DRAFT

HYDROLOGY & HYDRAULICS BRIEF

LORA BAY HEIGHTS

RICHPARK HOMES (THORNBURY) LTD.

PREPARED BY:

C.F. CROZIER & ASSOCIATES INC.
40 HURON STREET, SUITE 301
COLLINGWOOD, ONTARIO
L9Y 4R3

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1.0 INTRODUCTION

C.F. Crozier & Associates Inc. (Crozier) has been retained by Richpark Homes (Thornbury) Ltd. to provide engineering analysis in support of the proposed channel realignment for the tributary of the Little Beaver Creek which traverses the lands of the Lora Bay Heights development. The 1.18 ha property is located at 188 Peel Street, south-east of the intersection of Peel Street North and High Bluff Lane, in the Town of the Blue Mountains (herein referred to as the Town). The property is legally described as Town Plot Lot 47 to 49; Arthur E/S, Town of the Blue Mountains, County of Grey. The concept plan consists of 22 semi-detached and 2 detached units with a private roadway. See Figure 1 for the Site Location Plan.

The site is zoned residential through the Town's Zoning By-Law Amendment 2014-78, with a hold on the property that will be removed once the watercourse is relocated to the satisfaction of the Department of Fisheries and Oceans (DFO), the Grey Sauble Conservation Authority (GSCA), and the Town. Preliminary reports by Genivar Inc. and Gartner Lee (AECOM) indicated that the channel realignment can be located to the southern limits of the property.

This memo has been prepared to serve as a stand-alone technical brief pertaining to the hydrologic and hydraulic analysis of the channel valley corridor. Design of the low flow meandering channel has been prepared by GEO Morphix (submitted under separate cover) and their design report should be read in conjunction with this memo.

2.0 SITE DESCRIPTION AND BACKGROUND

Currently the Subject Site contains an existing residential dwelling with a detached garage, and the watercourse traverses the site to the undeveloped land parcel to the southeast. This watercourse is a tributary to the Little Beaver Creek. Upstream of the site, the tributary splits and a portion of the flow crosses the Georgian Trail to the site and the remaining flow travels within the tributary that continues along Highway 26 until it reaches the Little Beaver Creek. See Figure 2 for a summary of the various tributaries.

In order to determine the volumetric flow rate for the tributary traversing the site, Crozier undertook a desktop review of previous reports and the Ontario Flow Assessment Tool for the preliminary determination of drainage area characteristics. Following our desktop review, Crozier staff performed a site visit to collect field data including channel slope and typical cross-sections as well as culvert sizes and slopes. Using the results of the previous steps, we were able to quantify the flow entering the tributary from the upstream drainage areas and tributaries.

3.0 HYDROLOGIC ANALYSIS

To determine the Regional flow rate for the channel corridor sizing, we reviewed the previous work completed for the proposed channel realignment, which includes the Proposed Channel Realignment Report (October 2008) prepared by Gartner Lee Ltd, previously with AECOM. Given the location of the site downstream of Highway 26 and the MTO culvert, we also reviewed the Highway 26 Rehabilitation, Thornbury to Meaford (Part A), Drainage Report prepared by Stantec Consulting Ltd. (April 2009) prepared for the Ministry of Transportation, attached.

It was determined that the hydrologic analysis conducted by AECOM to determine flow rates within the subject tributary was based on historic stream gauge data for the Beaver River and transposed for the tributary using the equation Q2=Q1(A2/A1)0.75. This method compared a drainage area of 572 km2 to the 3.0 km2 drainage area of the tributary which resulted in an estimated flow rate of 10 m3/s for the Regional Storm event.

A more in-depth hydrologic analysis was performed for the Peel Street box culvert and the Highway 26 box culvert immediately upstream from the Georgian Trail twin CSP culverts at the upstream end of the subject tributary. This analysis was performed as part of the Drainage Report prepared by Stantec for the MTO. Crozier reviewed the catchment area delineation and hydrologic parameters used, along with the SWMHYMO model output to determine the suitability of their analysis. The report identifies undersized culverts crossing Highway 26 resulting in spill flow which is conveyed along the southern ditch to the Highway 26 culvert directly upstream of the subject tributary (herein referred to as Culvert 29 to maintain consistency with the Stantec report).

With the information gathered during the desktop review, Crozier staff undertook a site visit on November 29, 2017 to verify the elevation of Highway 26 and the conditions of the ditch downstream of Culvert 29. During the site visit, typical cross sections for each section of the tributaries were surveyed and the slopes were determined. Culvert slopes and sizes were also measured.It was also noted that there was no ditch segment downstream as the Thornbury sign had been constructed on an earth mound at this location and there was also an entrance with no culvert. Based on the site conditions it was determined that the head water would be split between overtopping the highway and the entrance. Therefore, 50% of the overtopping flow was assumed to enter the tributary upstream of the Georgian Trail culverts.

