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Memorandum

To/Attention	Charles Warnock	**Date**	16 March 2015
From	Peter Spal JF Sabourin	**Project No**	28661 - 5.3.1.5
cc	Lyon Sachs Mary Jarvis Bob Wingate		
Subject	Kanata Lakes Summary of High Level Stormwater Solution for Beaver Pond		

As requested, the following memo outlines the evaluation of high level stormwater (SWM) solutions for the future development area (Phases 7 and 8) of Kanata Lakes as undertaken by IBI Group and JF Sabourin and Associates (JFSA).

High Level Stormwater Solution

Two high level SWM options are outlined below and represent the worst case scenarios for treating and controlling the stormwater for future Phases 7, 8 and 9. These options rely on the physical expansion of the Beaver Pond volume or a new SWM facility to accommodate the future development. The water quantity and quality treatment requirements for each option are evaluated and presented within their respective sections.

Hydrological Modeling

The hydrological modeling, utilizing SWMHYMO, was undertaken for both options and is based on the existing conditions single event SWMHYMO calibrated model from AECOM. This model was obtained from the City on March 27, 2014. This model contains the underground storage component as assessed by AECOM. The outflow from the underground storage uses the equivalent to a 300 mm diameter orifice.

The future development areas are located north of the existing Kizell Cell and Beaver Pond. Phase 9 is located north of the Beaver Pond and Phases 7 and 8 are located north of the Kizell Cell. Phase 9 is represented in the hydrological model as Area 8 and major and minor flow from this phase is conveyed to the Beaver Pond regardless of the option. Phases 7 and 8 are located north of the Kizell Cell. These phases are represented in the hydrological model by Areas 12, 12A, 13, 14 and 15. The hydrological model schematic from the Kanata Lakes North Serviceability Study (IBI Group, June 2006) is included in **Attachment A** and presents the location of the aforementioned areas.

The future development areas (Phases 7, 8 and 9) were entered into the model by IBI. To accommodate the future development into the existing conditions AECOM model the following modifications were made:

- For Phase 9 (north of Beaver Pond): Rural area (Area 8) was replaced with an urban area of 34.3 ha which represents the Phase 9 development.
- For Phases 7 and 8 (north of Kizell Cell): Area 11 was reduced to 25 ha and the future areas (Areas 12, 12A, 13, 14 and 15) were added to the end of the hydrological model.

The hydrological modeling of future development areas is consistent for both options (same areas, impervious values, CN values, etc). However, there are slight differences in each hydrological model depending on the high level SWM option. These differences are related to either directing first flush to another cell or modeling of a conceptual SWM pond. The difference in the hydrological model for each respective option will be discussed within their section.

Hydraulic Modeling

The hydraulic modeling was undertaken using XPSWMM. The base XPSWMM model was developed by AECOM and received from the City of Ottawa on December 12, 2013. It was confirmed with AECOM that this is the most up to date model. Hydrographs from the hydrological model are read into either the Kizell Cell or Beaver Pond node to undertake hydraulic evaluation of the system.

OPTION 1

Water Quantity Control

To evaluate the water quantity requirements for the Beaver Pond to accommodate Phases 7, 8 and 9 the following was assumed:

Hydrological Modeling

- First flush flow (25 mm 4 hour Chicago, 3.57 m^3/s) from Phases 7 and 8 would be conveyed to the Beaver Pond for treatment.
- The balance of minor system flow (between the 25 mm and 5 year 10 minute flow) from Phases 7 and 8 would be conveyed to the Kizell Cell.
- The majority of major system flow from Phases 7 and 8 would be conveyed to a re-aligned Shirley's Brook. The one exception is Area 12, where the major flow would be conveyed directly to the Kizell Cell.

Hydraulic Modeling

- Use of bathometric and LIDAR information from AECOM for the Kizell Cell and Beaver Pond as the base stage-area curve. It should be noted that AECOM utilized bathometric information to generate the permanent storage stage-area curves and LIDAR to generate the extended storage stage-area curves.
- No overflow to the Carp River watershed from the Kizell Cell.
- Removal of proposed orifice and weir at Goulbourn Forced Road.
- Maintain a maximum of 92.60 m water level in the Beaver Pond during the 100 year storm event consistent with the current Ontario Ministry of Environment (MOE) Certificate of Approval (CofA No. 5190-7L6RRY, dated November 26, 2008).

