repair information.

Section 4 Beaver Dam Drain Evaluation Results

The evaluation has been separated into four (4) subgroups for clarity. (1) Electrical Equipment and Systems, (2) Mechanical Equipment and Systems, (3) Code Compliance, and (4) Maintainability. A detailed description of the evaluation results are presented below. For further details, please refer to the site report and photo gallery included in the appendix section of this report.

A detailed description of the evaluation results is presented below. For further details, please refer to the site report and photo gallery included in the appendix section of this report.

4.1 Electrical Equipment & Systems

The dam and structure has no connected loads and the main 3 phase 600 volt utility feeder from the nearby utility pole has been disconnected. Only area lighting is available near the structure, which is powered from the nearby lamppost.

4.2 Mechanical Equipment & Systems

The mechanical review includes a visual inspection of the gate and pump mechanisms, process piping and ventilation systems for the equipment associated with the dam structure. Our findings are as follows:

4.2.1 Conclusion and Recommendation

As indicated earlier, the mechanical systems are in good condition requiring only minor maintenance and inspection on an as required basis.

4.3 Code Compliance (Visual Inspection)

The Code Compliance review considered infractions associated with the building code, fire / life safety, health / safety, TSSA and ESA issues. The issues found during the inspection are addressed as follows:

The structure and equipment appear to meet the current codes and regulations. However, area lighting could be improved, which would mitigate any life safety issues for operations and maintenance staff working on the structure during nighttime hours.

4.3.1 Conclusion and Recommendation

No action required to meet current regulation. The City is to determine if additional area lighting is required.

4.4 Maintainability

This section considers the current maintenance and inspection program, available maintenance documentation and records, accessibility, and the ongoing maintenance requirements and repairs.

The facility is an unmanned structure used only sporadically when weather related problems threaten the local area. As such, we understand that there is only occasional inspections taking place and no regular monthly exercising program for the equipment.

During our site visit we noted that there was minimal “as built” documentation and few equipment shop drawings available for review. No maintenance or operational data was available. However, there was significant historical report data available compiled by the City that have been prepared by various city engineers and consulting engineering companies over the life of the structure.

Over the years, this facility has been upgraded and modified several times to meet the current needs of the City.

4.4.1 Conclusion and Recommendation

We recommend regular monthly inspections and equipment exercise to be practiced, along with maintaining concise monthly equipment operating and maintenance records and repair data.

We recommend that a regular maintenance program be considered, consisting of a minimum of monthly mechanical and electrical inspections and service work performed in accordance with the equipment manufacturers recommendations. We also recommend that an Operations & Maintenance Manual to be prepared including a library of shop drawings, contract drawings, regular maintenance requirements and repair information for future use.

Section 5 Summary of Recommendations & Upgrade Replacement Costs

The following is summarized recommendations and associated estimated costs for the proposed changes at each facility.

5.1 Wignell/Michener Drain Recommendations

Generally, the dam's mechanical and electrical equipment is in very poor condition. The river pump mechanical and electrical systems are in especially poor condition. It is our understanding that the pump house structure was demolished in 2014 along with its electrical components. We therefore recommend that if the drain is to have any automatic functionality in the future that a new electrical power distribution and control system and associated pumps and mechanical piping be incorporated into the existing dam structure and that it includes suitable monitoring and control functionality.

5.2 Wignell/Michener Drain Estimated Capital Costs

The estimated costs for the above recommendations are:

Pump House replacement (including River Pump system) -$100,000.00

5.3 Beaver Dam Drain Recommendations

With the exception of area lighting, supplied from the nearby lamp post that could be upgraded to illuminate walkways, there is no electrical systems on the structure and therefore no need for any further upgrade. The mechanical operated Well pump is also able to function as designed, requiring only regular maintenance and the annual clean out of sand collected in the Well. We recommend maintaining these features to minimize operating costs and maintenance activities.

5.4 Beaver Dam Drain Estimated Capital Costs

The estimated costs for the above recommendations are:

Pump Maintenance Repairs (if required)	$4,000.00
Upgrade Area Lighting (if required)	$4,000.00
Total	$8,000.00

Appendix

City of Port Colborne
Wignell/Michener Drain Dam Photos

1. Dam Structure - North Side		The concrete structure and river pump shown.
2. East Side		The pump house corrugated steel structure is in very poor condition with notable damage and holes in the roof, which allows rainwater to enter during rainstorms. We suggest that this pump house be replaced.

Inspected Area	Photo	Comments & Recommendations
3. South Side		The concrete structure supporting the pump station and well appears.
4. Pump House Internal View		The internal construction of the pump house is in very poor condition. The wooden beams supporting the walls and roofing show significant weather damage and rotting. The corrugated steel walls, floor leak and the room is not properly insulated. This is a very poor environment to house electrical equipment.

Inspected Area	Photo	Comments & Recommendations
6. Walkway Structure		Illustrates the condition of the walkway and railing system, providing safety protection for operations staff working on the dam gate mechanisms. This appears to be too narrow and not in accordance with the latest building codes and regulation requirements.
1. Hydro Transformer Feeding Station		The transformer appears to be quite old and should be replaced. The overhead station feeder lines are susceptible to weather damage and are showing signs of aging. We suggest replacing the transformer and feeder cables.

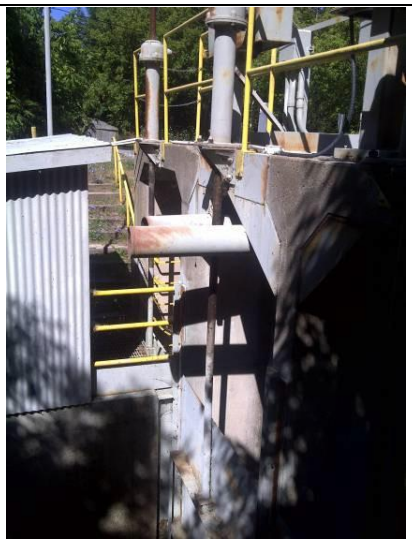
2. River Pump Panel Metering and Disconnect		A separate feeder runs from the hydro pole to the disconnect and metering equipment (as shown in the picture) to supply power to two river pumps. Only river pump 2 remains installed. River pump 1 has been fully removed. The disconnect equipment is connected directly to the starter panel shown in picture 3. The equipment appears to be in good condition.

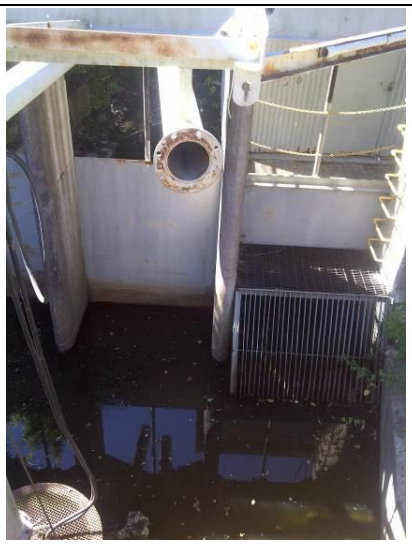
Inspected Area	Photo	Comments & Recommendations
3. River Pump Starter Panel		The river pump starter panel has been modified several times over the years and now only provides power and manual control for River Pump 2. The starter panel appears to be in reasonably good condition, but needs minor repairs and clean up.
4. River Pump Power and Starter Panel Structure		The ~~telegraph~~ pole structure is beginning to show signs of weather damage and aging, and will need a replacement if the river pump remains in service.

Inspected Area	Photo	Comments & Recommendations
5. Well Pump Motor		The Well Pump Motor is showing significant signs of aging and should be replaced along with its starter (refer to picture 7).
6. Pump House Metering and Power Distribution		The majority of this equipment is in fair condition, with the exception of the well pump starter and can continue to be used for approximately the next 3 years. However, due to the pump stations structural issues and lack of insulation we recommend replacement.

Inspected Area	Photo	Comments & Recommendations
7. Well Pump Starter		The Well Pump Starter is well beyond its asset life and must be replaced as it no longer meets code and regulatory requirements.
8. Outdoor Light		The outdoor light is generally in poor condition, has limited area lighting capacity and is beyond its asset life. We recommend replacing the existing light and adding additional lighting to the dam structure, to ensure that code and health and safety regulations are met.

Inspected Area	Photo	Comments & Recommendations
9. Hydro Pole		The hydro pole is showing significant signs of aging and should be replaced. This hydro pole is part of the utility's mainline which may very well represent the overall condition of the mainline as in the age of the transformer, however it is not a specific component of the Wignell / Michener facility.
MECHANICAL		
1. River Pump 2		River Pump 2 is showing significant signs of aging and the debris surrounding the protective / filter house greatly diminishes its usefulness and operational capability. River Pump 1 has already been removed most likely due to the protective / filter housing issue and the difficulty of maintaining the unit in its present location. We recommend replacement if the pump 2 is to remain in the future operation of the facility.

Inspected Area	Photo	Comments & Recommendations
2. River Pump Piping		The discharge piping for River Pump 1 has been partially removed. The discharge piping for River Pump 2 is in reasonably good condition. If both river pumps are no longer required, we recommend fully removing the pumps and their associated piping.
3. Dam Gates		All of the Dam gate mechanisms appear to be in reasonably good condition. The actuators may require minor repair and maintenance to bring them to fully operational condition. The gates and slide have been modified over the last few years and nylon slides have been installed, which will allow the gates to operate more efficiently. We suggest that minor repair and general maintenance be carried out.

Inspected Area	Photo	Comments & Recommendations
4. Well Grating		The entry grate to the Dam well appears to be in reasonably good condition. The grate had been previously modified to change the angle of the grate However, we understand that there is an issue regarding the well elevation that limits the pumping capability of the well pump. This should be further reviewed before making a recommendation on how to proceed. There is correspondence early on after the installation (circa 1973) where modifications in
5. Mechanical Well Discharge Gate Hoist		The Hoist appears to be in reasonably good condition.

City of Port Colborne
Beaver Dam Drain Photos

Inspected Area	Photo	Comments & Recommendations
1. Dam Grating - North Side		Upstream side Dam
2. Dam Grating - South Side		Downstream side of Dam.

Inspected Area	Photo	Comments & Recommendations
3. Well and Mechanical Pump structure - North side		Photo taken from Dam.
ELECTRICAL		
1. Hydro power transformer		Hydro pole and transformer are in reasonably good condition. Hydro feeds the structure lighting only.
MECHANICAL		

Inspected Area	Photo	Comments & Recommendations
1. Mechanical pump structure		The structure is in good condition. Mechanical pump is functional and in reasonably good condition.
2. Well pump discharge piping & walkway		The discharge piping appears to be generally functional and in good condition. The steps structure and walkway are mounted on an angle that could potentially carry a trip hazard. We recommend further investigation to determine if repairs are required.

Inspected Area	Photo	Comments & Recommendations
3. Dam gate mechanism		The gates and hoist mechanism are in reasonably good condition. You will not that the protective wind/spray shield mounted to the hoist mechanism were added recently (circa 2009-2010).

VEGETATION CHARACTERIZATION & RESTORATION OPPORTUNITIES REPORT

Formatted for inclusion in AMEC report

Contents:

Introduction

Dougan & Associates (D&A) was retained to provide terrestrial ecology support to the AMEC team for the improvement and repair of the Wignell/Michener and Beaver Dam municipal drains in Port Colborne, Ontario. The purpose of this project is twofold; to assess the current function of the drains and provide maintenance recommendations and to look for solutions to the near shore water quality issues in Lorraine Bay that are arising due to poor quality water in the drains. The scope of D&A's work included assessing the existing vegetation and land uses along all reaches of both drains, researching ways in which vegetation and vegetation communities can be used to improve water quality, and using the field work and research findings to describe opportunities and constraints for water quality improvement measures along specific reaches of each drain.

Background

Natural Heritage Policy Context

Relevant natural heritage policies for the Port Colborne area include:

- Provincial:
  - Provincial Policy Statement Natural Heritage Reference Manual
  - MNR: Species-at-Risk protection legislation (COSEWIC & SARO)
- Regional:
  - Niagara Region policies – Section 7, Natural Resources and Environmental Areas
  - Niagara Peninsula Conservation Authority – Conservation Authorities Act Regulation 155/06 (REGULATION OF DEVELOPMENT, INTERFERENCE WITH WETLANDS AND ALTERATIONS TO SHORELINES AND WATERCOURSES)
- Local:
  - City of Port Colborne Official Plan – Land Use Policies
  - City of Port Colborne Zoning By-Law

In addition, because the features being studied are municipal drains, they fall under the jurisdiction of the Drainage Act. See engineering report for a discussion of how Drainage Act policies affect this project. Any site work will have to satisfy the applicable regulatory agencies and policy.

Completed Local Background Studies

Multiple local background studies have been conducted related to water quality, natural heritage, and/or drain restoration and are directly applicable to this project. These studies were reviewed by D&A to inform this report, particularly the Opportunities and Constraints section. The studies' reference information is provided below and in Appendix 1.

Water Quality Studies:

- **Edge et al. 2011.** Microbial Source Tracking Studies at Niagara Region Beaches, Progress Report for 2010. Aquatic Ecosystem Protection Research Division, Environment Canada.
- **NPCA. 2010. Water Quality Monitoring Program, 2009 Annual Report.** Available (online) at http://www.npca.ca/wp-content/uploads/2009NPCAWaterQualityReport.pdf

Natural Heritage Studies:

- **Ministry of Natural Resources. 2004.** Wetland Evaluation for Beavers Dam Creek Pt. Col. WC. (not published).

- **NPCA Lake Erie North Shore Watershed Plan. 2010.** Available (online) at: http://www.npca.ca/wp-content/uploads/Lake_Erie_North_Shore_Watershed_Plan_Draft.pdf

Drain Restoration Studies:

- **Ministry of Natural Resources. 2008.** Wetland Drain Restoration Project Feasibility Study for Beaverdam Drain, Regional Municipality of Niagara, City of Port Colborne. (not published).
- **Wiebe Engineering. 2001-2002.** Incomplete engineering study for Wignell/Michener Drain by (not published).

Summaries of information in these reports relevant to restoration of the Wignell/Michener and Beaver Dam drains through improvements to terrestrial ecology are provided in Appendix 3.

Methods

On March 1st, 9th and April 2nd 2012, the Beaverdam (BD) and Wignell-Michener (WM) drains were examined from their upstream ends to their outputs into Lorraine Bay. The WM drain is a total of 13.1 km long with a watershed of 1,087 ha and the BD drain is 9.5 km long with a watershed of 1,223 ha. Prior to the field visits, using vegetation and infrastructure cues during aerial photography interpretation, the BD and WM drains were separated into distinct reaches. Characteristics of each reach were then recorded in the field including its Ecological Land Classification (ELC) system for Southern Ontario (Lee et al, 1998) community to community series level, dominant tree, shrub and herb species, vegetation structural composition, infrastructure and disturbances. Additionally, for every reach the GPS coordinates at its up and downstream ends were recorded and photos highlighting important characteristics of the reach were taken.

While examining factors such as adjacent land use, infrastructure, vegetation cover and areas of high drain input (e.g. active agricultural lands) a list of opportunities and constraints was developed. Constraints in this context are being defined as areas that are undesirable or unfeasible to undergo modifications that would improve water quality. Conversely, opportunities are defined as areas that are desirable or feasible for various modifications to the municipal drain that would improve water quality. Constraints such as high quality natural areas, agricultural, residential and commercial use lands as well as road, culvert and hardened bank infrastructure were described. Opportunities to increase vegetative buffer and create wetlands were recorded. The current extent of vegetative buffer separating the drain from the surrounding areas was also noted for every reach.

