Drainage Study of the Farr, Webber and River Road Area

Town of Pelham Council Meeting

April 19, 2023

Presented by: Dr. Bahar SM





AGENDA OF THE MEETING

Objective and Scope of the Study

Drainage Analysis of the Study Area: Historical and Existing

Findings of Technical Analysis: Hydrologic, Hydraulic & Floodplain Mapping

Recommendations

Objective of the Study



Residential and farm properties in the area have been experiencing drainage issues & flooding



The Town of Pelham has undertaken a drainage study to understand the drainage concerns and pertinent issues. The study area is within the jurisdiction of the Niagara Peninsula Conservation Authority (NPCA)

Brief Overview of the Study Area

- The Farr, Webber and River Road area in the Town of Pelham encompasses an area of approximately **1.27 sq.km**
- **Extent of Study Area:** Victoria Avenue in the West and Church Street in the East. The Area is bounded Webber Road in the north and River Road in the South •
- Types of Data Used for analysis:
 - Hydrometeorological data of the study area (i.e., Rainfall Data using the Ministry of Transportation IDF Curve Lookup Table)
 - Hydrogeology of the study area (i.e., Soil Data)
 - Land Use of the study area (i.e., Land-use and Land-cover Data)
 - Topographic data (Field survey and Hydraulic structure survey)
 - Historical Aerial Images
- Drainage Area after delineation of watershed : 2.74 sq.km
 Number of Delineated Subbasins: 21 ٠



1 Collection and Review of background data and reports

- Perform field work to verify topographic mapping data,
 obtain topographic data and historic mapping data of the study area
- 3 Perform on-field fluvial geomorphic assessment
 - Development of hydrologic model(s) for the sub-watersheds within the drainage area(s)

- ⁵ Development of 1D hydraulic model(s) to determine the extent of flooding
- 6 Identify properties under flood risk and recommend mitigation options

Scope of Work

4

Methodology for the Study



FIELD DATA COLLECTION





Field Data Collection (Hydraulic Structure Survey)

Culver t no.	Road	Culvert Type	Shape	Measurements		
				Width(m)	Height(m)	Dia(m)
1	River Road	Box Culvert	Rectangul ar	2.45	2.2	
2	Balfour St.	2*CSP	Circular			2.1
3	Railway	1*CSP	Circular			1.25
4	Church St	1*CSP	Eliptical	1.15	0.8	
5	Farr St	1*CSP	Circular			0.6
6	Church St 2	1* Plastic Blade Culvert (new)	Circular			0.6
7	Webber#1	1*CSP	Circular			1.4
8	Webber#2	1*CSP	Circular			1.15
9	Webber#3	1*CSP	Circular			0.9
10	Webber#4	1*CSP	Circular			0.7
11	Victoria- Webber	1*CSP	Circular			0.5~0.9
12	River Road 2	1*CSP	Circular			0.45
13	Farr St 2	1*CSP	Circular			0.65
13A	Farr Rd- Ditch	1*CSP	Circular			0.45
14	Victoria Avenue Properties	1*CSP	Circular			0.6

A total of 15 culverts were surveyed



Field Data Collection (Culvert Condition)



Figure 1: Near the Victoria Avenue



Figure 2: Webber Road



Figure 3: Farr Road



Figure 4: Victoria Avenue



Figure 5: Farr Road



Figure 6: Webber Road

Field Data Collection

Culvert at 275-285 Victoria Avenue Property



Culvert Inlet near 265-275 Victoria Avenue Property



Culvert outlet near 285 Victoria Avenue Property

Field Data Collection





FLOW OBSTRUCTION due to High Vegetation along the Crossings and Open Channels



HISTORIC AND EXISTING DRAINAGE





Historical Aerial Image Analysis (2002 and 2010)





2002 and 2010 shows almost similar condition where the change of flow directions can be noticed near the Farr road, where one direction of the reach flows towards the west and the other towards the east.

