APPENDIX A

Stormwater Management System Design Report

December 2014

APPENDIX A

Stormwater Management System Design
Volume IV Design and Operations Report
Capital Region Resource Recovery Centre

REPORT

Report Number: 12-1125-0045/4500/vol IV

Table of Contents

TABLES

FIGURES

ATTACHMENTS

1.0 INTRODUCTION

A new integrated waste management facility, the Capital Region Resource Recovery Centre (CRRRC), is proposed for the Capital Region of eastern Ontario. If approved, the CRRRC would provide facilities and capacity for the recovery of resources and diversion of materials from wastes that are generated by Industrial, Commercial and Institutional (IC&I) and Construction and Demolition (C&D) sectors in Ottawa and eastern Ontario. It would also provide landfill disposal capacity on the same Site for post-diversion residuals and materials that are not diverted.

This report has been prepared as an Appendix to the overall facility Design and Operations (D&O) report and should be read in conjunction with it and its other Appendices. The D&O report, and this Stormwater Management (SWM) System Design report and drawings will be used to support the Environmental Assessment (EA) and a subsequent application for an Environmental Compliance Approval (ECA) under the *Environmental Protection Act* (EPA) (MOE, 2010) and the *Ontario Water Resources Act* (OWRA) (MOE, 2011).

1.1 Background

The proposed CRRRC Site is located in the east part of the City of Ottawa just southeast of the Highway 417/ Boundary Road interchange. The property is located on the east side of Boundary Road, north of Devine Road and west of Frontier Road, and east of an existing industrial park, on Lots 22 to 25, Concession XI, Township of Cumberland.

The Boundary Road Site (the Site), totalling approximately 192 hectares (ha), is located in the Bear Brook Subwatershed in the Lower Ottawa – South Nation Watershed. The area surrounding the Site primarily consists of rural and agricultural land, an industrial park, residential properties and open spaces. Figure 1 shows the Site and surrounding area. The Site is generally flat, and slopes from local high point elevations at the western side of the Site at Boundary Road, towards the lowest portion of the Site found along the eastern edge at Frontier Road. The Mer Bleue bog is about 3.7 km to the north/northwest of the Site.

The property is adjacent to an existing Industrial Park with few existing immediate neighbours. It is underlain by a surficial silty sand layer followed by a thick deposit of silty clay soil.

2.0 PURPOSE AND METHODOLOGY

The purpose of the SWM system design report is to document the existing surface water conditions at the Site, and present the proposed Site drainage design and SWM system to mitigate potential impacts of the proposed CRRRC development on the surface water environment.

The process steps used to conduct the surface water assessment aspects of the EA/EPA study at the Boundary Road Site are described in the approved Terms of Reference (TOR) and are summarized below (from Appendix C-2.3, of the TOR, which is reprinted in Volume I, Appendix A of this document package). The sections of the design report also generally follow this order and are as follows:

1) Assess existing surface water conditions;

2) Assess potential environmental effects of the proposed CRRRC on surface water; and,

3) Complete EPA (MOE, 2010)/OWRA (MOE, 2011) level design activities for the proposed CRRRC.

The methodology used for the SWM system design was conducted within the general framework outlined above. The potential effects of the proposed CRRRC were considered based on full build out of the diversion/recovery facilities and post-closure landfill conditions since this is the time frame when there will be the greatest change to surface water conditions at the Site.

The following sections provide an overview of the tasks within each of the above steps.

2.1 Assess Existing Surface Water Conditions

Surface water testing

A field monitoring program was initiated to capture seasonal changes that exist at the Site and surrounding area. Surface water sampling was conducted at Site drainage points as well as downstream and background locations.

Data sources listed in Section 3.2, Appendix C-2.3 of the TOR (reprinted in Volume I, Appendix A of this submission) were reviewed to develop the monitoring program and collect data for surface water quality. Background sources, including municipal waterway monitoring reports, topographic mapping and aerial photography as well as published sources were used to delineate and identify characteristics of the study area. Characteristics of the study area include drainage watershed areas, flow paths, outfalls, discharge points, groundwater discharge areas and receiving water bodies. Watersheds in the Site-vicinity were also identified and characterized.

Grab surface water samples were collected and analyzed for target parameters selected at monitoring stations. The sampling station locations are shown on Figure 1. Flow measurements were collected following standard Provincial protocols where possible. Standard water quality parameters such as dissolved oxygen, pH, conductivity, and temperature were collected at each station using appropriate, calibrated instruments.

Existing conditions summary

Data regarding the existing surface water flow and quality representative of conditions upstream and downstream of the proposed CRRRC was collected and summarized from the field monitoring program, as well as other resources such as municipal waterway monitoring reports.

Hydrologic model

A hydrological model was used to calculate surface water runoff and peak flows in the area of the proposed CRRRC under existing conditions, using 2, 5, 25 and 100 year design storms as set out in *Ontario Regulation* (O.Reg.) 232/98 (MOE, 1998). To assist with the assessment and designs, Golder prepared a SWM model for the Site using the U.S. Environmental Protection Agency Stormwater Management Model Version 5.0.02 ('SWMM5') software program (US-EPA, 2008). The SWMM5 software was used to estimate the hydrologic pre-development conditions for the Site's sub catchment areas.

SWMM5 is widely used for single event and long-term (continuous) simulation of runoff quantity from urban and non-urban areas. In the runoff component, sub-catchment areas receive precipitation and generate runoff. The routing portion then transports this runoff through a system of pipes, channels and storage reservoirs that are user defined. SWMM5 tracks the quantity of runoff generated within each sub-catchment, and the flow rate and flow depth of water in each pipe and channel during a simulation period comprised of multiple time steps.

2.2 Assess Environmental Effects

The surface water aspects examined in the assessment are surface water quantity and surface water quality.

Based on the proposed Site development plan, the conceptual SWM model was developed to identify the preferred location of stormwater collection and conveyance features and SWM facilities. The hydrological model created to predict existing surface water runoff and peak flows was updated based on proposed post-development Site conditions. The post-development results of peak runoff using the 2, 5, 25 and 100 year design storms were compared against results of the pre-development conditions to assist in further refining the SWM designs. The assessment also considered potential impacts to surface water quality and proposed mitigation measures were incorporated into the designs.

The SWMM5 software was used to estimate the hydrologic post-development conditions for the Site's three Municipal Drain sub-catchment areas and to design effective post-development controls to meet pre-development runoff targets conveyed from the Site.

Additional mitigation measures, if required following the prediction of future environmental conditions, were identified and refined as necessary. The future surface water conditions were predicted, assuming all design and operational mitigation measures will be present.

2.3 EPA/OWRA Level Design

The SWM design report and drawings will be used to support the EA, and also to support approvals under the EPA (MOE, 2010) and OWRA (MOE, 2011). As such, the Site designs are to the required level of detail to include Site grading, drainage and conveyance aspects, and more defined SWM facilities. Site drainage has been designed in accordance with the Ministry of the Environment and Climate Change (MOECC) Landfill Standards (MOE, 1998).