Using the data gathered from the desktop review, the flow rate for the Regional Storm event was determined directly upstream of the Georgian trail culverts based on the addition of the flow through the Peel Street culvert, flow through Culvert 29 and 50% of its overtopping flow. Upstream of the Georgian Trail culverts is a confluence between the tributary downstream of the Peel Street Culvert and the tributary downstream of Culvert 29. At this location there is also a split where a portion of the flow is conveyed through the Georgian Trail culverts and a portion is conveyed within the tributary along Highway 26 and the Georgian Trail.

Bentley FlowMaster was used to determine the normal depth of the water surface of the tributary along the highway using the typical cross-section data surveyed and the measured slope. A Manning's value of 0.05 was used for the tributaries as they contain vegetation and light brush on the banks. This analysis assumed 100% of the flow was being conveyed within this tributary and it was determined that the water surface elevation would not exceed the elevation of the Georgian Trail. From there, iterations were conducted to determine the amount of flow conveyed through the Georgian Trail culverts using Bentley CulvertMaster by equalizing the water surface elevation for the tributary and the headwater elevation of the culverts were equal. Tailwater was also taken into account in the iterations by determining the normal depth for the typical cross-section of the subject reach and its measured slope.
The results of our analysis determined that the Regional Storm flow before the split is 14.5 m3/s where approximately 82% of the flow is conveyed via the tributary along Highway 26 and 18% percent is conveyed through the Georgian Trail culverts, the resulting flows are 11.82 m3/s and 2.64 m3/s, respectfully. The flows for both tributaries are summarized in Table 1. Supporting calculations have been attached.

Table 1: Flow Summary

Storm Event	Total Flow	Tributary A (Subject Site)		Tributary D (South of Georgian Trail)	
	(m^3/s)	Flow (m^3/s)	% of Total Flow	Flow (m^3/s)	% of Total Flow
2-year	3.67	1.03	28.1	2.64	71.9
5-year	6.37	1.60	25.2	4.76	74.8
10-year	8.44	1.90	22.5	6.54	77.5
25-year	10.72	2.21	20.6	8.52	79.4
50-year	11.44	2.30	20.1	9.14	79.9
100-year	12.32	2.40	19.5	9.92	80.5
Regional	14.46	2.64	18.3	11.82	81.7

4.0 HYDRAULIC ANALYSIS

Having determined the Regional flow of 2.64 m3/s entering the tributary upstream of the Subject Site, Bentley FlowMaster was used to determine the required channel geometry to safely convey the flow across the development. A trapezoidal channel with varying bottom width to maintain a 3.0 m setback from the low flow channel meanders and 5:1 side slopes was delineated and the normal depth at the narrowest channel section was determined. A Manning's value of 0.045 was used to model the realigned channel. A trapezoidal channel with 2.0 m bottom width and 5:1 side slopes is required where the realigned channel converges with the existing channel on the neighbouring property. Given this contraction will increase the normal depth, a gradually varied flow model was created in FlowMaster to determine the backwater effect. It was determined that the depth of flow will be affected up to 40 m upstream of the contraction. The top of bank of the realigned channel has been design to provide 0.3 m freeboard from the regional water surface elevation. The low flow channel was not included in the sizing of the channel valley corridor to convey the Regional Flow. See Figure 3 Channel Alignment and the attached supporting calculations. Normal Depths within the proposed channel are summarized in Table 2.

Table 2: Depth of Flow

Storm Event	Section 1-1	Section 2-2
	Normal Depth (m)	Normal Depth (m)
2-year	0.16	0.34
5-year	0.21	0.42
10-year	0.23	0.45
25-year	0.25	0.49
50-year	0.26	0.50
100-year	0.26	0.51
Regional	0.28	0.53

5.0 CONCLUSIONS AND RECCOMENDATIONS

The desktop review identified additional spill flow conveyed along the Highway 26 ditch to the confluence of tributaries upstream of the subject site. This flow was added to the flow from the tributary's drainage area and the total flow entering the tributary within the Subject Site was determined through the analysis of its geometry and the upstream culverts. It was also determined that the majority of the flow is conveyed within the tributary along Highway 26 to the Little Beaver Creek.

A proposed channel corridor was determined to safely convey the Regional flow through the site and no structures are proposed to be constructed within the floodlines. In addition, 0.3 m of freeboard from the Regional water surface elevation was added to the channel corridor. The proposed channel geometry is a trapezoidal channel with a minimum 9.4 m bottom width and 5:1 side slopes. The channel contracts at the property limit (Section 2-2) and was modelled for gradually varied flow to determine the backwater affect upstream.

Should you have any questions or require any further information, please do not hesitate to contact the undersigned.

Sincerely,

C.F. CROZIER & ASSOCIATES INC.

DRAFT

Stuart West, P.Eng.
Project Engineer
SW/ml

C.F. CROZIER & ASSOCIATES INC.

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Mathew Lemieux, E.I.T.

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APPENDIX A

Flow Calculations

APPENDIX B

Channel Sizing Calculations

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