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Attention: **Kevin Murphy, P.Eng.**

Subject: **Downstream of 7000 Campeau Drive – Hydrologic Assessment**

Introduction

In support of the proposed residential development at 7000 Campeau Drive in Kanata, Ontario, J.F Sabourin and Associates (JFSA) were commissioned to complete a downstream hydrologic assessment, to ensure that the proposed development will not result in or exacerbate any existing adverse effects on downstream lands and infrastructure, with regards to flooding and erosion. This memo will assess pre-and post-development flows on the Kizell Drain and Watts Creek under the full suite of design storms (2 to100 year events) to assess any flooding concerns. Continuous simulations were also completed to assess potential erosion concerns on the watercourse downstream of the development.

Background

The modelling work outlined in this memo builds on the 2017 Mississippi Valley Conservation Authority (MVCA) Watts Creek hydrologic (SWMHYMO) model, which was updated by JFSA in July 2020 to provide a better fit with the field-gathered data obtained in 2019 at the Beaver Pond and upstream storm sewer network. This model was also updated downstream of the development on Watts Creek to use subcatchment parameters that were more representative of field observed conditions obtained by C. Brennan et al and described in their September 2017 journal article “Continuous prediction of clay‐bed stream erosion in response to climate model output for a small urban watershed”. Full details of this model calibration process have been documented in JFSA’s July 2020 “Kanata Golf & Country Club 2019 Monitoring & Hydrologic Model Calibration Report”.

Design Scenarios

The following section outlines the various scenarios assessed as a part of this downstream impact analysis. This analysis includes the Future MVCA model of record, the updated JFSA existing conditions model, the proposed redevelopment of the Kanata Golf and Country Club (with SWM pond and Etobicoke Exfiltration Systems) designed to ensure no upstream or downstream impacts, and the Kanata Lakes North (KNL) Stage 9 development. As discussed in JFSA's June 2021 memo "7000 Campeau Drive Subdivision - Preliminary Stormwater Management Plan", the proposed development will implement Etobicoke Exfiltration Systems (EES) to provide quality control for the site while also offsetting any groundwater recharge deficits caused by the increase in impervious areas. As specified in John Tran & James Li's "Planning and Design Manual of the Etobicoke Exfiltration System for Stormwater Management", for the EES units to achieve 80% TSS removal, the systems should be designed to treat the 95th percentile rainfall event. Based on the statistical analysis of historical rainfall data recorded at the Ottawa Airport, completed by J.L Richards as a part of the Barrhaven South Master Servicing Study, the 95th percentile rainfall event in Ottawa equates to the 22 mm event. To represent the operation of the proposed EES, DAULHYD commands have been added to the model. These commands have a storage volume matching the total runoff volume from the proposed development for the 22 mm event and can simulate units exfiltrating back to the groundwater based on an assumed 72-hour draw downtime (conservative draw downtime).

In total there are 5 different scenarios assessed in this report that are a mix of the various items addressed above. The following section discusses in detail each of the various scenarios and provides the model reference code.

1. **MVCA Future Conditions**- *(MVCA):*

   MVCA 2017 model of record reflective of future conditions, used for floodplain mapping purposes.

2. **Existing Conditions-** *(KWEX):*

   Reflective of the current conditions (2019) with various model parameters adjusted to reflect the field-collected data more accurately. Refer to JFSA's July 2020, "Kanata Golf & Country Club 2019 Monitoring & Hydrologic Model Calibration Report" for full details on the calibration process.

3. **KNL Development -** *(KWEX_KNL9):*

   Reflective of existing conditions with the inclusion of the KNL Development Stage 9 in place as per IBI's detailed design. Stage 7 & 8 of the KNL have been left undeveloped since these Stages have yet to be approved by the City.

4. **The Kanata Golf and Country Club Development with SWM controls + EES-** *(KWEX_KGC-EES):*

   Reflective of existing conditions with the proposed redevelopment of the Kanata Golf and Country Club in place with dry Storm Water Management (SWM) ponds sized to provide quantity controls and Etobicoke Exfiltration Systems implemented to provided quality controls throughout the site, to mitigate impacts both upstream and downstream of the development.