Historical Aerial Image Analysis (2018)



2018 shows the change in flow direction location shifted towards the west of Farr Road. Development through residential houses took place within the area compared to 2010. An additional channel is seen between two properties at the Victoria Avenue properties which turns at an angle of 90 degree (approx.)



Historical Aerial Image Analysis (2020)



2020 shows the flow direction location change location like 2018. In the West channel, a 0.6m diameter and 125m long culvert runs in between 275 Victoria Avenue and 285 Victoria Avenue properties which runs 35m in between the two properties and then turns 90 degrees under the ditch along Victoria Avenue and the West Channel downstream.



Existing Condition at the Study Area



The change in flow location obtained from the topographic survey conducted (in 2022) (*right side image*) shows the shifting of the changed location more towards west due to land filling issues.

Changes in Bed Elevation from the Topographic Data Collected



SUMMARY OF FINDINGS FROM TECHNICAL ANALYSIS





2-Year VS 100-Year Inundation



Flood Inundation Extent Map



- Near the Victoria Road and Webber Road, the extent of inundation appears to be higher.
- High inundation has also been observed near the Farr Road.
- The extent of flooding near the Church Street appears to be moderate.
- At the east side of the Webber Road, there seems to be a minimal degree of inundation.

Maximum Inundation

- In the West channel, a 0.6m diameter and 125m long culvert runs in between 265 Victoria Avenue and 275 Victoria Avenue properties which runs 35m in between the two properties and then turns 90 degrees under the ditch along Victoria Avenue and the West Channel downstream.
- This under sized culvert provides backwater effect even for the 2-year flow and flooding in both sides of the watercourse in the West channel.



Buildings within the Floodplain

The bounding area of Farr, Webber, Victoria, and River Road has the maximum extent of flooding and inundated water surface elevation compared to the other segments of the study area.

 A considerable number of properties (i.e. 950-990,1000 Webber Road properties, 225-285 Vitoria Avenue properties) fall within the area of extreme flooding.



DRAINAGE ANALYSIS FOR THE EXISTING CONDITION AND FINDINGS







Major Drainage Issues

- Landfilling & Alteration of the Drainage System
- Alteration of the Historical Natural Watercourses
- Hydraulic Capacity of the Culverts

RECOMMENDATONS AND PROPOSED MITIGATION ALTERNATIVES





Recommendations

• The NPCA Policy Document: *Policies for the Administration of Ontario Regulation 155/06 and the Planning Act*, specifies several development setbacks associated with flooding and alteration of watercourses. Following those guidelines before planning and construction a new building or any advancement of land near the floodplain, can eliminate the flood risk.

- Assessing the drainage issues, some mitigation options have been proposed below:
 - 1) Increase/Upgrade Culvert Hydraulic Capacity of 265-275 Victoria Avenue Culvert.
 - 2) Install Road Crossing at 265-275 Victoria Avenue for the upgraded culvert.
 - 3) Reinstall the Historical Watercourse between the 990 Webber Rd. and 285 Victoria Ave. properties.
 - 4) Increase/Upgrade Culvert Hydraulic Capacity of the Victoria-Webber intersection culvert along with reinstallation of the Historical Watercourse
 - 5) Implement Natural Channel Design to route flow from Farr Road to Victoria Avenue

• Drainage issues involve work on private properties and will require the willingness of private property owners to work together to resolve the drainage issues and that the municipality is restricted to do work on private property.

Proposed Three (3) Mitigation Alternatives

AHYDTECH assessed three alternative options to eliminate flooding issues within the study area. These are-

- 1. <u>The existing culvert under the Victoria Road should be sized for the 50-year return period</u> <u>flood event to minimize flooding because of backwater under major storm events.</u>
- 2. An overland flow channel should be constructed passing in between 285 Victoria Avenue, 990 and 1000 Webber Road properties, along the historical/original channel from the existing channel.
- 3. At final detailed design, <u>the Region and Town should consider a diversion of some or all of the</u> <u>stormwater from the tributaries that originate north of Webber Road and convey the flows</u> <u>easterly along the Webber Road ditches to Victoria Ave and the Welland River.</u> The design would need to confirm that the ditch system has the capacity to convey the design flow without impacting the existing property owners.

