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MEMORANDUM

Date: January 25, 2021 **MA-Project No**: 2017-849

To: Sameer Dhalla
Director, Development and Engineering Services
Toronto and Region Conservation Authority

From: David Hoover
Masongsong Associates Engineering Limited

Subject: Robinson Creek Channel Re-Alignment
12148 Albion Vaughan Road, Bolton
Town of Caledon, Ontario

Masongsong Associates Engineering Limited (MAEL) has been retained by Aztec Restoration to prepare this technical memorandum in support of the channel re-alignment at Reach 1 of Robinson Creek, a tributary to the Humber River. The purpose of this memo is to identify the existing hydraulic conditions and to demonstrate how the proposed alignment will preserve and enhance the function of the watercourse to the satisfaction of the Toronto and Region Conservation Authority (TRCA).

The proposed re-alignment is located entirely within the property of 12148 Albion Vaughan Road and characterized by proposed site grading in support a new building. The requirement for this re-alignment was identified during the zoning by-law and site plan application process when it was discovered that the previous land use had significantly altered the site topography resulting in negative impacts to regulatory floodplain. Therefore, channel re-alignment is necessary to restore and enhance the function of the watercourse while supporting the proposed development.

The areas of concerns for Robinson Creek is identified as Reach 1 starting from River Station 2223.1 to River Station 2223.16. The lands tributary to this length of Robinson Creek is limited to the subject property.

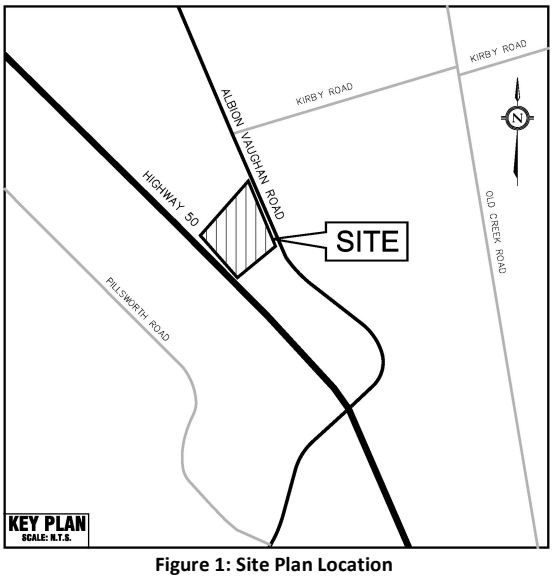

Figure 1: Site Plan Location

1. BACKGROUND

The subject property is approximately 1.3 ha (3.2 acres), bound by Highway 50 (a Peel Regional arterial roadway) to the west, and bound by Albion Vaughan Road (the designated "frontage") to the east. Directly to the north is existing rural residential and to the south is a commercial site with outdoor storage provisions. The legal description of the property is Part 1 of Lot 1, Concession 7 in the Town of Caledon. Refer to FIGURE 1 for the Site Plan Location.

2. HYDRAULIC MODELLING (GEOHEC-RAS) RESULTS

The hydraulic modelling results presented herein describes the channel hydraulics based on the details of the TRCA 2015 HEC RAS model, existing topography and site design where applicable. The following tasks were undertaken:

- Update the relevant cross sections for each modelling scenario based on available topographic data.
- Determine regulatory flood elevations for the pre-existing (PEX), existing (EX) and proposed (PR) scenarios
- Evaluate the results of the proposed (PR) channel re-alignment with the pre-existing (PEX) and existing (EX) scenarios

METHODOLOGY

To achieve the modelling objectives described in the preceding section, the U.S. Army Corps of Engineers' River Analysis System (HEC-RAS) was utilized. HEC-RAS is designed to perform one-dimensional steady and unsteady flow river hydraulics calculations, sediment transport-mobile bed modelling, and water temperature analysis. The HEC-RAS software supersedes the HEC-2 river hydraulics package.

The modelling system calculates water surface profiles for steady gradually varied flow. The system can handle a full network of channels, a dendritic system, or a single river reach. The steady flow component is capable of modelling subcritical, supercritical, and mixed flow regime water surface profiles.

The basic computational procedure is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is utilized in situations where the water surface profile is rapidly varied. These situations include mixed flow regime calculations (i.e., hydraulic jumps), hydraulics of bridges, and evaluating profiles at river confluences (stream junctions).

This model has the ability to consider the effects of various obstructions, such as bridges, culverts, dams, weirs, and other structures in the floodplain on water levels. The steady flow system is designed for application in floodplain management, estimation of floodplain storage, and for assessing the change in water surface profiles due to channel modifications.

The model requires the following input:

- Channel geometry (low flow centerline profile and cross-sections; culvert crossing details);
- Manning’s roughness for main channel and overbank areas;
- Cumulative flow; and,
- Downstream boundary conditions.

