MEMO

TO: Rémi Godin, P.Eng
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FROM: Kathryn Kerker, P.Eng

Eeshan Kumar, P.Eng., P.E., PMP

SUBJECT: **West Carleton Environmental Centre – Stormwater Analysis for Proposed Maintenance Building**

DATE: **February 9, 2026**

The Stormwater Design Brief prepared in August 2015 by WSP Canada Inc. provides an analysis of the proposed site conditions and design of the stormwater management ponds and infiltration basins on site. A new 1027 m^2 maintenance building is proposed on land that was gravel-covered in the original design. The purpose of this memo is to verify that the existing stormwater infrastructure has the capacity to accept the additional flow from this new building. The original Stormwater Design Brief has been attached for reference.

DESIGN CRITERIA

The design criteria used in the original design of the stormwater management system are as follows:

- Internal ditches and stormwater structures: 1:25 year storm, with overland flow route to carry peak flow from 1:100 year storm
- Surface Water Quality Control: Stormwater ponds sized to store/treat runoff generated from a 4-hour, 25mm storm event.
- Surface Water Quantity Control: Control post-development peak flows to pre-development levels. However, as there is no off-site discharge from the central site area, this condition is automatically met.
- Infiltration Basins: At least 1m to bedrock and water table, and no more than 0.6m water storage depth.

STORMWATER MODELLING

Modelling was previously completed using Bentley PondPack. As we no longer have access to this software, modelling was replicated in PCSWMM to determine the impact of the added

impervious area on the overall stormwater management system. The PCSWMM model was calibrated to align with the PondPack results by adjusting CN values over the landfilled area for the 100-year 24-hour SCS Type II storm. PCSWMM model results are attached for reference.

The proposed maintenance building lies within catchment area A8, which was originally modelled with parameters as shown in Table 1. The new 1027 m^2 maintenance building will be placed on land that was previously gravel-covered, which leads to a slight increase in runoff coefficient and CN value. Under the proposed scenario, Catchment A8 was refined by separating the proposed maintenance building into its own subcatchment (A8_MB) to accurately reflect the updated impervious area assumptions. Runoff from the proposed building will be directed to Infiltration Basin #2 through a connection to the existing overflow pipe. Roof runoff is typically free of sediment and other pollutants, so the risk of clogging or contamination of the infiltration basin is low. At-grade runoff will be directed to SWM pond #2. Drainage mosaics for pre-development and post-development conditions are included at the end of this memo within the Drawings section.

Table 1: Catchment A8 model parameters

	Without Maintenance Building	With Maintenance Building
C	0.561	0.58
CN	85.7	86.1

As the maintenance building roof runoff will flow directly to the infiltration basin, catchment A8 was subdivided into to catchments. The parameters used in the PCSWMM model are shown in Table 2.

Table 2: Subdivided Catchment A8 Parameters

	Area (Ha)	Runoff Coefficient	CN
A8	2.69	0.57	85.7
A8_MB	0.11	0.90	98

RESULTS

INFILTRATION BASIN

The PCSWMM model was run with the 100-year 24-hour SCS Type II storm. Under existing conditions, the infiltration basin reaches a maximum depth of 0.59m, which remains unchanged under proposed conditions. This meets the design requirement of ponding less than 0.60m in the infiltration basin. Modelling results are shown in Table 3.

Table 3: PCSWMM Modelling Results

	Without Maintenance Building	With Maintenance Building
Maximum water depth in Infiltration Basin #2	0.590 m	0.590 m
Total runoff volume entering Pond #2	28800 m^3	28787 m^3
Peak runoff Subcatchment A8	0.582 m^3/s	0.594 m^3/s^*

*Sum of A8 and A8_MB hydrographs

As shown, there is no change to the maximum water depth in Infiltration Basin #2. The total volume entering Pond #1 slightly decreases due to the diversion of roof runoff directly to the infiltration basin. The increase in peak runoff from Subcatchment A8 is due to the added imperviousness as a result of the proposed building.

WATER QUALITY

The 25mm 4-hour Chicago storm event was run in the model under proposed conditions. The total volume reaching the pond during the water quality event is 256 m^3. As the pond has a permanent pool volume of 4200 m^3 and an extended detention volume of 19520 m^3, there is sufficient volume to store and treat runoff generated from a 4-hour, 25mm storm event.

The quality criteria outlined in the MOE SWM Planning and Design Manual were also assessed. Based on Table 3.2 of the manual and extrapolating for a 4.5% impervious contributing area, the pond also meets an enhanced 80% TSS removal protection level as shown in Table 4.

Table 4: Pond Water Quality Parameters

Parameter	Value
Contributing Area Imperviousness	4.5%
Contributing Area	52 ha
Storage Volume for Imperviousness Level	75 m^3/ha
Required Extended Detention Volume (40 m^3/ha)	2080 m^3
Available Extended Detention Volume	19520 m^3
Required Permanent Pool Volume (35 m^3/ha)	1820 m^3
Available Permanent Pool Volume	4200 m^3

CONVEYANCE

The existing ditches and stormwater infrastructure were verified to ensure that they still meet the design criteria with the additional flow from the new maintenance building. Figure 1 shows that the existing triangular ditch (1.1m deep, 3:1 side slopes) and 0.6 m culvert convey the 25-year storm without surcharging and convey the 100-year storm without overtopping.

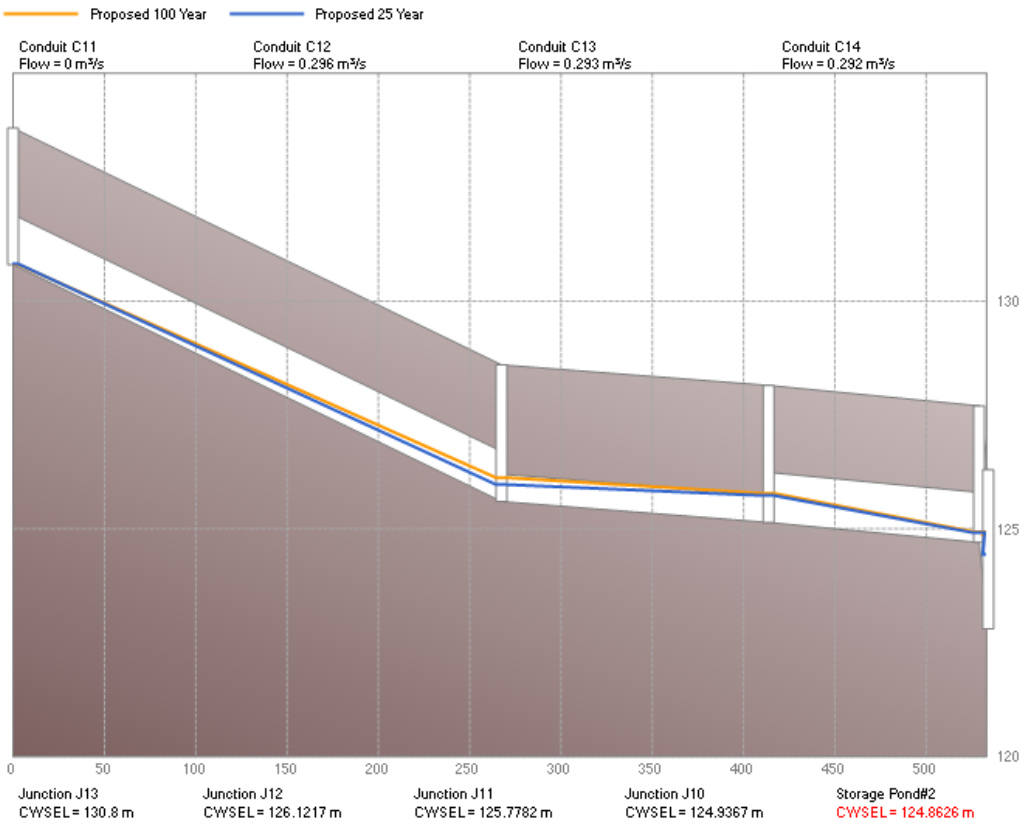


Figure 1: Hydraulic Grade Line along ditch and culvert adjacent to new maintenance building

Furthermore, under the updated grading and drainage concept, ditch flow south of Street A converges with the roadside ditch from Street B and is conveyed north to SWM Pond 2 within the same ditch system that also receives runoff from the area surrounding the future maintenance building. The design has been revised such that surface runoff in the vicinity of the future maintenance building is directed to the ditch east of Street D, rather than discharging directly to the infiltration basin overflow connection.

ALIGNMENT WITH CARP RIVER WATERSHED/SUBWATERSHED STUDY

The proposed maintenance building at the West Carleton Environmental Centre incorporates a stormwater management design in which all runoff is infiltrated on-site. This approach is consistent with the recommendations of the Carp River watershed/subwatershed study (Robinson, 2004), which emphasizes maintaining pre-development hydrologic conditions, minimizing surface runoff, and promoting infiltration to protect water quality and reduce downstream erosion. By ensuring complete infiltration, the project avoids contributing additional flows to the Carp River system, thereby preventing increases in peak discharge and pollutant loading, while maintaining a cool water thermal regime. Furthermore, infiltration supports the study's objective of sustaining groundwater recharge and baseflow contributions, which are critical to the ecological health and long-term stability of the watershed. In this way, the proposed building demonstrates compliance with the study's guidance and advances its broader goals of watershed protection and restoration.

CURRENT SYSTEM OPERATION

The construction of the stormwater ponds and infiltration basins began in 2023, and were not completed until late 2024 (See attached Environmental Assessment (EA) Compliance Monitoring Report). Monitoring of the water levels in the infiltration basin was done in Nov 2024, where it was found to be dry (excerpt from 2024 Annual Report attached). The ECA for the original SWM design is attached.

CONCLUSIONS

The peak depth in the infiltration basin, water quality treatment, and stormwater conveyance have all been confirmed to meet the design criteria. This memo has shown that the existing stormwater system is sufficient to support the proposed maintenance building.

We trust that the foregoing satisfies your current requirements. Should you have any questions regarding the above, please do not hesitate to contact our office.