3.0 ASSESSMENT OF EXISTING SURFACE WATER CONDITIONS

3.1 Drainage

A small portion of the northern section of the Site is currently used for agricultural purposes, but the majority of the Site is heavily vegetated and treed. The Site is known to have generally high groundwater levels, minimal relief and gradual slope of typically less than 1% draining west to east, with elevations ranging from approximately 78 metres to 76 metres above sea level (masl). Soils encountered in the Site area during the subsurface investigation program consisted of surficial silty sand to approximately 1.5 metres below ground surface (mbgs), underlain by an extensive and thick silty clay deposit. Based on these investigations, Site visits performed by the Golder team, aerial photography and available topography, the model hydrologic parameters, including Soil Conservation Service (SCS) Curve Number, depression storage, Manning's coefficient and land use were defined for the pre-development drainage areas. Other user-defined hydrologic parameters applied in SWMM5 are area, width, slope, and percentage impervious surfaces. All of the hydrologic input parameters for the modeling are summarized in Attachment A.1.

Drainage in the vicinity of the Site is mainly by means of a network of agricultural ditches and three municipal drains. Ditches that cross the Site, some of which are old farm field drainage, have not been maintained. There are roadside ditches along Boundary, Devine and Frontier Roads that eventually all drain eastward. At present, drainage on the Site is not well established and the land is poorly drained. Sub-catchment delineation is challenging due to the poorly drained land and many references, including municipal drainage plans, were used. Ultimately, delineations were based on those previously concluded by Stantec (Stantec, 2000). Delineated pre-development drainage catchments are presented in Figure 2.

The Site is in the headwaters of the Shaw's Creek sub-watershed of approximately 35 km^2, and the Bear Brook watershed of approximately 484 km^2. Bear Brook is a tributary to the South Nation River and the Site is therefore within the South Nation Conservation area. The Site contributes roughly 5% of the land area draining to the Shaw's Creek drainage area.

The Site is divided into three sub-catchment areas with discharge to the eastern boundaries of the Site. The discharge ditches of the three sub-catchments all eventually tie into municipal drains. Summaries for each of these Site drainage areas, including additional descriptions of off-Site downstream routing to Highway 417, are provided below. The SWMM5 schematic illustrating the existing drainage is provided in Attachment A.2, Figure A-1.

Regimbald Municipal Drain

The northern Site sub-catchment area primarily drains to two on-Site agricultural ditches. One ditch segment drains northerly from the Site while another drains easterly towards Frontier Road. Both ditch segments eventually become part of the Regimbald Drain, the first about 200 metres north of the northern property limit, while the second is on the east side of Frontier Road.

Drainage to the east is conveyed via a 600 millimetre diameter culvert under Frontier Road. Off-Site drainage from this sub-catchment area is then conveyed northeast via a ditch to a 1,000 millimetre diameter culvert under Highway 417, meeting up with the other branch of the Regimbald Drain approximately 800 metres northeast of Highway 417.

The Site drainage to the northern ditch segment appears to be relatively insignificant based on Site observations. For the purposes of the assessment it has been considered that the east discharge location is the outlet for the northern portion of the Site. The portion of the Site draining to the Regimbald Drain is about 21 ha, or about 11% of the Site.

Simpson Municipal Drain

The Simpson Municipal Drain bisects the Site, and drains from west to east. An upstream drainage area drains to the Simpson Drain segment through the Site, extending to the west of Boundary Road, along Mitch Owens Road to Black Creek Road.

The runoff from the central portions of the Site is directed to the Simpson Municipal Drain and is conveyed off-Site and then discharges through a 1,200 mm diameter culvert under Frontier Road. Downstream, the Simpson Drain continues to a culvert under Highway 417 approximately 1 km further east of the Site. Downstream of Highway 417, the Simpson Drain continues as Shaw's Creek, which eventually feeds Bear Brook Creek. The stream flow distance of the Simpson Municipal Drain from the east perimeter Site boundary to Bear Brook Creek is approximately 11 km.

The portion of the Site draining to the Simpson Drain is about 75.6 ha, or about 39% of the Site.

Wilson - Johnston Municipal Drain

The southern portion of the Site is primarily drained by a ditch flowing west to east across the entire width of the Site. This ditch extends west to Boundary Road but only receives runoff from the eastern half of the road allowance as the western portion connects to the Simpson Drain at Mitch Owens Road. This ditch continues to flow east and eventually becomes part of the Wilson-Johnston Municipal Drain.

Off-Site flows from the Site are routed under Frontier Road, via a 1,000 mm diameter culvert. The ditch then turns south and parallels Frontier Road for about 150 metres before turning back to the east. The Wilson-Johnston Drain crosses under Highway 417 via a culvert about 2.4 km east of the Site.

A second small ditch in the southeast corner of the Site drains east to Frontier Road and crosses under the road via a 600 mm culvert and ties into the main ditch at the location where it turns east.

Some drainage along the southern limits of the Site may drain to the roadside ditch along Devine Road. It doesn't appear that very much runoff follows this route and it is difficult to estimate how much due to the very flat topography. Since the Devine Road drainage also eventually connects into the Wilson-Johnston Drain, it has been assumed that no runoff from the Site discharges to Devine Road.

The portion of the Site draining to the Wilson-Johnston Drain is about 95.1 ha, or about 50% of the Site.

3.2 Water Quantity

Flow measurements were conducted at the surface water sampling station locations when possible. The conditions at the time of sampling resulted in very low or no flow conditions in many cases or unreliable information in others. This prevented successful determination of consistent flow quantities. As a result, this data was not used in preparation of the SWM model nor for calibration.

A hydrological model using SWMM5 was used to calculate surface water runoff and peak flows in the area of the proposed CRRRC under existing conditions, using 2, 5, 25 and 100 year design storms as set out in O.Reg. 232/98 (MOE, 1998).

Precipitation conditions on-Site are represented by the record from Environment Canada's Ottawa CDA RCS meteorological station. The station is located approximately 20 km northwest of the Site at 45°23'N 75°43'W and an elevation of 79 masl. Rainfall depths for 24-hour storms were extracted from the Ottawa short duration rainfall Intensity-Duration-Frequency (IDF) data. Total precipitation depths for 24-hour rainfall events used in the hydrologic assessment are provided in Attachment A.3.

The collection, conveyance and detention of runoff through the Site were modelled. The modelling data denotes the extent of knowledge on the quantity of surface runoff water from the Site. The values from the hydrological modelling are presented in Table 1.

Table 1: Estimated Pre-Development Peak Flow Rates

Peak Flow (L/s)				
24 Hour Design Storm				
Sub-Catchment Area	**1:2 Year**	**1:5 Year**	**1:25 Year**	**1:100 Year**
Regimbald (northern)	86	298	471	538
Simpson (central)	35	284	585	732
Wilson-Johnston (southern)	40	345	715	898

The Regimbald sub-catchment experiences the highest peak flows for the 1:2 year event, while the Wilson-Johnston Drain experiences the highest peak flows in all the other design storm events.

3.3 Water Quality

3.3.1 Monitoring Stations

Surface water monitoring stations for the CRRRC have been established since December 2012 and a number of monitoring events have been conducted to establish the existing surface water quality conditions on-Site and in the immediate downstream waterways. Originally there were seven stations (BSW1 to BSW7), with an eighth (BSW8) and ninth (BSW9) added in spring and fall 2013, respectively. Surface water monitoring station locations are shown on Figure 1. Water was not collected and sampled at all stations as some were dry at the time of sampling. A summary of the monitoring locations and sampling sessions is presented in Table 2, with an 'X' denoting when samples were collected.