The existing culvert under the Victoria Road should be sized for the 50year return period flood event.

- Existing diameter of the culvert at inlet was found to be 0.5m and hydraulic analysis shows that the culvert has the capacity to convey up to 25-year return period flood events.
- Different culvert diameter (0.6m, 0.8m and 1m) were used in the hydraulic model to check and assess the flooding extents.
- When the size of the culvert has been increased to <u>1m diameter, no flow stagnation and inundation</u> <u>occurs in the properties which had been flooded</u> <u>previously.</u>



Figure : Existing undersized Culvert under Victoria Road



Figure : Flooding extent with the existing 0.5m diameter Culvert under Victoria Road

Figure : Flooding extent with the proposed 1m diameter Culvert under Victoria Road along when implemented along with the Alternative Option 2

A substantial reduction in inundation extents can be observed when the diameter of the Victoria Road culvert is increased to 1m.

area to provide a positive flow gradient from Farr Road to Victoria Avenue outlet.

An overland flow channel should be constructed passing in between 285 Victoria Ave. 990 and 1000 Webber Road properties, along the historical/original channel from the existing channel. The channel should be designed for the major event storms. A detailed natural channel design should be prepared for the overland flow channel including for the channel in the study

- Scenario-1: 20% of the total flow generated within the West channel will be conveyed by the channel with 125m culvert.
- Scenario-2: No flow conveyed by the channel with 125m culvert.



Alternative Option 2 (Scenario-1)

Scenario-1: 20% of the total flow generated within the West channel will be conveyed by the channel with 125m culvert (80% will be conveyed by the recommended overland flow channel.)

-Model results show that the 125m culvert can successfully convey 20% of the flow generated by 2-year and 5-Year Return Period floods to the Welland river without causing any inundation.

-The 125m culvert cannot capacitate 20% of the flow generated by 25-year flood event and causes significant backwater for 25 and greater return period's floods.



Flood Extents for the Recommended Mitigation Option 2 (Scenario 1) and Option 3

Alternative Option 2 (Scenario-2)

Scenario-2: No flow conveyed by the channel with 125m culvert. (100% will be conveyed by the proposed overland flow channel.)

-Model results show that the proposed channel which runs between the properties at 990, 1000 Webber road and 285 Victoria Avenue has the capacity to convey 100% of the flow without causing any flooding issues.

-No inundation occurs within the area for 2, 5, 25 and 50-year flood scenarios.



It is recommended either to close the channel passing between 265 to 285 Victoria Avenue, diverting the entire flow to the proposed overland channel passing through the 990, 1000 Webber Road and 285 Victoria Avenue properties

or

To increase the diameter of the 125m culvert such that it conveys a considerable portion of flow without causing any backwater throughout the channel and surrounding area.

Two of the tributaries which originated from the north of Webber Road and conveyed flow to the main channel south of Webber Road, will be diverted to Welland River through a roadside ditch north of Webber Road.



Model result shows that this diversion channel notably eliminates flooding and reduce the extent of inundation within the project study area when implemented along with the Alternative Option 1 and Alternative Option 2.



Flood Extents for the proposed Alternative Option 1, Option 2(Scenario 2) and Option 3

Thank you!

Dr. Bahar SM, P. Geo. (Ltd), P. Eng.

Managing Director AHYDTECH Geomorphic Ltd. 22 Zecca Drive, Guelph, ON, N1L 1T1 Phone +1 519-400-0264 E: bahar@ahydtech.com

Barbara Weins, MCIP, RPP

Director, Community Planning and Development, Town of Pelham D: 905-980-6658 T: 905-892-2607x316 20 Pelham Town Square, PO Box 400, Fonthill, ON, LOS 1EO, Email: <u>bweins@pelham.ca</u>