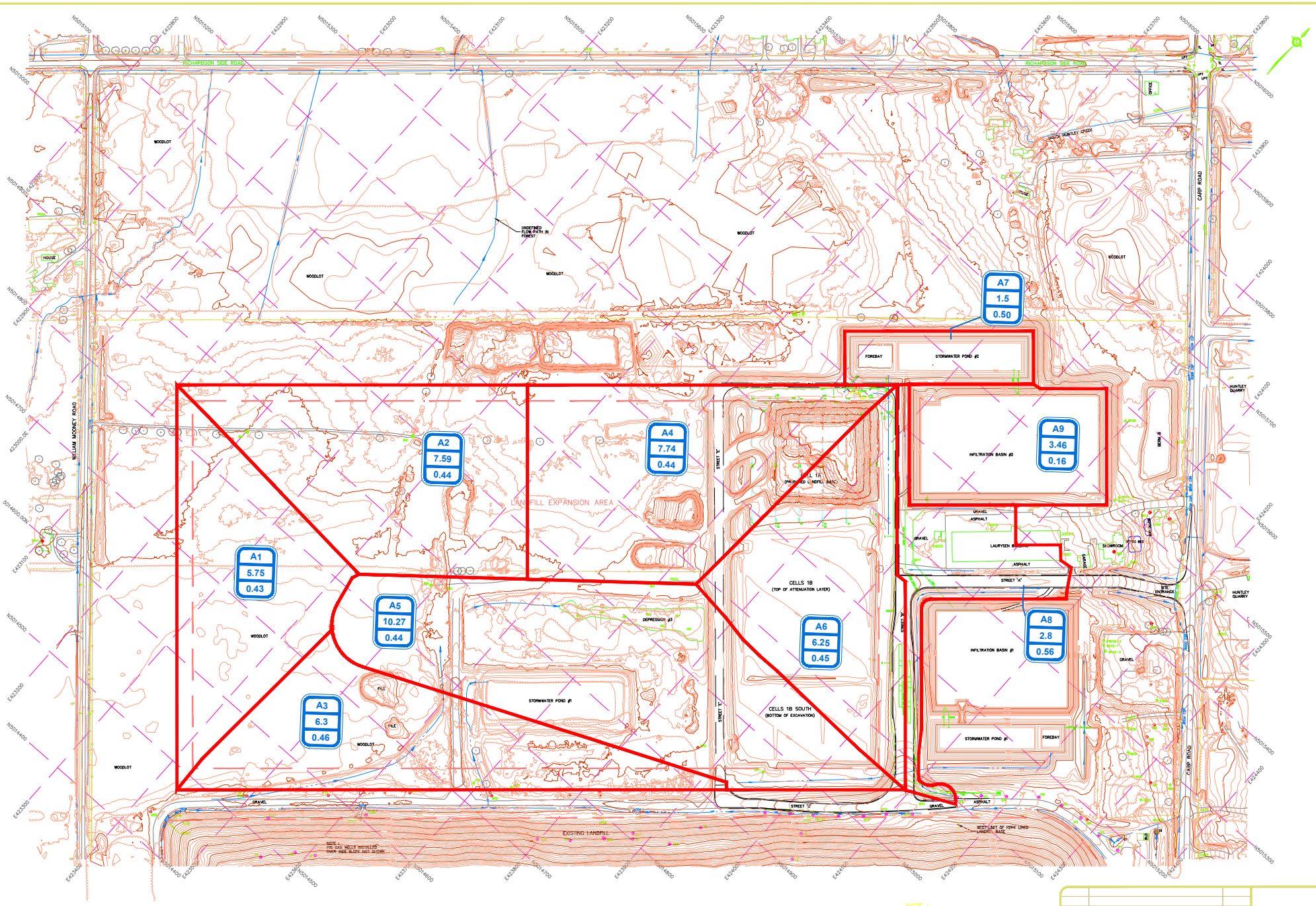
Sincerely,

Kathryn Kerker, P.Eng, M.A.Sc.
Water Resources Engineer

Eeshan Kumar, P.Eng., P.E., PMP
Senior Water Resources Engineer

ATTACHMENTS

- Proposed Maintenance Building Location and Drainage Area Plans
- Stormwater Design Brief, August 2015
- PCSWMM Model Output
- Waste Management of Canada Limited West Carleton Environmental Center Environmental Assessment (EA) Compliance Monitoring Report (CMR) for 2023
- WCEC 2024 Annual Report Excerpt
- Environmental Compliance Approval (June 2, 2016)



NOTE :
1. TOPOGRAPHIC FEATURES SHOWN ON THIS PLAN ARE BASED ON FIELD SURVEY DATA OBTAINED BY TOMLINSON CONSTRUCTION TO MARCH 26, 2025

DATE	DESCRIPTION	
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04\08\24	ISSUED FOR CONSTRUCTION	COR

REVISION / ISSUE

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WSP
96 KING STREET, SUITE 100
ST.CATHARINES, ONTARIO, CANADA L2R 3W6
TEL: 905-687-7717 | WWW.WSP.COM

DRAINAGE AREA PLAN
PRE-DEVELOPMENT CONDITIONS

WEST CARLETON ENVIRONMENTAL CENTRE

DWN BY: N S
CHK BY: E K
DATE: SEPTEMBER 2025
SCALE: AS SHOWN

WASTE MANAGEMENT OF CANADA CORPORATION

DRAWING NO. CA0051319.2938 - 2502C

DRAWING
DAP1

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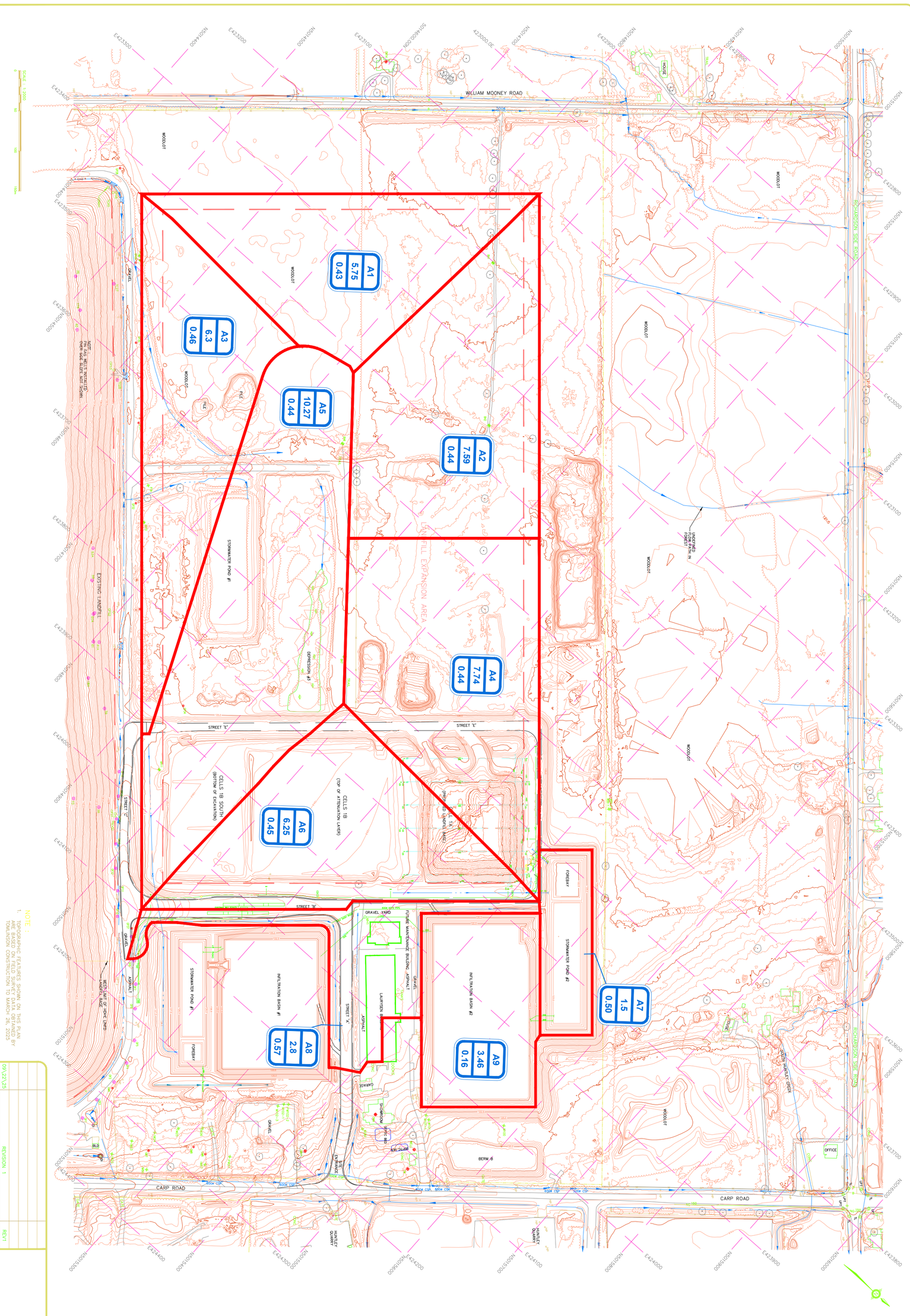

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	REVISION 1	REVI	09\22\25

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DRAWING
DAP2

DWN BY: N S DATE: SEPTEMBER 2025
CHK BY: E K SCALE: AS SHOWN

WASTE MANAGEMENT OF CANADA CORPORATION

DRAWING NO.
CA0051319.2938 - 2502C

DRAINAGE AREA PLAN
POST-DEVELOPMENT CONDITIONS

WEST CARLETON ENVIRONMENTAL CENTRE

wsp
55 KING STREET, SUITE 700
ST.CATHARINES (ONTARIO) CANADA L2R 3H5
TEL.: 905-687-1771 | WWW.WSP.COM

LEGAL DESCRIPTION:

INFO TAKEN FROM:

REGISTERED PLAN 5R-11322
PLAN OF SURVEY OF
PART OF THE SOUTH HALF
OF LOT 5
CONCESSION 3
GEOGRAPHIC TOWNSHIP OF
HUNTLEY
TOWNSHIP OF WEST CARLETON
FAIRHALL, MOFFATT & WOODLAND LTD.

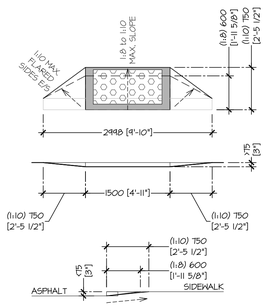
SITE LEGEND:

+ 00.00	- EXIST. GRADE ELEVATION
00.00	- PROPOSED GRADE ELEVATION
00.00	- PROPOSED DITCH ELEVATION
	- FLOW / DIRECTION
H	- HYDRO
STM	- STORM PIPE
SAN	- SANITARY PIPE
W	- WATER LINE
G	- GAS LINE
B	- BELL LINE
X	- FENCE
M.H.	- MAN HOLE
H.P.	- HYDRO POLE
LS	- LIGHT STANDARD
F.H.	- FIRE HYDRANT
C.B.	- CATCH BASIN
D.I.	- DITCH INLET
	- ACCESS / ENTRANCE
	- WATER LINE CURB STOP
	- SOD / GRASS / LANDSCAPE
	- EXISTING GRAVEL
#1	- DENOTES REVISION NUMBER

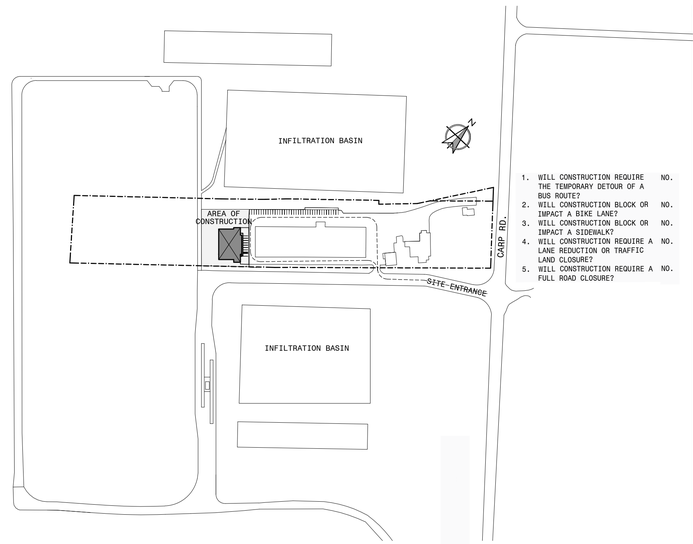
SITE STATISTICS:

ZONED :	RH Zone
MIN. PROPERTY AREA :	8,000 s.m.
PROPERTY AREA :	41,188 s.m.
NEW FACILITY AREA :	1,027 s.m.
EXISTING FACILITY AREA :	5,604 s.m.
TOTAL FACILITY AREA:	6,631 s.m.
LOT COVERAGE:	16.0 %
MAX LOT COVERAGE:	50 %
NEW BUILDING HEIGHT :	10.6 m.
MAX BUILDING HEIGHT :	15 m.
No. OF STOREYS :	-1-
MIN. FRONT YARD SETBACK :	15 m.
BLDG. FRONT SETBACK:	301.5 m.
MIN. INTERIOR SIDEYARD SETBACK :	3 m.
BLDG. MIN. INTERIOR SIDEYARD SETBACK:	4.9 m.
MIN. REAR YARD SETBACK :	15 m.
BLDG. REAR SETBACK:	175.5 m.
No. OF PROPOSED PARKING SPACES Shown :	9 SP.
No. OF BARRIER-FREE SPACES - INCL. :	1 SP.
No. OF REQUIRED PARKING SPACES	
0.75/100m2 HEAVY EQUIP.SERVICE:	8 SP.
0.8/100m2 LIGHT INDUSTRIAL EXISTING:	39 SP.
TYPICAL PARKING WIDTH	2.8 m.
TYPICAL PARKING LENGTH	6.0 m.

