APPENDIX B

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Memorandum

To	Shelley Gorenc, M.Sc., P.Geo	Page	1
CC			
Subject	Hydraulic Analysis For Wilket Creek, Sites 6 and 7		
From	Angela MacLean, M.A.Sc., EIT and Jonathan Bastien, M.A.Sc.		
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1. Hydrology

The hydrology of the creek is urban in nature, resulting in flashy flows. A Visual Otthymo hydrological model for Wilket Creek was provided by the Toronto Region Conservation Authority (TRCA). This hydrological model was reviewed. The previously-determined design flows for sites 6 / 7 are given in Table 1. These design flows were previously included in the HEC-RAS hydraulic model of Wilket Creek, which is discussed in the next Section.

Table 1: Design flows for Site 6 and 7 on Wilket Creek

Design Storm	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	Regional
Flow (m3/s)	19.35	29.98	37.02	48.65	57.23	66.92	127.09

In addition, the hydraulic assessment was extended to include a range of low-flow profiles (less than 2 Year design period) along the study reach of Wilket Creek. This was undertaken to ensure that the channel alterations do not adversely affect low-flow instream hydraulics. The flow profiles were adopted by maintaining the distribution of flows throughout the creek as per the design storm flow profiles, but with reduced flow magnitudes. This approach was used due to the fact that insufficient observed flow data was available to estimate design storm flows for return periods less than 2 Years. The adopted low flows at Site 6/7 are summarized in Table 2. The adopted low-flows do not have a design period return frequency associated with them; as such they are labelled as profiles PR 9 to PR 15.

Table 2: Adopted LowFlowsfor Site 6 and 7 on Wilket Creek

Design Storm	PF 9	PF 10	PF 11	PF 12	PF 13	PF 14	PF 15
Flow (m3/s)	12.9	8.6	5.7	3.8	2.6	1.7	1.1

2. Hydraulics

2.1 Existing Conditions

A HEC-RAS model for Wilket Creek was provided by the TRCA. Sites 6 /7 are located between HEC-RAS stations 15.035 and 15.038. For the Site 6/7 area of the creek, the model was updated to include additional cross-sections based on the 2010 survey data (collected and provided by the TRCA) and additional 1m contour data for areas outside the surveyed area (such as the upper extents of the floodplain). The updated channel geometry better reflects the existing channel profile including scour and pool-riffle formations. In addition, the two existing pedestrian crossings within Site 6/7 were also included in the model. Bridge details were determined from the survey data; however the available data was limited. As the assessment included an evaluation of design flows for lower to moderate major events, it was deemed beneficial to include the pedestrian bridges.

A comparison of the updated existing conditions model to the original TRCA model showed some changes in the water surface elevation, predominantly in the vicinity of Sites 6 / 7. These changes are a result of the refined creek profile and inclusion of the two pedestrian crossings. The original and refined water elevations are unchanged upstream of the bridge structure at Station 15.060 and downstream of the Sites 6/7. A comparison of the geometry and water surface profiles for Sites 6 / 7 of Wilket Creek are illustrated in Figure 1.