5. **The Kanata Golf and Country Club Development with SWM controls + EES + KNL Development -** *(KWEX_KGC-EES_KNL9):*

   Reflective of existing conditions with the proposed redevelopment of the Kanata Golf and Country Club in place with dry Storm Water Management (SWM) ponds sized to provide quantity controls and Etobicoke Exfiltration Systems implemented to provided quality controls throughout the site, to mitigate impacts both upstream and downstream of the development. Includes the KNL Development Stage 9 in place as per IBI's detailed design. Stage 7 & 8 of KNL have been left undeveloped as directed by the City.

Design Storms

The various scenarios discussed above were assessed using a range of design storms, which include the 12 Hour SCS, 24 Hour SCS and 3 Hour Chicago storms. Flows into and out of the Beaver Pond were extracted from the various models and have been provided in Table 1A. Flows at the downstream extent of the model, at Watts Creek's confluence with the Ottawa River, are provided in Table 2A below. To provide some context to the calibration process, the results from the 2017 MVCA Future conditions model (MVCA) have also been provided. The updated calibrated existing conditions model (KWEX) was considered as the baseline scenario and used to set the targets for matching post-development flows. It was assumed that no quantity controls will be implemented on the KNL Stage 9 development and as such for scenarios that include the KNL Stage 9 development, the scenario (KWEX_KNL9) is considered to be the baseline condition, as the Kanata Golf and Country Club Redevelopment should not be required to offset the impacts of the KNL development.

Comparing the results of the existing calibrated model (KWEX) to the scenario where the Kanata Golf and Country Club is redeveloped with SWM ponds & EES in place (KWEX_KGC-EES), the peak flows out of the Beaver Pond are reduced for all events below existing conditions, with reductions in the range of 4% - 10% depending on the event. The same is observed downstream at the Ottawa River, with this scenario (KWEX_KGC-EES) resulting in a reduction in peak flows from pre-development levels for all events, with reductions in peak flow in the range of 0.0% - 0.6%.

Comparing the peak flow results of the existing calibrated model (KWEX) to the scenario where only KNL Stage 9 is developed (KWEX_KNL9) an increase in peak flows out of the Beaver Pond is observed for all events, with increases in the range of 3% - 24% depending on the event. This increase continues all the way downstream to the Ottawa River where these increases in peak flows are in the range of 0.0% - 0.6%.

When both Kanata Golf and Country Club and KNL Stage 9 developments are in place (KWEX_KGC-EES_KNL9), the peak flows for all design storm events are less than KNL Stage 9 alone, but still results in an increase from existing conditions out of the Beaver Pond for most events. Through with both Kanata Golf and Country Club and KNL Stage 9 developed the 100-year peak flows out of the Beaver Pond are still less than existing.

Note that the 100-year peak flows out of the Beaver Pond for KWEX_KGC-EES, KWEX_KNL9 and KWEX_KGC-EES_KNL9 are all less than 0.96 m^3/s as specified in the Certificate of Approval for the Beaver Pond issued in 2008.