SITE BENCHMARKS:
VERTICAL: COSINE STATION 0011970U242 = 114.689 m.
HORIZONTAL: NAD83-CSRS (ZONE 18) EPOCH 2010



CURB RAMP @ EXTERIOR WALKS
3.8.3.2(3) Vertical Rise less than 75mm



KEY PLAN
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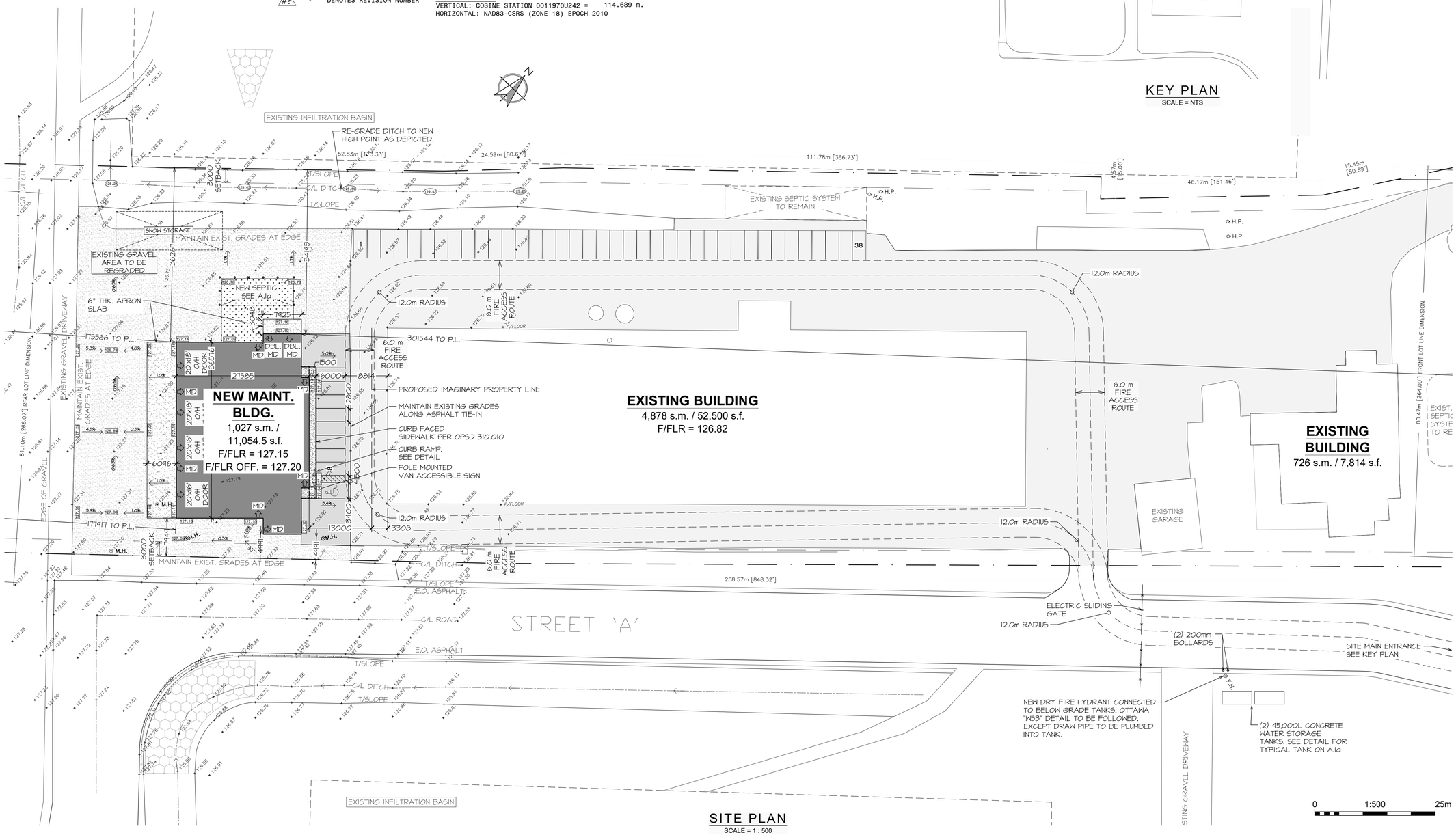

SITE PLAN
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THE CONTRACTOR SHALL VERIFY AND BE RESPONSIBLE FOR ALL DIMENSIONS AND SHALL REPORT ANY DISCREPANCY TO *TaskForce Engineering Inc.* BEFORE PROCEEDING WITH ANY WORK.

SITE PLAN NOTES:

1. ALL DIMENSIONS & NOTES MUST BE VERIFIED ON JOB SITE BY CONTRACTOR. ANY DISCREPANCIES SHALL BE REPORTED TO THE OWNER.
2. ALL UNDERGROUND WORK AND ABOVE GROUND WORK TO BE DONE IN ACCORDANCE WITH CURRENT CITY PLANS, STANDARDS & SPECS.
3. THE OWNER COVENANTS & AGREES NOT TO MAKE A MATERIAL CHANGE OR CAUSE A MATERIAL CHANGE TO BE MADE TO A PLAN, SPECIFICATION, DOCUMENT OR OTHER INFORMATION, ON THE BASIS OF WHICH THIS DRAWING WAS APPROVED BY THE CITY, WITHOUT NOTIFYING, FILING DETAILS WITH AND OBTAINING THE WRITTEN AUTHORIZATION OF THE CITY.
4. EXISTING ASPHALT.

   HEAVY DUTY ASPHALT:
   - 50mm HL8
   - 40mm HL8
   - 150mm (6") GRANULAR 'A', TYPE II
   - 300mm (12") GRANULAR 'B', TYPE I
5. ALL GRANULAR MATERIAL SHALL BE PLACED IN 300mm LIFTS AND COMPACTED TO 100% STANDARD PROCTOR.
6. INSTALL CONCRETE SIDEWALKS IN ACCORDANCE WITH OPSD-308.03 AND OPSD-303.04 FOR SIDEWALK RAMP.
7. SILT FENCE AS REQUIRED PER OPSD 219.110
8. GRASSED AREAS SHALL BE SOD AND 4" MINIMUM TOPSOIL. HYDROSEED FOR SLOPES EXCEEDING 4:1 SOD & STAKE.
9. CONTRACTOR SHALL OBTAIN A R.O.W. WORK PERMIT FROM THE CITY OF QUINTE WEST PRIOR TO COMMENCING ANY WORK WITHIN THE MUNICIPAL ROAD ALLOWANCE.
10. UTILITY CUTS WITHIN THE MUNICIPAL ROAD ALLOWANCE TO BE RESTORED USING HEAVY DUTY ASPHALT STANDARDS.
11. CONNECTION OF ALL SANITARY AND STORM SEWERS TO CONFORM TO OPSD-1006.010
12. NO LIGHTING WILL BE DIRECTED ONTO ADJACENT PROPERTIES BUT WILL ONLY BE DIRECTED ONTO THE SUBJECT LANDS
13. ALL GURBING IN ACCORDANCE WITH OPSD - 600.110
14. BARRIER FREE SIGNAGE FOR PARKING AREA TO BE IN ACCORDANCE WITH OBC 3.8.3.1 (1)

OPSD REFERENCES

1. RIGID PIPE BEDDING, COVER AND BACKFILL OPSD - 802.030
   EXCEPT a) USE "CLASS B-BEDDING" DETAIL ONLY FOR ALL PIPE BEDDING. DELETE "CLASS C" - BEDDING" DETAIL.
   b) THE "GRANULAR BEDDING MATERIAL" IS TO BE GRANULAR 'A' CRUSHED MATERIAL.
   c) "COVER MATERIAL" IS TO BE SAND FILL
   d) DELETE "150 mm " FROM "NOTE 1" AND INSERT 225 mm FOR THE MINIMUM BEDDING DEPTH
   e) FOR A "WET TRENCH" CONDITION AS DETERMINED BY THE CITY ENGINEER;
      I) THE "GRANULAR BEDDING MATERIAL" IS TO BE AN "HL8 COARSE" GRADATION, CRUSHED LIMESTONE MATERIAL, AND
      II) THE "COVER MATERIAL" IS TO BE LIMESTONE SCREENINGS OR GRANULAR 'A' CRUSHED MATERIAL.
2. PRECAST CONCRETE MAINTENANCE HOLE, OPSD - 701.010
   1200 mm DIAMETER, EXCEPT USE PRECAST MONOLITHIC BASE ONLY.
3. MAINTENANCE HOLE STEPS, HOLLOW OPSD - 405.010
   EXCEPT DELETE "RECTANGULAR STAINLESS STEEL" STEP DETAILS. CAST IRON, SQUARE FRAME WITH CIRCULAR CLOSED OR OPEN.
4. COVER FOR MAINTENANCE HOLES OPSD - 401.010
   EXCEPT DELETE "TYPE 'B' OPEN COVER".
5. CAST-IN-PLACE MAINTENANCE HOLE DROP OPSD - 1003.010
   STRUCTURE TEE, EXCEPT THE INVERT OF THE INLET END OF THE 90 DEGREE BEND IS TO BE PLACED AT THE "SPRINGLINE" OF THE MAIN SEWER PIPE.
6. SEWER SERVICE CONNECTIONS FOR RIGID MAIN PIPE SEWER, EXCEPT; OPSD - 1006.010
   a) THE BEDDING AND COVER MATERIALS ARE TO BE SUPPLIED AND INSTALLED IN ACCORDANCE WITH OPSD-802.030
   b) FACTORY MADE TEES OR WYES ARE NOT REQUIRED FOR SANITARY SERVICE CONNECTIONS TO THE MAIN SEWER PIPE UNLESS SPECIFIED.
7. CONCRETE SIDEWALK OPSD - 310.010
8. CONCRETE BARRIER CURB WITH WIDE GUTTER OPSD - 600.010
9. CONCRETE BARRIER CURB OPSD - 600.110