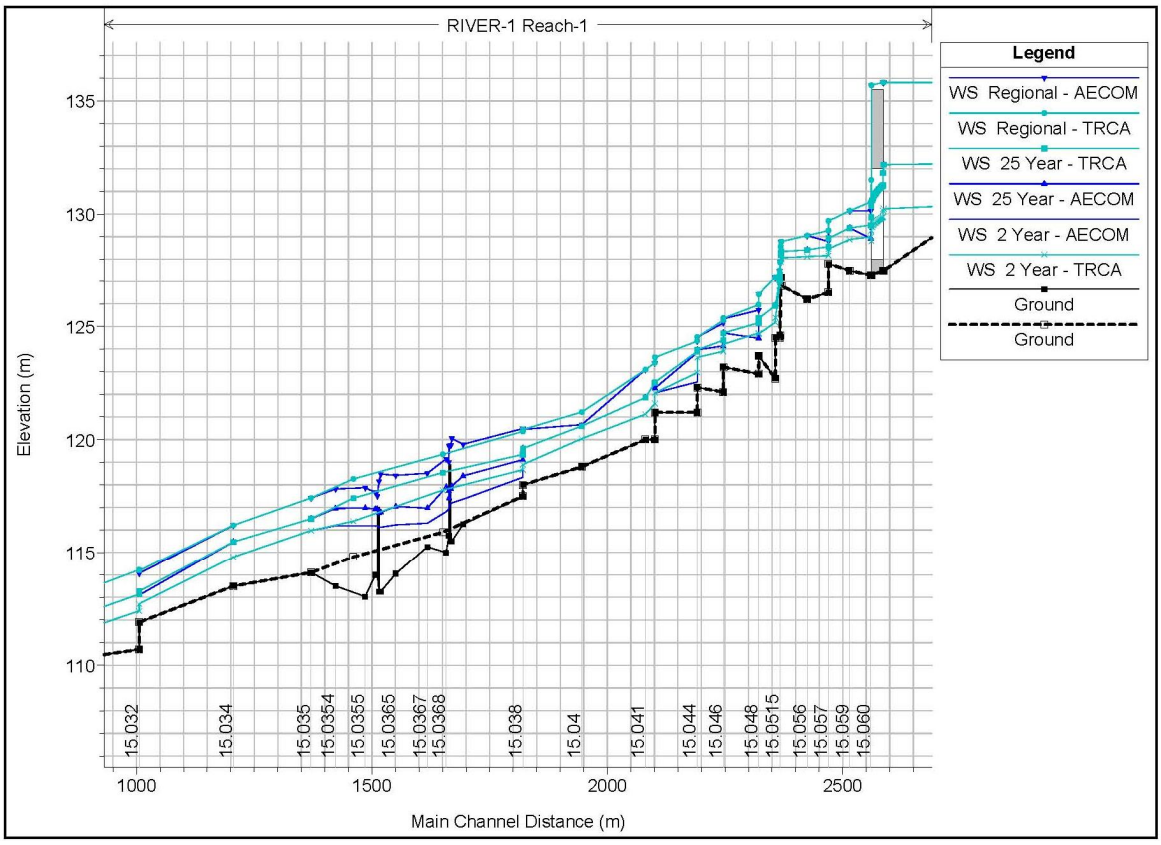

Figure 1: Comparison of existing geometry and water surface profiles

2.2 Proposed Conditions

A proposed conditions model was developed based on the proposed design (profiles and cross sections) provided by Parish Geomorphic. Cross sections were updated within the HEC-RAS model and the planform was refined as per the proposed creek re-alignment.

For the proposed design provided, the existing pedestrian bridge near Site 7 is to be relocated as a result of the relocation of the path. Due to limited detail at this time regarding the proposed new bridge structure, as well as limited creek geometry data for this area, this bridge could not be included as part of the hydraulic model.

The existing and proposed water surface profiles and changes to channel geometry are included in Figure 2. Due to the proposed creek re-alignment, the existing and proposed centreline chainages are different. To allow for easier comparison, the profiles have been adjusted so that for a particular Chainage within the Figure, the shown bed and water elevations represent approximately the same location along the creek.