Findings

The field survey recorded a total of 34 reaches, 20 for the Wignell-Michener Drain and 14 for the Beaver Dam Drain. The lands adjacent to these drains were comprised of 8 ELC vegetation community types, which are:

- Agricultural (AG);
- Anthropogenic (ANTH);
- Coniferous Plantation (CUP);
- Cultural Meadow (CUM);
- Cultural Thicket (CUT);
- Cultural Woodland (CUW);
- Deciduous Forest (FOD);
- Deciduous Swamp (SWD); and
- Meadow Marsh (MAM).

The dominant vegetation communities were agriculture and deciduous swamp, followed by rural residential properties. The drains run directly adjacent to roads in several locations and through two golf courses. The ground plan was typically very flat except for the remnant dunes along Lake Erie, which were large and rolling. Soils were not surveyed but field observations confirmed the background documents' classification of the area as heavy clay, except for the Lake Erie dunes which are sand-based.

The key characteristics of each reach are summarized below and the extents of the reaches and the adjacent land use are shown on Map 1, Reach Mapping. The detailed findings of D&A's field investigations are summarized in Table 1, Wignell/Michener Findings Table and Table 2, Beaver Dam Findings Table, which are included in this report as Appendix 4.

WignellW1 & W2 and Michener M1 & M2 Drain

The Wignell-Michener Drain is the combination of two drains, the Wignell and the Michener, which join adjacent to the intersection of Snider Road and the Friendship Trail as well as at Lakeshore Road. These are the first agricultural drains to the east of the City of Port Colborne's built-up area. Wignell W1, W2, and W2a comprise Reaches 1-WM to 5-WM and 7-WM to 9-WM in D&A's field studies, while Michener M1 and M2 comprise Reaches 10-WM to 20-WM in D&A's field studies. Generally, the Wignell Drain is the western branch while the Michener Drain is the eastern branch. See Figure 1 for an illustration of D&A's survey reaches and how these relate to the W1, W2, M1, and M2 naming for the drains.

Reach 1-WM & Reach 2-WM

Reach 1-WM is the northernmost segment of the Wignell Drain east of Babion Road, and Reach 2-WM is the next section downstream from Babion Road to Highway 3; these correspond to the Wignell W2 and W2a naming of the Drains. Reach 1-WM was combined with Reach 2-WM during field work and thus is not shown on the final mapping. These two reaches both run southwest and lie within an active quarry, and were therefore not surveyed due to access restrictions. It is unknown what impacts the quarry may have on the water's quality and quantity, but the quarry is a major constraint to restoration of these reaches because quarrying is ongoing and the eventual scope of the operation is not known by the study team. Common Reed (*Phragmites australis*), an aggressive invasive species of wetland habitats, was observed adjacent to the culvert under Highway 3.

Photo 1: Reach 2-WM channel character

Photo 2: Reach 2-WM from Highway 3

Reach 3-WM

Reach 3-WM runs generally southwest from Highway 3, past one residence then through agricultural fields to Snider Road. Downstream of the residential property, at the bend, where the drain changes from an east/west direction to a north/south direction, this is the confluence of the W1 & W2 Drains. The W1 Drain, formerly continued in a northerly direction under Hwy. # 3 and through what is now Quarry Pit No. 2 to its terminus at the north road ditch of Con Rd. 2. A portion of the W1 Drain was abandoned under a Report by Wiebe Engineering Group Inc., dated February 19, 1999. The remaining watershed to the north of Con Rd. 2 was diverted in 2009 to the east along the north road ditch of Concession Rd. 2 to Babion Rd. and south along the west road ditch of Babion Rd. to the W2 Drain. Adjacent to the drain is one small patch of cultural thicket immediately downstream from Highway 3, mowed turf and several small bridges where the drain runs through a residential property, then agricultural fields with little buffer zone and few trees.

Photo 3: Reach 3-WM from Highway 3

Photo 4: Reach 3-WM showing cattails in drain

Reach 4-WM

Reach 4-WM runs generally north-south from Snider Road to Killaly Street East. The majority of the lands adjacent to the drain are naturalized (cultural meadow and deciduous forest), with one small agricultural section which is cultivated to the top of bank. Reaches 4-WM to 9-WM are all part of the W1 Drain.

Photo 5: Reach 4-WM showing deciduous forest adjacent to drain

Photo 6: Reach 4-WM showing cattails in drain

Reach 5-WM

Reach 5-WM runs north-south from Killaly Street East to the confluence of the Wignell W1 and the Michener M2 Drains at Snider Road and the Friendship Trail. The adjacent habitats are wet cultural meadow and cultural thicket communities with scattered trees and shrubs.

Photo 7: Reach 5-WM, ATV use through drain

Photo 8: Reach 5-WM channel form and adjacent vegetation

Reach 6-WM

Reach 6-WM was combined with Reach 7-WM during field work and thus is not shown on the final mapping.

Reach 7-WM

Reach 7-WM runs north-south from the confluence of the two Drains at Snider Road and the Friendship Trail to a sharp corner along the rear lots of homes which front on Lakeshore Road. Both sides of the drain are naturalized cultural meadow, formerly market gardening lands, with wet meadow marsh patches dominated by the invasive Common Reed, (*Phragmites australis*). Adjacent to the drain on its east side is the southernmost, disused, section of Snider Road, which is now a dirt footpath, a remnant berm along the drain which was constructed to hold back floodwaters.

Photo 9: Reach 7-WM showing channel width

Photo 10: Reach 7-WM adjacent footpath and vegetation

Reach 8-WM

Reach 8-WM runs generally east-west along the rear lots of homes which front on Lakeshore Road to the confluence of the Wignell W1 and Michener M2 Drains north of Lakeshore Road. Lands to the north are naturalized cultural meadow and lands to the south are residential.

Photo 11: Reach 8-WM, channel character and hardened edge (emergency erosion protection works constructed circa 2008)

Reach 9-WM

Reach 9-WM runs generally north-south from the water control structure just south of Lakeshore Road to Lake Erie. This section of the drain runs through a Lake Erie shoreline dune community, which is an upland deciduous forest, and thus has much larger banks and a very different species composition than the rest of the drain.

Photo 12: Reach 9-WM, water control structure at Lakeside Road

Photo 13: Reach 9-WM, adjacent vegetation

Reach 10-WM

Reach 10-WM runs north-south from the confluence of the WignellW1 and Michener M1 Drain north of Lakeshore Road to the southern extent of the Whiskey Run Golf Club. The adjacent vegetation communities are cultural woodland and cultural plantation as well as a semi-maintained turf embankment which contains a water reservoir for the Whiskey Run Golf Course.

Photo 14: Reach 10-WM, looking south from Whiskey Run Golf Course

Photo 15: Reach 10-WM, typical drain character, except for beaver dam in foreground of photo

Reach 11-WM

Reach 11-WM runs north-south through the Whiskey Run Golf Club. The drain has been altered to have a sinuous shape and is mowed to its edges with occasional small shrubs and cattails within the channel. This shape is the result of the drain being altered/constructed by the property owner without the prescribed requirements of the Drainage Act R.S.O. These works were incorporated afterwards under a Report by Wiebe Engineering Group Inc. dated November 15, 1996. Numerous small bridges cross the drain to facilitate golf cart traffic through the course.

Photo 16: Reach 11-WM, drain character, showing cattails in channel

Photo 17: Reach 11-WM, drain crossings and shrubs

Reach 12-WM

Reach 12-WM runs north-south from the northern extent of the Whiskey Run Golf Club through agricultural land to the southern extent of a deciduous swamp which lies south of the Friendship Trail and west of Lorraine Road. The drain has a dense 2-4m wide buffer of deciduous shrubs on both sides, followed by agricultural fields. Reaches 12 through 14 depict a lack of routine drain maintenance.

Photo 18: Reach 12-WM, drain character

Photo 19: Reach 12-WM, adjacent land use

Reach 13-WM

Reach 13-WM runs north-south adjacent to the deciduous swamp which lies south of the Friendship Trail and west of Lorraine Road. The deciduous swamp lies primarily to the west of the drain, with naturalized cultural meadow to the east. In some areas the channel is fully treed on both sides.

Photo 20: Reach 13-WM, deciduous swamp adjacent to drain

Photo 21: Reach 13-WM, channel character

Reach 14-WM

Reach 14-WM runs north-south from the deciduous swamp which lies south of the Friendship Trail and west of Lorraine Road to the Friendship Trail. The drain's banks are very shallow throughout this reach, and patches of meadow marsh are forming where the drain's waters are spilling into the adjacent fields.

M1 was formerly the outlet for M2, connecting with M2 at the culvert structure under the Friendship Trail. Bedrock is much closer to the surface along the route of M1 than it is at W1.

The naturalized character of Reaches 12 through 14 are likely due to a lack of routine drain maintenance.

Photo 22: Reach 14-WM, channel character

Photo 23: Reach 14-WM, adjacent vegetation

Reach 15-WM

Reach 15-WM runs east-west from the confluence of the W1 and M2 Drain at Snider Road and the Friendship Trail along the Friendship trail, jogs north-south, then east-west again to the back of the residential properties along Lorraine Road. The adjacent lands are agricultural with scattered trees.

Photo 24: North-south section of Reach 15-WM, channel & adjacent vegetation character

Reach 16-WM

Reach 16-WM runs east-west from the back of the residential properties along Lorraine Road to Lorraine Road. The adjacent lands are residential with scattered trees. At Lorraine Road a small meadow marsh has formed adjacent to the channel. The adjacent lands are agricultural with scattered trees.

Photo 25: Reach 16-WM, adjacent vegetation

Photo 26: Reach 16-WM, channel character

Reach 17-WM

Reach 17-WM runs northeast from Lorraine Road to Killaly Street East. The adjacent lands are agricultural with a narrow buffer of trees.

Photo 27: Reach 17-WM channel with surrounding vegetation

Photo 28: Reach 17-WM, channel character

Reach 18a-WM

Reach 18 was divided into 18a and 18b because of differing conditions on the east and west side of Weaver Road.

Reach 18a-WM runs northeast from Killaly Street East to Weaver Road. The channel runs along the back of residential properties which front on both Killaly Street East and Weaver Road. The property owner in photo 30 has since altered the slope of the north bank of the drain.

Photo 29: Reach 18a-WM adjacent residential land

Photo 30: Reach 18a-WM, channel and residential land

Reach 18b-WM

Reach 18b-WM runs northeast from Weaver Road to Highway 3. The adjacent lands are agricultural with scattered trees.

Photo 31: Reach 18b-WM channel character

Photo 32: Reach 18b-WM, adjacent vegetation

Reach 19-WM

Reach 19-WM runs generally north-south from Highway 3, adjacent to a car-racing track, then through meadow marsh to a 90-degree bend to the east. The adjacent lands vary from agricultural to cultural meadow to thicket swamp. The car-racing track property extends to the channel and many abandoned vehicles, parts, and other debris are scattered on this property.

Photo 33: Reach 19-WM channel with surrounding land use

Photo 34: Reach 19-WM, channel and derelict vehicles

Reach 20-WM

Reach 20-WM runs northwest from the drain's 90-degree bend to a deciduous swamp along Carl Road. The adjacent lands are agricultural cultivated to the top of bank with very occasional cattails and shrubs within the channel. Lands adjacent to the channel are primarily agricultural and fallow agricultural, with some regenerating deciduous swamp. The northern-most section of this reach runs adjacent to a deciduous swamp/deciduous forest complex that fronts onto Concession 2.

Photo 35: Reach 20-WM channel character

Photo 36: Reach 20-WM, adjacent forested and

Beaver Dam Drain

The Beaver Dam Drain runs roughly parallel to the Wignell-Michener Drain, 1-2 km to the east. For the majority of its length the Beaver Dam drain is a single drain, but splits into three branches north of Concession 2. For the purposes of this study the Beaver Dam drain has been divided into reaches 1 - 14.

Reach 1-B

Reach 1-B runs north-south from Lake Erie to a culvert under Weaver Road. Approximately 50m upstream from Lake Erie is a water control structure that regulates flow into and out of the drain, with a primary purpose of preventing Lake Erie storm surge waters from inundating the drain. Weaver Road runs parallel to the drain on its east side throughout this reach, separated by an excess concrete/precast concrete block retaining wall and a small mowing strip. On the drain's west side the land use is residential, deciduous swamp, and agricultural. The agricultural segment is cultivated to within 1m of the top of bank.

Photo 37: Reach 1-B, water control structure

Photo 38: Reach 1-B, hardened banks and adjacent agricultural land

Reach 2-B

Reach 2-B runs east-west from a culvert under Weaver Road to a 90-degree bend where the drain enters a deciduous swamp. There is one private concrete bridge crossing in this reach. Reach 2-B has been broken into two sections, 2a-B is flanked by residential uses while 2b-B has naturalized vegetation on both sides.

Photo 39: Reach 2a-B channel with adjacent residential land

Photo 40: Reach 2b-B, channel and adjacent vegetation

Reach 3-B

Reach 3-B runs north-south through a deciduous swamp to a 90-degree bend where the drain enters an agricultural field. This reach is fully treed on both sides with very shallow banks. It appears that water overflows into the swamp to the east during high water events.

Photo 41: Reach 3-B channel adjacent to deciduous swamp

Photo 42: Reach 3-B, channel character

Reach 4-B

Reach 4-B runs east-west through an agricultural field. The field to the north is actively cultivated to the top of bank, while the field to the south is fallow, with dense herbaceous vegetation and one tree. Patches of standing water were observed in the field to the south, possibly indicating a lack of routine drain maintenance, during the field investigation.

Photo 43: Reach 4-B channel with adjacent agricultural

Photo 44: Reach 4-B, flooded field south of channel

Reach 5-B

Reach 5-B enters a deciduous swamp running east-west, then makes a 90-degree bend to run north-south towards the Friendship Trail, then continues at a northeast angle to end at Killaly Street East. This reach is fully treed on both sides throughout its length except for a small patch of meadow marsh adjacent to Killaly Street East. The banks on both sides of the drain are former spoil banks and appear to be at a higher elevation than the surrounding swamp.

Photo 45: Reach 5-B shrubs adjacent to channel

Photo 46: Reach 5-B, channel character

Reach 6a-B

Reach 6 was divided into 6a and 6b to reflect the change in character from the predominantly anthropogenic character between Killaly Street East and White Road and the predominantly naturalized character where the drain runs parallel to White Road.

Reach 6a-B runs northeast from Killaly Street East, under Highway 3, to White Road. The adjacent land uses are anthropogenic and agricultural; the drain is mowed or cultivated to the top of bank on both sides throughout this reach. However, frequent 10-40cm DBH trees are present growing on the drain's banks.

Photo 47: Reach 6a-B, surrounding residential land

Photo 48: Reach 6a-B, Hwy # 3 culvert crossing headwall & lateral drainage (piped roadside ditching)pipinginterface. Former Geo. A. Schooley Award Drain.

Reach 6b-B

Reach 6b-B runs north-south adjacent to White Road on the road's west side. The profile of the drain follows the existing elevation/contour of the bedrock along this reach; the design grade has never been achieved here since 1916. The adjacent land use on the drain's west side through the southern half of this reach is agricultural, while the northern half is deciduous swamp. Three driveway bridges, circular steel/corrugated steel pipe structures, span the drain through this reach.

Photo 49: Reach 6b-B, channel character adjacent to White Rd.