No.	DATE	REVISION(S)	BY
5	JAN.29/26	RE-ISSUED FOR SITE PLAN APPROVAL	ERB
4	DEC. 19/25	REVISED SEPTIC AREA	ERB
3	OCT. 14/25	ISSUED FOR TENDER	DGT
2	SEPT. 22/25	RE-ISSUED FOR SITE PLAN APPROVAL	ERB
1	AUG. 13/25	ISSUED FOR SITE PLAN APPROVAL	ERB

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NEW 11,054 s.f. BUILDING for
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2413 CARP RD.
OTTAWA, ON

SITE PLAN AND DETAILS

DATE: JUNE 2025	CONTRACT No.: 0000
CHECKED BY:	DRAWING No.: A.1
DESIGNED BY:	
DRAWN BY: ERB	
SCALE: AS NOTED	

Stormwater Design Brief
West Carleton Environmental Centre

August 2015

Prepared for:
Waste Management of Canada Corporation
2301 Carp Road
Carp, Ontario K0A 1L0

Prepared by:
WSP Canada Inc.
1450 1st Avenue West, Suite 101
Owen Sound, Ontario N4K 6W2

Project No. 131-19416-00

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1. Introduction and Background

This report has been prepared in support of the Waste Management of Canada Corporation (WM) Site Plan Control application for a site expansion at the West Carleton Environmental Centre (WCEC). The Site Plan Control approval is required by the City of Ottawa before the proposed site development, in addition to the Environmental Compliance Approval (ECA) by Ontario Ministry of the Environment and Climate Change (MOECC). WM applied for an ECA approval in September 2014 and their application is under review.

Details of the proposed landfill expansion are outlined in the Development and Operations Report dated July 2014, by WSP Canada Inc.

1.1 Location

The WCEC is located adjacent to Carp Road and Highway 417, locally known as 2301 Carp Road, at the westerly end of Ottawa. The landfill site expansion is an extension of the existing Waste Management Facility, owned and operated by WM.

The WCEC is located on Parts of Lots 2, 3 and 4, Concession 2 and parts of Lots 3, 4 and 5, Concession 3, in the former Township of Huntley, formerly in the Township of West Carleton, now the City of Ottawa, near Carp Road and Highway 417. The existing landfill footprint occupies approximately 34 hectares (ha), bordered by the City of Ottawa Road 5 (Carp Road) on the east, Highway 417 on the south, William Mooney Road to the west and private lands south of Richardson Sideroad. Those lands between Richardson Sideroad and 300 m southerly, between William Mooney Road and Carp Road, are owned by WM, but are not designated as part of the site. The Contaminant Attenuation Zone (CAZ) part of the site consists of two (2) land parcels, one large parcel north of Highway 417 and the second small parcel south of Highway 417. **Figure 1-1** shows these lands and various facilities within the existing and proposed landfill site.

2. Stormwater Management

The stormwater management features of the landfill expansion are shown on **Drawing 4**. Sections through the stormwater ponds and infiltration basins are shown on **Drawings 9 and 10. Figure 8-1** shows the drainage areas before development of the landfill expansion. **Figure 8-2** shows how drainage and subdrainage areas are broken down and controlled after the development of the new landfill footprint. **Figure 8-3** provides details related to water storage facilities.

2.1 Existing Topography and Drainage

The natural topography on the area of WCEC property, which has been modified by aggregate extraction and waste disposal activities, ranges from an elevation of approximately 131 metres above sea level (masl) southwest of the landfill site to less than 110 masl on the Huntley Quarry property, east of Carp Road. The present landfill extends to an elevation of approximately 174 masl, and the Huntley Quarry has been mined to a floor elevation of less than 75 masl. Refer to **Figure 1-1** for the area conditions.

From within the boundaries of the existing landfill property, there is no direct off-site discharge of surface water that is in contact with waste that has been landfilled; internal surface water drainage is contained within the landfill property and is directed to on-site ponds, which are engineered, natural, or depressions remaining from aggregate extraction. The exceptions to this are the external slopes of the vegetated site perimeter berms along the east and south boundaries of the landfill property; this amount of surface water is very minor and is not in contact with activities at the landfill. Runoff from the vegetated berms flow into Carp Road and Highway 417 drainage systems. There is a small area of drainage from the extreme western end of the site, in the area of the existing service entrance which flows into the ditch along William Mooney Road and northward into the tributary of Huntley Creek.

The above noted tributary of Huntley Creek originates from the wetland west of William Mooney Road and west of the WCEC property. The wetland feeds a drainage course that collects surface water from the agricultural and residential properties along William Mooney Road, west of the WCEC property. Flowing from west to east under William Mooney Road the drainage course bends to the north and flows towards Richardson Sideroad. Along the south side of Richardson Sideroad, the creek is aligned as a roadside drainage ditch, flowing eastward to a point approximately 450 m east of William Mooney Road. Surface water from the agricultural land east of William Mooney Road and south of the Richardson Sideroad is controlled by drainage ditches and flows northward to the roadside ditch along Richardson Sideroad.

The Huntley Creek tributary then flows northward through a culvert under Richardson Sideroad. Here the creek collects drainage from the area north of Richardson Sideroad, including several residential and commercial/industrial properties. Approximately 250 m west of Carp Road, Huntley Creek flows in a southeasterly direction under Richardson Sideroad and bends towards the northeast, where it passes under Carp Road. From there, the creek flows eastward, parallel to Richardson Sideroad, then northward through a culvert under the road, eventually discharging to the Carp River, some 3.8 km northeast of the landfill property. Ditches along both sides of Carp Road between the landfill property and Richardson Sideroad also drain into this tributary.

Drainage south of the existing landfill is contained within a large wet forested area on the westerly end. The south central and southeasterly lands largely drain through a series of on-site stormwater ditching to a sedimentation pond and infiltration pond designated Stormwater Pond #2, which in turn discharges to the low lying area of Depression #1. The southerly part of the existing landfill at the easterly end drains to Depression #2 and recharges into the water table.

The stormwater flow pattern on the lands for the new landfill footprint can be divided into two (2) zones. On the south central and easterly part, surface flow is controlled by a series of ditches and Stormwater Pond #1, which recharges the water into the water table. Surface flow is generally from southwest to northeast. Because the east end of the property was used for aggregate extraction, the ground surface is lower than the surrounding area, and consequently there is no direct off-site surface water runoff from this area. A previous residential property is located beyond the eastern limit of the former extraction area, west of Carp Road. Surface water flow is northeast, following the slope of the land surface. On the north half of the property for the new landfill footprint, and the complete westerly part, is partially wooded and partially agricultural land. The southeast corner was a manufacturing facility (Laurysen Kitchens Limited). The western and north central part is flat lying, and surface drainage follows land contours and agricultural ditches in a northerly to northeasterly orientation toward Richardson Sideroad and into the tributary of Huntley Creek described previously. The eastern portion of the new lands for the landfill slopes, and has a northeasterly orientation along the edge of a post-glacial beach ridge. Surface drainage follows the land slope into ditches along Carp Road. These ditches drain northerly into the Huntley Creek tributary. West of the previous residential properties, a large depression from aggregate extraction remains, and designated as Depression #5 on **Figure 1-1**. Where the land surface in former extraction areas are depressed, surface water collects in localized ponds. The water level in the depressions reflects low flow groundwater table elevation.

There are no flood hazard zones located within the proposed landfill area. Elevated topography and high recharge potential on beach ridge deposits along Carp Road negate the potential for surface flooding.

2.2 Objectives

The general objectives of the stormwater management plan are as follows:

- control surface water draining on-site;
- control quality and rate of runoff discharging directly from the site to protect water quality and wildlife habitat and to prevent flooding within the South Huntley Creek watershed. Off-site discharge of surface water will be limited to the site perimeter and no offsite discharge from the existing and proposed waste fill areas will occur; and
- control sediment discharge and erosion during site operation and development.

Runoff from the landfill expansion area will drain into landfill perimeter ditching and pass through lined Stormwater Pond #2, where it will be settled before being discharged into Infiltration Basin #2. Runoff from the existing landfill footprint will be contained on-site in one of several depressions including new Infiltration Basin #1. These natural and manmade water storage facilities serve as groundwater recharge areas. Clean runoff from non-operating areas along the site perimeter will continue to drain off-site bypassing the above noted groundwater recharge areas.

The stormwater management plan complies with the MOE Landfill Standards. The design criteria for the site's stormwater facilities are as follows:

Internal Ditches and Stormwater Structures

- 1:25 year storm
- Provide overland flow route to carry peak flow from a 1:100 year storm.

Surface Water Quality Control

- Stormwater ponds sized to store/treat runoff generated from a 4-hour, 25-mm storm event.

Surface Water Quantity Control

- Control post-development peak flows from all storm events up to 1:100 year at or below pre-development levels. This applies only to the areas with direct off-site discharge along the site

boundary. There will be no off-site discharge from the central part of the site containing all waste disposal areas.

Infiltration Basins

The proposed infiltration basins are sized for 1:100 year storm event and in accordance with design criteria outlined in the MOE "Stormwater Management Planning and Design Manual" as follows:

- Depth to bedrock and water table – at least 1 m
- Water storage depth – no more than 0.6 m

The 1:100 year storm is the regulatory flood for Eastern Ontario (Zone 2), which includes the WCEC Facility.

2.3 Detailed Stormwater System Assessment

2.3.1 Pre-Development Conditions

Refer to **Figure 8-1** for the outline of the pre-development drainage areas. General hydrologic information concerning each drainage area is presented in **Table 8-1**.

The site is situated within the South Huntley Creek watershed which drains in an easterly direction north of the site. The South Huntley Creek is a tributary of Huntley Creek which in turn empties into the Carp River northeast of the site. South Huntley Creek is a permanent warm water system that has been significantly impacted historically by surrounding agricultural land use and roadways which have bisected its length into smaller reaches, separated generally by culverts. The South Huntley Creek watershed extends to the south of Highway 417 west of the site. The drainage divide runs near the south limit of the WM property just north of Highway 417. The lands draining south to Highway 417 belong to the Feedmill Creek watershed. Feedmill Creek is also a Carp River tributary. The active quarry on the east side of Carp Road locally influences drainage patterns.

The site is relatively flat with the exception of the existing landfill mound which rises approximately 40 – 45 m above the adjacent ground. Generally, the land slopes northeasterly and local drainage patterns are influenced by wetlands and manmade depressions (ponds, pits). These no outlet features serve as groundwater recharge areas and contribute to South Huntley Creek base flow. A portion of the groundwater flow is also drawn by the quarry east of the site.

As shown on **Figure 8-1**, the existing landfill footprint belongs to three (3) separate, no outlet Drainage Areas B, C and D. The existing Waste Transfer & Processing Facility (WTPF) in the southwest part of the site is located within Drainage Area E. The old aggregate extraction pit (Depression #5) forms another no outlet Drainage Area A. In total, on site, no outlet areas occupy 127.5 ha out of 188.3 ha under pre-development conditions. The remaining drainage areas (SH1 and SH2) discharge off-site to the South Huntley Creek and Drainage Area FD to the Highway 417 drainage system and ultimately to Feedmill Creek. A small portion of the site near the existing landfill entrance (Drainage Area F) drains into the quarry on the east side of Carp Road. Generally, drainage areas discharging off-site are located along the site perimeter and do not encroach waste fill or waste processing areas.