Table 1A: Beaver Pond Inflow/Outflow Summary

Design Storms	MVCA				KWEX				KWEX_KNL9					KWEX_KGC-EES					KWEX_KGC-EES_KNL9					
	Area (ha)	Qp In (m^3/s)	Qp Out (m^3/s)	Runoff (1000 m^3)	Area (ha)	Qp In (m^3/s)	Qp Out (m^3/s)	Runoff (1000 m^3)	Area (ha)	Qp In (m^3/s)	Qp Out (m^3/s)	Runoff (1000 m^3)	Qp/Qp_{KWEX}	Area (ha)	Qp In (m^3/s)	Qp Out (m^3/s)	Runoff (1000 m^3)	Qp/Qp_{KWEX}	Area (ha)	Qp In (m^3/s)	Qp Out (m^3/s)	Runoff (1000 m^3)	Qp/Qp_{KWEX}	Qp/Qp_{KNL9}
25 mm CHI 4Hr	n/a	n/a	n/a	n/a	415.85	4.626	0.139	14.8	430.02	5.878	0.173	17.3	1.245	320.66	4.593	0.131	16.7	0.942	334.83	5.792	0.161	18.8	1.158	0.93
2Yr SCS 12 hour	477.35	1.352	0.454	86.6	415.85	4.644	0.314	30.6	430.02	5.811	0.369	35.2	1.175	362.97	4.609	0.283	39.1	0.901	377.14	5.776	0.335	43.3	1.067	0.91
5Yr SCS 12 hour	477.35	2.439	0.615	127.9	415.85	7.164	0.486	48.6	430.02	9.071	0.538	55.2	1.107	382.23	6.941	0.463	63.7	0.953	396.40	8.847	0.513	70.1	1.056	0.95
10Yr SCS 12 hour	473.45	3.248	0.671	156.2	415.85	9.686	0.599	65.2	430.02	12.049	0.640	73.3	1.068	390.47	9.071	0.578	85.0	0.965	404.64	11.434	0.618	92.8	1.032	0.97
25Yr SCS 12 hour	466.66	5.342	0.775	192.1	415.85	13.964	0.718	90.3	430.02	16.894	0.757	100.1	1.054	397.17	12.648	0.689	115.3	0.960	411.35	15.578	0.726	124.8	1.011	0.96
50Yr SCS 12 hour	462.31	7.378	0.859	217.8	415.85	17.893	0.792	109.5	429.92	20.057	0.826	120.5	1.043	400.30	15.935	0.749	137.6	0.946	414.47	18.410	0.791	148.3	0.999	0.96
100Yr SCS 12 hour	458.30	9.941	0.924	243.9	415.80	24.521	0.854	129.9	429.46	27.228	0.889	141.9	1.041	402.35	22.183	0.805	160.5	0.943	416.52	24.890	0.842	172.4	0.986	0.95
2Yr SCS 24 hour	n/a	n/a	n/a	n/a	415.85	6.603	0.358	39.0	430.02	8.420	0.414	44.3	1.156	365.28	6.502	0.322	48.0	0.899	379.45	8.320	0.379	53.0	1.059	0.92
5Yr SCS 24 hour	n/a	n/a	n/a	n/a	415.85	10.871	0.548	63.5	430.02	13.567	0.589	70.9	1.075	383.14	10.398	0.521	79.2	0.951	397.31	13.094	0.570	86.3	1.040	0.97
10Yr SCS 24 hour	n/a	n/a	n/a	n/a	415.85	14.605	0.642	82.5	430.02	17.877	0.684	91.2	1.065	390.21	13.588	0.618	102.2	0.963	404.38	16.859	0.658	110.5	1.025	0.96
25Yr SCS 24 hour	n/a	n/a	n/a	n/a	415.85	19.100	0.745	108.5	429.66	23.390	0.783	118.7	1.051	395.75	17.526	0.714	132.3	0.958	409.92	21.815	0.750	142.2	1.007	0.96
50Yr SCS 24 hour	n/a	n/a	n/a	n/a	415.48	23.303	0.813	129.9	428.68	27.929	0.846	141.0	1.041	397.92	20.855	0.776	155.6	0.954	412.10	25.483	0.810	166.8	0.996	0.96
100Yr SCS 24 hour	n/a	n/a	n/a	n/a	415.01	34.161	0.881	153.8	428.23	37.596	0.911	166.1	1.034	400.19	30.800	0.833	181.4	0.946	414.36	34.234	0.868	193.8	0.985	0.95
2Yr CHI 3Hr	n/a	n/a	n/a	n/a	415.85	7.098	0.238	22.0	430.02	8.959	0.288	25.5	1.210	352.07	7.039	0.219	28.2	0.920	366.24	8.870	0.265	31.4	1.113	0.92
5Yr CHI 3Hr	n/a	n/a	n/a	n/a	415.85	12.180	0.437	38.4	430.02	15.038	0.480	43.5	1.098	377.97	11.954	0.419	52.2	0.959	392.14	14.799	0.459	57.0	1.050	0.96
10Yr CHI 3Hr	n/a	n/a	n/a	n/a	415.85	15.175	0.533	50.5	429.78	19.126	0.578	56.6	1.084	386.48	14.594	0.513	69.1	0.962	400.66	18.539	0.562	74.9	1.054	0.97
25Yr CHI 3Hr	n/a	n/a	n/a	n/a	415.68	19.916	0.626	66.5	428.37	24.857	0.667	73.8	1.065	392.22	18.503	0.603	90.6	0.963	406.40	23.442	0.642	97.9	1.026	0.96
50Yr CHI 3Hr	n/a	n/a	n/a	n/a	415.09	25.585	0.692	79.4	427.58	29.438	0.728	87.7	1.052	395.33	23.931	0.659	107.6	0.952	409.51	27.696	0.699	116.0	1.010	0.96
100Yr CHI 3Hr	n/a	n/a	n/a	n/a	414.44	29.457	0.750	93.9	426.98	35.943	0.790	103.2	1.053	397.84	27.321	0.711	126.0	0.948	412.01	33.807	0.750	135.5	1.000	0.95
100Yr SCS 24Hr + 20%	n/a	n/a	n/a	n/a	413.86	50.926	1.007	207.7	427.240	57.648	1.039	222.5	1.032	403.280	46.667	0.950	237.4	0.943	417.450	53.389	0.985	252.3	0.978	0.948