PRE-EXISTING CONDITIONS (PEX)

The Robinson Creek HEC-RAS was obtained from the TRCA and has been used to establish the original floodline conditions for our site, 12148 Albion Vaughan Road. The following outlines the measures taken when analyzing the pre-existing hydraulic model:

- Uses flow data from the provided TRCA HEC-RAS model (**Table 1**)

Table 1: TRCA Flows

Storm Event	XS 2223.18 Flow (m^3/s)	XS2223.12 Flow (m^3/s)
2-Year	5.47	5.69
5-Year	7.78	8.09
10-Year	9.36	9.73
25-Year	11.54	11.99
50-Year	13.25	13.77
100-Year	15.21	15.81
Regional	17.88	18.59

- Uses original geometry from the provided TRCA 2015 HEC-RAS model

The resultant water surface elevations (W.S.E.) for regulatory storm event in the pre-existing model are summarized in **Table 2**. The floodplain mapping complete with river station locations and flood line for this scenario can be found on **Drawing PEX**.

EXISTING CONDITIONS (EX)

The existing condition model was established by updating the relevant cross sections of the Robinson Creek HEC-RAS obtained from the TRCA. The update is based on the data from a topographic survey of the existing grades which were found to be significantly altered from the original geometry in the pre-existing (PEX) scenario above. The following outlines the measures taken when analyzing the existing hydraulic model:

- Uses flow data from the provided TRCA 2015 HEC-RAS model (**Table 1**)
- Uses existing geometry and sections from the provided TRCA 2015 HEC-RAS model and then updated with the topographical survey (see below):
  - Section 2223.15
  - Section 2223.14
  - Section 2223.134
  - Section 2223.133
  - Section 2223.132
  - Section 2223.131
  - Section 2223.112
  - Section 2223.11
- Additional cross sections have been provided to increase the accuracy across the site (see below):
  - Section 2223.156
  - Section 2223.152

- Section 2223.148
- Section 2223.146
- Section 2223.145
- Section 2223.143
- Section 2223.141
- Section 2223.125

The resultant water surface elevations (W.S.E.) for regulatory storm event in the existing model are summarized in **Table 2**. The floodplain mapping complete with river station locations and flood line for this scenario can be found on **Drawing EX**.

PROPOSED CONDITIONS (PR)

The proposed conditions model includes the projected grading for our site. The following outlines the measures taken when analyzing the proposed hydraulic model:

- Uses flow data from the provided TRCA 2013 HEC-RAS model (Table 1)
- Uses existing geometry from the Baseline Model HEC-RAS model with modifications which are as follows:
    - Section 2223.105 which represents a culvert structure has been removed from the model which as the existing culvert that serviced the driveway access is no longer required in the proposed condition.
- Uses existing geometry and sections from the provided TRCA 2015 HEC-RAS model and then updated with the proposed site grading design (see below):
    - Section 2223.15
    - Section 2223.14
    - Section 2223.134
    - Section 2223.133
    - Section 2223.132
    - Section 2223.131
    - Section 2223.112
    - Section 2223.11
- Additional cross sections have been provided to increase the accuracy across the site (see below):
    - Section 2223.156
    - Section 2223.152
    - Section 2223.148
    - Section 2223.146
    - Section 2223.145
    - Section 2223.143
    - Section 2223.141
    - Section 2223.125

The resultant water surface elevations (W.S.E.) for regulatory storm event in the proposed model are

summarized in **Table 2**. The floodplain mapping complete with river station locations and flood line for this scenario can be found on **Drawing PR**.

Table 2: Regulatory W.S.E. For Various Scenarios

River Station	Regulatory W.S.E. (m)		
	PEX	EX	PR
2223.16	230.20	230.20	230.20
2223.156		229.92	229.93
2223.152		229.76	229.68
2223.15	229.60	229.80	229.36
2223.148		229.78	229.33
2223.146		229.79	229.32
2223.145		229.79	229.32
2223.143		229.78	229.31
2223.141		229.77	229.19
2223.14	229.23	229.70	229.19
2223.134	229.20	229.56	229.01
2223.133	229.19	229.45	229.07
2223.132	229.18	229.44	229.07
2223.131	229.17	229.36	229.05
2223.13	229.09	228.87	229.02
2223.125		228.84	228.98
2223.12	229.05	228.94	228.97
2223.11	228.69	228.68	228.97
2223.105	CULVERT	CULVERT	REMOVED
2223.1	228.44	228.41	228.94
2223.09	228.60	228.56	228.50
2223.08	227.91	227.88	228.05
2223.075	CULVERT	CULVERT	CULVERT
2223.07	227.73	227.71	227.71
2223.06	227.63	227.61	227.61
2223.05	226.71	226.69	226.69
2223.04	226.27	226.24	226.24
2223.03	226.00	225.99	225.99
2223.025	CULVERT	CULVERT	CULVERT
2223.02	225.61	225.61	225.61