The site soil textures according to the Ontario Soil Map are classified as follows:

- Kg – Kars Gravely Sandy Loam Soil Group B
- Rs – Rubicon Sand Soil Group AB
- Li – Lyons Loam Soil Group B

These soils provide good drainage and are relatively permeable.

The Rational Method was used to determine peak flows using Ottawa rainfall intensity duration frequency (IDF) data. The design rainfall intensity was calculated in accordance with the formula:

$$i = A \times T_c^B$$

where i = rainfall intensity (mm/hr)
Tc = time of concentration (hr)
A, B = rainfall equation coefficients dependent on storm return frequency and meteorological station location.

The following runoff coefficients were used to calculate a cumulative runoff coefficient “C” for each drainage area:

- pavement/buildings - 0.9
- gravel areas - 0.55
- existing capped landfill – soil C - 0.45
- woods-soil B - 0.19
- pasture-soil B - 0.24
- pond, wetland - 0.05

- proposed landfill 5% slope – soil C/D - 0.42
- proposed landfill steep slope – soil C/D - 0.50
- lined stormwater pond - 0.5
- infiltration basin - 0.16

The time of concentration required to determine rainfall intensity in the Rational Method was calculated using the Kirpich Method. This method gives conservative, relatively short travel times as shown in **Table 8-1**.

In the Rational Method, peak flows for storms having a return period of more than ten (10) years were increased as follows:

- 1:25 year - 10%;
- 1:50 year - 20%; and
- 1:100 year - 25%.

2.3.1.1 Drainage Areas With No Off-Site Discharge

a) Drainage Area A

Drainage Area A, located in the northeast corner of the site, occupies approximately 10.08 ha. Surface water drains overland into Depression #5 which is an old, presently unused aggregate extraction pit. The west part of the existing Laurysen manufacturing facility and gravel yard west of the building belong to this catchment. Surface water flow is not channelized. The bottom of Depression #5 is at approximately 117.5 masl.

b) Drainage Area B

Drainage Area B is subdivided into two (2) subcatchments, B1 and B2. Catchment B1 collects stormwater from the north slope of the existing landfill. The landfill perimeter ditch directs stormwater to the existing Stormwater Pond #1 which overflows into the elongated natural wetland (Depression #3). Under high flow conditions Depression #3 may overflow into the rehabilitated old Dibbley Pit (Depression #4) which has a bottom elevation at approximately 122.0 masl. Sub-Area B2 drains directly into Depression #4.

Drainage Area B has a very large water storage capacity particularly within Depression #4 where the water level would have to rise more than 3 m before overflowing in a northerly direction. Drainage Area B encompasses 39.47 ha.

c) Drainage Area C

Drainage Area C is also subdivided into two (2) subcatchments, C1 and C2. Area C1 includes a large portion of the south slope of the existing landfill and lands to the south of the existing landfill. Sub-basin C2 collects runoff from the majority of the Closed South Cell including the poplar plantation and lands surrounding the Gas to Energy Facility. Area C1 drains via manmade ditch into existing Stormwater Pond #2. Under high flow conditions, this pond may overflow into adjacent Depression #1 which services sub-basin C2. Depression #1 also has substantial storage capacity and the water level may rise up to 124.5 masl (approximately 2 m) without overflowing. Drainage Area C encompasses 45.19 ha.

d) Drainage Area D

Drainage Area D includes the most easterly part of the existing landfill and the north section of the Closed South Cell. Stormwater drains into Depression #2 which lies south of the lined part of the existing landfill. Ground elevations range from 121.5 (bottom of Depression #2) to 170 masl at the top of the existing landfill mound. The area occupies 21.34 ha.

e) Drainage Area E

This 11.50 ha catchment in the southwest part of the site is very flat and mostly tree covered. Stormwater drains into the wetland inside the wooded area north of Highway 417. The existing waste transfer station is located within the slightly elevated west part of this area.

2.3.1.2 Drainage Areas Discharging Off-Site

a) Drainage Area F

This relatively small drainage area of 5.8 ha, on the west side of Carp Road near the existing landfill entrance, drains northerly along the roadside ditch which crosses Carp Road south of the existing Laurysen building entrance. Further downstream this channel enters Huntley Quarry. The 1:100 year peak flow at the Carp Road crossing is estimated at 0.99 m^3/s. This area has a higher level of imperviousness due to paved road surfaces within the Carp Road allowance and near the existing landfill entrance.

b) Drainage Area SH1

This large catchment of 41.35 ha occupies the northwest part of the site. Generally, it drains northerly towards South Huntley Creek through several channels. A large part of this area drains overland towards

Richardson Sideroad along an undefined flow path. Ditching north of the WTPF directs stormwater westerly across William Mooney Road where it joins the tributary of South Huntley Creek. In summary, stormwater outletting from this basin follows multiple pathways instead of a single concentrated channel.

The area is relatively flat with ground elevations varying from 127 masl in the south beside the existing landfill to 121.5 masl in the north near the property boundary. This basin includes a large woodlot and open field which is used for agricultural purposes.

c) Drainage Area SH2

Runoff from this area of 5.77 ha, located in the northeast corner of the site, drains northerly via roadside ditch along Carp Road into South Huntley Creek. This area includes the commercial/industrial strip on the west side of Carp Road including a large part of the Laurysen manufacturing facility. Generally land in this part of the site slopes easterly towards Carp Road. The Rational Method 1:100 year peak flow at the outlet of this area was calculated as 0.75 m^3/s.

d) Drainage Area FD

This small drainage area of 7.79 ha is situated along the southern property boundary and drains into the Highway 417 ditching system which ultimately discharges into the Carp River through Feedmill Creek east of the site. There is minimal direct off-site discharge from this catchment, generally limited to the external slopes of perimeter berms along the south and east boundaries of the landfill property.

2.3.2 Post-Development Conditions

Refer to **Figure 8-2** for the outline of the post-development drainage areas. Hydrologic parameters characterizing each catchment are shown in **Table 8-2**.

Post-development conditions are characterized by higher runoff coefficients and shorter travel times (time of concentration) due to steep landfill grades and flow channelization. These factors tend to increase peak flows but because the site design is based on no off-site discharge, peak flow attenuation is not an issue for the landfill development area. Runoff from the proposed landfilling area will be contained on-site in Infiltration Basin #2.

The existing Stormwater Pond #1 and small wetland (Depression #3) located within the landfill expansion area will be eliminated and replaced with new clay lined Stormwater Pond #1 and Infiltration Basin #1 within Depression #4. Similarly, Stormwater Pond #2 and Infiltration Basin #2 are proposed in the area designated

as Depression #5. Infiltration Basin #2 will service the entire landfill expansion area while Infiltration Basin #1 almost the entire north half of the existing landfill. The landfill expansion will shift drainage boundaries within Drainage Areas A and B, and in catchments located along the site perimeter (SH1, SH2 and F). Drainage patterns within the remaining part of the property will be hardly affected and generally will remain the same as under pre-development conditions. There will be a significant increase in the size of on-site no outlet areas to 151.76 ha from 127.48 ha under pre-development conditions. As a result, more stormwater will be contained on-site and recharged into groundwater and less discharged off-site as surface flow from lands located along the site perimeter.

Drainage Areas A and B were subdivided into small subcatchments for the purpose of hydrologic modelling which was used for sizing of the proposed stormwater storage facilities. Cumulative runoff coefficients and times of concentration were established in a similar fashion as those for the pre-development conditions. Runoff coefficient for the entire study area will increase to 0.35 from 0.29 before the development.

The following soil/land use CN curve numbers were used to establish cumulative CN value for each subcatchment within Drainage Areas A and B, which were subject to hydrologic modelling:

- pavement/buildings - 98
- gravel areas - 90
- existing capped landfill – soil C - 81
- pasture – native or imported soil B - 73
- lined stormwater pond - 85
- proposed landfill 5% slope – soil C/D - 81
- proposed landfill steep slope – soil C/D - 83
- infiltration basin - 70

All above values are for the average antecedent moisture conditions (AMC II).

2.3.2.1 Drainage Areas With No Off-Site Discharge

a) Drainage Area A

This drainage area was subdivided into nine (9) smaller sub-areas to facilitate hydrologic modelling. The overall size of the catchment will expand to 51.66 ha. The cumulative runoff coefficient was calculated as 0.432 in comparison to 0.29 prior to landfill expansion. The Rational Method 1:100 year peak flow at Pond #2 was calculated as 5.31 m^3/s.

Stormwater Pond #2 will control stormwater flows by providing temporary storage and treatment before releasing water into Infiltration Basin #2. All runoff originating from the landfill expansion area will be handled within this catchment. The proposed landfill will be graded such that all runoff from the mound will drain toward the landfill perimeter and be intercepted by the perimeter ditching. The ditching system will direct stormwater into Stormwater Pond #2. A large part of the on-site road network, including the main access road and scale house area, will be also routed through Stormwater Pond #2. Stormwater accumulating over the landfill base during base preparation as well as stormwater pools west of the lined area will be pumped to the perimeter ditching system, on an as required basis.

b) Drainage Area B

This watershed was also subdivided into multiple sub-areas to facilitate hydrologic modelling. Drainage Area B will be smaller, 22.58 ha down from 39.47 ha originally as a result of the proposed development. The northwest part of the catchment will be shifted into Drainage Area A and comprise part of the landfill footprint. The cumulative runoff coefficient increases to 0.398 from 0.32 prior to development. The overall CN number was estimated at 79.1 and the Rational Method 1:100 year flow at Pond #1 was calculated as 2.13 m^3/s.

Stormwater Pond #1 and Infiltration Basin #1 will function in the same fashion as stormwater storage facilities within Drainage Area A. New ditching will be provided on the west and south side of the existing landfill to intercept runoff coming from side slopes and direct it towards new Stormwater Pond #1. The south half of the main access road between two (2) mounds and the entire Mini-Transfer Area (MTA) are included within this drainage basin.

c) Remaining Drainage Areas

The size of Drainage Areas C, D and E will not change as a result of the landfill expansion as there is no major development planned for the south half of the WM property. Construction activities will be limited to the leachate treatment plant, contingency poplar plantation, road improvement (paving), extension of underground utilities and minor building improvements (blower building). These activities will have a negligible effect on the existing drainage patterns, and stormwater flows will remain the same as under pre-development conditions.

2.3.2.2 Drainage Areas Discharging Off-Site

a) Drainage Area F

The catchment boundary will be slightly realigned as a result of the landfill expansion with a minor reduction in size to 5.24 ha from 5.8 ha. The imperviousness level will increase with construction of the new access road off Carp Road and the Carp Road widening near the new entrance. This part of the site will also be subject to landscaping activities such as tree and bush planting, etc. The runoff coefficient for this area will increase by approximately 10% to 0.38. The 1:100 year peak flow will remain at the pre-development level of 0.99 m^3/s. This area will continue to discharge into the quarry east of the site.

b) Drainage Area SH1

The post-development size of this area will decrease to 18.44 ha down from 41.35 ha. For this reason there will be no increase in flows leaving the site. A decrease in size of this basin is a result of the proposed development; a portion of this area would become part of the landfill footprint.