Scenario Summary:

KWEX JFSA updated Existing Conditions

KWEX_KNL9 JFSA updated Existing Conditions + KNL Stage 9 Development

KWEX_KGC-EES JFSA updated Existing Conditions + The Kanata Golf and Country Club Development with SWM controls + EES sized to infiltrate up to 22mm event

KWEX_KGC-EES_KNL9 JFSA updated Existing Conditions + The Kanata Golf and Country Club Development with SWM controls + EES sized to infiltrate up to 22mm event + KNL Stage 9 Development

Table 2A: Outlet to Ottawa River Summary

Design Storms	MVCA			KWEX			KWEX_KNL9				KWEX_KGC-EES				KWEX_KGC-EES_KNL9				
	Area (ha)	Qp (m^3/s)	Runoff (1000 m^3)	Area (ha)	Qp (m^3/s)	Runoff (1000 m^3)	Area (ha)	Qp (m^3/s)	Runoff (1000 m^3)	Qp/Qp_{KWEX}	Area (ha)	Qp (m^3/s)	Runoff (1000 m^3)	Qp/Qp_{KWEX}	Area (ha)	Qp (m^3/s)	Runoff (1000 m^3)	Qp/Qp_{KWEX}	Qp/Qp_{KNL9}
25 mm CHI 4Hr	n/a	n/a	n/a	2550.68	3.572	88.5	2549.94	3.573	102.5	1.000	2448.43	3.568	89.9	0.999	2447.68	3.572	92.8	1.000	1.000
2Yr SCS 12 hour	2590.480	8.051	422.0	2550.68	6.176	194.6	2549.94	6.186	218.5	1.002	2490.74	6.164	202.2	0.998	2489.99	6.181	207.7	1.001	0.999
5Yr SCS 12 hour	2590.480	12.467	649.7	2550.68	9.396	303.0	2549.94	9.437	336.1	1.004	2510.00	9.379	317.5	0.998	2509.25	9.431	324.9	1.004	0.999
10Yr SCS 12 hour	2586.580	15.905	813.7	2550.68	11.946	394.6	2549.94	11.997	433.2	1.004	2518.24	11.924	413.2	0.998	2517.49	11.991	422.4	1.004	0.999
25Yr SCS 12 hour	2579.790	20.780	1029.9	2550.68	16.548	539.5	2549.94	16.645	584.7	1.006	2524.94	16.506	562.8	0.997	2524.20	16.636	573.8	1.005	0.999
50Yr SCS 12 hour	2575.440	24.531	1187.8	2550.57	20.883	660.9	2549.83	21.018	709.9	1.006	2528.07	20.830	686.9	0.997	2527.32	21.008	698.8	1.006	1.000
100Yr SCS 12 hour	2571.430	28.263	1349.5	2550.12	25.754	793.6	2549.38	25.900	845.6	1.006	2530.12	25.701	822.0	0.998	2529.37	25.890	834.7	1.005	1.000
2Yr SCS 24 hour	n/a	n/a	n/a	2550.68	6.225	238.2	2549.94	6.232	264.7	1.001	2493.05	6.213	246.3	0.998	2492.31	6.228	252.5	1.000	0.999
5Yr SCS 24 hour	n/a	n/a	n/a	2550.68	9.900	383.9	2549.94	9.942	419.0	1.004	2510.91	9.866	398.5	0.997	2510.16	9.936	406.6	1.004	0.999
10Yr SCS 24 hour	n/a	n/a	n/a	2550.68	13.432	505.0	2549.94	13.507	544.7	1.006	2517.98	13.395	523.2	0.997	2517.23	13.498	532.4	1.005	0.999
25Yr SCS 24 hour	n/a	n/a	n/a	2550.32	18.763	671.0	2549.58	18.868	715.9	1.006	2523.52	18.716	693.0	0.997	2522.77	18.858	703.6	1.005	0.999