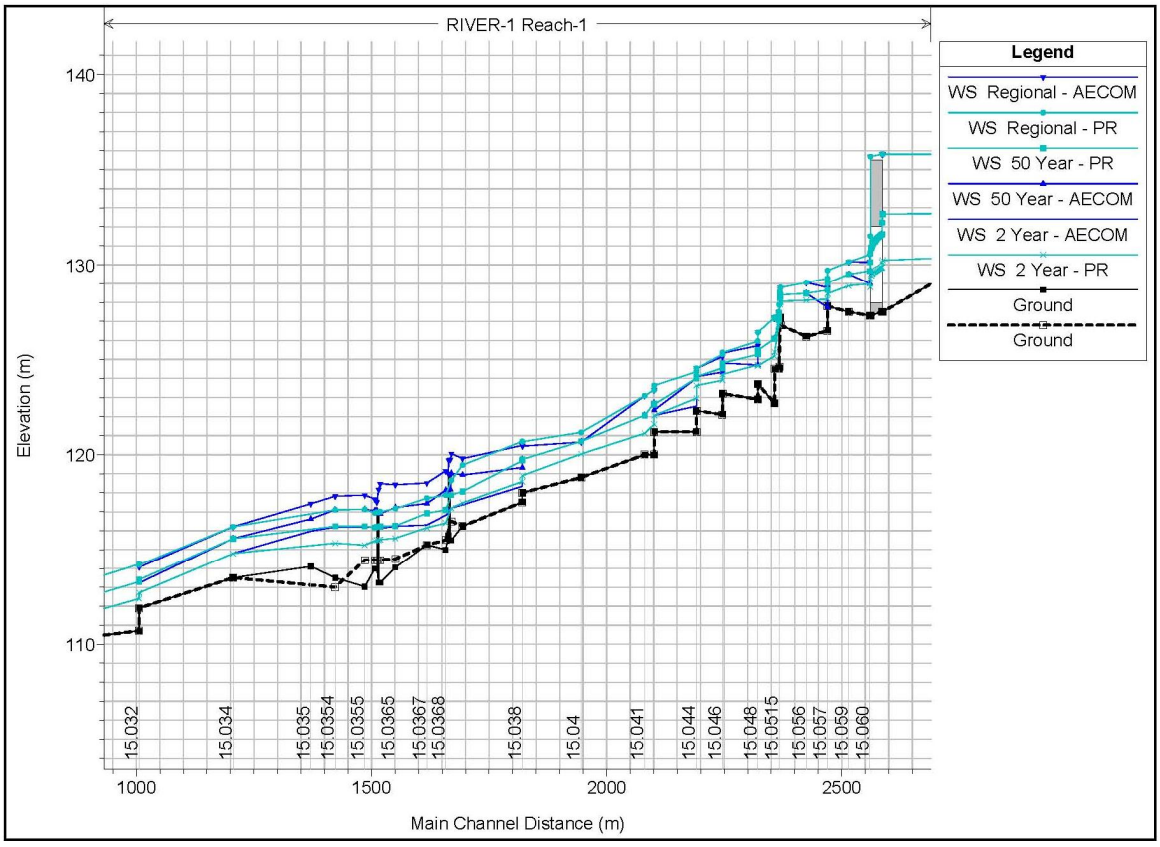

Figure 2: Comparison of existing and proposed geometry and water surface profiles

The water surface elevations are expected to decrease across Sites 6 /7 due to the proposed design by 1.2 – 1.5 m for the 2 year return period and Regional storm, respectively. The water surface elevations under the proposed conditions are expected to be similar to existing conditions downstream and upstream of Sites 6/7.

An analysis of the shear and velocity forces in the channel shows an overall increase in shear and velocity with the proposed channel design. Shear forces were calculated to be the highest entering the reconstructed channel at Site 7, 190N/m^2 for the 50 year design storm. The highest velocities were modeled at the commencement of the reconstructed channel at Site 7 as well. The maximum velocities were 4.4 and 4.7 m/s for the 50 year design storm and Regional Storm, respectively. The increased shear and velocities are likely the result of increased bed slopes. The overall bed slope has increased slightly (to 1.23% from 1%) and the proposed riffles have a slope of around 4%.

A summary of the water surface elevations, channel velocities, Froude numbers, and shear stresses for the 2 year, 50 year and Region design storms are presented in Table 3, 4, and 5, respectively. Also provided is a model results summary for a low-flow at Sites 6/7 of 1.1 m^3/s (see Table 6).