Reach 7-B

Reach 7-B was merged with Reach 8-B during field investigations.

Reach 8-B

Reach 8-B runs north-south adjacent to White Road on the road's east side, then takes a 90-degree bend to run east-west between an agricultural property and a deciduous swamp. Since D&A's field work was undertaken the Municipality has carried out shoulder stabilization works through the installation of Gabion wire baskets on alternating sides of the bridge approaches and safety improvements through the installation of guide rails. The entire east side of the drain through this reach is treed while the west side is adjacent to White Road, with no buffer, or is adjacent to agricultural pasture with has a 3-4m herbaceous buffer.

Photo 50: Reach 8-B, channel adjacent to White

Photo 51: Reach 8-B, channel character and surrounding vegetation

Reach 9-B

Reach 9-B runs generally north-south through agriculture and the Emerald Pines Golf Club to Concession 2. The adjacent land uses are meadow marsh, agriculture, and the golf course. The amount of buffer is good except in the golf course, where the vegetation is mowed to within 1m of the top of bank. There is one concrete bridge structure crossing and several clear span wooden bridges throughout the golf course, including associated irrigation/utility pipe crossings in this reach.North of Concession 2 the East Branch of the Beaver Dam Drain (Reach 11-B) breaks off to the east while the Reach 10-B continues to the north.

Photo 52: Reach 9-B, channel through golf course with crossings

Photo 53: Reach 9-B, channel character and adjacent vegetation

Reach 10-B

Reach 10-B runs generally north-south from Concession 2, splitting in two after approximately 300m; one branch continues north-south along the edge of a deciduous swamp and the other runs east-west to White Road. The north-south branch of this reach has a deciduous swamp on its east side and agriculture to the west while the West Branch of the Beaver Dam Drain has agriculture on both sides mowed to within 1m of the top of bank. The north-south branch has a 5-6m buffer zone between the drain and the cultivated area; this zone is mainly herbaceous with some shrubs and cut tree stumps.

Photo 54: Reach 10-B, channel character

Photo 55: Reach 10-B, adjacent agricultural land

Reach 11-B

Reach 11-B, the East Branch of the Beaver Dam Drain, runs generally east-west along the southern edge of a deciduous swamp adjacent to Concession 2 and agricultural land. The drain runs alongside Concession 2 for approximately 0.5 km and then runs within deciduous swamp, cultural woodland, and cultural thicket for the remainder of this reach. In the time since D&A`s field survey the portion of this reach east of the unopened portion of the Sherk Road allowance has been cleared on the south side of the drain for cultivation.

Photo 56: Reach 11-B, channel adjacent to Conc. 2

Photo 57: Reach 11-B, channel character

Reach 12-B

Reach 12-B runs generally north-south from the edge of a deciduous woodlot to the drain's upstream beginning at Concession 2. This reach is cultivated to the top of bank with scattered shrubs and cattails growing within the channel. The status of the drain under the Drainage Act currently ends here, however the watercourse continues in a north-easterly direction to Brookfield Road as a combination grassed waterway and tile sub-drainage system.

Photo 58: Reach 12-B, channel character

Photo 59: Reach 12-B, adjacent agricultural land

Reach 13-B

Reach 13-B, the West Branch of the Beaver Dam Drain, runs generally east-west between an industrial property, a former residential property, and agricultural land, ending at a deciduous forest that fronts onto Miller Road. The reach is generally treed to the top of bank except through parts of the agricultural area. Some concrete structures, pipes, and a bridge associated with the adjacent waste treatment facility have been installed in this reach of the drain.

Photo 60: Reach 13-B channel character and adjacent residential/commercial land

Photo 61: Reach 13-B, pipe crossing the drain and adjacent forest

Reach 14-B

Reach 14-B runs within a deciduous forest that extends from Miller Road approximately 100m eastwards. This reach is fully treed on both sides and runs within one private property.

Photo 62: Reach 14-B, channel character, Miller Road cross culvert at point of discharge of roadside ditching system into the West Branch of Beaver Dam Drain.

Photo 63: Reach 14-B, adjacent forest

Opportunities, Constraints, & Recommendations

Approach

Natural watercourses and wetlands, through their structure, orientation, and vegetation composition, serve nutrient cycling and uptake functions in the natural landscape. Conversely, municipal drains are systems which typically function poorly in both nutrient uptake and ecological function. The structure and related function of natural watercourse and wetland systems will be used to form the basis for the Wignell/Michener and Beaver Dam drains' restoration designs in order to mitigate the drains' poor water quality, while allowing the drains ability to carry out the primary function of maintaining the ideal soil and water ratio in the production of agricultural crops. These natural systems will be the analog, or reference, systems for the drain restoration works. Identifying analogue systems is the first step in an ecological restoration process – with these analogues in mind the site can be analyzed for opportunities and constraints which will help or hinder the transformation of these sites to their target system.

Following are descriptions of the main analogues to be used for restoration of the Wignell/Michener and Beaver Dam drains and specific recommendations that can be used to implement the drains' restoration. Detailed tables and corresponding maps for each drain showing opportunities, constraints, and recommendations for restorations are provided in Appendix 5 and Maps 2-18.

Using Natural Analogues to Guide Design

Only by understanding the process of natural systems can these principles be applied to restoration design. This discussion describes the features of natural systems that can be incorporated into the drain restoration design to increase nutrient uptake as well as aspects of the existing drains which, although they differ from natural systems, do help to improve water quality or contribute some positive ecological function. Because of the focused intent of this report, aspects of streams and wetlands which serve nutrient cycling and uptake functions are stressed over other features of these systems, such as wildlife habitat and flood control, which are equally important from an ecological perspective.

Analogue 1: Watercourses*

Watercourses are dynamic, complex, and very variable over different temporal and spatial scales. The general physical features of a watercourse are:

- Cross-sectional channel shape;
- Elevation change over the length of the watercourse;
- Frequency & size of horizontal meanders;
- Frequency & size of riffles & pools;
- Frequency & size of channel bars; and
- Size of floodplain & riparian wetlands.

(OMNR 2001)

The size, extent, and number of these features within a system are affected by the amount of water in a system, flow rates, average sediment size, and the system's location in its watershed. The character of watercourses varies greatly along their lengths; the following is a simplified explanation of the river continuum concept (Vannote et al 1980), which classifies watercourse characters into upper, middle, and lower reaches.

- **Upper reaches:** generally being narrow, deep (for their size), fast-moving systems with high oxygen levels and high rates of erosion. Little to no floodplain or flooding. Produce sediment that is transported downstream.
- **Middle reaches:** variably sized with moderate flow rates and oxygen levels. Transport sediment produced farther upstream, with some further erosion & sediment deposition occurring through outer bank erosion, inner bank deposition, point or mid-channel bars moving, etc. Some floodplain and flooding.
- **Lower reaches:** broad, shallow, and slow-moving, with low rates of erosion and low oxygen levels. Broad floodplain and frequent flooding. Slow speeds cause deposition of sediments from upstream reaches.

According to the 2010(b) Lake Erie North Shore Watershed Plan prepared by the Niagara Peninsula Conservation Authority, over 61% of the watercourses in the study area, which includes Port Colborne, have been classified as municipal drains. These drains do not easily fit into the river continuum concept because they are constructed systems, but would best fit in the Lower Reaches category because of their position in their watersheds.

Dynamic Stability

Healthy watercourses are "dynamically stable", where the location of individual physical features change over time but the overall functions of the watercourse are stable. Watercourses are more stable if they have:

- Clay, bedrock, or concrete banks;
- Slow moving water;
- Non-flashy systems/consistent water inputs;
- Low sediment loads;
- Minimal change in elevation; and/or
- Vegetated banks & vegetated watersheds.

(OMNR 2001)

Some of these features can be adjusted in a restoration design, such as adjusting water inputs and vegetating banks, and others are inherent in the system and cannot easily be changed, i.e. change in elevation over a channel's length.

Erosion

Erosion serves to disperse the energy in moving water; in general, the more energy there is the greater the force of erosion. In natural systems erosion is not a negative feature, as dynamically healthy systems adapt to its impacts and downstream habitats such as estuaries are naturally adapted to high sediment levels. However, in systems with spatial constraints and/or major human influences such as storm surges caused by high percentage of impermeable surfaces, erosion can be problematic (OMNR 2001).

Nutrient Cycling

Primary production of nutrients in natural watercourses is from algae and inputs of leaf litter and woody debris. These nutrients are transported through the watercourse and are utilized by vegetation, both in-channel and riparian. The slower-moving waters of riparian wetlands are where most vegetation grows and consequently where most nutrient uptake occurs. In natural systems nutrient levels are relatively

stable, but the nutrient balance in watercourses can be easily disrupted by inputs such as agricultural fertilizers or a disruption in the food chain (OMNR 2001). In the annual cycle of a riparian system, it is most efficient at removing nutrients when the vegetation is actively growing and then re-deposits some nutrients as leaf litter in the fall. Consequently, in systems where vegetation is removed (through coppicing, tree harvesting, or mowing) nutrient removal is more efficient (Haycock Associates 2001), but this is not a common occurrence in natural systems.

Floodplain Dynamics

A floodplain is an area of land directly adjacent to a watercourse that is flooded during times of high water flow. Flooding is not a constant event, but occurs in "flood pulses" throughout the season (Middleton 1999). The "pulse" itself is the act of water overflowing from a watercourse's banks and flowing over the adjacent land. In the temperate climate of Ontario, the major flood pulse" occurs in the spring as winter snow melts, and smaller pulses occur throughout the season during major rainfall events. Flooding is an important component of natural watercourses as it dissipates water energy, distributes sediment and nutrients over the floodplain (Haycock Associates 2001), and exposes surfaces and allows the renewal of vegetation on these newly cleared substrates (Middleton 1999).

Flooding, while good for the ecological stability of watercourses and floodplains, is bad for human infrastructure, and so many steps have been taken in human-dominated landscapes to minimize the occurrence and impact of flooding. Two common approaches in southern Ontario are water control structures and deeply channelized banks. Water control structures minimize the amount of flood pulse while channelized banks contain the watercourse and do not allow it to overtop its banks. Dynamic stability is difficult to achieve with these flood control measures in place.

*Please note that the author of this section of this report is not a fluvial geomorphologist and therefore errors or omissions may be present in the detailed descriptions; the information given is based on the sources referenced in the text.

Analogue 2: Wetlands

Wetlands are diverse systems that provide habitat to a wide range of species and provide natural water filtration services. There are 6 types of wetlands in southern Ontario:

- **Shallow aquatic** (water up to 2m deep, >25% submerged and/or floating-leaved macrophytes, no tree or shrub cover)
- **Shallow marsh** (water up to 2m deep, standing or flowing water for most of the growing season, <25% submerged and/or floating-leaved macrophytes, grasses, sedges, rushes are dominant)
- **Meadow Marsh** (flooding is seasonal, grasses & sedges usually dominant)
- **Bogs** (acidic systems with no water flow in or out other than rain water, usually in kettle features, typically organic peaty soils, sedges, rushes, and low shrubs dominate, tree cover up to 25%)
- **Fens** (similar to bogs except water flow does occur between these systems and their surrounding landscapes, mildly acidic to alkaline, typically organic peaty soils, sedges, rushes, and low shrubs dominate, tree cover up to 25%)
- **Swamps** (flooding is seasonal, thicket swamps are dominated by shrubs, treed swamps are dominated by trees)

(Lee et al 1997)

In the Port Colborne area the majority of the wetlands present are deciduous treed swamps, but there are some meadow marshes, thicket swamps, and the Wainfleet Bog, the largest true bog in the region. The Wignell/Michener and Beaver Dam drains flow through multiple treed swamps and have frequent regenerating meadow marshes and thicket swamps along their banks. The following Figures 1-3 show, graphically how the drain relates to treed swamps, thicket swamps, and meadow marshes.

Figure 1: Meadow Marsh

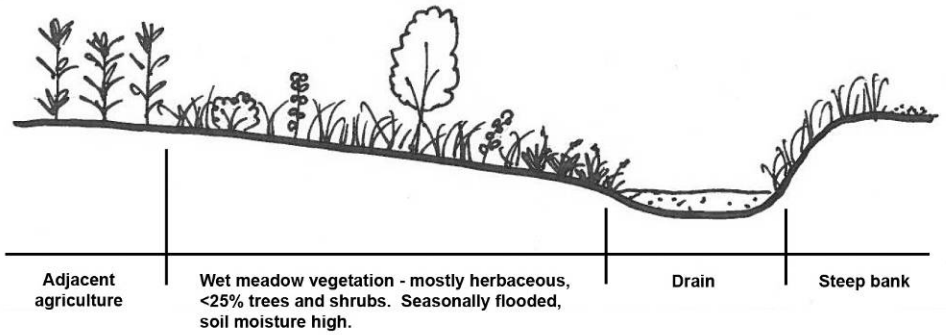


Figure 2: Thicket Swamp

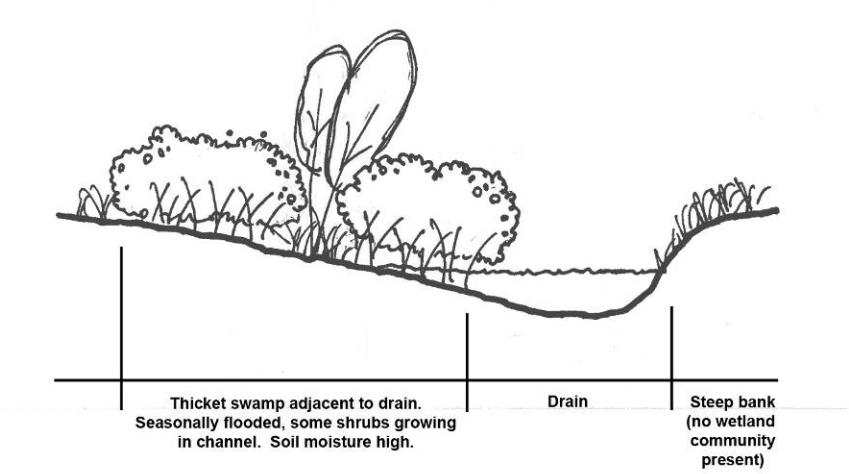
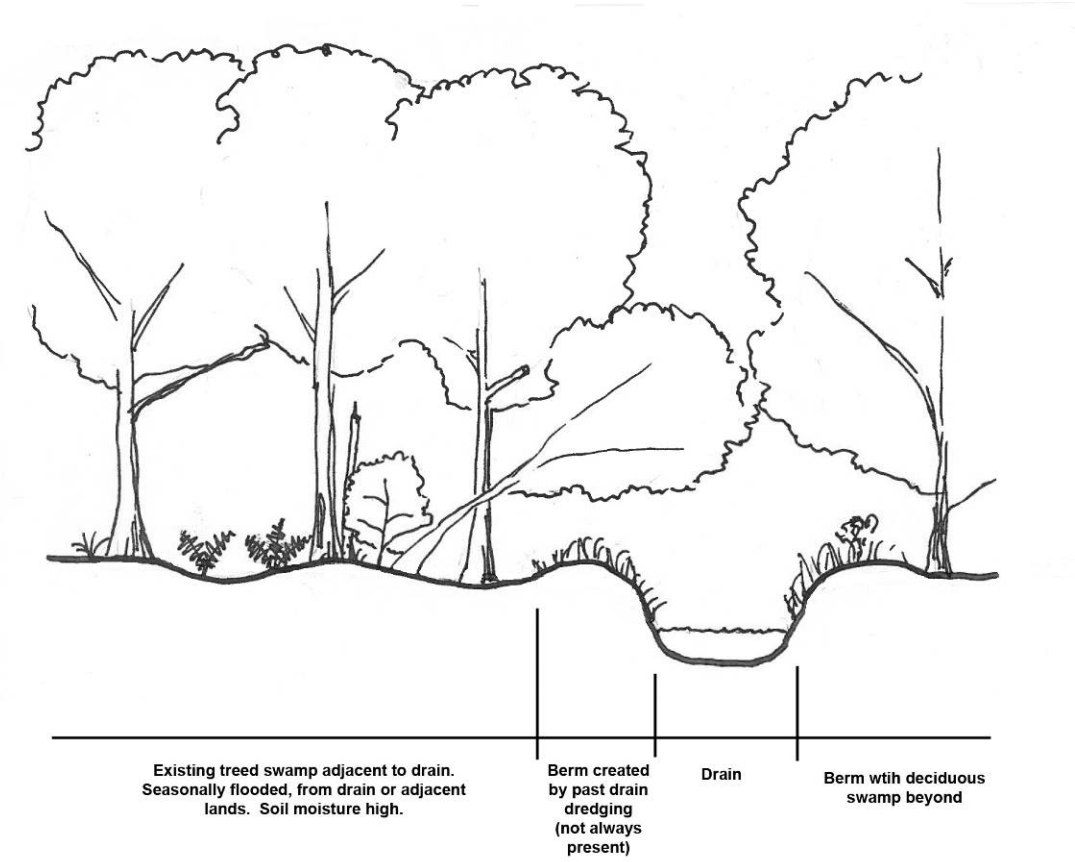