50Yr SCS 24 hour	n/a	n/a	n/a	2549.34	23.492	812.5	2548.60	23.617	859.9	1.005	2525.69	23.437	836.0	0.998	2524.95	23.606	847.6	1.005	1.000
100Yr SCS 24 hour	n/a	n/a	n/a	2548.89	28.781	975.0	2548.15	28.927	1024.6	1.005	2527.96	28.700	1000.1	0.997	2527.21	28.915	1012.4	1.005	1.000
2Yr CHI 3Hr	n/a	n/a	n/a	2550.68	4.959	124.7	2549.94	4.963	144.3	1.001	2479.84	4.951	130.4	0.998	2479.09	4.961	134.6	1.000	1.000
5Yr CHI 3Hr	n/a	n/a	n/a	2550.68	7.749	209.4	2549.94	7.768	238.2	1.002	2505.74	7.734	222.3	0.998	2504.99	7.765	228.5	1.002	1.000
10Yr CHI 3Hr	n/a	n/a	n/a	2550.44	10.781	285.4	2549.70	10.816	320.2	1.003	2514.25	10.759	303.0	0.998	2513.51	10.814	310.2	1.003	1.000
25Yr CHI 3Hr	n/a	n/a	n/a	2549.03	15.301	388.7	2548.29	15.373	430.2	1.005	2519.99	15.270	411.5	0.998	2519.25	15.367	420.5	1.004	1.000
50Yr CHI 3Hr	n/a	n/a	n/a	2548.24	19.003	471.7	2547.50	19.097	518.2	1.005	2523.10	18.966	498.6	0.998	2522.36	19.091	508.5	1.005	1.000
100Yr CHI 3Hr	n/a	n/a	n/a	2547.64	22.967	563.3	2546.89	23.074	614.6	1.005	2525.61	22.931	593.5	0.998	2524.86	23.067	604.7	1.004	1.000
100Yr SCS 24Hr + 20%	n/a	n/a	n/a	2547.90	41.079	1341.2	2547.15	41.245	1393.0	1.004	2531.05	41.016	1367.5	0.998	2530.31	41.230	1381.0	1.004	1.000

Scenario Summary:

KWEX JFSA updated Existing Conditions

KWEX_KNL9 JFSA updated Existing Conditions + KNL Stage 9 Development

KWEX_KGC-EES JFSA updated Existing Conditions + The Kanata Golf and Country Club Development with SWM controls + EES sized to infiltrate up to 22mm event

KWEX_KGC-EES_KNL9 JFSA updated Existing Conditions + The Kanata Golf and Country Club Development with SWM controls + EES sized to infiltrate up to 22mm event + KNL Stage 9 Development

Erosion Threshold Assessment

In July 2020, GEO Morphix completed an Erosion Threshold Assessment on the Kizell Drain downstream of the proposed development and identified two (2) critical erosion locations along the watercourse. The first location referred to as "KDR-4" extends from the outlet of the Beaver Pond to a partially confined wetland area upstream of the CN Rail to the north. The second location referred to as "KDR-3" extends from March Road to Legget Drive and is located between two large parking areas which drain directly to the riparian zone of the Kizell Drain.