Table 2: Summary of Surface Water Monitoring

Surface Water Monitoring Stations	Location	Dec-12	May-13	Jul-13	Oct-13	Nov-13	Dec-13
BSW-1	Southern Site discharge at Frontier Road	X	X	X	X	X	-
BSW-2	Discharge of Simpson Municipal Drain at Frontier Road	X	X	X	X	X	-
BSW-3	Northern Site discharge at Frontier Road	X	X	X	X	X	-
BSW-4	Simpson Municipal Drain at western limit of Site	X	X	X	X	X	-
BSW-5	Northern ditch upstream limit	Dry	X	X	X	X	-
BSW-6	Shaw's Creek at Sand Road	X	X	X	X	X	-

Surface Water Monitoring Stations	Location	Dec-12	May-13	Jul-13	Oct-13	Nov-13	Dec-13
BSW-7	Shaw's Creek at Frank Kenny Road	X	X	X	X	X	-
BSW-8	Drainage Ditch south of Highway 417, East of Site, North of Devine Road	-	X	X	X	X	-
BSW-9	417 Auto Parts property ditch	-	-	-	-	X	X

The purpose of each monitoring location is to provide a representative indication of the water quality for a reach of waterway.

BSW-1 is positioned to represent data of water conditions in the on-Site tributary eventually outletting to the Wilson-Johnston Municipal Drain section just before the ditch crosses the property boundary to the east. This data can be compared to downstream data to identify any differences between the water qualities. BSW-2 represents the discharge from the Simpson Municipal Drain at Frontier Road and has a similar purpose to BSW-1 for the Simpson Municipal Drain. BSW-3 also serves a similar purpose for the northern ditch that discharges to the Regimbald Municipal Drain. BSW-4 is located near the west entry point of the Simpson Municipal Drain and provides data of water quality entering the Site. BSW-5 is located at the west end of the on-Site ditch that discharges into the Wilson-Johnston Municipal Drain, and serves a similar purpose to BSW-4. BSW-6 and BSW-7 monitor segments of Shaw's Creek at Sand Road and Frank Kenny Road, respectively. BSW-8 represents water quality in the ditch that eventually discharges into the Wilson-Johnston Municipal Drain before it is joined by discharge from the Regimbald and Simpson Municipal Drains. BSW-9 is used to establish baseline water quality in the ditch (moat) around the 417 Auto Parts Yard.

Surface water characteristics for the greater watershed area were also obtained from the City of Ottawa, Water Environmental Protection Program (WEPP) study (City of Ottawa, 2014)for the area. Bear Brook water quality data is used to characterize the larger downstream watercourse for which the sub-watershed is named.

3.3.2 Historical Trends

Historical trends for the region were inferred from the City of Ottawa WEPP (City of Ottawa, 2014).

Water quality monitoring information for Bear Brook Creek is available from the City of Ottawa WEPP (City of Ottawa, 2014). Water level information is available from the HYDAT (HYDAT: Environment Canada, 2010).

The City of Ottawa WEPP (City of Ottawa, 2014) sampled in various locations of the Bear Brook Creek Watershed, including a location near Carlsbad Springs, just north of the Site.

The water quality in the Bear Brook Creek is reflective of the rural, agricultural population in its vicinity. According to the 2008 to 2014 data from the City of Ottawa WEPP (City of Ottawa, 2014), 0% to 44% of the phosphorus, E. coli and copper water quality samples meet provincial and federal targets and 95% to 100% of the zinc samples meet provincial and federal targets.

3.3.3 Existing Conditions

Surface water monitoring was conducted in December 2012, May 2013, July 2013, October 2013, November 2013 and December 2013. Samples were analyzed for a comprehensive list of parameters. A summary table containing the sample results and analyzed parameters is provided in Attachment B.

Many samples were found to have elevated levels of phosphorus and iron. A single sample, BSW-3 in December 2012 detected elevated copper levels (6.9 µg/L), which was not detected in subsequent sampling sessions. An exceedance of the chromium PWQO occurred one time at location BSW4 during the November 2013 sampling session. Elevated phosphorus levels (observed between 17 µg/L and 140 µg/L), were relatively consistent for all stations. This is expected due to the mainly agricultural land use in the area and the accompanying fertilizer use. Iron levels were observed within the range of 110 µg/L and 3,100 µg/L for the majority of the stations. Phenolics were detected at elevated levels in the fall 2013 sampling session for each station (with the exception of BSW-8). An additional winter 2013 sampling session was added to the monitoring program to confirm these results. Concentrations of phenols exceeded the PWQO at locations BSW1, BSW2, BSW3, BSW5, BSW8 and BSW9 only during the winter 2013 session.

Two reaches can be analyzed based on the locations of the stations. Ordered from upstream to downstream, BSW-4, BSW-2, BSW-6, and BSW-7 are located along the Simpson Municipal Drain and Shaw's Creek watercourse reach. BSW-5, BSW-1, and BSW-8 are located along the ditch discharging to the Wilson-Johnston Municipal Drain and Shaw's Creek.

A comparison of stations upstream and downstream of drainage ditches that cross the Site reveals decreases of phosphorus levels, and improving dissolved oxygen levels downstream of the Site. Iron levels were observed to decrease along the Wilson-Johnston Municipal Drain to Shaw's Creek reach, but they also increased along the Simpson Municipal Drain and Shaw's Creek reach.

The existing conditions established from the surface water monitoring are intended to act as a baseline for future monitoring, but were also used to assist with the consideration of leachate treatment options, including on-Site treatment and discharge to surface water.

4.0 ASSESSMENT OF POTENTIAL EFFECTS ON SURFACE WATER

The aspects of surface water examined in the assessment are surface water quantity and surface water quality. The post-development model results were compared to the pre-development results, with consideration of proposed mitigation systems, to determine the "net effects" of the proposed CRRRC.

The objectives of the SWM design are to:

1) Control post-development stormwater discharges from the Site to the three Municipal Drains at or below pre-development rates, for the 1 in 2 year to 1 in 100 year design storm events;

2) Minimize sediment loading in runoff leaving the Site during and post-construction, to adhere to the MOECC Guidelines for Enhanced Level of treatment (80% Total Suspended Solids (TSS) removal) or greater (MOE, 2003); and,

3) Maintain Site runoff water quality at or above Site water quality standards.

The SWM design criteria for the Site to meet the above objectives are set out in following:

- The City of Ottawa, Stormwater Control Quantity and Surface Water Quality Policies (City of Ottawa, 2009).
- O.Reg. 232/98 for Landfilling Sites (MOE, 1998).
- The Ontario MOECC SWM Pond sizing guidelines for impervious area percentages to achieve TSS removal objectives (MOE, 2003).

Table 3 below summarizes the SWM criteria presented in this design report.

Table 3: Site SWM Design Criteria

Criterion	Description	Target
Peak Runoff Control	1 in 2 year to 1 in 100 year runoff events	Post-development peak flows at/below pre-development
Conveyance Capacity	Internal drainage ditches, storm sewers and conveyance structures Continuous overland flow route	Design Capacity to accommodate 1 in 25 year design storm Convey the peak flow from the 1 in 100 year design storm
Stormwater Water Quality	Total Suspended Solids (TSS)	Enhanced level of treatment (80% TSS removal) (MOE, 2003)

4.1 Surface Water Quantity

Since the proposed project has the potential for effects on surface water management, predicted impacts were assessed with consideration of mitigation measures. Several mitigation measures are incorporated into the conceptual Site design to manage surface water quantity and minimize potential off-Site impacts. Mitigation options were explored by routing runoff to different outlets in the SWMM5 model, and used to predict changes in water quantity.