Figure 3: Treed Swamp



Water Levels & Disturbance Dynamics

Wetlands, as with watercourses, are dynamic systems, with disturbances frequently occurring associated with water flow changes. Disturbances are important in resetting the wetland cycle (Middleton 1999), and the typical natural wetland disturbance is water level change. The concept of flood pulsing, or "the idea that the physical and biotic functions of the floodplain wetland are dependent on the dynamics of water discharged from the river channel" (Middleton 1999) is an important concept in understanding wetland function. Flood pulses are predictable seasonal water level changes, in our region typically spring flooding followed by progressive dryness through the growing season. The depth of water and water level fluctuations vary according to the type of wetland:

- Shallow aquatic & shallow marsh – always flooded
- Bogs & fens – always saturated, rarely flooded
- Meadow marshes & swamps – seasonally flooded, typically flooded in spring with water levels progressively lowering throughout the growing season

(Lee et al 1997)

Water level fluctuation disturbances contribute to a healthy and dynamically stable wetland plant community. Natural water fluctuations are due to seasonal variations in rainfall and temperature, whereas human factors such as quarry dewatering would directly impact wetlands within the quarry limits and could indirectly impact others if the dewatering disrupts groundwater. A major decrease in water levels would trigger a gradual change towards a terrestrial, or non-wetland, plant community.

Wetlands & Water Quality

Wetlands improve the quality of the water that passes through them, but as they are dynamic living systems this process is not constant over time. Nutrient uptake is seasonal, with nutrients being depleted during the growing season and increasing during the winter. However all of this is cyclical, as plants will uptake nutrients while growing then release them when they die and decompose. Natural wetlands range from nutrient-rich to nutrient poor, and by extension the plants naturally found in these systems are adapted to those conditions. The chemical interactions between the water, soil, and plants in wetlands is complex and changes annually, seasonally, and even daily for different substances. Changes in water chemical composition or pH due to human inputs can result in changes to the wetland ecosystem; this new ecosystem may take time to adjust to these new inputs and be effective in improving water quality but may never be able to produce pure water depending on the type and quantity of inputs (Kadlec & Knight 1996). Waste lagoon discharges would be an example of changes in chemical composition that a wetland would have difficulty treating effectively.

Suspended Solids & Sedimentation

Wetlands often function to remove sediments because they slow the water velocity, which promotes physical settling of suspended solids. However, the accumulation of solids over time can have a negative impact on systems because it increases the bottom elevation of the wetland and fills in pore spaces in the wetland substrate (Kadlec & Knight 1996). Settled sediments can become re-suspended during flooding events, because of wind action on large open water areas, or due to animal action such as livestock grazing, bottom-feeding fish, and/or beaver activity. In general, the more vegetated the wetland is, the lower probability that sediments will become re-suspended (Kadlec & Knight 1996).

Biodiversity

Natural wetlands support a wide variety of plant and animal species, as they provide a variety of ecological niches along their hydrologic gradients. Disturbed wetlands tend to be less diverse, as they often do not have the same disturbance patterns that cause water to fluctuate and these niches to remain distinct (OMNR 2012). In the urbanizing landscape, wetlands that are not cleared for agriculture or developments are often associated with watercourses, which often are associated themselves with valley systems and woodlands. These watercourse corridors act as ecological systems through the landscape. Because a large proportion of historic wetlands in southern Ontario have been drained, both natural and created wetlands are important habitat for permanent and migratory species.

Re-Use of Existing Infrastructure and Vegetation

Municipal Drain Form & Function

Municipal drains are channelized watercourses whose main purpose is to drain agricultural land. Some drains were natural streams prior to being channelized, and others are entirely man-made. They are typically straight with flat bottoms and steep banks. They generally lack features of natural channels such as riffles, pools, meander patterns, substrate variability, and vegetation. Water inputs to the drains come from overland flow as well as tile drainage from fields. These drains typically run through agricultural landscapes and outlet into a larger body of water such as a lake or river. Because municipal

drains receive the majority of their inputs from agriculture, they tend to have poor water quality because of runoff contaminated with pesticides and fertilizers. Sometimes drains will run through wetland or forest communities but usually this is only a means to move the water most efficiently through the landscape, and the channels are not intended not to drain these features. Municipal drains are an important part of the agricultural landscape and allow many areas to be farmed which would otherwise be inaccessible to machinery and too saturated to grow crops.

Aspects of Existing Drains to be Retained

Although municipal drains are constructed systems, they can contain elements that add ecological form or function to the landscape, which is particularly useful in landscapes dominated by agricultural uses. These elements include existing natural vegetation growing on the drain's banks, buffers of vegetation between the top of the channel's banks and the adjacent land use, trees growing along the drain which are not impeding water flow, and natural communities that the drain may run through. Vegetation on the banks provides soil stabilization, which reduces erosion and siltation into the drain. Buffers slow down water velocity from adjacent land uses and filter some sediment and nutrients out of the water that passes through them. Adjacent trees and natural communities serve to shade the water's surface, which is beneficial because cooler water temperatures can be better for fish and other aquatic life. These elements should be incorporated into restoration efforts, because the functions of existing vegetation cannot be provided by newly planted vegetation for several, to many, years until it is established.

Specific Restoration Recommendations

D&A is recommending specific restoration measures for the Wignell/Michener and Beaver Dam municipal drains. A detailed description of the opportunities, constraints, and recommended restoration measures for each drain on a reach-by-reach basis are found in Tables 3 and 4 and Maps 2-18. These recommendations fit into the following categories:

1. Buffer Plantings;
2. Channel Modifications;
3. Wetland/Impoundment Creation; and
4. Utilizing Existing Wetlands in High Water Events.

Following is a description of the form and function of each of these techniques; this is meant to serve as an overview of the site-by-site recommendations given in Tables 3 and 4.

Category 1: Buffer Plantings

Buffer plantings are a strip of continuous vegetation along the top of bank consisting of herbs and grasses, shrubs, and/or trees; see Figure 1 for a graphic representation of a buffer. Environment Canada's publication "How Much Habitat Is Enough?" (2004) recommends that 75% of the length of any watercourse should have a riparian buffer, a goal that D&A supports for this project. The Lake Erie North Shore Watershed Plan indicates that at the time of its publication (2010) the riparian cover for the watershed was, on average, 64%.

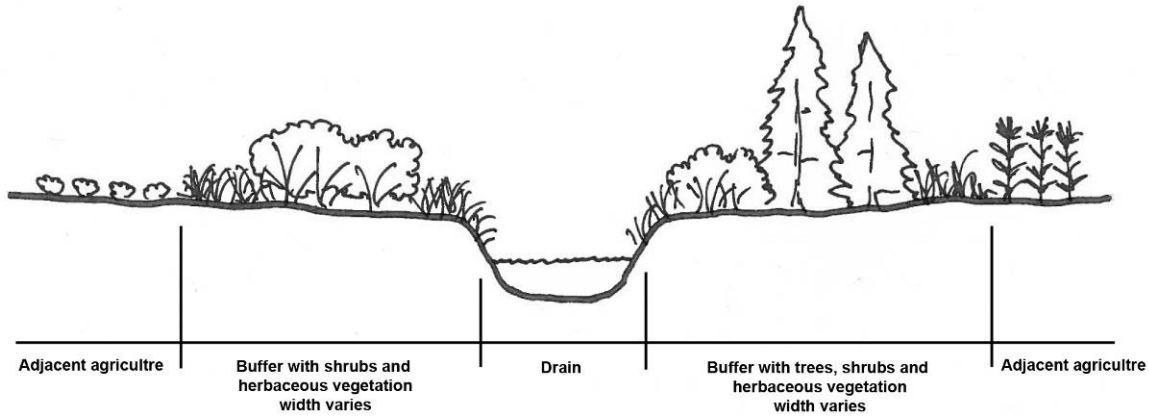
Academic studies on buffer zone effectiveness have provided varying results, but in general found that a larger, more diverse buffer containing both woody and herbaceous species is more effective than a narrow, herbaceous-dominated buffer. Buffers with dense herbaceous layers (i.e. dense grass) will filter

more sediments than those with an open understory (i.e. shrub cover). Nutrient uptake by vegetation will be most effective when the plants are actively growing, so a mix of plants which mature at different points of the season is best (Haycock Associates 2001) In order for buffers to function optimally, water must flow as sheet flow rather than highly focused flow (i.e. rills, gullies) for effective removal of particulates, dissolved nutrients, and toxic materials (Haycock Associates 2001), as "Buffer zone must provide enough friction to slow flows to improve efficiency of particulate trapping and provide leaf litter to help assimilate the trapped nutrients and toxic materials". A diverse 10m buffer seems to be a minimum for effective removal of significant quantities of water-borne nitrogen and phosphorus as well as trapping wind-blown sprays, although some studies recommend a minimum of 30m (Hickey & Doran 2004).

The Lake Erie North Shore Watershed Plan (2010) identifies areas along the Wignell/Michener Drain and the Beaver Dam Drain which are potential groundwater recharge and discharge areas. Discharge areas are "locations where the water table intersects the land surface" and recharge areas are "locations where water is transmitted downward to an aquifer" (NPCA 2010b). In addition, both Drains are located in areas with medium to high intrinsic susceptibility to groundwater contamination. On possible benefit of buffers is that groundwater passing through the buffer zone may "be cleansed of nitrate and acidity due to a combination of denitrification, biostorage, and changes in soil composition (Haycock Associates 2001).

A number of studies have been carried out by the University of Waterloo studying the feasibility and impacts of agroforestry systems in riparian buffers, where trees are used to intercept and uptake nutrients then periodically harvested to generate revenue for the land owners (Jose & Gordon 2008). Incorporating agroforestry into buffer plantings could be a good way to increase landowner participation in buffer projects.

Figure 4: Buffer Plantings



Pros:

- Effective in reducing overland contaminant flow;
- If buffer is 10m or more wide, effective in reducing wind-blown contaminants (i.e. spray);
- Buffers are more effective for sediment removal when ground is flat, and the landscape in Port Colborne is very flat;

- Buffer zone can provide shade, which cools the channel and is beneficial for some aquatic life forms;
- Can retain original channel size and shape;
- Easy to implement;
- Creates wildlife habitat;
- Relatively inexpensive;
- Variety of planting techniques available for different cost and effort levels (herbaceous seed only, woody & herbaceous seed, seed with shrubs & tree plantings); and
- Possibility of incorporating agroforestry into buffers in order to generate long-term revenue for land owners.

Cons:

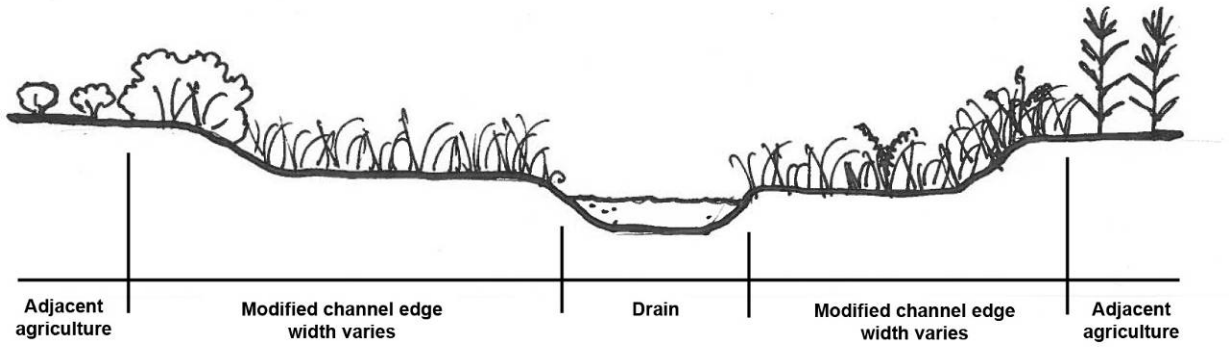
- Reduces amount of land available for agriculture;
- Most effective for overland flow, less effective for tile drainage flow;
- Effectiveness of buffers for sediment removal decreases over time as sediment accumulates;
- Maintenance may be required in order to remove accumulated sediment and/or stimulate dense herbaceous plant growth;
- No effectiveness on water quality in channel; andEasy for landowners to remove or reduce over time, although buffers can be protected under the Drainage Act R.S.O. 1990.

Buffer strips can be contentious in agricultural landscapes because they remove land from active production. Therefore it may be most effective to prioritize areas to receive buffer strips in the short term with a long-term goal of a consistent buffer application. D&A recommends that buffer strips be prioritized on the south and west sides of channels, as well as for channels with large catchment areas. The rationale for plantings on the south and west is that plantings on these sides will, in time, provide more shade (particularly in the hot afternoon sun) to the water's surface than plantings on the north and east sides. Also, the dominant winds in Port Colborne are from the north-west, so establishing vegetation on these sides will reduce windblown contaminants into the channel. Channels with large catchment areas are a priority because they will contribute more water to the drain than small catchment areas, and so should be targeted for sediment and nutrient removal.

Category 2: Channel Modifications

Channel modifications are reconstruction of the municipal drain channels to mimic natural watercourses. This technique can include a buffer strip and/or riparian wetland shelf combined with either a typical straight channel or a sinuous natural channel design; see Figure 2 for a graphic representation of these designs. The buffer or riparian shelf is below the top of bank level and is intended to flood in high water events, providing a way to minimize water velocities and encourage sediment deposition. Constructing a sinuous channel, such what was constructed in the Whiskey Run Golf Course along the M1 drain, will also minimize the water velocity in the channels and encourage deposition. The overall size of the modified channel as well as the natural channel design configuration would need to be designed by a water resources engineer and a fluvial geomorphologist.

Figure 5: Channel Modifications



Pros:

- Increases wildlife habitat;
- Effective in reducing overland contaminant flow;
- Can keep typical municipal drain channel dimensions (flat bottom, steep banks) for low-flow channel;
- Use of natural channel design would slow down water velocities, which would result in more sediment and nutrient deposition in channel rather than at end of system;
- Provides an outlet for flood water energy; and
- Variety of planting techniques available for different cost and effort levels (herbaceous seed only, woody & herbaceous seed, seed with shrubs & tree plantings).