From this analysis, it was determined that the channel bed material has been relatively resilient to erosion, with the bank materials more susceptible; as bank undercutting and sloughing were the most common forms of erosion observed throughout the watercourse. At KDR-4 (just downstream of the Beaver Pond) GEO Morphix determined that the critical bank and bed shear stress was 6.78 N/m² and 9.01 N/m², respectively. At KDR-4 (March Road and Legget Drive) GEO Morphix determined that the critical bank and bed shear stress was 8.5 N/m² and 11.29 N/m², respectively. Full details of this study can be found in GEO Morphix's July 2020 report titled "Kizell Drain Downstream of 7000 Campeau Drive Geomorphological and Erosion Threshold Assessment".

Erosion Analysis

To assess the existing and potential future erosive impacts on the Kizell Drain at these two critical locations, the various scenarios were converted to continuous hydrologic models and simulated using 39 years of hourly historical rainfall data taken from the Ottawa Airport. The model was also updated to make use of SWMHYMO's erosion analysis tools at the critical locations, based on the respective bed and bank shear stresses determined above by GEO Morphix. For each scenario, the annual average exceedance volume (the total annual flow through a reach above the erosion threshold), the total exceedance hours (duration of time flows are above this threshold) and the Cumulative Work Index (CWI) (the numerical quantification of the amount of erosive pressure applied to a reach above a determined erosion threshold) have been calculated. Tables 3A and 3B below provide a full summary of this erosion analysis for the various scenarios. Both the bed and bank shear stress have been assessed as a part of this analysis, but as GEO Morphix has determined that the channel bed material is relatively resilient to erosion, with the bank materials being more susceptible, the primary focus of this analysis is the impacts to the bank erosion.

From Tables 3A and 3B below, it was found that the Kanata Golf and Country Club development with the proposed SWM controls and EES (KWEX_KGC-EES) will result in the annual bank Cumulative Work Index to decrease by 14.04% and 13.02% at locations KDR-4 and KDR-3, respectively. This equates to a reduction in the average erosive hours of 5.5 hours and 3.5 hours annually, at locations KDR-4 and KDR-3, respectively.

The development of KNL Stage 9 (KWEX_KNL9) will result in the bank cumulative work index to increase by 26.86% and 39.63% from existing conditions. This equates to an increase in the average erosive hours of 15.6 hours and 9.8 hours annually, at locations KDR-4 and KDR-3, respectively. With both KNL9 and the Kanata Golf and Country Club development in place (KWEX_KGC-EES_KNL9), the bank cumulative work index will increase by 10.13% at KDR-4 from existing conditions but is a reduction of 13.18% from the scenario where only KNL9 is developed.

Table 3A: Erosion Analysis Summary - KDR-4 (upstream of the CN Rail)

Bank Shear Stress Erosion Threshold = 6.78 N/m²

	KWEX			KWEX_KNL9			KWEX_KGC-EES			KWEX_KGC-EES_KNL9		
	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)
Result	21,499	48.3	2.15E+05	28,482	64.0	2.72E+05	18,683	42.8	1.84E+05	24,876	56.5	2.36E+05
Change from KW_EX	n/a	n/a	n/a	32.48%	32.36%	26.86%	-13.10%	-11.52%	-14.04%	15.71%	16.94%	10.13%
Change from KW_KNL9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-12.66%	-11.65%	-13.18%

15.6

Bed Shear Stress Erosion Threshold = 9.01 N/m²

	KWEX			KWEX_KNL9			KWEX_KGC-EES			KWEX_KGC-EES_KNL9		
	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)
Result	6,182	9.9	8.40E+04	7,519	13.6	9.59E+04	5,457	8.8	7.14E+04	6,647	11.6	8.26E+04
Change from KW_EX	n/a	n/a	n/a	21.63%	37.47%	14.14%	-11.74%	-11.27%	-14.99%	7.52%	16.99%	-1.74%
Change from KW_KNL9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-11.60%	-14.90%	-13.91%

Vol Exc: Average Annual volume exceeding the erosion threshold
Hrs Exc: Average Annual Exceedance Hours
CWI: Average Annual Cumulative Work Index

Scenario Summary:

KWEX	JFSA updated Existing Conditions
KWEX_KNL9	JFSA updated Existing Conditions + KNL Stage 9 Development
KWEX_KGC-EES	JFSA updated Existing Conditions + The Kanata Golf and Country Club Development with SWM controls + EES sized to infiltrate up to 22mm event
KWEX_KGC-EES_KNL9	JFSA updated Existing Conditions + The Kanata Golf and Country Club Development with SWM controls + EES sized to infiltrate up to 22mm event + KNL Stage 9 Development