As previously discussed, there are three main drainage areas on-Site that convey drainage off-Site.

4.1.1 Predicted Changes in Drainage Areas

The post-development conditions scenario considers the Site layout for the ultimate build-out of the CRRRC facilities, the landfill final cover, and the SWM controls shown on Figure 3.

The three Site sub-catchment drainage areas and corresponding land uses for the proposed ultimate build-out state of the Site, and the technical details of the proposed SWM controls for each sub-catchment are described below in more detail. Figure 4 shows individual sub-catchments for each SWM Pond.

The SWMM5 schematic illustrating the proposed routing of post-development Site drainage is provided in Attachment A.2, Figure A-2. The sub-catchment areas on Figure A-2 are shown on Figure 4.

Regimbald Municipal Drain

The proposed northern Regimbald Municipal Drain, sub-catchment area will increase by 3.3 ha, to a total sub-catchment area of 24.3 ha. The proposed grading and servicing plans route the drainage from this part of the CRRRC facility area to the two cell SWM/Fire Ponds. This post-development Site sub-catchment area includes buildings, parking areas, roadways, stockpile areas, preserved existing and/or landscaped green space, and the two SWM/Fire Pond cells (Ponds 5a and 5b) located in the central area of this sub-catchment.

Simpson Municipal Drain

The proposed Simpson Municipal Drain post-development total sub-catchment area of approximately 83.8 ha increases from existing conditions by approximately 8.2 ha.

This post-development drainage area is proposed to control runoff via a pond northwest and northeast of the Simpson Drain (Ponds 3, 4a and 4b), and one pond southwest of the drain (Pond 1). The area north of the Drain will include pads for the composting operations and soil treatment facilities, buildings, roadways and leachate storage ponds. The area south of the Simpson Drain will include the northwest segment of the landfill.

Wilson - Johnston Municipal Drain

The post-development final build-out sub-catchment area to the Wilson-Johnston Drain will decrease by approximately 11.5 ha, from 95.1 ha to 83.6 ha. This area will include approximately two-thirds of the landfill area and will include one long pond located along the southern and eastern sides of the Site.

A summary of existing and proposed drainage areas is presented in Table 4.

Table 4: Existing and Proposed Drainage Areas

Site Municipal Drain Sub-catchment	Area (ha)	
	Existing	**Proposed**
Regimbald	21.0	24.3
Simpson	75.6	83.8
Wilson-Johnston	95.1	83.6
Total Site	***191.7***	***191.7***

The total drainage area is not expected to change. The Regimbald Municipal Drain still has the smallest drainage area, and the Simpson and Wilson-Johnston Municipal Drains will have identically sized drainage areas.

4.1.2 Predicted Effects on On-Site Flows

The ditches within the Site are designed to convey stormwater to the SWM Ponds, or eastern Site boundary culverts directly, as shown on Figures GD1 and GD2 in Attachment C. Three types of channels (ditch, SWM Pond inlet, or outfall channels and spillways) have been designed considering the slope along with the peak flow and corresponding velocity computed for a 1 in 25 year design storm. Based on the functionality of the channels, with consideration of peak velocity results, these conveyance features have been designed with two types of surface treatment: rip-rap lined, or vegetated ditches. Conveyance channel design details are outlined in Section 5.2.

Post-closure conditions are used for the surface water quantity assessment as the entire Site will be contributing to Site runoff when the landfill component has been capped. In order to minimize potential for nuisance flooding during minor storm events, and property damage during major events, the ponds have been designed for the 1:100 year storm event.

Peak flow rates were extracted from the SWMM5 model for pre- and post-development conditions. Under the post-development scenario, the increase in respective impervious land use and average slopes for the sub-catchment areas are expected to generate increased runoff conditions.

The model identified that the calculated post-development peak flows at all Site outlet locations exceeded pre-development peak flow conditions. The model was then updated to include SWM Ponds (storage reservoirs). Table 5 below compares the pre-development and controlled, post-development peak flows for each Site sub-catchment area.

Table 5: Pre- and Post-Development Peak Flow Rates Comparison

Municipal Drain Sub-Catchment		Drainage Areas (ha)		Peak Discharge to Municipal Drains (L/s)							
				1:2yr		1:5yr		1:25yr		1:100yr	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	Regimbald	21	24.3	86	38	298	195	471	336	538	455
2	Simpson	75.6	83.8	35	13	284	251	585	549	732	617
3	Wilson-Johnston	95.1	83.6	40	25	345	338	715	580	898	675

These SWMM5 peak flows, generated from local IDF curves over a 24 hour period using the SCS type II distribution, are conservative for the purposes of recommending the approximate SWM Pond sizes to meet storage volume requirements to manage peak flows without flooding (James, 2003).

4.1.3 Predicted On-Site Runoff Flow Volumes

Climate normals were used to estimate annual water budget comparisons for the existing and proposed Site conditions. Results from the existing Site condition water budget are provided in Table 6. Results from the post-development Site condition water budget are provided in Table 7. The values in both Tables 6 and 7 represent the average annual water budget values for the Site, based on the Environment Canada (1940-2011) record from Ottawa International Airport meteorological station No. DC20492 (located 24 km northwest of the Site (Environment Canada, 1940-2011).

Table 6: Existing Conditions Water Budget

Municipal Drain Sub-catchment	Average Annual Volumes			
	Area (ha)	**Surplus (m^3/yr)**	**Runoff (m^3/yr)**	**Infiltration (m^3/yr)**
Regimbald	21.0	81,340	63,000	18,340
Simpson	75.6	270,430	196,790	73,640
Wilson-Johnston	95.1	334,850	245,940	88,910
Total	***191.7***	***686,620***	***505,730***	***180,890***

Table 7: Proposed Conditions Water Budget

Municipal Drain Sub-catchment	Average Annual Volumes			
	Area (ha)	**Surplus (m^3/yr)**	**Runoff (m^3/yr)**	**Infiltration (m^3/yr)**
Regimbald	24.3	100,510	94,660	5,850
Simpson	83.8	308,170	254,030	54,140
Wilson-Johnston	83.6	273,450	194,470	78,980
Total	***191.7***	***682,130***	***543,160***	***138,970***

Due to the proposed changes in land use, the overall Site is expected to see a decrease in annual infiltration and a corresponding increase in annual runoff. Also, shifting of drainage area boundaries at the sub-catchment levels is expected to result in larger changes when compared to pre-development conditions. The Regimbald sub-catchment area is increased, which results in an increase in runoff and a decrease in infiltration. A similar scenario is expected for the Simpson sub-catchment area with an expected increase of approximately 30%. Since the Wilson-Johnson sub-catchment is proposed to be reduced in area, the runoff is expected to decrease by approximately 20%; the expected annual infiltration will also decrease.

Since all drainage originating from the CRRRC Site combine at Shaw's Creek, any impacts associated with post-development drainage will be primarily limited to the sections of ditches immediately downstream of the Site.