- Maintain approximately 1.0 m^3/s outflow from the Beaver Pond during the 100 year storm event and the current MOE CofA.
- Provide a future emergency overflow Walden Road close to the Beaver Pond outlet at an elevation of 92.60 m.

From the hydrological and preliminary hydraulic evaluation of this high level SWM option, it was determined that an additional 77,000 m^3 (7.7 ha-m) of water quantity storage is required in the Beaver Pond to maintain the maximum 100 year water level of 92.60 m. The additional storage could be provided through a potential pond expansion presented on **Figure A**. The additional water quantity storage available in this potential area expansion is approximately 100,000 m^3 (10 ha-m). The original AECOM stage-area curve was updated to include the additional extended storage available within the potential Beaver Pond expansion presented in **Figure A**. The updated stage-area curve was input into the hydraulic model and the resulting water levels (Kizell Cell and Beaver Pond) and Beaver Pond outflow are summarized in **Table 1**.

The hydrological and hydraulic modeling files supporting this high level SWM option are presented in **Attachments A and B**, respectively. In addition, the stage-area curves for the Beaver Pond for existing conditions and potential expansion are included in **Attachment C**.

Based on the modeling evaluation noted above, the following table summarizes the post-development Kizell Cell and Beaver Pond water levels and Beaver Pond outflow for various return periods. For comparison purposes, the normal water levels and water levels and outflow resulting from the AECOM existing conditions model are also presented in the table below.

Table 1. Summary of Kizell and Beaver Pond Water Levels and Outflow from the Beaver Pond for Various Storm Events - Option 1

Design Storm	Existing Conditions*			Post-Development High Level SWM Option 1		
	Kizell Pond	Beaver Pond		Kizell Pond	Beaver Pond	
	Maximum Water Level (m)	Maximum Water Level (m)	Maximum Outflow (m^3/s)	Maximum Water Level (m)	Maximum Water Level (m)	Maximum Outflow (m^3/s)
Permanent (Normal) Water Level	92.02	90.42	n/a	92.02	90.42	n/a
4 hr - 25 mm	92.24	91.87	0.744	92.16	90.75	0.117
5 yr - 24 hr SCS	92.35	91.26	0.483	92.87	91.37	0.537
100 yr - 24 hr SCS	93.10	92.29	0.897	93.46	92.40	0.931
100 yr - 24 hr Chicago	93.07	92.24	0.879	93.48	92.36	0.918
100 yr - 24 hr SCS (old Ottawa Standard with 88.6 mm)	92.84	91.87	0.744	93.15	91.96	0.781

** Water levels and outflow are from the AECOM existing conditions single event model.*

From the above table, it should be noted that the maximum water level of 92.60 m in the Beaver Pond is not exceeded under any of the above noted storm events. In addition, the outflow from the Beaver Pond is below 1.0 m^3/s under any of the above noted storm events.

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Water Quality Control

The water quality requirements for the Beaver Pond to accommodate future development of Phases 7, 8 and 9 were based on the following assumptions:

- Water quality treatment (permanent pool) for all existing and future development areas tributary to either the Kizell Cell or Beaver Pond would be provided only in the Beaver Pond.
- The Beaver Pond is a wet pond for water quality calculations.
- The Beaver Pond would provide Enhanced Level of Protection (80% TSS removal) consistent with the current MOE CofA for the facility.
- All existing rural areas from the AECOM hydrological model evaluated using a NASHYD routine were assumed a total imperviousness (TIMP) of 0.
- 35,210 m^3 (3.5 ha-m) of permanent storage currently exists within the Beaver Pond as per AECOM bathometric information.

For water quality treatment, the total drainage area tributary to the Beaver Pond is 562 ha with a weighted average imperviousness of 39%. The following table summarizes the water quality requirements for the Beaver Pond as per the *MOE Stormwater Management Planning and Design Manual* (March 2003) for an Enhanced Level of Protection. The supporting water quality calculation is provided in **Attachment D**.