Table 3: Existing and proposed conditions for the 2yr design storm, Q=19.35 m^3/s

	Existing Conditions				Proposed Conditions			
River Station	W.S. Elev	Vel Chnl	Froude #	Shear	W.S. Elev	Vel Chnl	Froude #	Shear
	(m)	(m/s)		(N/m^2)	(m)	(m/s)		(N/m^2)
15.038	118.33	3.98	1.61	227.95	118.58	2.8	1	104.12
15.0371	117.36	2.61	0.82	81.35	117.46	2.36	0.71	64.52
15.037	117.2	2.43	0.64	69.7	117.19	2.47	1.01	86.92
15.0369	116.93	3.03	1	118.04				
15.0368	116.81	2.24	0.59	54.78	116.4	2.5	1.01	88.54
15.0367	116.3	3.05	0.98	112.27	116.15	1.82	0.66	43.61
15.0365	116.23	1.06	0.25	11.24	115.6	2.15	0.79	62.16
15.0364	116.13	1.72	0.35	26.87	115.53	1.48	0.49	27.25
15.0359	116.18	0.88	0.21	7.78	115.47	1.57	0.54	31.35
15.0355	116.19	0.43	0.08	1.6	115.23	2.13	0.82	62.5
15.0354	116.19	0.44	0.09	1.78	115.34	0.64	0.15	4.1
15.035	115.97	1.96	0.54	43.67	114.8	2.68	0.83	88.18

Table 4: Existing and proposed conditions for the 50yr design storm, Q=57.23 m^3/s

	Existing Conditions				Proposed Conditions			
River Station	W.S. Elev	Vel Chnl	Froude #	Shear	W.S. Elev	Vel Chnl	Froude #	Shear
	(m)	(m/s)		(N/m^2)	(m)	(m/s)		(N/m^2)
15.038	119.32	3.98	1.12	180.41	119.52	3.35	0.88	122.67
15.0371	118.93	2.75	0.54	66.21	118.07	4.35	1.06	189.97
15.037	119.02	1.9	0.34	32.74	117.87	3.27	0.94	121.17
15.0369	117.93	4.01	0.97	169.43				
15.0368	118.13	2.4	0.46	50.76	117.09	3.08	0.97	114.33
15.0367	117.43	3.91	0.86	143.19	116.92	2.56	0.67	69.45
15.0365	117.22	1.86	0.36	29.9	116.25	3.15	0.93	116.12
15.0364	116.9	3.31	0.58	91.21	116.22	2.37	0.59	58.01
15.0359	117.06	1.64	0.32	23.64	116.17	2.39	0.61	59.37
15.0355	117.12	0.78	0.13	4.76	116.23	1.72	0.43	30.47
15.0354	117.1	0.86	0.15	5.95	116.23	1.11	0.22	10.83
15.035	116.62	3.25	0.73	105.66	115.58	3.33	0.78	113.22

Table 5: Existing and proposed conditions for the Regional design storm, Q=127.09 m^3/s

	Existing Conditions				Proposed Conditions			
River Station	W.S. Elev	Vel Chnl	Froude #	Shear	W.S. Elev	Vel Chnl	Froude #	Shear
	(m)	(m/s)		(N/m^2)	(m)	(m/s)		(N/m^2)
15.038	120.48	3.43	0.7	108.13	120.58	3.19	0.64	92.58
15.0371	119.79	3.93	0.67	122.98	119.45	4.66	0.84	178.84
15.037	120.05	2.21	0.34	40.35	118.65	4.06	0.92	159.03
15.0369	119.01	4.07	0.77	148.4				
15.0368	119.15	2.74	0.45	59.88	117.87	3.63	0.86	131.27
15.0367	118.51	4.37	0.78	156.27	117.71	3.4	0.72	106.31
15.0365	118.42	2.3	0.37	40.47	117.16	3.69	0.83	134.09
15.0364	118.47	2.06	0.3	30.95	117	3.25	0.67	96.03
15.0359	117.67	2.91	0.51	69.03	116.94	3.26	0.68	96.95
15.0355	117.87	1.2	0.18	10.73	117.12	2.1	0.42	39.34
15.0354	117.82	1.44	0.23	15.86	117.1	1.65	0.28	21.81
15.035	117.42	3.58	0.68	114.38	116.21	4.38	0.89	178.41