4.1.4 Predicted SWM Pond Water Levels

The proposed SWM Ponds are typically set to have a permanent pool elevation at approximately 0.5 metres below existing grade so that the water level is similar to the existing Site groundwater elevations. The ponds typically include 1.5 metres of permanent pool and 1.5 – 2.0 metres of active retention capacity. Drawings of the proposed ponds are provided in Attachment C. The predicted maximum water elevations in the proposed SWM Ponds under the design storm events are shown in Table 8.

Table 8: Predicted SWM Pond Water Levels

SWM Pond	Pond Level	Maximum Water Level (m)							
		1-2yr		1-5yr		1-25yr		1-100yr	
	NWL (masl)	Depth (m)	Water Level (masl)	Depth (m)	Water Level (masl)	Depth (m)	Water Level (masl)	Depth (m)	Water Level (masl)
1	76.00	1.99	76.14	2.45	76.6	2.89	77.04	3.12	77.27
2	75.35	1.62	75.47	2.08	75.93	2.19	76.04	2.22	76.07
3	75.50	1.96	75.96	2.64	76.64	2.8	76.80	2.86	76.86
4a	varies	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4b	75.25	1.95	75.7	2.42	76.17	2.66	76.41	2.78	76.53
5a	75.75	1.61	76.06	2.01	76.46	2.19	76.64	2.22	76.67
5b	75.75	1.39	75.84	1.48	75.93	1.55	76.00	1.59	76.04

Notes:
1. NWL – Normal Water Level, at lowest hydraulic control outlet invert.
2. Water Level is water surface above the normal water level

4.2 Surface Water Quality

Stormwater quality control will be provided for the Site to remove a minimum of 80% TSS loading (Enhanced Level Treatment (MOE, 2003)) for each of the three sub-catchment systems. Table 9 presented in Section 4.2.1 outlines the extended detention requirements and storage volumes provided for each sub-catchment, to meet the MOECC Enhanced 80% TSS long-term removal efficiency target based on the prescribed extended detention volume per ha for impervious land use area from the Stormwater Planning and Design Manual (MOE, 2003). Figure A-7 in Attachment A.4 shows that the extended detention drawdown time for SWM Ponds 1 to 5 is approximately 24 hours, considering the 25 millimetre City of Ottawa design storm event.

To improve the settling of TSS within the permanent pool, SWM Ponds 1, 2, 3, and 4b will be constructed with a forebay equal to approximately 1/5 of the width and length of the pond bottom. Due to the long, linear nature of most of the SWM Ponds, some of the runoff entering the ponds will bypass the forebays. To assist with removal of TSS, it is proposed that much of the runoff for these areas be promoted to enter the ponds as sheet flow across vegetated buffer areas adjacent to the ponds. To avoid re-suspension of accumulated sediments and flushing of the ponds during major storm events exceeding the 1 in 100 year event, a pond bypass/overflow would convey excess flow to the outlet.

4.2.1 Predicted Effect on Surface Water Quality

During the operational/construction phase of the project, ditches and swales at the perimeter of unvegetated portions of the Site will be protected from potential runoff containing suspended solids through the use of temporary berms and silt fences. Perimeter ditches along the completed and capped areas will divert runoff through grass lined swales to the SWM Ponds.

The ponds and the swales will serve to remove suspended sediment from the runoff, and prevent significant outflows that could potentially impair the water quality in downstream watercourses in extreme events.

In the post-closure phase of the Site, finalized perimeter ditches along the outer berm of the landfill footprint will capture and direct runoff from the landfill surface and will continue to direct the water via grass lined swales or ditches to the SWM Ponds. As described earlier, the SWM Ponds on-Site are designed for Enhanced protection levels (MOE, 2003).

During operational phases of the northern diversion facilities or the landfill, drainage features will be implemented to keep potentially contaminated runoff separate. Drainage around the active face of the landfill will be directed to the landfill leachate collection system. Pond 4a will be a two celled storage pond dedicated to receive runoff from the proposed compost pad area. One cell will be dedicated to receive runoff from final curing areas of the pad while the other will be for runoff from the remainder. This pond is sized to contain runoff equivalent to 110% of a 1:25 year, 24 hour event for the pad area, without discharge to off-Site surface water. The stored water within the pond cells will be managed to maintain adequate capacity by re-using the water from the appropriate cell for compost pile spraying and Site irrigation. To ensure Site irrigation is a viable option, water quality samples from both cells of Pond 4a will be collected for analysis during the demonstration phase of the organics processing facility. Should water quality be such that Site irrigation is not possible, surplus water from Pond 4a would be taken to the City of Ottawa wastewater treatment plant with the pre-treated wastewater from the Site.

The proposed works are predicted to result in surface water quality conditions that are comparable to existing conditions and meet MOECC Provincial Water Quality Objective (PWQO) (MOE, 1994). Post-closure, the ponds will continue to operate to ensure surface water quality downstream of the Site remains protected.

Table 9 outlines the permanent pool storage volumes required and provided for each SWM Pond and the corresponding Site sub-catchment area. The volumes provided for Ponds 5a and 5b far exceed the volumes required as these ponds will also provide storage for firefighting, assuming ice cover of 0.6 metres.

Table 9: Permanent Pool SWM Pond Volumes for Enhanced Level Treatment

Storage	Required Storage Volume per unit Area (m^3/ha)	Required Storage Volume of SWM Pond (m^3)	Volume Provided by SWM Pond (m^3)
Regimbald Municipal Drain Sub-Catchment			
SWM/Fire Pond 5a (contributing sub-catchment area = 14.74 ha)			
Permanent Pool	185	2,730	13,020
SWM/Fire Pond 5b (contributing sub-catchment area = 9.48 ha)			
Permanent Pool	185	1,760	8,680
Simpson Municipal Drain Sub-Catchment			
SWM Pond 1 (contributing sub-catchment area = 48.18 ha)			
Permanent Pool	100	4,280	4,420
*SWM Pond 3 (contributing su*b-catchment area = 11.30 ha)			
Permanent Pool	150	1,700	1,730
SWM Pond 4b (contributing sub-catchment area = 16.3 ha)			
Permanent Pool	173	2,830	2,910
Wilson-Johnston Municipal Drain Sub-Catchment			
SWM Pond 2 (contributing sub-catchment area = 83.62 ha)			
Permanent Pool	100	8,360	10,650

Notes:

1. Additional 40m^3/ha provided as active pond storage.
2. Impervious Levels: 70% considered for SWM Ponds 5a & 5b; 65% for SWM Ponds 4a and 4b; 55% for SWMP 3; and 35% for SWM Ponds 1 and 2.s

5.0 STORMWATER MANAGEMENT DESIGN

Design drawings for the Site grading and proposed stormwater control works are required to support EPA (MOE, 2010)/OWRA (MOE, 2011) approvals. The stormwater infrastructure consists of:

- SWM Ponds;
- Conveyance Channels (Ditches, Spillways, Outfall Channels); and,
- Culverts.

The drawing set is attached in Attachment C and includes drawings of the SWM Ponds, typical sections of the conveyance features, and typical details of berms, along with a grading plan, and erosion and sediment control information. The following sections summarize the detailed design of the SWM and conveyance features for the Site.