Cons:

- Reduces amount of land available for agriculture;
- Channel may be more difficult to maintain in future drain maintenance; and
- Excavation work is expensive.

Channel modifications may be contentious because they remove land from agricultural use, but they can be targeted to areas where they are most effective. Targeted areas would be in the lower half of the watershed, where more water is flowing and more sediments are present ("the most bang for the buck" approach). Several areas exist where land is already out of agricultural production and where the channel could be modified without greatly affecting the existing farmland, these are shown on Maps 4, 5, 14, and 17.

Category 3: Wetland/Impoundment Creation

This option involves the design and construction of a treatment wetland using the principles used for storm water management ponds; see Figure 3 for a graphic representation of this technique. The constructed wetlands would use a series of ponds to allow sediment to settle out of the water column and could also be designed to include a shallow marsh section to facilitate the uptake of nutrients. These constructed wetlands would be built adjacent to the drain and would be designed to admit water from the channel at a variety of water levels or could be designed as in-channel impoundment areas,

provided that these structures do not impede the function of the drains. The banks and land surrounding the wetlands could be planted with native species to provide wildlife habitat and serve some buffer function.

The Weibe engineering study in 2008 discussed the creation of treatment wetlands, proposing the following:

- Construction of 8 ponds (3 drawing water from the Wignell drain, 5 drawing water from the Michener drain, both draining back into the Wignell main drain);
- Ponds to be 1.3m deep with permanent water level of 0.3m and 5:1 side slopes;
- Ponds designed to receive water from 0-10 year storms and divert water from 25 year storms. The diversion of large storm flows was intended to protect the ponds from high velocities which could stir up sediments and damage plant life;
- Proposed wetland ponds were designed as per MOE guidelines primarily for water quality criteria, using measures designed to provide Level 2 protection as per the MOEE guidelines. Level 2 protection pertains to fish habitat including feeding areas, unspecialized spawning areas, and pool riffle run complexes along watercourses.

In order for these treatment to function biologically as wetlands as opposed to simply being sediment impoundment areas it would be useful for the following aspects to be incorporated into the design:

- Design wetlands to incorporate sediment bays at input points capture excess sediments before water flows into vegetated wetland area;
- Incorporate “pool” areas into design to provide habitat for fish;
- Design wetland with variation in edge configuration and bottom profile to encourage a diversity of plant habitat and to increase the value of fish habitat;
- Incorporation of a “low flow” channel into design so that wetland receives consistent water input rather than only storm input; and
- Ensure that wetland is re-vegetated with a diversity of native plants following construction;

D&A refer comments on the engineering aspects of the treatment wetlands to AMEC Earth & Environmental.

Pros:

- Increases wildlife habitat;
- Area impacted is very localized, can be achieved with one cooperative landowner rather than needing the input of many;
- Can use standardized storm water management pond design principles for water quality enhancement to reduce contaminant and sediment loads; and
- Can retain existing municipal drain channel and perform typical maintenance.

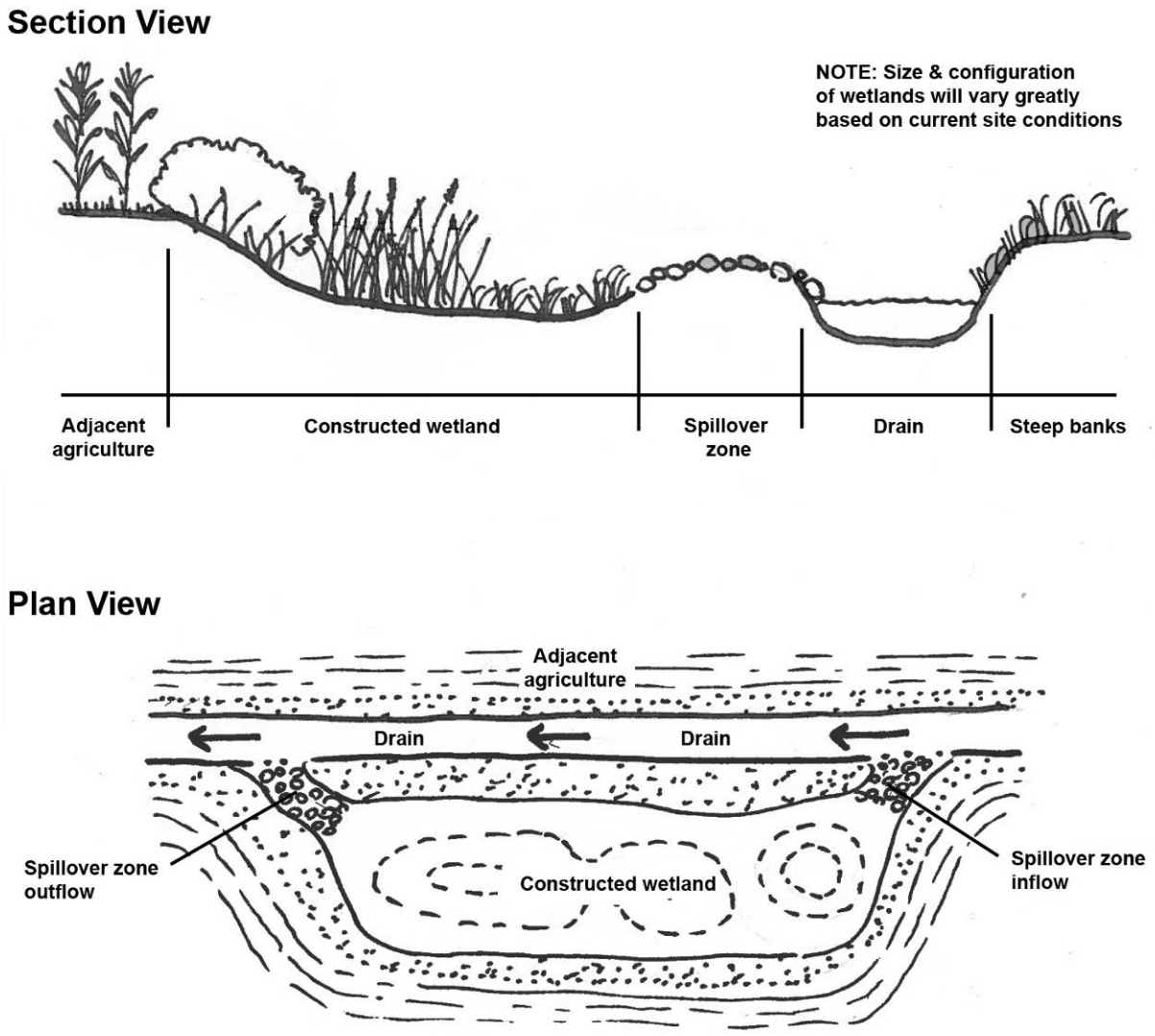
Cons:

- Requires a large amount of land permanently removed from agricultural production;
- Planting typically limited to seeding;
- Requires regular maintenance;
- No effectiveness in reducing overland contaminant flow; and

- Very expensive.

Wetland creation may be contentious because it requires the removal of a large area of land from agricultural use. They are best installed in the lower reaches of a watershed so that the maximum amount of water can pass through the system. Several areas exist where land is already out of agricultural production and where the channel could be converted to constructed wetland without greatly affecting the existing farmland.

Figure 6: Constructed Wetlands



Category 4: Utilizing Existing Wetlands in High Water Events

This technique would involve diverting water from the channels during high water events into existing wetlands (forested and non-forested) and using these existing features to store and infiltrate this water.

Wetlands lower in the watershed would be a higher priority for this use because they would receive more water and would be more effective for treating water..

Pros:

- Can keep typical municipal drain channel dimensions (flat bottom, steep banks);
- Provides an outlet for flood water energy;
- No impacts to farmland;
- Minimal re-planting or seeding should be necessary; and
- Low cost.

Cons:

- Possible damage to wetland ecosystem due to high water velocities in storm events;
- Possible damage to wetland ecosystem due to nutrient & pesticide loading;
- Possible damage to wetland ecosystem due to sediment loading; and
- Maintenance required on sediment trap if one is installed (recommended).

The major disadvantage of this technique is that the majority of the existing wetlands in the Wignell/Michener and Beaver Dam drains are forested swamps, and the impacts of using these communities for this technique are not well studied. At a minimum, the system would have to be designed with a sediment trap at the upstream end before the water disperses into wetland so that sediment loading in the wetland is minimized.

The Beaver Dam Drain Wetland Drain Restoration Feasibility Project (2008) concluded that project partners and landowners were not in agreement about redirecting flows through existing wetlands, and that an increase in flows may do “more harm than good”. Unless further research is conducted which determines what the impacts, positive or negative, to the existing wetlands may be, this restoration option should not be implemented.

Detailed Description of Opportunities & Constraints

Table 3, Wignell/Michener Opportunities and Constraints and Table 4, Beaverdam Opportunities and Constraints describe, on a reach-by-reach basis, the opportunities and constraints to restoration along each drain. These are provided as Appendix 5.

Detailed Mapping of Opportunities & Constraints

Maps 2-18 illustrate the locations of opportunities and constraints to restoration along each drain. The reach-by-reach descriptions of opportunities and constraints to improve water quality in the Wignell-Michener and Beaver Dam drains were categorized into High, Medium and Low categories for the opportunities and constraints mapping. An area with a ‘High Opportunity’ rating is defined as a specific region that, if modified, could significantly improve water quality. Sections with a ‘High Constraint’ rating are defined as areas along the drain that have very significant barriers to modification.

The following table illustrates characteristics that guide the categorization of a section of the drain into one of the three ratings for opportunities and constraints.

OPPORTUNITIES	
Rating	Description
High	-Located downstream (for wetland creation sites) -Fallow fields -Meadow marshes/shallow marshes -Existing farm ponds -Any area that could have buffer creation/expansion
Medium	-Located upstream -Residential/anthropogenic land use type -Active agricultural lands - Forested swamps
Low	-Hard structure (culverts, bridge footings, road crossings etc.) -Adjacent to a road

CONSTRAINTS	
Rating	Description
High	-Hard structures (culverts, bridge footings, road crossings etc.) -Adjacent to road
Medium	-Residential/anthropogenic land use type -Active agricultural lands -Forested Swamps -Steep slopes between channel and top of bank
Low	-Fallow fields -Meadow marshes/shallow marshes -Low grade change between channel and top of bank

The intent of this mapping is to provide the land owners and study team a variety of conceptual options for restoration along the Wignell/Michener and Beaver Dam drains.

Conclusion

Achieving water quality improvement in the Wignell/Michener and Beaver Dam municipal drains in Port Colborne, Ontario, is possible through the use of ecological restoration techniques. The existing vegetation and land uses along all reaches of each drain were assessed during the site investigations conducted by D&A staff in winter and early spring of 2012, and areas which were seen as opportunities or constraints to restoration works were identified. The adjacent land uses were found to be highly agricultural, with some deciduous swamps, thicket swamps, and naturalized wet meadows. Constraints found include road crossings, residential properties, and proximity of adjacent farm lands, while opportunities included marginal farm land and existing vegetated areas. Four specific restoration techniques were identified that are appropriate for use along the Wignell/Michener and Beaver Dam municipal drains:

1. Buffer plantings;
2. Channel modifications;
3. Wetland creation; and
4. Utilizing existing wetlands in high water events.

A balance will need to be struck between these ecological restoration techniques and the engineering recommendations for drain maintenance and water conveyance in order for the techniques to have a noticeable impact on water quality. Therefore the final detailed design will need to carefully consider which techniques are most applicable in which location and how much water quality improvement can be achieved with each piece implemented restoration work. The best results will likely be achieved with a combination of all four restoration techniques along key areas of the drains.

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APPENDIX 2: ONTARIO'S CLASS AUTHORIZATION SYSTEM CHART

Table 1: Municipal Drain Classification and Ontario's Class Authorization System

Drain Type	Flow	Temperature	Drain Classification Table Species	Time Since Last clean-out	Authorization	Associated Drain Maintenance Activities	Typical Terms and Conditions for Work
A	Permanent	Cold/cool	No sensitive species and/or communities present	Not applicable	Class A	Brushing of side slope, bottom clean-out (bed of drain only) and debris clean-out	• Re-establish riparian/bank vegetation if removed timing restrictions (to protect fish during critical or sensitive life stages) • Finish channel to be as narrow and deep as possible • Sediment and erosion control measures • Riparian vegetation to left in unaltered state on shade producing side (i.e., maintaining vegetation along the south or west side of drain) • Bends in channel stabilized • Work in-water only when flows are not elevated
B	Permanent	Warm	Sensitive species and/or communities present	Less than 10 years	Class B	Brushing of side slope, bottom clean-out (bed of drain only) and debris clean-out	• Finished channel to be as narrow and deep as possible • Riparian vegetation can be removed from either bank (not both) • Riparian and bank vegetation to be re-established if removed • Timing restrictions (to protect fish during critical or sensitive life stages) • Sediment and erosion control measures • Bends in channel stabilized • Work in-water only when flows are not elevated
C	Permanent	Warm	No sensitive species and/or communities present	Not applicable	Class C	Brushing of side slope, bottom clean-out (bed of drain) and full clean-out	• Finished channel to be as narrow and deep as possible • Riparian vegetation can be removed from either bank (not both) • Timing restrictions (to protect fish during critical or sensitive life stages) • Sediment and erosion control measures • Bends in channel stabilized • Work in-water only when flows are not elevated
D	Permanent	Cold/cool	Sensitive species and/or communities present	Not applicable	Project specific	Projects in type D or E drains are reviewed on a project-by-project basis. If the HADD cannot be fully mitigated, a project specific authorization	• Project specific
E	Permanent	Warm	Sensitive species and/or communities present	Greater than 10 years	Project specific		• Project specific
F	Intermittent or ephemeral (dry for more than two consecutive months)	Not applicable	Not applicable	Not applicable	Not required (if work is done in dry)	Bottom or full clean-out and vegetation removal	• Work is done in dry • All disturbed soil is stabilized upon completion of work *Note: If the drain is wet at the time of clean out and it has been classified as an F, the drain will be treated as type A, B or C with requirement to follow respective Class Authorization terms & conditions*

Some examples of sensitive species include: brook trout, eastern sand darter, northern pike, pugnose shiner and spotted sucker (among others), and Species at Risk as identified in the *Species at Risk Act*. If a Species at Risk has been identified in your drain, a site specific review will be required.

APPENDIX 3: LOCAL BACKGROUND STUDY SUMMARIES

Water Quality Studies

Edge et al. 2011. Microbial Source Tracking Studies at Niagara Region Beaches, Progress Report for 2010. Aquatic Ecosystem Protection Research Division, Environment Canada.

In 2010 this study was initiated to investigate potential sources of fecal contamination, particularly *E. coli*, at Niagara beaches in order to protect public health and reduce beach postings. The study was carried out by Environment Canada's National Water Research Institute, McMaster University and the Region of Niagara. Research was conducted in 2010 to determine E. coli levels and identify human sewage contamination levels at 15 Niagara beaches.