Generally, this area extends near the limit of the development area and as such will not see major construction activities. Clearing and earthwork will be limited to the south and east catchment boundary. Landscaping and reforestation activities will take place within the westerly and northerly buffer area.

c) Drainage Area SH2

This area will not be heavily affected by the proposed development and its boundary will be slightly realigned because of interference with Infiltration Basin #2 and Stormwater Pond #2. Other project related activities will be limited to the Carp Road widening and minor landscaping work along the site boundary. Post-development size of this catchment will shrink to 5.06 ha down from 5.77 ha originally. The runoff coefficient remains unchanged at 0.36 after development. The 1:100 year flow was estimated as 0.66 m^3/s at the catchment outlet and is lower than under pre-development conditions.

d) Drainage Area FD

There will be no change in hydrologic characteristics of this area as there is no new development proposed within this part of the site.

2.3.3 Hydrologic Modelling

The Bentley Pondpack Version 8i computer program utilizing the SCS Unit Hydrograph Method was used for hydrologic modelling. A summary of the modelling procedure is outlined in **Appendix A**. Pondpack printouts for post-development conditions within Drainage Areas A and B are provided in **Appendix B**. The reader is referred to the same appendix for schematic of both catchments. **Tables 8-3 and 8-4** provide a comprehensive summary of the hydrologic modelling results. These results include rainfall data, flows, runoff volumes and coefficients, water levels, storage capacities and draining times.

The synthetic SCS Type II rainfall distribution for the 24-hour storm for the Ottawa meteorological station was used for hydrograph development with the following input parameters:

- size of drainage area;
- time of concentration;
- calibrated CN curve number; and
- constant infiltration rate of 12 mm/hr for both infiltration basins as recommended by the geotechnical investigation and hydrogeologist.

Default equations for time to peak and peak discharge of the hydrograph were used.

Hydrograph routing and addition in accordance with the drainage area schematic was carried out by the computer model. Stormwater ponds and infiltration basins were sized through an iterative process until they complied with the established design criteria. The Modified Puls Method was used for reach routing to account for hydrograph translation through the on-site ditching network.

It is interpreted that modelling results are conservative because simulated low frequency peak flows exceed those calculated manually with the Rational Method. For example, simulated 1:100 year flow at Pond #2 is 7.71 m^3/s, and is 45% higher than the same flow determined with the Rational Method. Similarly, runoff coefficients shown in **Table 8-3**, Column (7) for low frequency events are generally higher than the corresponding coefficients shown in **Table 8-2** even when accounting for the Rational Method peak flow increase factor for infrequent storms. For example, the simulated 1:100 year runoff coefficient for Catchment B is 0.533 and higher than the adjusted corresponding Rational Method coefficient of 0.498 (0.398 x 1.25) shown in **Table 8-2**. This indicates that the ponds are not undersized and that their storage capacities are adequate and conservative.

2.3.4 Stormwater System Infrastructure

2.3.4.1 Ditching

The overall layout of the proposed ditching system including invert elevations is shown on **Drawing 4**.

Ditching will be trapezoidal in the section with bottom width ranging from zero (triangular section) to 2 m depending on estimated flow. Schedule of ditch bottom widths is provided on **Drawing 4**. The highest flows will be in the landfill perimeter ditch draining into Stormwater Pond #2. The design 1:25 year flow for the south and north branches of the landfill perimeter ditch near Pond #2 inlet was calculated at approximately 1.8 m^3/s. Water depth under such flow in trapezoidal channel having a bottom width of 2 m and a slope of 0.5% would be 0.5 m which is less than the minimum ditch depth of approximately 1.1 m.

The landfill perimeter ditch will have an outer slope of 3H:1V (minimum) and an inner (landfill side) slope of 4H:1V (minimum) which is the same as the landfill side slopes. All other ditches will have side slopes not steeper than 3H:1V. Generally, the proposed ditches are relatively flat at grades around 0.5%. Flow velocity under such conditions for the 1:25 year storm event will be low at less than 1.0 m/s. Such velocities are suitable for grass lining which will assist in sediment filtering and erosion control.

Locally, ditching will be steeper and all ditches sloping at more than 3 to 4% will be rip rap lined with appropriately sized stone over geotextile. This includes ditching along the high access road having a grade of up to 8%. The rip rap lining will also be provided at all culvert ends, ditch inlets and at ditch alignment changes exceeding 45 degrees. Rip rap grouting may be used to further reduce erosion potential and washouts. Rock check dams will be installed along the long, steep ditch sections to reduce flow velocity.

Erosion control mats and sod may be used wherever establishment of vegetation cover is critical.

2.3.4.2 Storm Sewers and Culverts

Two (2) sections of storm sewers are part of the proposed drainage system. The first is 300 mm diameter overflow line for Infiltration Basin #1 discharging into Infiltration Basin #2. This line is provided in compliance with design guidelines which require overflow protection for infiltration basins. The line will not transmit any stormwater under normal conditions.

The second short section of storm sewer will service the mini-transfer drop-off area. This sewer line will be equipped with an isolation valve and Stormceptor unit to provide continuous treatment of total suspended solids as well as oil separation in case of an accidental spill upstream within the drop-off area. The above

noted system components will prevent pollution from reaching Stormwater Pond #1 and ultimately Infiltration Basin #1.

Corrugated steel pipe (circular and arch) will be used for culvert installation. Corrugated steel pipe arch (CSPA) is proposed under roads where increased depth of cover is required to withstand loadings from vehicular traffic. Concrete culverts are proposed at critical locations where heavy truck traffic is anticipated and where lighter pipe integrity could be in question.

All culverts were sized for the 1:25 year flow with sufficient spare capacity to allow for the 1:100 year flow to pass without overtopping ditch embankments.

2.3.4.3 Stormwater Ponds

Two (2) new stormwater ponds are proposed for surface water quality control in accordance with the MOE Landfill Design Standards. The ponds will attenuate peak flows but this function is not important since pre-treated stormwater discharges into the infiltration basin where it is recharged into the shallow groundwater system. The ponds outflow rates are controlled by recharge capacity of the shallow groundwater regime in the vicinity of the downstream infiltration facilities.

Stormwater pond dimensions and outlet pipe details are outlined on **Figure 8-3**. Hydrologic modelling results related to stormwater ponds are shown in **Table 8-3**. This table shows pond flows, volumes, water levels and drainage times. The ponds internal side slopes will be 4H:1V (minimum) and external side slopes 3H:1V (minimum). Each pond will consist of the following storage zones:

- permanent water pool, which includes sediment storage – between pond bottom and invert of the outlet pipe; and
- settlement zone – above invert of the outlet pipe.

The outlet pipe will be a relatively small diameter culvert (HDPE pipe) equipped with an isolation valve. A typical section for Pond #1 and Pond #2 are shown on **Drawing 9**. All ponds will be lined with a 600 mm clay liner. The pond base and side slopes up to 0.3 m above the normal water level will be covered with at least 150 mm of drainage gravel which will be placed over geotextile separator. The gravel layer will protect the underlying clay liner and serve as an indicator during sediment removal operations. In addition, drainage gravel will protect pond side slopes against wave action. The remaining portion of the internal side slopes will be topsoiled and vegetated. Fill placed within containment berms will consist of well compacted fine grained soils. In order to increase the infiltration contact area with native soils, fill material underlying the clay liner below the pond base will be composed of well compacted permeable granular

material (sand). All surficial, in-place loose fill will be removed down to native soil before any fill placement. A large quantity of such unsuitable material has been identified through the geotechnical investigation within Dibbley Pit (Depression #4). All of the above noted requirements are illustrated on Sections C, D and E, **Drawing 9**. The stability of pond side slopes has been assessed by the geotechnical engineer and found to be satisfactory under various operational scenarios.

The proponent may change the lining of the stormwater ponds and use geomembrane supported geosynthetic clay liner (GCL) instead of a conventional clay liner. This option would be decided based on economics and subject to a geotechnical slope stability assessment.

Each pond will be capable of settling particles larger than 40 microns even during major storm events. It was determined that both ponds will be capable of settling particles as small as 7 microns. A high sediment capture efficiency is caused by relatively low outflow rates. Refer to **Appendix A** for the theoretical size of settled particle calculations.

Both ponds have sufficient capacity to store/treat all runoff generated from the 25 mm storm event. This volume, as determined through hydrologic modelling, is 436 m^3 and 1,296 m^3 for Ponds #1 and #2 respectively and they are substantially lower than the corresponding permanent water pool volumes of 2,600 m^3 and 4,200 m^3 as is shown in **Table 8-3**.

Both ponds were sized with a relatively high length to width ratio exceeding 4:1.

A plunge pool (forebay) will be provided near each pond inlet to capture coarser suspended particles. The forebay will be 0.5 m deeper than pond bottom design elevation, providing additional sediment storage capacity. The forebay area will also be covered with drainage gravel and geotextile. Each pond inlet will be reinforced with rip rap. Accumulated sediment will be removed in accordance with criteria outlined in the Erosion and Sediment Control Plan, West Carleton Environmental Centre, WSP, March 2015. Removed sediment will be used as daily cover within the active disposal area.

A rip rap baffle across the pond width downstream of the inlet(s) is proposed to improve flow distribution, minimize short circuiting and to separate forebay from the more quiescent settling zone. Each pond will be equipped with a rip rap lined overflow spillway sized for the 1:100 year flow rate discharging into the downstream infiltration basin. Pond draining time will not exceed 48 hours.

2.3.4.4 Infiltration Basins

Infiltration facilities are designed to capture and retain runoff and allow it to infiltrate rather than discharge to surface water. This system has several benefits such as reducing surface runoff volume and pollutant discharge as well as augmenting low flow stream conditions and thus supporting wildlife habitat during low flow periods.

Subsurface exploration consisting of several borings was carried out to determine in-situ soil and groundwater conditions within the designated groundwater recharge areas. This work is summarized in the Supplemental Geotechnical Investigation by Alston Associates Inc. Refer to "Geotechnical Studies, West Carleton Environmental Centre" assembled in March 2015 by WSP. The permeability of soil from numerous samples collected within the footprint of infiltration facilities was estimated with the Hazen formula and ranged from 5×10^{-2} cm/s to 1.6×10^{-5} cm/s.

The constant rate infiltration rate of 12 mm/hr was selected for design in consultation with the hydrogeologist based on the observed local subsurface conditions. This rate was used as an input in hydrologic modelling and was used for sizing of both basins.

Groundwater recharge at infiltration facilities will result in the long term localized mounding of the shallow groundwater table. The maximum long term elevation of the shallow groundwater was determined by the hydrogeologist using "Modflow" groundwater flow computer model as follows:

- Infiltration Basin #1 – 120.81 masl
- Infiltration Basin #2 – 120.86 masl

Infiltration basin base elevations were selected to provide at least 1 m separation from the maximum predicted groundwater level.

Suspended solids loading in stormwater draining into each basin will be largely reduced by sedimentation taking place in both of the new stormwater ponds. This will control/reduce blinding and plugging of the basin base surface.