Throughout the course of the Site development, the phased construction of the landfill area will be conducted such that any contact-runoff is contained within the limit of the proposed waste footprint, through a series of berms. Buffer zones of existing and constructed vegetation screening will be maintained. Erosion and Sediment Control (E&SC) measures, including perimeter silt fencing, will also be installed and maintained between the vegetation screening area and the perimeter road during the phased construction of the landfill.

5.1 SWM Pond Design

The SWM Pond design plans, sections and details are included in Attachment C. A summary of the SWM Pond dimensions and capacities for each feature is outlined in Table 10 below.

Table 10: SWM Pond Design Information

SWM Pond	Perm. Pool Volume (m^3)	Extended Detention Storage Volume (m^3)	Total Pond Volume[1] (m^3)	Pond Bottom Invert[2] (masl)	Top of Berm Elev. (masl)	Depth of Pond[2] (m)	Outlet Control		
							Type	Dia. (mm)	Invert Elev. (masl)
1	4,420	10,420	14,840	74.15	77.15	3.0	Culvert	1,000	75.65
2	10,650	48,560	59,210	73.85	76.85	3.0	Orifice; Culvert	500; 1,000	75.35; 75.85
3	1,730	3,400	5,130	74.0	77.0	3.0	Culvert	600	75.50
4a	N/A	N/A	4,530	73.85	76.75	2.9	N/A	N/A	N/A
4b	2,910	9,220	12,130	73.75	76.75	3.0	Culvert	750	75.25
5a	13,020	22,940	35,960	74.20	77.25	3.05	Culvert	600	75.75
5b	8,680	15,980	24,660	73.85	77.25	3.4	Culvert	600	75.75

Notes:
1. Total pond volume does not include additional freeboard volume to top of berm.
2. Depth of pond includes additional 0.25 m of freeboard between the outfall spillway weir and the top of berm.

5.2 Conveyance Channels

The ditches within the Site are designed to convey stormwater to the SWM Ponds, or eastern Site boundary culverts directly, as shown on Grading and Drainage Plans GD1 and GD2.

The three types of channels (ditch, SWM Pond inlet or outfall channels, and spillways) have been designed, considering the slope, along with the peak flow and corresponding velocity computed for a 1 in 25 year design storm. Based on the functionality of the channels, with consideration of peak velocity results, these conveyance features have been prescribed with two types of surface treatment: rip-rap lined, or vegetated ditches.

Summaries of both types of ditches, along with the rip-rap lining and associated geotextile fabric specifications for a few prescribed locations at the outlets of the conveyance features are outlined below. Typical details and slopes for channels are provided on Design Drawings GD1, GD2 and P1 (Attachment C).

Perimeter Vegetated Ditches

The perimeter ditches around the landfill boundaries are proposed to be grass lined. These perimeter ditches will be trapezoidal with a 0.5 metre bottom width, a 7H:1V sideslope on the landfill side and a 3H:1V sideslope on the outer side. Slopes will be approximately 0.30%, respecting the proposed topography, and will have a minimum depth of 0.5 metres.

Interior Ditches – Facility Operations Area

Most of the interior ditches will be trapezoidal with a 1.0 metre bottom width, 4H:1V side slopes, and will have a maximum depth of 0.5 metres. The longitudinal slopes of these ditches vary with a minimum of 0.15%, respecting the existing topography.

Inlet, Outlet and Spillway Channels with Rip-Rap Lining

Pond inlet conveyance channels, overflow spillways or outfall channels experience high erosive forces. To provide effective energy dissipation and minimize erosion potential from the 1 in 25 year design storm, and any larger major events (e.g. 1 in 100 year storm), it is proposed these channels be lined with rip-rap and annual maintenance and repair practices be followed.

The thickness of the rip-rap layer is to be a minimum of 1.5 times the rip-rap nominal diameter. The mean diameter for the rip-rap stone was selected to have nominal diameter of 200 millimetres.

Reversed slope outlet pipes will be used for stormwater management ponds that receive drainage from vehicle parking areas. Geotextile Fabric

A geotextile fabric will be required beneath rip-rap areas, and is recommended to be extended three to five channel widths downstream to mitigate any scour potential. The fabric is required to be "keyed in" 200 mm from the crest of the ditch as indicated in the Ontario Provincial Standard Drawing 219.211 (MTO, 2006).

5.3 Culvert Design

All of the culverts on-Site have been designed to convey the 1 in 25 year, 24 hour storm event and will be located beneath existing roadways. The culvert structural design and cover depths will be confirmed prior to procurement. Minimum culvert diameter will be 600 millimetres.

6.0 MONITORING, OPERATION AND MAINTENANCE

The inspection of E&SC measures during construction should occur on a weekly basis, at minimum. E&SC inspection during construction should also occur after significant rainfall events (e.g., greater than approximately 10 mm). An inspection report, highlighting any E&SC deficiencies, should be prepared for each inspection and kept on-Site for reference and reporting purposes, if needed (GGHA CAs, 2006).

Visual inspections of SWM or water conveyance features should be performed post-construction on a quarterly (seasonal) basis to ensure sediment build-up has not caused any conveyance capacity issues or potential for an increase in TSS loadings transported downstream. During rainfall-runoff events, visual observations will continue to support the post-development runoff assessment and the successful performance of the SWM Ponds in meeting Enhanced Level of treatment (MOE, 2003).

At minimum, the following should be observed during inspections:

- Signs of erosion of the SWM structures. This is important particularly before the re-vegetation cover has been established;
- Sediment build-up in the swales. For any retention controls (i.e., rock check dams, sediment traps), sediment build-up can be expected at the upstream end of these structures and therefore the stormwater conveyance channels should be inspected on a regular basis and cleaned out periodically to avoid sediment deposits being transported off-Site. Clean-out is recommended to occur once sediment accumulation is clearly visible (GGHA CAs, 2006). In practical terms, clean-out of the rock check dams is recommended if the build-up is greater than one-half the height, from the toe to the spillway. Sediment should be removed in a matter that avoids escape of the sediment downstream and that avoids damage to the control structure. Sediment should be removed to the level of the grade existing at the time the control structure was constructed;
- Ponding in the swales or sediment traps; and,
- Silt fencing. All silt fences used for E&SC should meet required minimum height of 0.6 m. They should be repaired or replaced if damaged.

Environmental monitoring related to surface water at the CRRRC will be carried out concurrently with the overall Site monitoring program. As such, reference should be made to the overall facility D&O report for monitoring, trigger mechanisms and contingency measures related to surface water, sediment and biology.

7.0 CLOSURE

We trust that this report meets your current needs. If you have any questions, or if we may be of further assistance, please contact the undersigned.

GOLDER ASSOCIATES LTD.

Steve Auger, M.Sc., P.Eng., C.P.E.S.C.
Water Resources Engineer, Technical Advisor

Douglas V. Kerr, P.Eng.
Civil Engineer, Associate

DLKH/DVK/PAS/sg
n:\active\2012\1125 - environmental and civil engineering\12-1125-0045 crrrc ea eastern on\phase 4500_final_easr\vol 4 - d&o\appendices\app a_stormwater\12-1125-0045 crrrc swm 5dec2014.docx

REFERENCES

City of Ottawa. (2009). *Infrastructure Master Plan.* Ottawa: City of Ottawa, Publication 23-20.