For this study water samples were taken twice a week from late May until late August 2010. Three water samples were taken at each sampling time for each beach as well as at nearby stormwater outfalls and agricultural drains. Sediment samples from foreshore sands were also collected at 10 beaches including Lorraine Road Beach. Samples were also collected from the Crystal Beach Wastewater Treatment Facility and other locations to use in testing for fecal pollution sources. The samples were analyzed and results are presented as colony forming units per 100mL of water (CFU/100mL). In addition, specialized methods testing for a "human marker" were used to determine whether human feces was a likely source of the *E. coli* contamination. Please see the study for a more detailed description of methods.

The study included data collection at Lorraine Road Beach, the results of which were:

- Mean *E. coli* (CFU/100mL): 70;
- Max *E. coli* (CFU/100mL): 730;
- % of samples > 100 CFU: 23; and
- Human marker detected on more than 10% of sampling days.

The *E. coli* concentrations were generally higher after rain events.

The report states that "concentrations of *E. coli* above 10,000 CFU/100mL might suggest the presence of a fecal contamination source such as human sewage needing further investigation". The study's authors consider the occurrence of the human marker at greater than 10% of sampling days to be significant and representing some measure of re-occurring human sewage contamination at the beach. However, Lorraine Road Beach was considered to have relatively low *E. coli* concentrations relative to the other beaches studied.

The study concluded that in general the water quality was relatively clean, with *E. coli* concentrations below 100 CFU/100mL, and that since the human marker was not common this indicated that human sewage impacts were not frequent. The study outlined follow-up research directions that could be carried out to continue studying *E. coli* at Niagara-area beaches.

Niagara Peninsula Conservation Authority (NPCA). 2010. Water Quality Monitoring Program, 2009 Annual Report. Available (online) at http://www.npca.ca/wp-content/uploads/2009NPCAWaterQualityReport.pdf

The NPCA conducts monthly water sampling and testing at 68 surface water and 13 groundwater stations throughout the NPCA watershed. The surface water samples are tested for indicators such as nutrients, *E. coli*, suspended solids, and metals, which are then used to calculate the Canada Council of Ministries of Environment (CCME) Water Quality Index, a Canada-wide standard for reporting water quality information. Water quality is also evaluated by sampling aquatic animals using the BioMAP protocol. The results of these surveys are compiled in an annual report; the 2009 report is the most recent report available on the NPCA's website.

The Wignell/Michener drain and Beaver Dam drain were both sampled as part of this process. The key observations for the drains are as follows:

- Beaver Dam drain has a WQI rating of "Poor*" and BioMAP rating of "Impaired**". Factors affecting water quality include exceedances of copper, total phosphorus, and E. Coli, frequent nickel occurrences, nutrient enrichment from upstream urban and agricultural areas, and lack of riparian buffer;
- Wignell drain has a WQI rating of "Marginal*" and BioMAP rating of "Grey Zone**". Factors affecting water quality include exceedances of copper, total phosphorus, and E. Coli, frequent nickel occurrences, nutrient enrichment from upstream urban and agricultural areas, and influence of groundwater discharge from upstream bedrock quarry.

*A WQI rating of "Poor" means that water quality is almost always threatened or impaired, conditions usually depart from natural or desirable levels; "Marginal" means that water quality is frequently threatened or impaired, conditions often depart from natural or desirable levels.
**A BioMAP rating of "Impaired" means that the organisms found are more tolerant of environmental stresses than organisms that would be present in an undisturbed system; "Grey Zone" means that the results were inconclusive and that further assessment is required to determine water quality.

These results confirm that the water quality is poor in both drains, but do not quantify what has caused the poor results. The study recommends that watershed restoration projects continue to be implemented with an emphasis on nutrient management, riparian buffers, and increased forest cover.

Natural Heritage Studies

Ministry of Natural Resources. 2009. Wetland Evaluation for Beavers Dam Creek Pt. Col. WC. (not published).

This study presents the technical Ontario Wetland Evaluation System (OWES) data compiled by Niagara Area Biologist A. Yagi in 2007. The OWES is a provincial science-based system that is used to evaluate and rank the relative value of wetlands; wetlands which are evaluated as "Provincially Significant" have policy protection through the Ontario Ministry of Natural Resources.

The study summary is as follows:

"This wetland is a complex. It is located behind Lake Erie Sand Dunes and is in part a backshore organic basin. The wetland units meet the OWES distance criteria <175m, presence of a connecting watercourse "Beaver Dam Creek" which is the smallest scaled functional aquatic linkage for the wetland, presence and uniformity of hydric soils (Clay loam and silty clay loam), swamp communities and species communities (flora and fauna). Several terrestrial linkages are also present such as hedgerows, abandoned agricultural fields and meadows. Other important linkages are Lake Erie to the south and Humberstone Marsh to the north.

This wetland scores more than 200 points in Special Features and over 600 points overall and is therefore provincially significant"

The technical data presented in this study is important for D&A's report in that it provides terrestrial ecology information that can be used to supplement D&A's field studies.

NPCA Lake Erie North Shore Watershed Plan. 2010. Available (online) at: http://www.npca.ca/wp-content/uploads/Lake_Erie_North_Shore_Watershed_Plan_Draft.pdf

This study provides an overview of the Lake Erie North watershed, including a characterization of physical structure, land use, natural heritage resources, constraints to natural systems, ecological restoration and environmental planning tools, and restoration strategies for each subwatershed. There is detailed information on both the Wignell/Michener and Beaver Dam drains as well as restoration habitat suitability mapping that will be useful in selecting restoration locations.

The most relevant sections of this study are:

- Ecological Restoration and Environmental Planning Tools;
- Watershed Best Management Practices;
- Watershed Habitat Restoration; and
- Watershed Strategy, including a strategy for both the Wignell Drain and Beaver Dam Creek (effectively this is Beaver Dam Drain).

The Ecological Restoration and Environmental Planning Tools section mentioned that the NPCA has riparian buffer policies; these will be useful in identifying suitable restoration locations. This section also identifies incentive programs for implementing restoration and other environmental works on private land.

The Watershed Best Management Practices (BMPs) section identifies BMPs that could be created to control sources or causes of pollution. The NPCA has developed agriculture BMPs; this report includes a detailed list of further BMPs that could be developed, including urban lands, storm water, sediment control, water quality, and nutrient management.

The Watershed Habitat Restoration section notes that Environment Canada's "How much Habitat is Enough?" (2004) document identifies targets for wetland and riparian habitat. These targets are 30% watershed cover for wetlands and 75% of stream length naturally vegetated for riparian zones. The Lake Erie North Shore watershed has approximately 20% wetland cover and approximately 64% vegetated stream length, so any measures to preserve and enhance these features will be beneficial.

The Watershed Strategy section is by far the most useful section of this document. It begins with a description of restoration suitability mapping that the NPCA has developed for the restoration of riparian, wetland, and upland habitats. This mapping will be used in D&A's opportunities and constraints analysis to refine and justify appropriate locations for restoration along the Wignell/Michener and Beaver Dam drains. This section also provides an in-depth restoration strategy for both the Wignell Drain and Beaver Dam Creek, which is effectively Beaver Dam Drain. A synopsis of these strategies is provided below.

Wignell Drain Restoration Strategy

This strategy encompasses both the Wignell W1 & W2 and Michener M1 & M2 drains. Michener drain and the upper reaches of the Wignell drain are classified as "Class F" drains, or systems with intermittent flow, and the remainder as "Class B", or a system with permanent flow, warm water temperature, and sensitive species and/or communities present. See the table in Appendix 2 for detailed information on Ontario's Class Authorization System. All of the Wignell/Michener drain system is classified as "important fish habitat" and Nickel Beach, which is in Gravelly Bay east of Lorraine Bay, is classified as "critical fish habitat". The strategy provides an overview of the drain's water quality, geomorphology, surrounding land uses, identified species-at-risk, adjacent natural heritage features, and major constraints to restoration. Restoration strategies are identified for two general areas of the drain (north and south of Durham St) and actions are recommended for public and private lands on a reach-by-reach basis. The primary riparian and wetland restoration strategies recommended are:

North of Durham St:

- Prioritize establishing riparian buffers (erosion of the drains' banks was observed during the study's field work, which is a significant observation as eroding banks contribute sediment to the watercourse, which decreases water quality);
- High wetland restoration suitability, especially for riparian wetlands and around the Wignell Drain Wetland Complex; and
- Protect existing wetlands.

South of Durham St:

- More riparian zone exists here than north of Durham St, but could be increased. Maintenance activities should attempt to maintain existing riparian cover;
- Increase buffer where drain runs adjacent to Snider Rd;
- Increase buffer on east branch (Michener Drain), as it has less buffer than west branch;
- Wetland restoration opportunities around the Nickel Beach Marsh PSW;
- Protect existing wetlands; and
- Inputs from the golf course could be minimized through an increase in vegetated buffers and through sensitive maintenance practices.

The "recommended actions for public and private lands" section characterizes the drain on a reach-by-reach basis and provides information about the channel structure, vegetation present, structures present, and impacts from adjacent land use. The recommendations given include:

- Avoid steep grading of channel banks to promote establishment of deep-rooted vegetation;
- Replacement of hard structures with bioengineered structures;
- Increase the amount of large woody vegetation adjacent to the channel to provide more canopy cover over the watercourse;

- Increase the size and diversity of native plant vegetation within the buffer zone;
- Consider alternatives to traditional channel design, including wetland creation, floodplain development, and natural channel design; and
- Continue to monitor water quality.

Beaver Dam Creek Restoration Strategy

This strategy refers to Beaver Dam Creek, but this creek is channelized into Beaver Dam Drain. The section of Beaverdam drain south of Firelane 1 is classified as "Class C", or a permanent warm water system with no sensitive species and/or communities present, and the rest of the drain is classified as "Class F", or having intermittent flow. This drain's fish habitat importance has not been evaluated. The strategy provides an overview of the drain's water quality, geomorphology, surrounding land uses, identified species-at-risk, adjacent natural heritage features, and major constraints to restoration. Restoration strategies are identified for three general areas of the drain (north of Second Concession Rd, Second Concession Rd to Killaly St, and south of Killaly St to Lake Erie) and actions are recommended for public and private lands on a reach-by-reach basis. The primary riparian and wetland restoration strategies recommended are:

North of Second Concession Rd

- Prioritize establishing riparian buffers, especially where drain flows through the Humberstone Marsh;
- High wetland restoration suitability, especially for riparian wetlands and around the Humberstone Marsh and West Humberstone Wetlands; and
- Protect existing wetlands.

Second Concession Rd to Killaly St

- Drains receive partial cover from natural areas, however establishment of more riparian cover should be a priority;
- Enhance buffers where drain flows beside roads;
- Enhance buffers where drain flows through golf course;
- High wetland restoration suitability, especially for filling in gaps in and around woodlands and for establishing riparian wetland along drain from Humberstone Marsh to Beaver Dam Creek Pt Col Wetland Complex; and
- Protect existing wetlands.

South of Killaly St to Lake Erie

- Large portion of drain flows through wetland, establishment of more riparian cover should be a priority south of this wetland;
- Maintain existing riparian cover;
- High wetland restoration suitability, especially for establishing riparian cover and around Beaver Dam Creek Pt Col Wetland Complex; and
- Protect existing wetlands.

The "recommended actions for public and private lands" section characterizes the drain on a reach-by-reach basis and provides information about the channel structure, vegetation present, structures present, and impacts from adjacent land use. See the description of recommendations given in the preceding "Wignell Drain Restoration Strategy" section.

The restoration strategies also makes note of a number of programs offered through the NPCA to educate landowners about naturalization, buffers, and water quality, as well as financial incentive programs to encourage landowners to implement environmental improvement measures.

Drain Restoration Studies

Ministry of Natural Resources. 2008. Wetland Drain Restoration Project Feasibility Study for Beaverdam Drain, Regional Municipality of Niagara, City of Port Colborne. (not published).

This study presents general restoration recommendations for the Beaver Dam drain, as prepared by the Ministry of Natural Resources in 2008. The study's recommendations are broken into four sections:

1. Wetland drain restoration project
   - It was originally suggested that the drain could be re-directed through an adjacent wooded swamp so that the swamp could act as a filtering system in order to improve water quality in Lorraine Bay.
   - Project partners and landowners believe that redirecting the flows could do more harm than good.
   - Designation of wetland as Provincially Significant could prevent implementation of this work regardless of partner and landowner wishes.
2. Restore buffers along the Beaver Dam drain
   - The goal of this idea is to improve downstream water quality through implementation of upstream buffers.
   - Sediment basins could also be constructed to collect sediments from upstream erosion/runoff.
   - Location and design of basins should be determined with input from engineers and the Drainage Superintendent, location should be along the road allowance to allow for easy access for maintenance.
3. Water quality monitoring
   - Existing data should be shared with project partners, monitoring efforts should be continued after restoration efforts have been implemented in order to determine whether or not water quality improvements have been made.
4. Point source
   - Data collected to date should be submitted to an agency to determine the most probable source for the elevated pollutants.

Wiebe Engineering. 2001-2002. Incomplete engineering study for Wignell/Michener Drain by (not published).

The majority of the documents produced by Wiebe Engineering do not relate to natural heritage. Those that do include:

Preliminary design comments from the NPCA

This letter, dated June 14, 2002, lists the NPCA's recommendations on Wiebe's proposed design for the created storm water wetlands. These recommendations include:

- Incorporate sediment bays at input points to wetland cells to capture excess sediments and provide pool habitat for fish;
- Incorporate non-linear wetland edges and diversity of bottom profile into wetland cells to increase the value of fish habitat;
- Re-vegetate the wetland cells with native species of aquatic plants, as well as native shrubs and trees along the banks to provide appropriate cover for fish and help filter water flowing through the wetland cells;
- Incorporate low flow channels into the new design for the drain channels where appropriate (i.e. Where width of channel allows);
- Incorporate buffer strips along the banks of the drain channels. The larger the buffer strips the more value they will provide for polishing of water and for side slope stabilization (minimum 3 metres on either bank is potentially feasible); and
- Incorporate sediment bays at road crossings along the drain channels to capture excess sediments and provide pool habitat for fish.

Synopsis of proposed wetland creation

This letter, dated May 31 2002, describes a proposed storm drainage system which has been designed to improve water quality in the Wignell and Michener drains. These ponds were not constructed. The design includes:

- Proposed construction of 8 ponds (3 drawing water from the Wignell drain, 5 drawing water from the Michener drain, both draining back into the Wignell main drain);
- The proposed ponds are all 1.3m deep with permanent water level of 0.3m and 5:1 side slopes;
- The proposed ponds were designed to receive water from 0-10 year storms and divert water from 25 year storms. The diversion of large storm flows was intended to protect the ponds from high velocities which could stir up sediments and damage plant life;
- These proposed wetland ponds were designed as per MOE guidelines primarily for water quality criteria, using measures designed to provide Level 2 protection as per the MOEE guidelines. Level 2 protection pertains to fish habitat including feeding areas, unspecialized spawning areas, and pool riffle run complexes along watercourses.