The following dimensions were established for the base of each infiltration basin:

- Infiltration Basin #1 – 116 x 158 m
- Infiltration Basin #2 – 118 x 217 m

Hydrologic modelling results including basin volumes, water levels and draining times are presented in **Table 8-4**. Maximum water storage under the 1:100 year design storm was calculated as 5,669 m^3 for Basin #1 and 15,530 m^3 for Basin #2. Each basin will have substantial additional capacity above the design water level which was calculated as follows:

- Infiltration Basin #1 – 19,573 m^3
- Infiltration Basin #2 – 28,062 m^3

This additional storage will provide a safety cushion in case of an extreme storm, heavier than the 1:100 year design event.

Sections of the infiltration basin are shown on **Drawings 9 and 10**. Imported, permeable fill will be required for construction of each basin. Permeable fill (sand having permeability ranging from 0.01 – 0.001 cm/s) will be placed loose over the scarified native soil following removal of all unsuitable loose fill material which was identified mainly within Infiltration Basin #1 area. Interior and exterior side slopes of infiltration basins will be 3H:1V. Fill placed within containment berms will consist of fine grained soil with the uppermost 600 mm consisting of the clay liner. Permeable material placed below the containment berms will be compacted to 98% SPMDD. Impermeable containment berms are required to ensure integrity and stability of fills when exposed to hydraulic gradients resulting from a sudden rise of water level. This requirement applies to the east and northeast berm in Infiltration Basin #2. The remaining banks of the basins constructed as fill or cut will not require the same treatment as exterior containment berms and engineered fill may be used at these locations. The reader is also referred to Sections C and D, **Drawing 9**, showing construction requirements along the boundary between infiltration basin and stormwater pond. All interior and exterior side slopes of infiltration basins will be topsoiled and vegetated, with the base remaining bare so it can be raked and scarified when needed. Permeable sand on the bottom of an infiltration basin will intercept silt, sediment and debris that could otherwise clog the base of the basin. The upper 50 – 100 mm of this sand layer can be readily restored following removal operations. Sand replacement material shall be of the same quality as originally installed material (hydraulic conductivity 1×10^{-4} to 1×10^{-5} m/s).

Rip rap lining for energy dissipation will be provided at all inlets into the basin for erosion control. All basins will also be equipped with an access ramp for maintenance access. Overflow spillways are provided in accordance with design guidelines to protect infiltration facilities against catastrophic failure from excessive rise in water level but due to the significant additional capacity within the basins are never anticipated to be used.

2.3.4.5 Operational Controls

Under normal conditions, isolation valves on the outlet piping from stormwater ponds will be open allowing water to drain by gravity into infiltration basins. These valves will be closed if contamination is suspected including the valve controlling drainage from the mini-transfer drop-off area.

Stormwater will flow into the ponds, deposit the coarse fraction of sediment in the forebay and settle smaller particles in the aft-bay section of the stormwater ponds before water is released into the infiltration basin.

In day-to-day operation, staff will visually monitor all stormwater ponds. Should contamination be suspected, testing of the stormwater pond's contents will be carried out by hand-held, on-site instrumentation to measure conductivity, pH and visual aesthetic conditions. Conditions present on site that might indicate the necessity to monitor the pond's contents could include the following:

- visible leachate seep to surface water flowing to one of the surface water ponds;
- evidence of dark stained water;
- oil or any other substance in amounts sufficient to create a visible film, sheen or foam on the receiving waters; or,
- accumulation of floating or settleable solids.

Refer to **Appendix C** for decision-making criteria related to regular and emergency operation of stormwater ponds. Stormwater quality criteria for field and laboratory sampling are also outlined in the same appendix.

The isolation valve on the outlet piping would be closed and remain closed when the pond's water quality is in question. A sample taken for further analysis would be placed in a "rush" category for reporting by an independent laboratory. If the stormwater does not satisfy the trigger concentrations then the stormwater contingency plan will be initiated. Refer to **Appendix C** for a list of contingency corrective actions.

The isolation valve controlling the mini-transfer area shall be closed immediately after spill detection and remain closed until satisfactory clean-up is completed and the area suitable for normal operations.

Depending on the type and severity of contamination, it may be desirable to remove accumulated sediment from the forebay and/or aft bay of the stormwater pond.

These procedures will allow control of surface water discharging into infiltration basins. Under normal conditions, surface water draining into infiltration facilities shall be deemed suitable for groundwater recharge.

Prepared by:

WSP Canada Inc.

Peter S. Brodzikowski, P. Eng.
Designated Consulting Engineer
Senior Environmental Engineer
PSB/dlw

Figures

RICHARDSON SIDEROAD

LANDS OWNED BY WASTE MANAGEMENT OF CANADA CORPORATION

SOUTH HUNTLEY CREEK

PROPERTY BOUNDARY (Typ)

PROPOSED NEW LANDFILL AREA

DEPRESSION #5

DEPRESSION #3

SWMF #1

DEPRESSION #4

LAND PROPOSED TO BE REZONED

PROPOSED NEW LOCATION FOR SITE ENTRANCE AND EXIT

HUNTLEY QUARRY

WILLIAM MOONEY ROAD

CARP ROAD

HIGHWAY 417

EXISTING LANDFILL

EXISTING ENTRANCE, SCALE AND OFFICE

CUMBERLAND READY-MIX

BIOSOLIDS STORAGE

DEPRESSION #2

EXISTING FLARE AND BLOWER BUILDING

LANDS SUBJECT TO SITE PLAN CONTROL

CLOSED SOUTH CELL

POPLAR FOREST

KARSON AGGREGATES

PROPERTY BOUNDARY (CAZ)

SWMF #2

DEPRESSION #1

LANDFILL GAS TO ENERGY BLD

HIGHWAY 417

PROPERTY BOUNDARY (CAZ)

NOTE :

1. TOPOGRAPHIC FEATURES SHOWN ON THIS PLAN ARE BASED ON AERIAL PHOTOGRAPHY BY BASE MAPPING LIMITED FROM JULY 2007

SCALE : 1 : 12500

0 100 200 300 400 500m

P.S.B.	REVISION No. 1	JULY 31, 2015

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WASTE MANAGEMENT

SITE PLAN
SURROUNDING AREA

WEST CARLETON
ENVIRONMENTAL CENTRE

DWN BY: T C G
CHK BY: F C F

DATE: JULY 2014
SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

DRAWING NO. 131-19416-00 - 1-1

FIGURE
1-1

G:\2013\GIS\13-401 - Environmental\131-19416-00 - Ottawa Landfill Expansion\DRAWINGS FOR SITE PLAN APPROVAL APPLICATION\JULY 2015 RE\131-19416-00 FIG 1-1.dwg Jul 29, 2015 - 2:46pm

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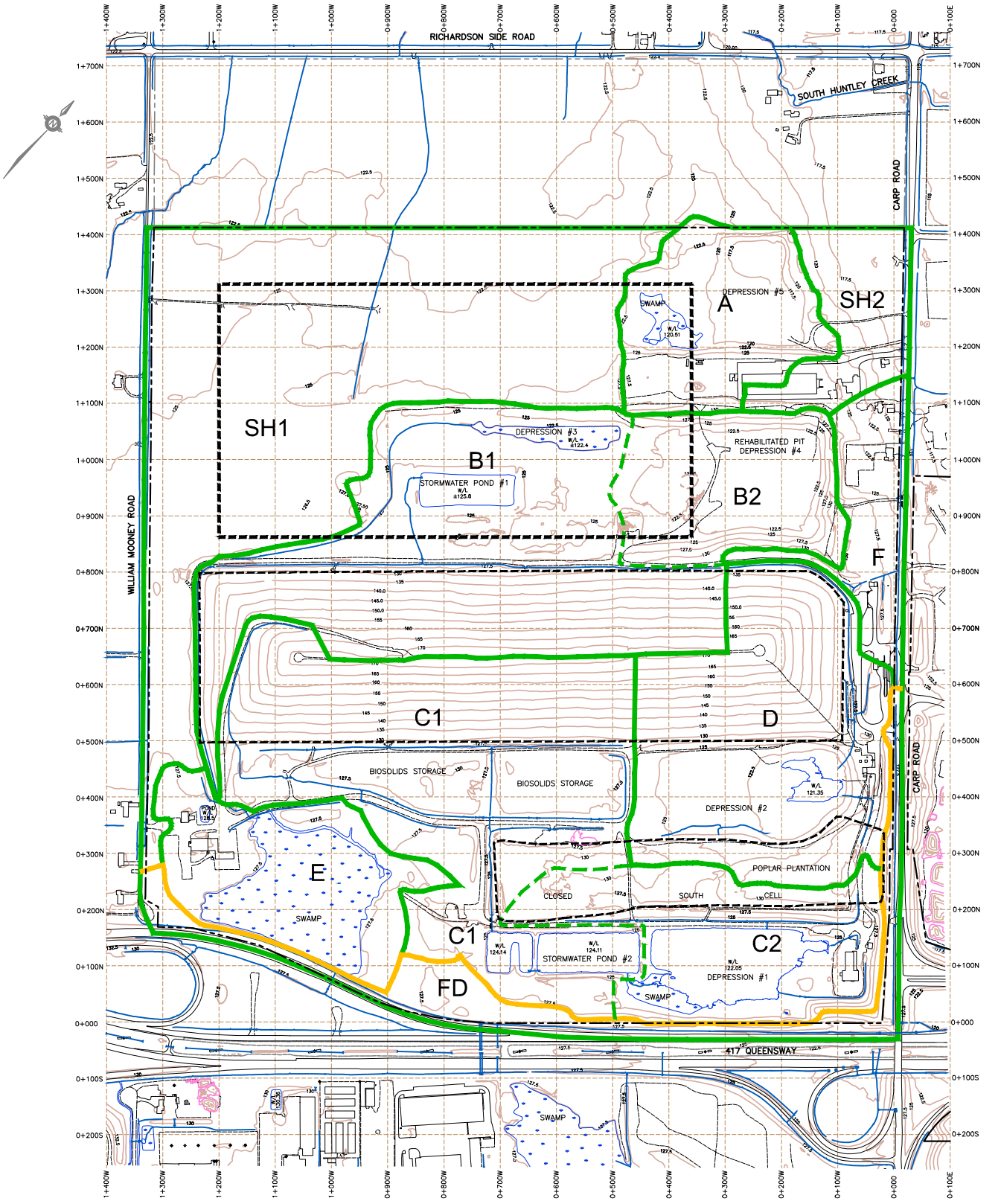

LEGEND :

- LIMIT OF DRAINAGE AREA
- LIMIT OF SUBCATCHMENT AREA
- DIVISION BETWEEN FEEDMILL AND SOUTH HUNTLEY CREEK WATERSHEDS
- PROPOSED LANDFILL LIMIT
- WASTE MANAGEMENT OF CANADA PROPERTY LIMIT
- EXISTING LANDFILL LIMIT
- EXISTING GROUND CONTOURS

SCALE :1:10.000:

0 80 160 240 320 400m

FIGURE 8-1

DWN BY: T C G
CHK BY: P S B
DATE: JULY 2014
SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