DISCUSSION

The regulatory water surface elevation for the pre-existing and the proposed condition is shown in **Table 3** below. The proposed channel re-alignment that only consists of site grading changes within the subject property restores and enhances the original (PEX) condition by significantly reducing the regulatory water surface elevation within this length of Robinson Creek

Table 3: Regulatory W.S.E. For Various Scenarios

River Station	Regulatory W.S.E. (m)		
	PEX	PR	Difference
2223.16	230.20	230.20	0.00
2223.15	229.60	229.36	-0.24
2223.14	229.23	229.19	-0.04
2223.134	229.20	229.01	-0.19
2223.133	229.19	229.07	-0.12
2223.132	229.18	229.07	-0.11
2223.131	229.17	228.05	-0.12
2223.13	229.09	228.02	-0.07
2223.12	229.05	228.97	-0.08
2223.11	228.69	228.97	0.28
2223.105	CULVERT	CULVERT REMOVED	-
2223.1	228.44	228.94	0.50
2223.09	228.60	228.50	-0.10
2223.08	227.91	228.05	0.14
2223.075	CULVERT	CULVERT	-
2223.07	227.73	227.71	-0.02
2223.06	227.63	227.61	-0.02
2223.05	226.71	226.69	-0.02
2223.04	226.27	226.24	-0.03
2223.03	226.00	225.99	-0.01
2223.025	CULVERT	CULVERT	-
2223.02	225.61	225.61	0.00

Based on **Table 3** above, the water surface elevations increase under proposed conditions at Station 2223.14 and Station 2223.1, both outliers are clarified as follows:

Station 2223.11 – The 0.28m increase in WSE is caused by different topographic data between the two conditions. Under the pre-existing condition, the channel is significantly wider at this cross section while the updated topographic survey under the proposed condition shows that this section and immediately upstream is steep and narrow. Therefore, the WSE in the pre-existing condition did not reflect actual ground conditions and does not provide an applicable comparison with the proposed model. Despite the 0.28m increase in WSE, the regulatory flood line is contained within the roadside ditch under the proposed condition as show in Drawing CP.

Station 2223.1 & 2223.08 – The increase in WSE is the result of the removal of the culvert that was facilitating the existing driveway access. Under the pre-existing condition, the low WSE at this station is caused by the

culvert changing the flow regime from subcritical to super critical as the water passes the driveway access. The WSE at the following station is higher which demonstrates that the flows transition from supercritical back to subcritical flows. Under the proposed conditions, with the culvert removed, the WSE remains constant or is lowers than the subsequent stations which illustrate that there the flow is not constricted along the creek. Therefore, an increase is negligible given an the WSE reduction between 0.01m to 0.24m across the subject area of study including the stations immediately upstream and downstream.

In addition, the increase in WSE is also caused by different topographic data between the two conditions. Under the pre-existing conditions, the WSE is shown to spill onto Highway 50 at the approximate centerline elevation of 228.51m. In the proposed conditions, an updated topographic survey shows an approximate centerline elevation of 228.79m. The 0.28m centerline elevation difference prevents any overland spill to occur on Highway 50 which would result in an increase of WSE. Despite the increase in WSE, the regulatory flood line is contained within the roadside ditch under the proposed condition as show in Drawing CP.

With the outliers clarified, there is no actual impacts caused by the proposed channel re-alignment. The detailed HEC-RAS summary output can be found as attached. The existing and proposed HEC-RAS cross-sections can be found in the appendix.

3. CONCLUSIONS

In summary, the proposed channel re-alignment will reduce the floodplain on the subject property without having any negative impact to the upstream or downstream water surface elevation. The newly re-alignment channel will be designed using BMP and erosion mitigation measures to maintain the meander belt and prevent negative effects to infrastructure and property limits. Erosion and sediment control strategies are in place to perform the channel re-alignment and satisfy both TRCA and the local municipal criteria. Details for the mitigation measures and the erosion and sediment control strategies are provided in the design package prepared by Palmer.

I trust that this memorandum is complete and to the satisfaction of the TRCA. If you have any questions or concerns, please do not hesitate to contact the undersigned at 905-944-0162 ext. 230.

Respectfully Submitted,
MASONGSONG ASSOCIATES ENGINEERING LIMITED

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Senior Project Engineer
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Attachments:
Pre-Existing Condition Plan (PEX)
Existing Condition Plan (EX)
Proposed Condition Plan (PR)
Composite Plan (CP)
Digital Model Output
Digital Modelling Files