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Reach Mapping
Wignell-Michener and
Beaverdam Municipal Drains

PROJECT: DA11-007-01

CLIENT:

N
W E
S
NAD 83 UTM Zone 17

DATE: JULY 2012

SCALE: 1:24,000

DRAWN BY: LC

CHECKED BY: TF

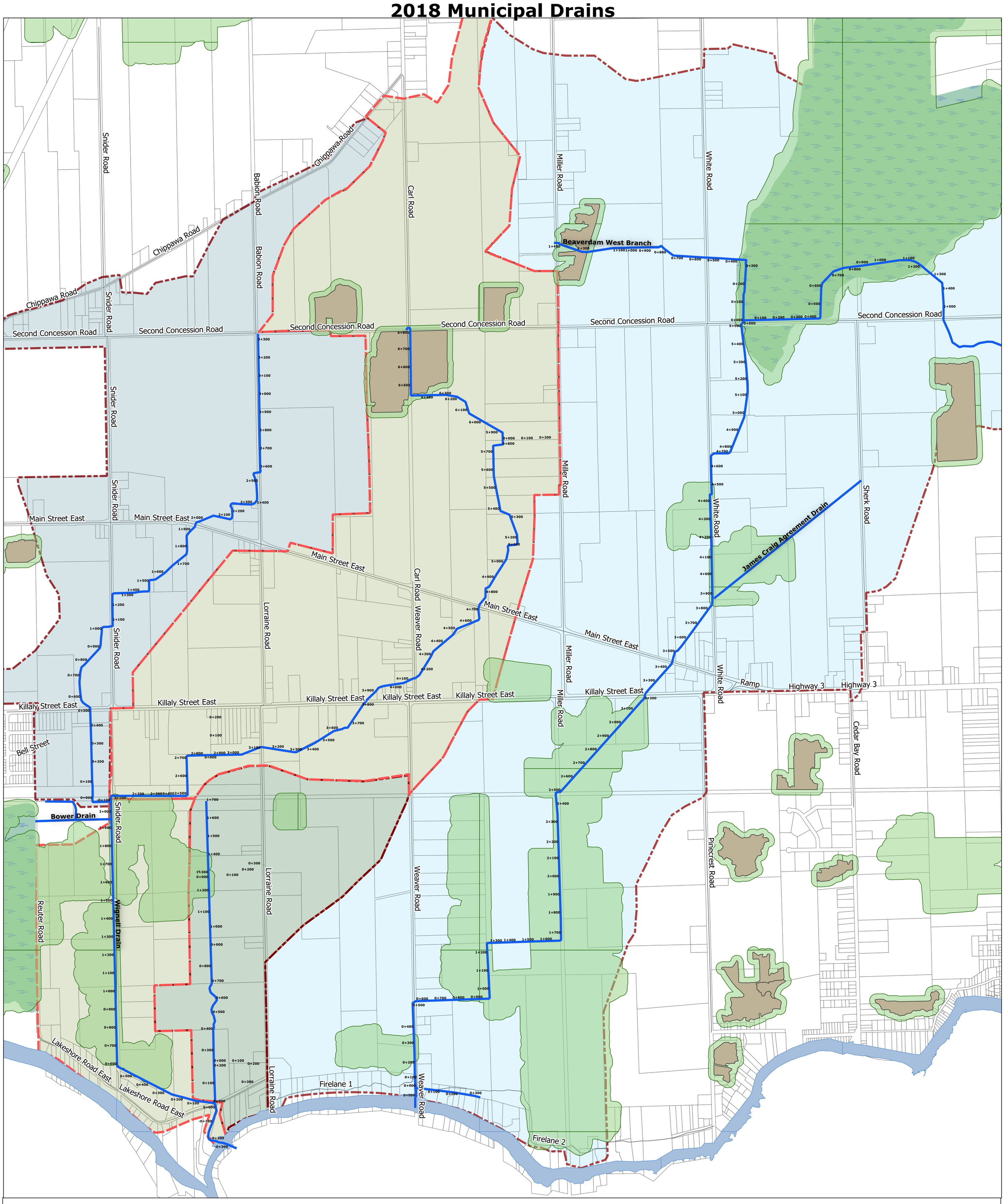
FIGURE:

1

Appendix D:

Environmental Mapping

2018 Municipal Drains



500 0 500 1000 1500 2000 m

Map Legend

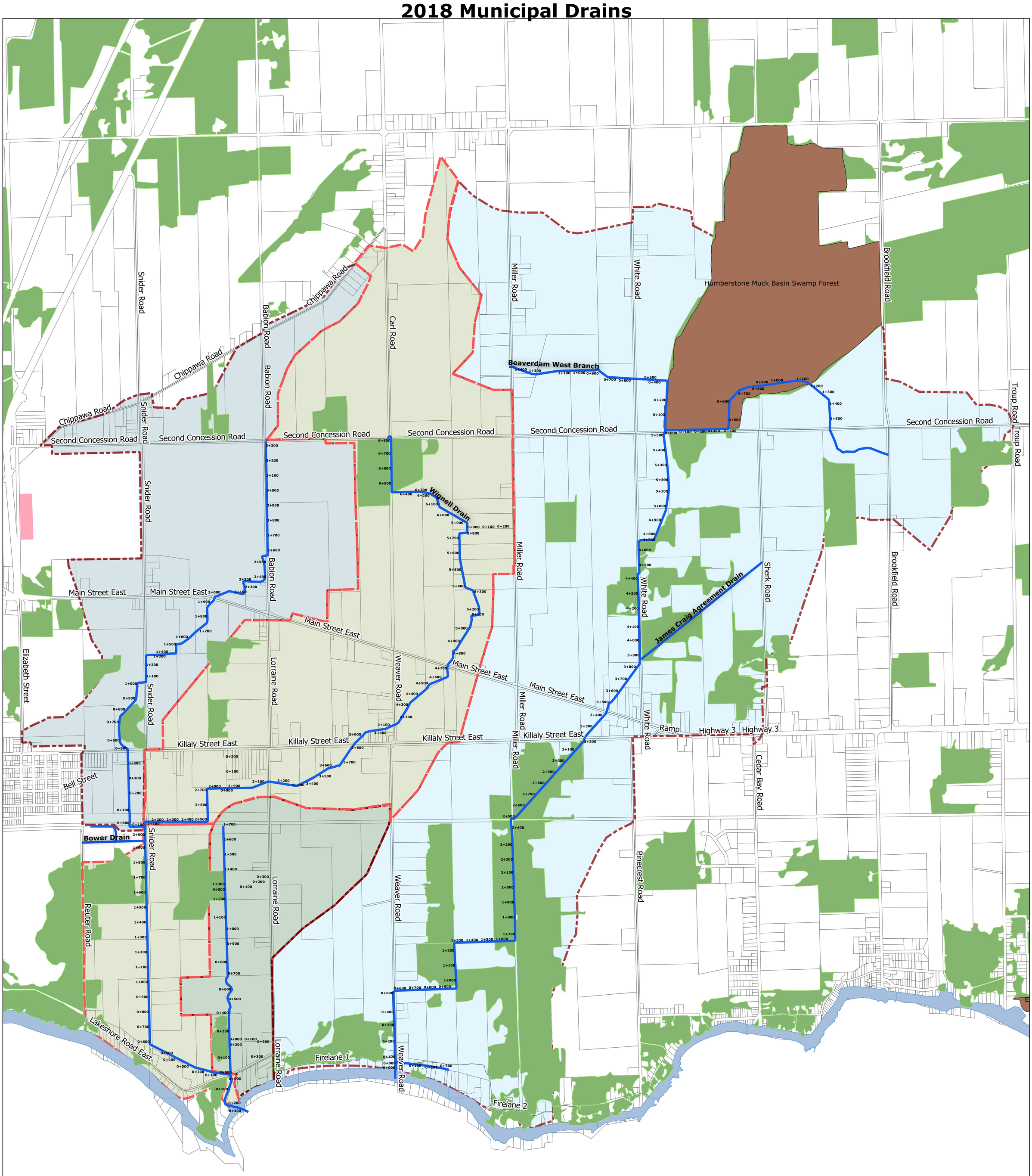
- Municipal Drain Centreline
- ECA_Other_Evaluated_Wetlands
- GR_WetlandAllowance_NPCA
- EPA_Provincial_Sig_Wetlands
- GR_RegulatedShorelineArea_NPCA
- Wignell Drain Boundary
- PColborne_Drain_Boundary
- Michener_Drain_Boundary
- Beaverdam_Drain_Boundary
- All_Drain_Parcel_Roads
- ALL_ASSESSMENT_PARCELS
- final chainage entities

EWA Engineering Inc.

NPCA Supplied Wetlands

Printed on: 2018-10-02T15:24:21

2018 Municipal Drains



EWA Engineering Inc.

NPCA Supplied Woodlands

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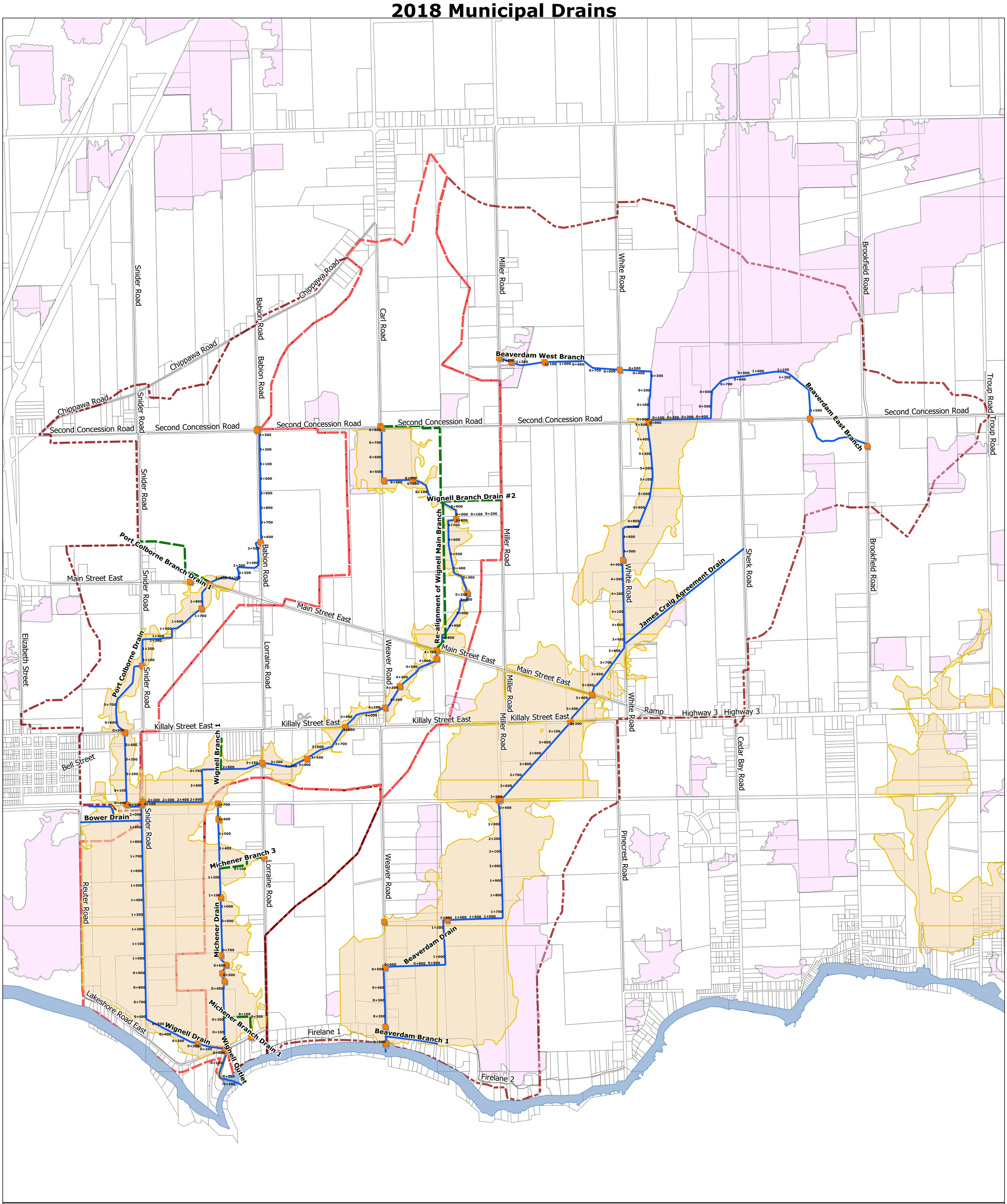
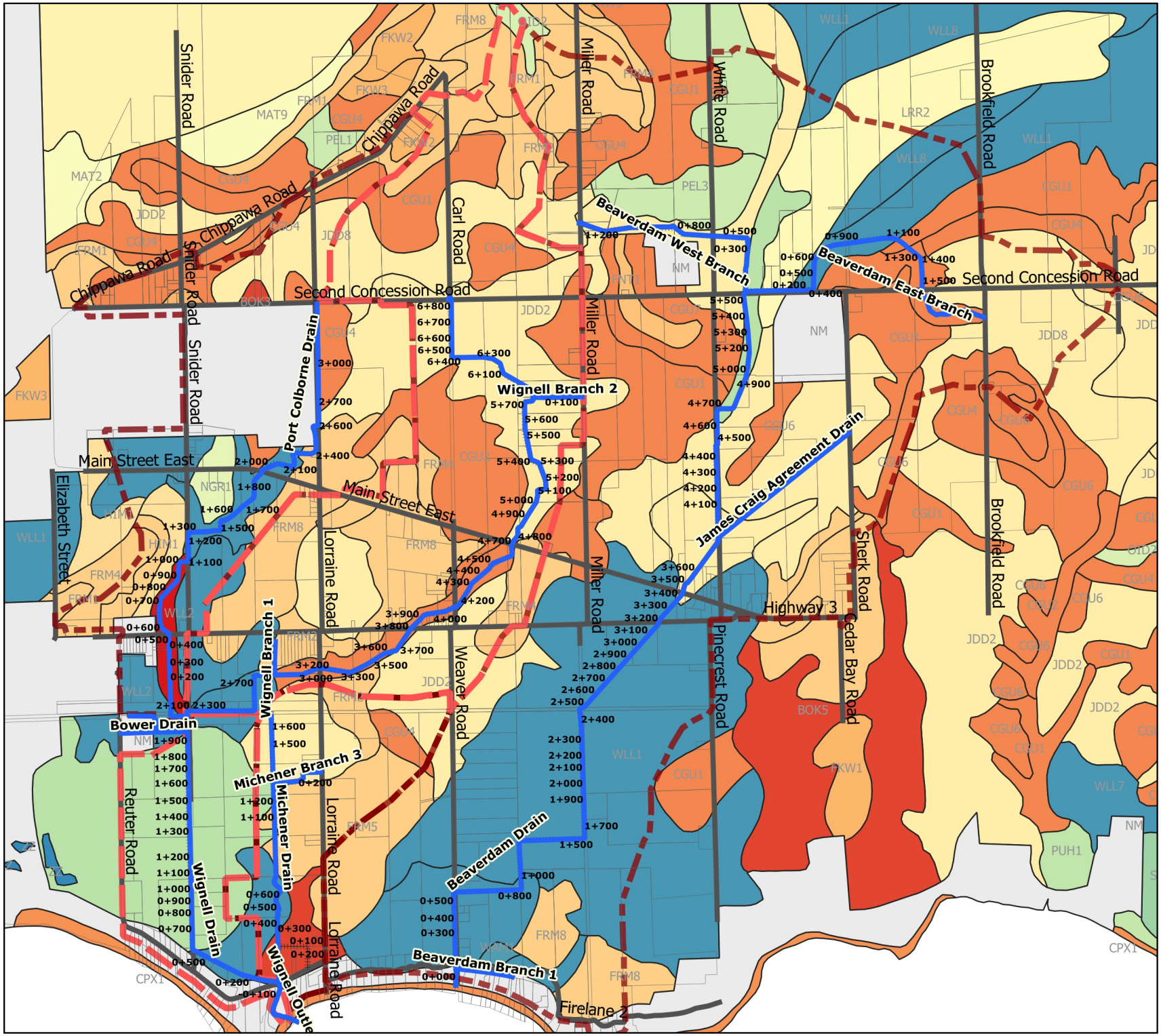
2018 Municipal Drains



NPCA Supplied Regulated Floodlines and Areas

EWA Engineering Inc.