Table 2. Water Quality Volume Requirements for the Beaver Pond – Option 1

Level of Protection	Urban Drainage Area (ha) / Type of Facility / % IMP	Permanent Storage (m^3)			Extended Storage (m^3)	
		Existing	Required	Provided*	Required	Provided**
Enhanced	562 Wet Pond 39%	35,210	61,575	110,210	22,448	152,002

** Permanent Storage Provided is the sum of existing permanent volume (35,210 m^3) and additional 75,000 m^3 permanent volume available within the pond expansion.*
*** Extended Storage Provided is the resultant volume resulting from the evaluation of the 25 mm 4 hour Chicago storm event. It should be noted that the extended storage volume presented excludes permanent storage.*

The system was evaluated using the 25 mm 4 hour Chicago water quality storm event. The detention release time from Beaver Pond indicates that it will take approximately 3.5 days for the Beaver Pond to release 90% of the runoff from a 25 mm storm and approximately 4.2 days to release 95% of the runoff from the same storm.

OPTION 2

The above noted results for water quantity and quality control are based on the assumption that Phases 7 and 8 would discharge into the Beaver Pond system. If a situation should occur where re-direction of flow from the Shirley's Brook system to the Beaver Pond system (and ultimately the Kizell Drain) are unacceptable, a second high level SWM option is available.

The second high level SWM option assumes that Phases 7 and 8 would have water quantity and quality control provided in a new independent SWM facility which would discharge to Shirley's Brook. A new facility could be located within the Phase 8 development area or further downstream along existing Shirley's Brook. A conceptual plan view of this facility is presented in **Figure B**.

Water Quantity Control

The SWM facility sizing for water quantity to accommodate Phases 7 and 8 was evaluated assuming the following:

Hydrological Modeling

- Total flow from Phases 7 and 8 (minor and major) would be conveyed to the facility.
- Phase 9 would be conveyed to the Beaver Pond for water quality and quantity control.
- Quantity storage within the facility was evaluated using a Route Reservoir routine in SWMHYMO.
- Maximum outflow from the facility during the 100 year storm event would be 500 l/s.

It should be noted that the outflow from the facility was assumed to be 500 l/s, however, this outflow would have to be optimized based on pre- to post-development evaluation of Shirley's Brook at the discharge point of the SWM facility.

In addition, the outlet pipe from the facility is shown crossing through a section of Trillium Woods to discharge into Shirley's Brook (see **Figure B**). The existing creek is too high at Goulbourn Forced Road to provide a gravity outlet, therefore, the outlet is proposed further downstream on Shirley's Brook. The alignment of the outlet, as shown on **Figure B**, is located at a low existing ground elevation where minimum excavation would required.

The following table summarizes the volume and outflow from the conceptual facility under various storm events. The modeling files in support of this option are provided in **Attachment E**.

Table 3. Summary of Volume and Outflow from the Conceptual SWM Facility for Various Storm Events - Option 2

Design Storm	Conceptual SWM Facility	
	Quantity Volume (m^3)	Outflow (m^3/s)
4 hr - 25 mm	15,510	0.091
5 yr - 24 hr SCS	44,600	0.262
100 yr - 24 hr SCS	84,540	0.497
100 yr - 24 hr Chicago	81,150	0.477
100 yr - 24 hr SCS (old Ottawa Standard with 88.6 mm)	67,070	0.395

Water Quality Control

The water quality requirements for the conceptual SWM facility to accommodate future development of Phases 7 and 8 were based on the following assumptions:

- The facility is a wet pond for water quality calculations.
- The facility provides Enhanced Level of Protection (80% TSS removal).

For water quality treatment, the total drainage area tributary to the conceptual SWM facility is 142 ha with a weighted average imperviousness of 49%. The following table summarizes the water quality requirements for the facility as per the *MOE Stormwater Management Planning and Design Manual* (March 2003) for an Enhanced Level of Protection. The supporting water quality calculation is provided in **Attachment F**.