City of Ottawa. (2014). *Water Environment Protection Program (WEPP): Water Quality in Ottawa's Rivers and Streams. 2008 to 2014 water quality data from Bear Brook Creek. Public Works, City of Ottawa.*

City of Ottawa. (2014). *Water Environment Protection Program (WEPP): Water Quality in Ottawa's Rivers and Streams. 2008 to 2014 water quality data from Bear Brook Creek. Public Works, City of Ottawa.*

Environment Canada. (1940-2011). *1940-2011 Climate Normals: Ottawa MacDonald-Cartier International Airport. Government of Canada.* Retrieved June 25, 2012, from http://climate.weather.gc.ca/climateData/monthlydata_e.html?timeframe=3&Prov=ONT&StationID=4337&dlyRange=1938-11-01|2011-12-14&Year=1940&Month=1&Day=1

GGHA CAs. (2006). *Erosion and Sediment Control Guideline for Urban Construction.*, 1-30, Appendices A-F. Greater Golden Horseshoe Area Conservation Authorities.

Golder. (2013). *Phase II Environmental Site Assessment - Pomerleau Land - Portion of 5455 Boundary Road, Ottawa, Ontario.* Kanata, Ontario: Golder - July 2013.

HYDAT: Environment Canada. (2010). *National Water Data Archive: Hydrometric Database: Bear Brook Near Bourget (02LB008).* Retrieved January 25, 2013, from http://www.wsc.ec.gc.ca/applications/H2O/graph-eng.cfm?yearb=&yeare=&station=02LB008&report=daily&data=flow&year=2010

James, B. (2003). Rules for Responsible Modelling. *Rules for Responsible Modelling*. Guelph, Ontario, Canada: Computational Hydraulics International, 3rd edition, Pages 1-278.

MOE. (1994). *Water Management Policies Guidelines Provincial Water Quality Objectives (PWQO) of the Ministry of the Environment and Energy.* Last Updated: 1999.

MOE. (1998). *Landfilling Sites. Ontario Regulation 232/98.* Last Updated: June 2011.

MOE. (1998). *Landfill Standards: A Guideline on the Regulatory and Approval Requirements for New or Expanding Landfilling Sites*. Toronto, Ontario, Canada: Queen's Printer for Ontario 2010. Last Updated: January 2012.

MOE. (2003). *Stormwater Planning and Design Manual. Government of Ontario. Queen's Printer for Ontario. ISBN 0-7794-2969-9.* Retrieved September 23, 2013, from http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079721.pdf

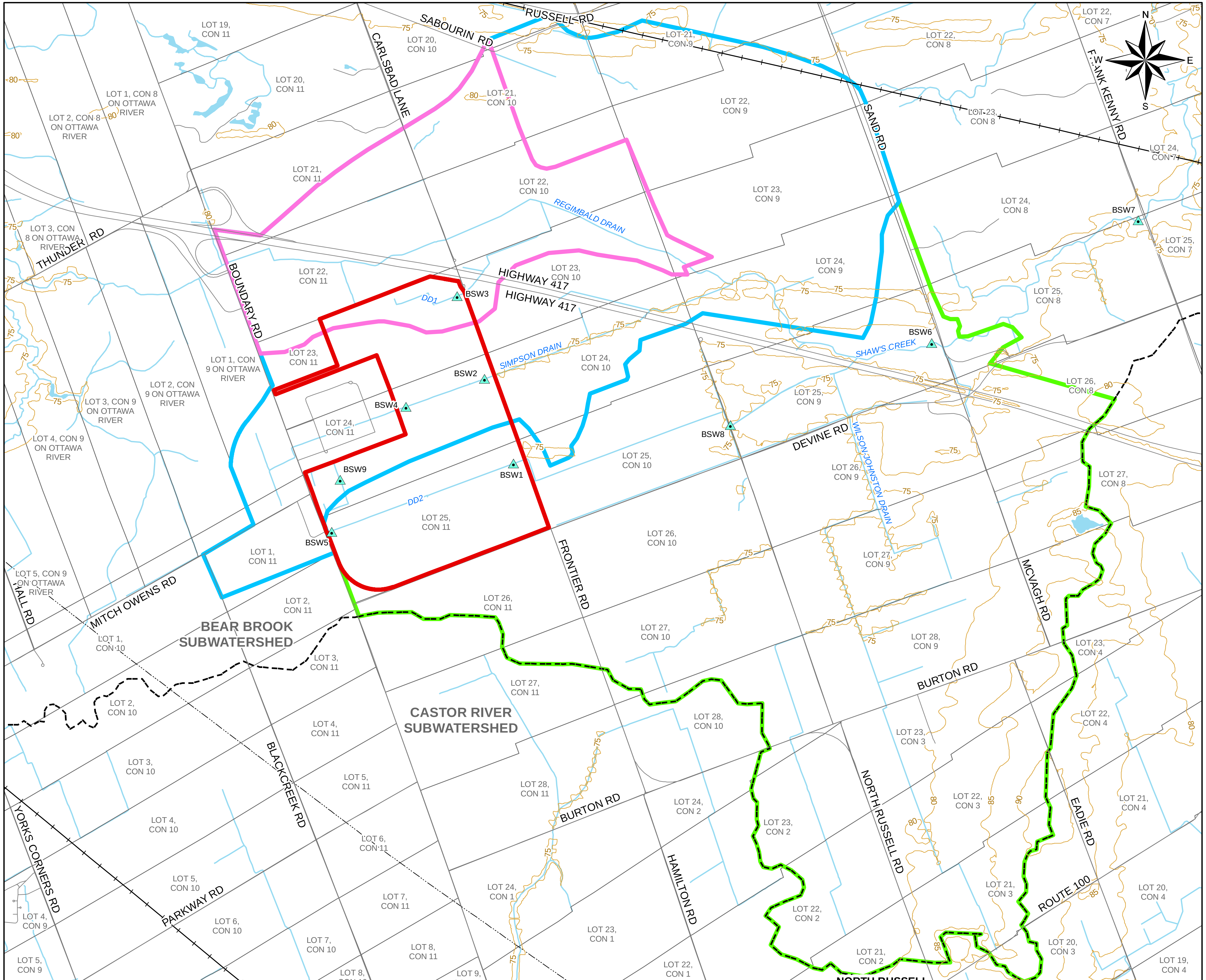
MOE. (2010). *Environmental Protection Act.* Last Updated: 2010.

MOE. (2011). *Ontario Water Resources Act*. Last Updated: 2011.

MTO. (2006). *Ontario Provincial Standards for Roads and Public Works: Temporary Rock Flow Check Flat Bottom Ditch of Channel, OPSD 219.211.*

Stantec. (2000). *Township of Cumberland Municipal Drain & Mutual Agreement, Stantec, Revised March 2000.*

US-EPA. (2008). *Stormwater Management Model User's Manual - Version 5.0. Lewis A. Rossman - Water Supply and Water Resources Division, National Risk Management Research Laboratory.*, 1-152, plus Appendices. Cinicinnati, OH 45268.