Table 6: Existing and proposed conditions for the low flow profile PR 15, Q=1.1 m^3/s

	Existing Conditions				Proposed Conditions			
River Station	W.S. Elev	Vel Chnl	Froude #	Shear	W.S. Elev	Vel Chnl	Froude #	Shear
	(m)	(m/s)		(N/m^2)	(m)	(m/s)		(N/m^2)
15.038	117.64	2.98	3.24	241.95	117.74	1.3	1.01	36.85
15.0371	116.47	1.22	1	33.41	116.72	0.44	0.23	3.25
15.037	116.07	0.51	0.23	4.09	116.61	1.03	1.02	27.28
15.0369	115.95	1.35	0.99	38.61				
15.0368	115.72	0.65	0.34	7.2	115.75	0.7	0.47	9.73
15.0367	115.46	1.26	1.01	35.07	115.36	1.02	1	26.46
15.0365	114.62	0.49	0.26	4.03	114.77	0.67	0.42	8.47
15.0364	114.62	0.3	0.1	1.15	114.71	0.41	0.26	3.15
15.0359	114.61	0.35	0.18	1.99	114.7	0.44	0.29	3.74
15.0355	114.62	0.07	0.02	0.05	114.56	1.03	1.01	26.89
15.0354	114.62	0.08	0.03	0.08	113.92	0.17	0.07	0.4
15.035	114.58	0.84	0.48	12.76	113.84	0.79	0.48	11.77

Under low-flow conditions of 1.1 m^3/s for the proposed conditions, the maximum shear forces are expected to be 37 N/m^2, with maximum velocities of 1.3 m/s. Similar values were found for the range of low-flow values evaluated.

3. Design Comments and Recommendations

Based on hydraulic review of the proposed design, summary comments and recommendations are as follows:

- The range of flows expected at Sites 6/7 are 19.4 to 127.1 m3/s for the 2 Year return period and Regional design storms;
- Water surface elevations are expected to decrease across Sites 6 /7 due to the proposed design by 1.2 – 1.5 m for the 2 year return period and Regional storm, respectively;
- Water surface elevations under the proposed conditions are expected to be similar to existing conditions downstream and upstream of Sites 6/7;
- Shear and velocities are expected to increase with the proposed channel design. The increased shear and velocities are likely the result of increased bed slopes;
- The maximum shear was located at the entrance to the reconstructed channel at Site 7, 190N/m^2 for the 50 year design storm;
- The highest velocities (4.4 and 4.7 m/s for the 50 year return period and Regional design storms, respectively) are expected at the entrance to the reconstructed channel at Site 7;
- The final assessment of the re-construction design for site 7 should incorporate the replacement of the pedestrian bridge;

- If the proposed profiles and spatial constraints permit, consideration should be given to the addition of a low flow channel within the re-constructed channel. This may add potential habitat and environmental benefits to the channel design;
- The proposed armouring at sections B and D are expected to be overtopped during a 50 year design storm. Additional armouring or bio-engineering is suggested to prevent scouring along the high bank and potential backcutting of the armouring;
- For Section E, the top of bank elevation should be confirmed as contour data suggests the bank may be as high as 122m (as opposed to 117m). If this is the case additional fill may be required to stabilize the toe of the bank and additional vegetation and bio-engineering may also be beneficial in bank stabilization in this area.

The provided water surface elevations, velocities and shear forces can be used in the detailed design of erosion protection for the proposed channel design.