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Table 4. Water Quality Volume Requirements for the Conceptual SWM Facility - Option 2

Level of Protection	Urban Drainage Area (ha) Type of Facility % IMP	Required Permanent Storage (m^3)	Required Extended Storage (m^3)
Enhanced	142 Wet Pond 49%	19,123	5,696

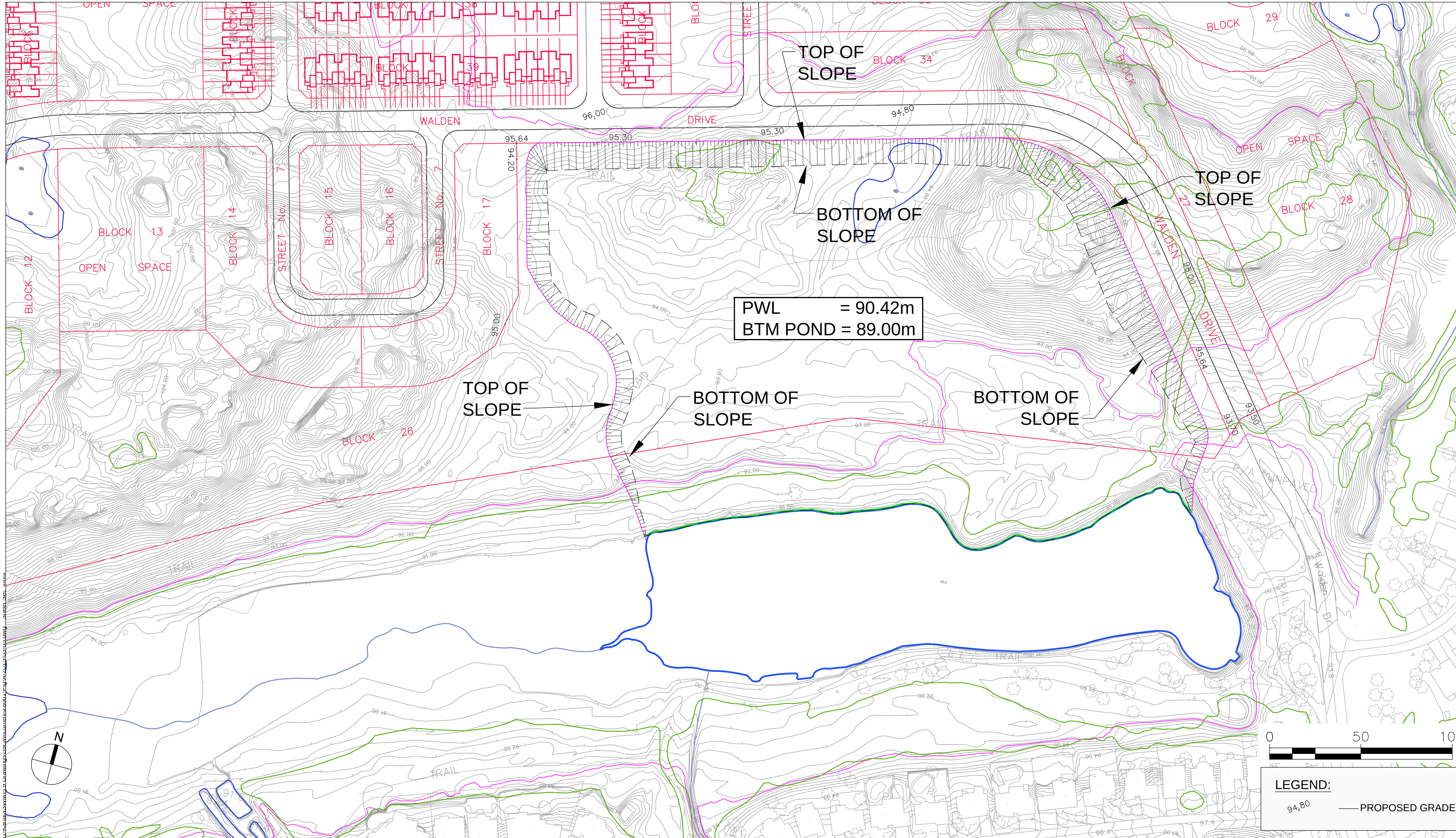
The conceptual SWM facility would be designed to accommodate the required permanent and extended storage to provide an Enhanced Level of Protection (80% TSS removal).

Conclusion

Moving forward in establishing a final SWM solution for Kanata Lakes under post-development conditions, the following are recommended to be considered and pursued, and include at a minimum:

- Overflow to the Carp River watershed from the Kizell Cell;
- Topographical survey of the Beaver Pond cattails to determine, at a design level of detail, the extended storage estimated by LIDAR information from AECOM;
- Refinement of the calibrated existing conditions AECOM model utilizing other modeling techniques;
- Refinement of the post-development model to optimize the preferred post-development servicing scheme; and,
- Evaluation of the downstream recipient watercourse (Kizell Drain) from an erosion and flood perspective to assess if additional discharge from the Beaver Pond could be facilitated.