LEGEND

- POPULATED PLACENAME
- SURFACE WATER SAMPLING STATION
- ROAD
- RAIL ROAD
- CONTOUR LINE, (5m)
- UTILITY LINE
- REGIMBALD MUNICIPAL DRAIN BOUNDARY
- SIMPSON MUNICIPAL DRAIN BOUNDARY
- WILSON-JOHNSTON MUNICIPAL DRAIN BOUNDARY
- SURFACE WATER FEATURE
- WATER AREA
- SUBWATERSHED DIVIDE
- LOT/CONCESSION
- PROPERTY BOUNDARY

500 250 0 500

SCALE 1:25,000 METRES

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT.

REFERENCE

LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2012.
PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

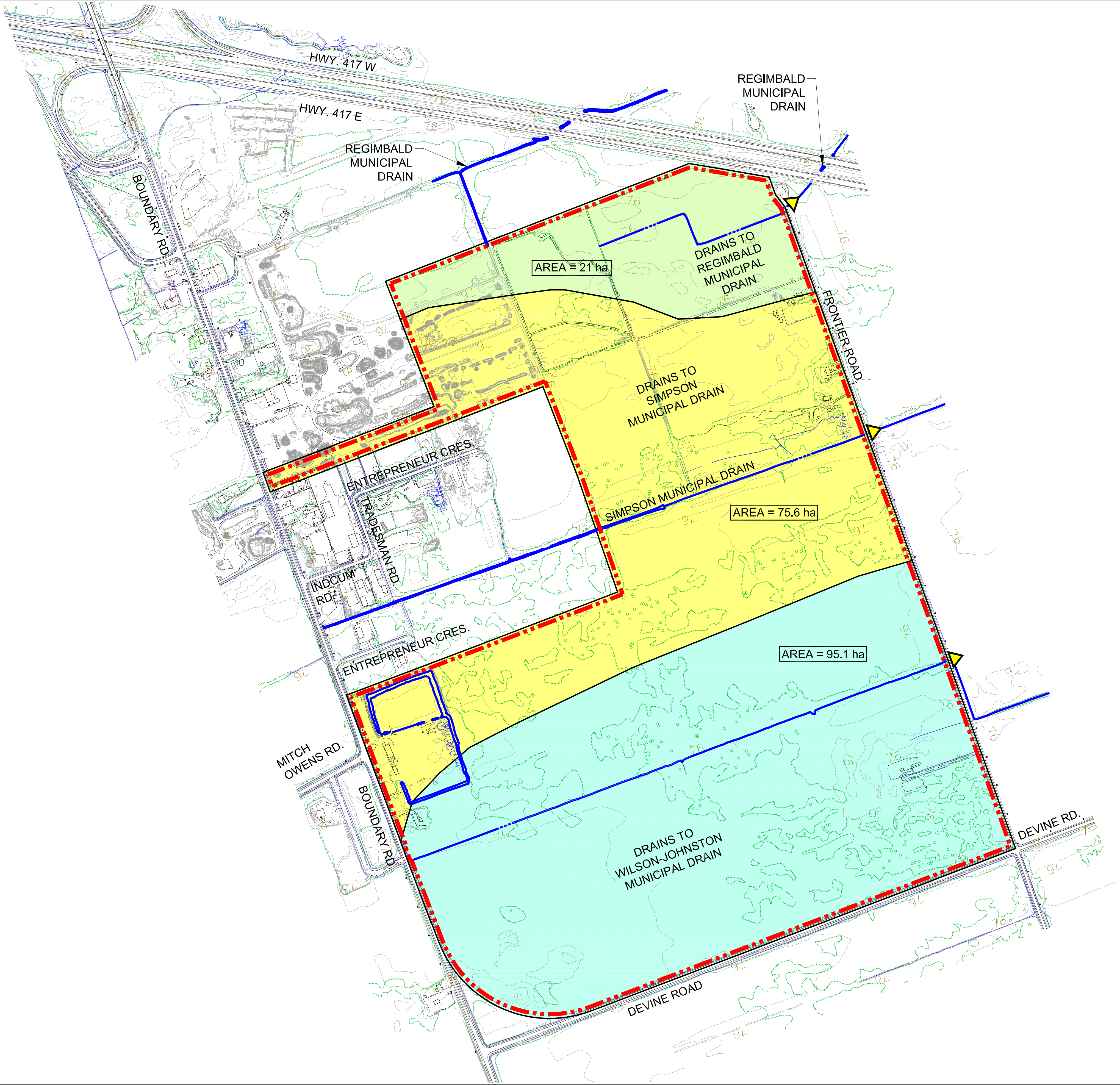
TITLE

SURFACE WATER SAMPLING STATIONS AND SURFACE WATER FEATURES

Golder Associates

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV. 0
DESIGN	JPAO	NOV. 2013	FIGURE 1	
GIS	BR	DEC. 2013		
CHECK	PLE	AUG. 2014		
REVIEW	PAS	AUG. 2014		

Path: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\12-1125-0045\Working\Phase4000\Task0120_GHandG\1211250045-4000-0120-01-SurfWaterSamplingStations.mxd



LEGEND:

- PROPERTY BOUNDARY
- SURFACE WATER
- OUTLET
- DRAINAGE AREA BOUNDARY

NOTE

1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

REFERENCES:

1. BASE DRAWING PROVIDED IN A DIGITAL FORMAT BY BASE MAPPING CO. LTD., CONTRACT No. 2517-12, PHOTO DATE: NOVEMBER 7, 2012, DATE RECEIVED: JANUARY 9, 2013.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18.
3. MUNICIPAL DRAIN BOUNDARIES FROM TOWNSHIP OF CUMBERLAND MUNICIPAL DRAIN & MUTUAL AGREEMENT PREPARED BY STANTEC, REVISED MARCH 2000.

200 0 200 400

SCALE 1:10,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

PRE-DEVELOPMENT DRAINAGE AREAS

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045
DESIGN	D.H.	Nov. 2013
CAD	M.L.F.	Nov. 2013
CHECK	D.V.K.	Aug. 2014
REVIEW	P.A.S.	Aug. 2014

FILE No.1211250045-V4-Storm-Fig 2.dwg

SCALE AS SHOWN REV. 0

FIGURE No.

2

PLOT DATE: September 5, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 4 (Report Figures)\Storm\1211250045-V4-Storm-Fig 2.dwg

N
W E
S

LEGEND:

- PROPERTY BOUNDARY
- SURFACE WATER
- OUTLET
- DRAINAGE AREA BOUNDARY

NOTE

1. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

REFERENCES:

1. BASE DRAWING PROVIDED IN A DIGITAL FORMAT BY BASE MAPPING CO. LTD., CONTRACT No. 2517-12, PHOTO DATE: NOVEMBER 7, 2012, DATE RECEIVED: JANUARY 9, 2013.
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18

200 0 200 400

SCALE 1:10,000 METRES

REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RVW

PROJECT

CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE

POST-DEVELOPMENT DRAINAGE AREAS

Golder Associates
Ottawa, Ontario, Canada

PROJECT No.		12-1125-0045	FILE No.1211250045-V4-Storm-Fig 3.dwg
DESIGN	D.H.	22 Nov. 2013	SCALE AS SHOWN REV. 0
CAD	M.L.F.	23 Nov. 2013	FIGURE No.
CHECK	D.V.K.	Aug. 2014	
REVIEW	P.A.S.	Aug. 2014	3

PLOT DATE: October 9, 2014
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\Vol 4 (Report Figures)\Storm\1211250045-V4-Storm-Fig 3.dwg