Printed on: 2018-10-02T16:46:44



- Municipal Drain Centrelines
- final chainage entities
- All_Drain_Parcels
- Wignell Drain Boundary
- PColborne_Drain_Boundary
- Beaverdam_Drain_Boundary
- Michener_Drain_Boundary
- All_Drain_Parcel_Roads

PORT COLBORNE

soil

- ALU
- BAY
- BFO
- BNG
- BOK
- BOO
- BRR
- BRANT
- BVY
- CAN
- CHINGUACOUSY
- CPX
- CSH
- CWO
- ESC
- FRANKTOWN
- FMB
- FNT
- FOX
- FARMINGTON Loam
- GRIMSBY
- GNY
- HALDIMAND
- HOY
- JEDDO Clay
- LINCOLN
- LRR
- MAR
- MAT
- MOY
- MAPLEWOOD
- NIAGARA
- NM
- OID
- OTI
- PEELSilty Clay
- PFD
- PUH
- QRY
- RVE
- SHV
- SIH
- SRK
- TFG
- TLD
- TUC
- TVK
- VIT
- VLD
- WAF
- WAM
- WELLAND Clay
- WUS
- ZZ

Port_Colborne_20

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Government of Canada Gouvernement du Canada

Canada

Species at Risk Public Registry

A to Z Species Index

The Act establishes Schedule 1 as the official list of wildlife species at risk. However, please note that while Schedule 1 lists species that are extirpated, endangered, threatened and of special concern, the prohibitions do not apply to species of special concern. The SARA and You guides can help you determine the presence of these SARA Schedule 1 species in any region of Canada.

Total: 121 record(s) found.

Species Index

Common name *	Scientific name	Population	Taxon	Range	COSEWIC status	Schedule	SARA status
			All	Ontario	Endanger	All	All

Filter Again

* A common name search will search all common names in English and French as well as aliases and former names which are not displayed below.

Acadian Flycatcher	Empidonax virescens		Birds	Ontario	Endangered	Schedule 1	Endangered
Allegheny Mountain Dusky Salamander	Desmognathus ochrophaeus	Carolinian population	Amphibians	Ontario	Endangered	Schedule 1	Endangered
American Badger jacksoni subspecies	Taxidea taxus jacksoni		Mammals	Ontario	Endangered	Schedule 1	Endangered
American Chestnut	Castanea dentata		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
American Columbo	Frasera caroliniensis		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
American Ginseng	Panax quinquefolius		Vascular Plants	Ontario, Quebec	Endangered	Schedule 1	Endangered
Aweme Borer	Papaipema aweme		Arthropods	Ontario	Endangered	Schedule 1	Endangered
Barn Owl	Tyto alba	Eastern population	Birds	Ontario	Endangered	Schedule 1	Endangered
Bashful Bulrush	Trichophorum planifolium		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Bent Spike-rush	Eleocharis geniculata	Great Lakes Plains population	Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Bird's-foot Violet	Viola pedata		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Blanchard's Cricket Frog	Acris blanchardi		Amphibians	Ontario	Endangered	Schedule 1	Endangered
Blanding's Turtle	Emydoidea blandingii	Great Lakes / St. Lawrence population	Reptiles	Ontario, Quebec	Endangered	Schedule 1	Threatened
Blue Racer	Coluber constrictor foxii		Reptiles	Ontario	Endangered	Schedule 1	Endangered
Bluehearts	Buchnera americana		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Bogbean Buckmoth	Hemileuca sp.		Arthropods	Ontario	Endangered	Schedule 1	Endangered
Broad-banded Forestsnail	Allogona profunda		Molluscs	Ontario	Endangered	No schedule	No Status
Butler's Gartersnake	Thamnophis butleri		Reptiles	Ontario	Endangered	Schedule 1	Endangered
Butternut	Juglans cinerea		Vascular Plants	Ontario, Quebec, New Brunswick	Endangered	Schedule 1	Endangered
Caribou	Rangifer tarandus	Eastern Migratory	Mammals	Manitoba, Ontario,	Endangered	No schedule	No Status

		population		Quebec, Newfoundland and Labrador			
Cerulean Warbler	Setophaga cerulea		Birds	Ontario, Quebec	Endangered	Schedule 1	Endangered
Channel Darter	Percina copelandi	Lake Erie populations	Fishes	Ontario	Endangered	No schedule	No Status
Channel Darter	Percina copelandi	Lake Ontario populations	Fishes	Ontario	Endangered	No schedule	No Status
Cherry Birch	Betula lenta		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Colicroot	Aletris farinosa		Vascular Plants	Ontario	Endangered	Schedule 1	Threatened
Cucumber Tree	Magnolia acuminata		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Downy Yellow False Foxglove	Aureolaria virginica		Vascular Plants	Ontario	Endangered	No schedule	No Status
Drooping Trillium	Trillium flexipes		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Eastern persius Duskywing	Erynnis persius persius		Arthropods	Ontario	Endangered	Schedule 1	Endangered
Eastern Banded Tigersnail	Anguispira kochi kochi		Molluscs	Ontario	Endangered	No schedule	No Status
Eastern Flowering Dogwood	Cornus florida		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Eastern Foxsnake	Pantherophis gloydi	Carolinian population	Reptiles	Ontario	Endangered	Schedule 1	Endangered
Eastern Foxsnake	Pantherophis gloydi	Great Lakes / St. Lawrence population	Reptiles	Ontario	Endangered	Schedule 1	Endangered
Eastern Prairie Fringed Orchid	Platanthera leucophaea		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Eastern Prickly Pear Cactus	Opuntia humifusa		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Engelmann's Quillwort	Isoetes engelmannii		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Eskimo Curlew	Numenius borealis		Birds	Yukon, Northwest Territories, Nunavut, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Schedule 1	Endangered
False Hop Sedge	Carex lupuliformis		Vascular Plants	Ontario, Quebec	Endangered	Schedule 1	Endangered
False-foxglove Sun Moth	Pyrrhia aurantiago		Arthropods	Ontario	Endangered	No schedule	No Status
Fawnsfoot	Truncilla donaciformis		Molluscs	Ontario	Endangered	No schedule	No Status
Five-lined Skink	Plestiodon fasciatus	Carolinian population	Reptiles	Ontario	Endangered	Schedule 1	Endangered
Forked Three-awned Grass	Aristida basiramea		Vascular Plants	Ontario, Quebec	Endangered	Schedule 1	Endangered
Four-leaved Milkweed	Asclepias quadrifolia		Vascular Plants	Ontario	Endangered	No schedule	No Status

Fowler's Toad	Anaxyrus fowleri		Amphibians	Ontario	Endangered	Schedule 1	Endangered
Gattinger's Agalinis	Agalinis gattingeri		Vascular Plants	Manitoba, Ontario	Endangered	Schedule 1	Endangered
Golden-eye Lichen	Teloschistes chrysophthalmus	Great Lakes population	Lichens	Ontario	Endangered	No schedule	No Status
Gray Ratsnake	Pantherophis spiloides	Carolinian population	Reptiles	Ontario	Endangered	Schedule 1	Endangered
Gypsy Cuckoo Bumble Bee	Bombus bohemicus		Arthropods	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Schedule 1	Endangered
Heart-leaved Plantain	Plantago cordata		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Henslow's Sparrow	Ammodramus henslowii		Birds	Ontario, Quebec	Endangered	Schedule 1	Endangered
Hickorynut	Obovaria olivaria		Molluscs	Ontario, Quebec	Endangered	No schedule	No Status
Hine's Emerald	Somatochlora hineana		Arthropods	Ontario	Endangered	Schedule 1	Endangered
Hoary Mountain-mint	Pycnanthemum incanum		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Hoptree Borer	Prays atomocella		Arthropods	Ontario	Endangered	No schedule	No Status
Horsetail Spike-rush	Eleocharis equisetoides		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Hungerford's Crawling Water Beetle	Brychius hungerfordi		Arthropods	Ontario	Endangered	Schedule 1	Endangered
Jefferson Salamander	Ambystoma jeffersonianum		Amphibians	Ontario	Endangered	Schedule 1	Endangered
Juniper Sedge	Carex juniperorum		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Kidneyshell	Ptychobranchus fasciolaris		Molluscs	Ontario	Endangered	Schedule 1	Endangered
King Rail	Rallus elegans		Birds	Ontario	Endangered	Schedule 1	Endangered
Kirtland's Warbler	Setophaga kirtlandii		Birds	Ontario	Endangered	Schedule 1	Endangered
Lake Chubsucker	Erimyzon sucetta		Fishes	Ontario	Endangered	Schedule 1	Endangered
Lake Sturgeon	Acipenser fulvescens	Saskatchewan - Nelson River populations	Fishes	Alberta, Saskatchewan, Manitoba, Ontario	Endangered	No schedule	No Status
Large Whorled Pogonia	Isotria verticillata		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Laura's Clubtail	Stylurus laurae		Arthropods	Ontario	Endangered	No schedule	No Status
Lilliput	Toxolasma parvum		Molluscs	Ontario	Endangered	No schedule	No Status
Little Brown Myotis	Myotis lucifugus		Mammals	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba,	Endangered	Schedule 1	Endangered

				Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador			
Loggerhead Shrike Eastern subspecies	Lanius ludovicianus ssp.		Birds	Ontario, Quebec	Endangered	No schedule	No Status
Massasauga	Sistrurus catenatus	Carolinian population	Reptiles	Ontario	Endangered	Schedule 1	Endangered
Monarch	Danaus plexippus		Arthropods	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia	Endangered	Schedule 1	Special Concern
Mottled Duskywing	Erynnis martialis	Great Lakes Plains population	Arthropods	Ontario, Quebec	Endangered	No schedule	No Status
Nine-spotted Lady Beetle	Coccinella novemnotata		Arthropods	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec	Endangered	No schedule	No Status
Nodding Pogonia	Triphora trianthophoros		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Northern Barrens Tiger Beetle	Cicindela patruela		Arthropods	Ontario, Quebec	Endangered	Schedule 1	Endangered
Northern Bobwhite	Colinus virginianus		Birds	Ontario	Endangered	Schedule 1	Endangered
Northern Dusky Salamander	Desmognathus fuscus	Carolinian population	Amphibians	Ontario	Endangered	Schedule 1	Endangered
Northern Madtom	Noturus stigmosus		Fishes	Ontario	Endangered	Schedule 1	Endangered
Northern Myotis	Myotis septentrionalis		Mammals	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Schedule 1	Endangered
Northern Riffleshell	Epioblasma torulosa rangiana		Molluscs	Ontario	Endangered	Schedule 1	Endangered
Ogden's Pondweed	Potamogeton ogdenii		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Pale-bellied Frost Lichen	Physconia subpallida		Lichens	Ontario, Quebec	Endangered	Schedule 1	Endangered
Pink Milkwort	Polygala incarnata		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Piping Plover circumcinctus subspecies	Charadrius melodus circumcinctus		Birds	Alberta, Saskatchewan, Manitoba, Ontario	Endangered	Schedule 1	Endangered

Prothonotary Warbler	Protonotaria citrea		Birds	Ontario	Endangered	Schedule 1	Endangered
Proud Globelet	Patera pennsylvanica		Molluscs	Ontario	Endangered	No schedule	No Status
Queensnake	Regina septemvittata		Reptiles	Ontario	Endangered	Schedule 1	Endangered
Rapids Clubtail	Gomphus quadricolor		Arthropods	Ontario	Endangered	Schedule 1	Endangered
Rayed Bean	Villosa fabalis		Molluscs	Ontario	Endangered	Schedule 1	Endangered
Red Knot rufa subspecies	Calidris canutus rufa		Birds	Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Schedule 1	Endangered
Red Mulberry	Morus rubra		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Red-headed Woodpecker	Melanerpes erythrocephalus		Birds	Saskatchewan, Manitoba, Ontario, Quebec	Endangered	Schedule 1	Threatened
Redside Dace	Clinostomus elongatus		Fishes	Ontario	Endangered	Schedule 1	Endangered
River Darter	Percina shumardi	Great Lakes - Upper St. Lawrence populations	Fishes	Ontario	Endangered	No schedule	No Status
Riverine Clubtail	Stylurus amnicola	Great Lakes Plains population	Arthropods	Ontario	Endangered	Schedule 1	Endangered
Round Hickorynut	Obovaria subrotunda		Molluscs	Ontario	Endangered	Schedule 1	Endangered
Round Pigtoe	Pleurobema sintoxia		Molluscs	Ontario	Endangered	Schedule 1	Endangered
Rusty-patched Bumble Bee	Bombus affinis		Arthropods	Ontario, Quebec	Endangered	Schedule 1	Endangered
Salamander Mussel	Simpsonaias ambigua		Molluscs	Ontario	Endangered	Schedule 1	Endangered
Scarlet Ammannia	Ammannia robusta		Vascular Plants	British Columbia, Ontario	Endangered	Schedule 1	Endangered
Shortnose Cisco	Coregonus reighardi		Fishes	Ontario	Endangered	Schedule 1	Endangered
Showy Goldenrod	Solidago speciosa	Great Lakes Plains population	Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Silver Chub	Macrhybopsis storeriana	Great Lakes - Upper St. Lawrence populations	Fishes	Ontario	Endangered	No schedule	No Status
Skinner's Agalinis	Agalinis skinneriana		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Slender Bush-clover	Lespedeza virginica		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Small Whorled Pogonia	Isotria medeoloides		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Small-flowered Lipocarpha	Lipocarpha micrantha		Vascular Plants	British Columbia, Ontario	Endangered	Schedule 1	Endangered
Small-mouthed Salamander	Ambystoma texanum		Amphibians	Ontario	Endangered	Schedule 1	Endangered
Snuffbox	Epioblasma triquetra		Molluscs	Ontario	Endangered	Schedule 1	Endangered

Spiny Softshell	Apalone spinifera		Reptiles	Ontario, Quebec	Endangered	Schedule 1	Threatened
Spotted Gar	Lepisosteus oculatus		Fishes	Ontario	Endangered	Schedule 1	Threatened
Spotted Turtle	Clemmys guttata		Reptiles	Ontario, Quebec	Endangered	Schedule 1	Endangered
Striped Whitelip	Webbhelix multilineata		Molluscs	Ontario	Endangered	No schedule	No Status
Tri-colored Bat	Perimyotis subflavus		Mammals	Ontario, Quebec, New Brunswick, Nova Scotia	Endangered	Schedule 1	Endangered
Unisexual Ambystoma	Ambystoma laterale - texanum	Small-mouthed Salamander dependent population	Amphibians	Ontario	Endangered	No schedule	No Status
Unisexual Ambystoma	Ambystoma laterale - (2) jeffersonianum	Jefferson Salamander dependent population	Amphibians	Ontario	Endangered	No schedule	No Status
Virginia Goat's-rue	Tephrosia virginiana		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Virginia Mallow	Sida hermaphrodita		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Warmouth	Lepomis gulosus		Fishes	Ontario	Endangered	Schedule 1	Special Concern
White Prairie Gentian	Gentiana alba		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Wood-poppy	Stylophorum diphyllum		Vascular Plants	Ontario	Endangered	Schedule 1	Endangered
Yellow-breasted Chat virens subspecies	Icteria virens virens		Birds	Ontario	Endangered	Schedule 1	Endangered

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