In the meantime, we trust the information provided in this memorandum is sufficient in detail to allow you to confirm that a “high level” SWM solution is available.



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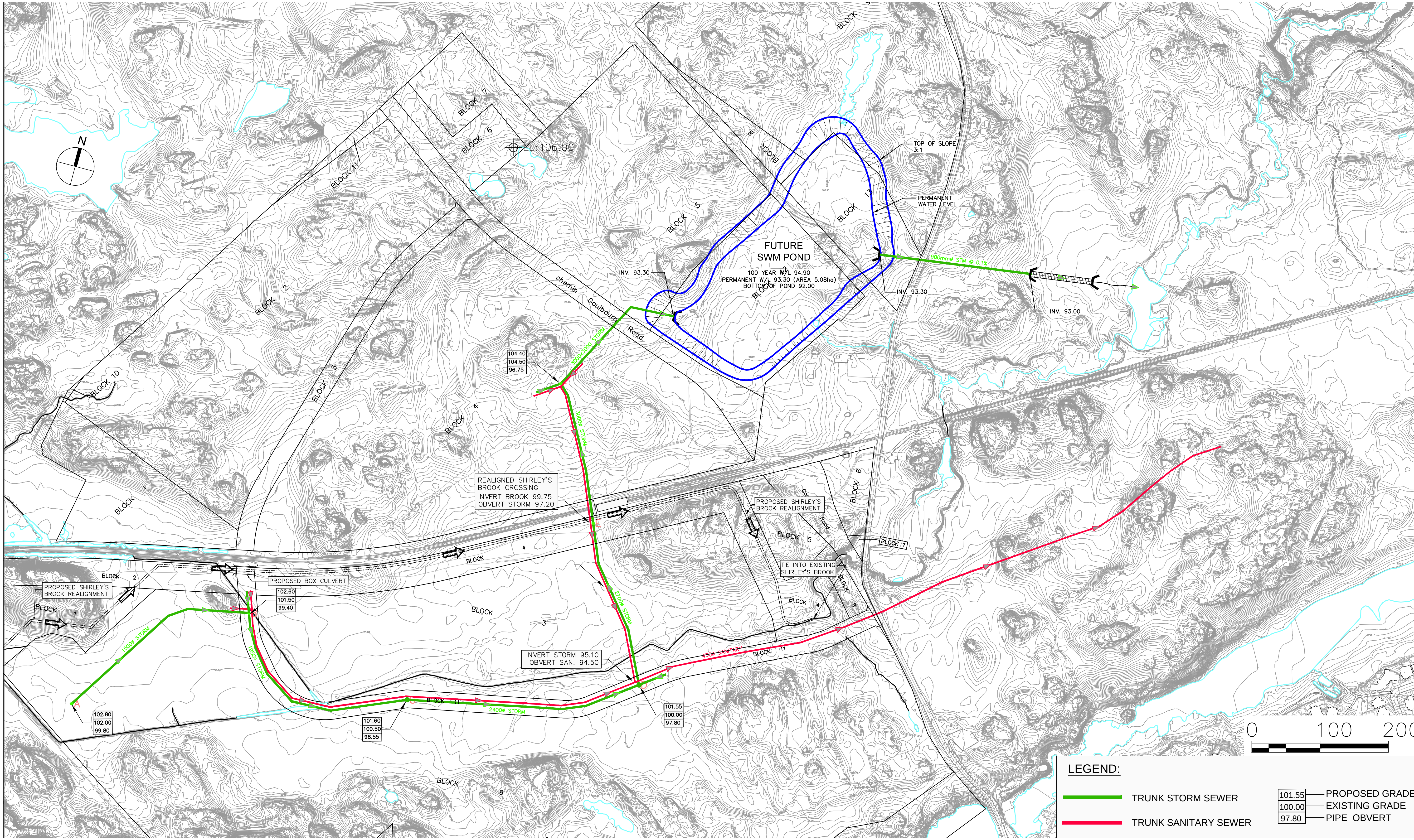
Scale	Project Title	Drawing Title	Sheet No.
1:2000	KANATA LAKES	HIGH LEVEL SWM ALTERNATIVE OPTION 1	FIGURE A