Table 3B: Erosion Analysis Summary - KDR-3 (March Road)

Bank Shear Stress Erosion Threshold = 8.5N/m²

	KWEX			KWEX_KNL9			KWEX_KGC-EES			KWEX_KGC-EES_KNL9		
	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)
Result	15,374	25.7	1.45E+05	21,285	35.5	2.03E+05	13,438	22.2	1.26E+05	18,828	30.8	1.79E+05
Change from KW_EX	n/a	n/a	n/a	38.45%	38.30%	39.63%	-12.60%	-13.64%	-13.02%	22.46%	19.96%	23.40%
Change from KW_KNL9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-11.55%	-13.26%	-11.63%

9.8

Bed Shear Stress Erosion Threshold = 11.29N/m²

	KWEX			KWEX_KNL9			KWEX_KGC-EES			KWEX_KGC-EES_KNL9		
	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)	Vol Exc (m^3)	Hrs Exc (hrs)	CWI (pa)
Result	3,188	4.3	4.75E+04	4,507	5.8	6.78E+04	2,755	3.9	4.07E+04	4,002	5.2	6.00E+04
Change from KW_EX	n/a	n/a	n/a	41.37%	34.83%	42.76%	-13.58%	-10.15%	-14.36%	25.51%	21.52%	26.41%
Change from KW_KNL9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-11.22%	-9.87%	-11.46%

Vol Exc: Average Annual volume exceeding the erosion threshold
Hrs Exc: Average Annual Exceedance Hours
CWI: Average Annual Cumulative Work Index

Scenario Summary:

KWEX	JFSA updated Existing Conditions
KWEX_KNL9	JFSA updated Existing Conditions + KNL Stage 9 Development
KWEX_KGC	JFSA updated Existing Conditions + The Kanata Golf and Country Club Development with SWM controls + EES sized to infiltrate up to 22mm event
KWEX_KGC_KNL9	JFSA updated Existing Conditions + The Kanata Golf and Country Club Development with SWM controls + EES sized to infiltrate up to 22mm event + KNL Stage 9 Development

Conclusion

From this analysis, it was found that the proposed redevelopment of the Kanata Golf and Country Club can be implemented with SWM measures in place to ensure no adverse impacts to peak flows out of the existing Beaver Pond, with all events either matching or resulting in a reduction in existing peak flows. The proposed development will also result in no increases in peak flows downstream on Watts Creek at the Ottawa River. The implementation of EES within the development to capture the 22 mm runoff, has been found to help reduce the peak flows out of the Beaver Pond and downstream on Watts Creek at the Ottawa River to be less than existing conditions for all design storms.

A detailed erosion analysis was completed for each of the scenarios using 39 years of historical rainfall data. The annual average cumulative work index was calculated based on critical shear stress values determined by GEO Morphix at two sensitive sites within the watercourse. From this analysis, it was found that the proposed development would reduce the existing cumulative work index at these critical locations by only 14.04% and 13.02% at locations KDR-4 and KDR-3, respectively. This equates to a reduction in the average erosive hours of 5.5 hours and 3.5 hours annually, at locations KDR-4 and KDR-3, respectively. From this analysis, it was found that the proposed Kanata Golf and Country Club development can also help offset erosion increases produced by the approved KNL Stage 9 development. This analysis confirms that the Kanata Golf and Country Club can be redeveloped, as proposed, without increasing downstream peak flows or exacerbating existing erosion concerns.

Yours truly,

J.F Sabourin and Associates Inc.

Jonathon Burnett, P.Eng

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Director of Water Resources Projects

Table 1A: Beaver Pond Inflow/Outflow Summary

Table 2A: Outlet to Ottawa River Summary

Table 3A: Erosion Analysis Summary - KDR-4 (upstream of the CN Rail)

Table 3B: Erosion Analysis Summary - KDR-3 (March Road)

NOTE: Due to the number and size of the various models used in this analysis, modelling files have been provided electronically.