J:\28661-KanataSWM\5.9 Drawings\59civil\current\28661-Fig-B-2015-03-04.dwg Sheet Set: ####

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Scale	Project Title	Drawing Title	Sheet No.
1:5000	KANATA LAKES	HIGH LEVEL SWM ALTERNATIVE OPTION 2	FIGURE B

Attachment A

2006 Serviceability Study Model Schematic and SWMHYMO Output Files – Option 1

NO.	DATE	BY	REVISION
1.	02:11:20		GENERAL REVISIONS
2.	02:11:26		REVISED AS PER NEW CONCEPT PLAN
3.	05:08:16		REVISED AS PER NEW CONCEPT PLAN
4.	06:02:14		REVISED AS PER NEW CONCEPT PLAN
5.	06:06:15		REVISED AS PER NEW CONCEPT PLAN

94.1 (OVERFLOW)
93.0
WATER LEVEL
93.3

Berm Detail

Legend:

- On-Site Storage
- S2 Sewer Outlet
- 9 Drainage Area ID
- Drainage Area Boundary
- Major Flow
- Minor Flow

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KANATA LAKES NORTH
MODEL SCHEMATIC

SERVICEABILITY
STUDY

SCALE:	1:6000		
DRAWN:	M.M.	DATE:	SEPT '02
DESIGN:	L.E.	DATE:	SEPT '02
CHECKED:	R.W.W.	DATE:	SEPT '02
PROJECT NO.	3433-LD	DRAWING NO.	5004

Attachment B

XPSWMM Output Files – Option 1

- 4 hr – 25 mm
- 5 yr – 24 hr SCS
- 100 yr – 24 hr SCS
- 100 yr – 24 hr Chicago
- 100 yr – 24 hr SCS (old Ottawa Standard with 88.6 mm)

Attachment C

Stage-Area Curves for Beaver Pond

Elevation-Depth-Area Curves for Hydraulic Modeling of Beaver Pond

Beaver Pond Initial Depth (both curves):	87.63	m
Beaver Pond Initial Depth (XPSWMM):	2.79	m
Beaver Pond Permanent Water Level:	90.42	m

Existing Beaver Pond			Potential Beaver Pond Expansion		
Elevation (m)	Depth (m)	Area (ha)	Elevation (m)	Depth (m)	Area (ha)
87.63	0	0.0001	87.63	0	0.0001
87.698	0.068	0.0002	87.698	0.068	0.0002
87.798	0.168	0.0003	87.798	0.168	0.0003
87.898	0.268	0.0146	87.898	0.268	0.0146
87.998	0.368	0.0444	87.998	0.368	0.0444
88.098	0.468	0.0872	88.098	0.468	0.0872
88.198	0.568	0.1288	88.198	0.568	0.1288
88.298	0.668	0.2309	88.298	0.668	0.2309
88.398	0.768	0.3783	88.398	0.768	0.3783
88.498	0.868	0.6258	88.498	0.868	0.6258
88.598	0.968	0.8016	88.598	0.968	0.8016
88.698	1.068	1.0357	88.698	1.068	1.0357
88.798	1.168	1.2162	88.798	1.168	1.2162
88.898	1.268	1.3863	88.898	1.268	1.3863
88.998	1.368	1.5083	88.998	1.368	1.5083
89.098	1.468	1.6212	89.098	1.468	1.6212
89.198	1.568	1.7271	89.198	1.568	1.7271
89.298	1.668	1.8247	89.298	1.668	1.8247
89.398	1.768	1.896	89.398	1.768	1.896
89.498	1.868	1.9549	89.498	1.868	1.9549
89.598	1.968	2.0027	89.598	1.968	2.0027
89.698	2.068	2.0432	89.698	2.068	2.0432
89.798	2.168	2.0818	89.798	2.168	2.0818
89.898	2.268	2.1193	89.898	2.268	2.1193
89.998	2.368	2.1563	89.998	2.368	2.1563
90.098	2.468	2.1932	90.098	2.468	2.1932
90.198	2.568	2.2299	90.198	2.568	2.2299
90.298	2.668	2.2664	90.298	2.668	2.2664
90.398	2.768	2.3034	90.398	2.768	2.3034
90.448	2.818	2.3035	90.448	2.818	7.9158
90.498	2.868	2.3036	90.498	2.868	7.9261
90.598	2.968	2.5089	90.598	2.968	8.1252
90.698	3.068	2.5883	90.698	3.068	8.2167
90.798	3.168	2.7353	90.798	3.168	8.3712
90.898	3.268	2.935	90.898	3.268	8.5737
90.998	3.368	3.6185	90.998	3.368	9.2597
91.098	3.468	4.8076	91.098	3.468	10.4472
91.198	3.568	5.3721	91.198	3.568	11.0087

Existing Beaver Pond		
Elevation (m)	Depth (m)	Area (ha)
91.298	3.668	5.9197
91.398	3.768	6.5021
91.498	3.868	7.2709
91.598	3.968	8.0626
91.698	4.068	8.3753
91.798	4.168	8.6723
91.898	4.268	8.9692
91.998	4.368	9.4301
92.098	4.468	10.2698
92.198	4.568	10.7888
92.298	4.668	11.3862
92.398	4.768	11.8852
92.498	4.868	12.857
92.548	4.918	13.2219
92.598	4.968	13.5868
92.698	5.068	13.9225
92.798	5.168	14.2095
92.898	5.268	14.4942
92.998	5.368	15.1506
93.098	5.468	15.65
93.198	5.568	15.9507
93.298	5.668	16.2476
93.398	5.768	16.5421
93.498	5.868	16.9556

Potential Beaver Pond Expansion		
Elevation (m)	Depth (m)	Area (ha)
91.298	3.668	11.5477
91.398	3.768	12.1147
91.498	3.868	12.8621
91.598	3.968	13.6126
91.698	4.068	13.8806
91.798	4.168	13.9961
91.898	4.268	14.1924
91.998	4.368	14.5007
92.098	4.468	15.2383
92.198	4.568	15.6819
92.298	4.668	16.0648
92.398	4.768	16.4903
92.498	4.868	17.3395
92.548	4.918	17.6589
92.598	4.968	17.9783
92.698	5.068	18.2667
92.798	5.168	18.3377
92.898	5.268	18.5178
92.998	5.368	18.9934
93.098	5.468	19.3915
93.198	5.568	19.5875
93.298	5.668	19.6445
93.398	5.768	19.8298
93.498	5.868	20.1036

Attachment D

Water Quality Calculations – Option 1

Water Quality Calculations - High Level SWM Solution - Option 1

Total Drainage Area to the Beaver Pond for Water Quality Treatment: 562 ha
(*****)Total weighted TIMP for Drainage Areas to Beaver Pond for Water Quality Treatment: 39 %

Enhanced Level of Treatment (80% TSS removal)
Permanent Storage required for Wet Pond (from MOE Manual p3-10 Table 3.2):

IMP (%)	Storage Volume (m^3/ha)
35	140
55	190

For Beaver Pond: 150

Calculated storage volume minus 40 m^3/ha extended storage: 110 m^3/ha
Total Permanent Storage Required in Beaver Pond: 61575 m^3

Existing permanent storage in Beaver Pond as per AECOM stage-area curve at permanent water elevation of 90.42 m: 35210 m^3
Deficit of Permanent Storage in Beaver Pond: 26365 m^3

Extended Storage Required in Beaver Pond: 22488 m^3

Notes: (*****) The weighted TIMP assumes rural areas (AECOM existing condition areas modeled with NASHYD) have a TIMP equal to 0.

Attachment E

SWMHYMO Output Files – Option 2

Attachment F

Water Quality Calculations – Option 2

Water Quality Calculations - High Level SWM Solution - Option 2

Phases 7 and 8 Drainage Area to the Conceptual SWM Pond for Water Quality Treatment:	142	ha
Total weighted TIMP for Phases 7 and 8 Drainage Areas for Water Quality Treatment:	49	%

Enhanced Level of Treatment (80% TSS removal)

Permanent Storage required for Wet Pond (from MOE Manual p3-10 Table 3.2):

IMP (%)	Storage Volume (m^3/ha)
35	140
55	190
For Conceptual SWM Pond:	174

Calculated storage volume minus 40 m^3/ha extended storage:	134	m^3/ha
Total Permanent Storage Required in Conceptual SWM Pond:	19123	m^3
Extended Storage Required in Conceptual SWM Pond:	5696	m^3