DRAWING NO. 131-19416-00 - 8-1

PRE-DEVELOPMENT DRAINAGE AREAS

WEST CARLETON ENVIRONMENTAL CENTRE

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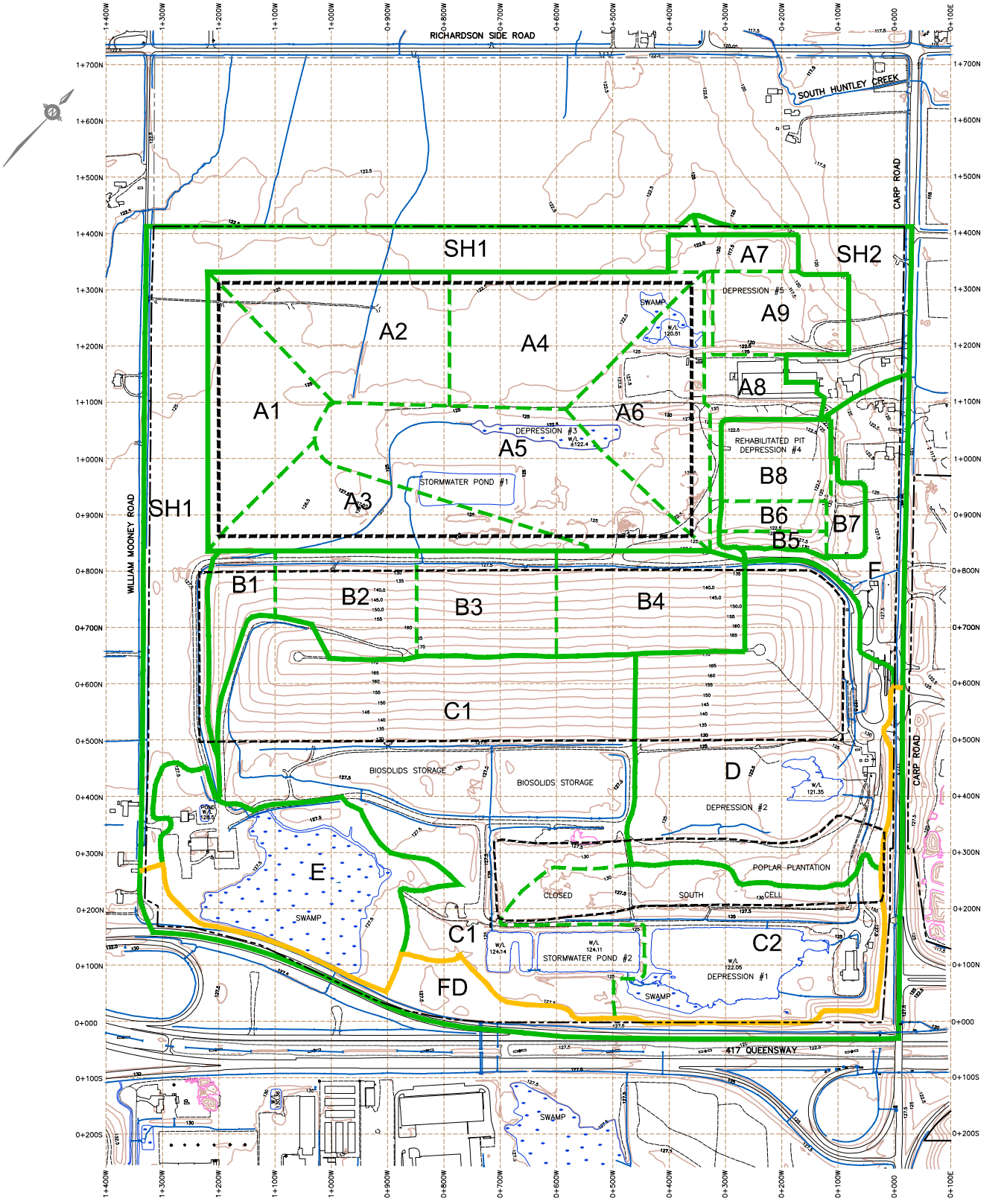

LEGEND :

- LIMIT OF DRAINAGE AREA
- LIMIT OF SUBCATCHMENT AREA
- DIVISION BETWEEN FEEDMILL AND SOUTH HUNTLEY CREEK WATERSHEDS
- PROPOSED LANDFILL LIMIT
- WASTE MANAGEMENT OF CANADA PROPERTY LIMIT
- EXISTING LANDFILL LIMIT
- EXISTING GROUND CONTOURS

SCALE :1:10.000:

0 80 160 240 320 400m

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FIGURE 8-2

DWN BY: T C G
CHK BY: P S B
DATE: JULY 2014
SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORP.

DRAWING NO. 131–19416–00 – 8–2

POST-DEVELOPMENT DRAINAGE AREAS

WEST CARLETON ENVIRONMENTAL CENTRE

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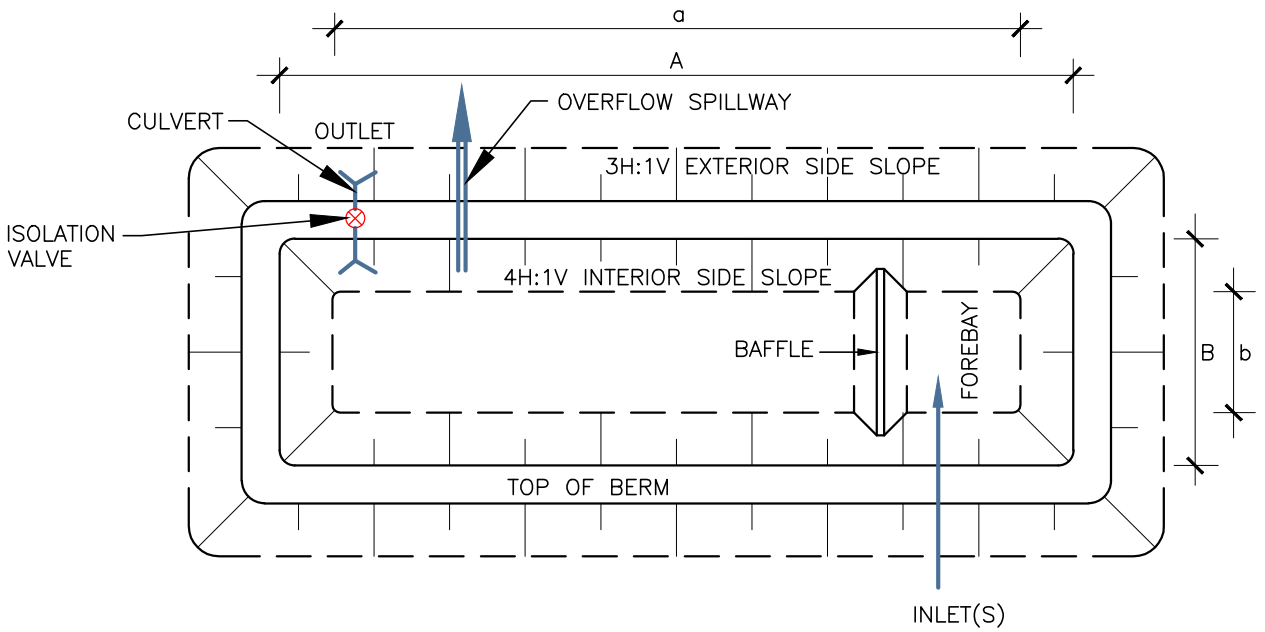

STORMWATER POND SCHEMATIC

SCALE: NTS

POND #	1	2
BOTTOM ELEVATION (m)	124.00	122.80
TOP OF BERM ELEVATION (m)	VARIES 126.75 – 129.00	VARIES 126.30 – 126.80
OUTLET PIPE NOMINAL ø (mm)	300	350
OUTLET INVERT UPSTREAM (m)	124.60	123.40
OUTLET INVERT DOWNSTREAM (m)	124.50	123.30
OVERFLOW SPILLWAY ELEVATION (m)	125.85	125.40
OVERFLOW SPILLWAY BOTTOM WIDTH (m)	3.0	6.0
a (m)	150	200
A (m)	184	228
b (m)	26	32
B (m)	51	62

NOTE :

ACTUAL INLET/OUTLET CONFIGURATION MAY VARY FROM THIS SHOWN HEREIN.

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FIGURE 8-3

DWN BY: T C G
CHK BY: P S B
DATE: JULY 2014
SCALE: NTS

WASTE MANAGEMENT OF CANADA CORP.

DRAWING NO. 131–19416–00 – 8–3

STORMWATER POND SCHEMATIC

WEST CARLETON ENVIRONMENTAL CENTRE

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Tables

TABLE 8-1
DRAINAGE AREA CHARACTERISTICS, PRE-DEVELOPMENT CONDITIONS
WM - WEST CARLETON ENVIRONMENTAL CENTRE

Drainage Area		Size [ha]		Time of Concentration (Tc) [(1)] [min]	Runoff Coefficient C		Rational Method Peak Flow Q_{100} [m^3/s]	Remarks
A		10.08		19	0.29		1.01	No outlet.
B	B1	39.47	29.41	35	0.32	0.34	2.30	No outlet.
	B2		10.06	10		0.25	1.34	No outlet.
C	C1	45.19	31.69	25	0.29	0.32	2.92	No outlet.
	C2		13.50	12		0.22	1.40	No outlet.
D		21.34		16	0.34		2.82	No outlet.
E		11.50		29	0.25		0.83	No outlet.
F		5.80		11	0.34		0.99	No outlet. Drains off-site to Huntley Quarry
SH	SH1	47.12	41.35	-	0.25	0.23	-	Multiple outlets to South Huntley Creek
	SH2		5.77	18		0.36	0.75	
FD		7.79		38	0.31		0.52	Drains to Feedmill Creek
TOTAL		**188.29**		**-**	**0.29**		**-**	

Notes:

(1) Tc established using Kirpich Method

TABLE 8-2
DRAINAGE AREA CHARACTERISTICS, POST-DEVELOPMENT CONDITIONS
WM - WEST CARLETON ENVIRONMENTAL CENTRE

Drainage Area		Size [ha]		Time of Concentration (Tc) [3] [min]		Runoff Coefficient C		Soil/Land Use Curve Number CN (AMC II)		Rational Method Peak Flow Q_{100} [m^3/s]		Remarks	
A	A1	51.66	5.75	32[1]	15	0.432	0.433	80.9	80.9	5.31[1]	1.01	No outlet	
	A2		7.59		15		0.435		81.2		1.34		
	A3		6.3		19		0.459		82.1		1.00		
	A4		7.74		19		0.435		81.1		1.17		
	A5		10.27		17		0.44		81.6		1.69		
	A6		6.25		15		0.45		81.4		1.14		
	A7		1.5		-		0.5		85		-		No concentrated flow
	A8		2.8		18		0.561		85.7		0.57		
	A9		3.46		-		0.16		70		-		No concentrated flow
B	B1	22.58	2.11	31[2]	11	0.398	0.412	79.1	79.6	2.13[2]	0.44	No outlet	
	B2		4.28		12		0.418		79.7		0.84		
	B3		4.67		14		0.42		79.9		0.84		
	B4		6.1		15		0.439		80.5		1.09		
	B5		0.64		6		0.24		72		0.12		
	B6		1.03		-		0.5		85		-		No concentrated flow
	B7		0.94		6		0.606		86.2		0.43		
	B8		2.81		-		0.16		70		-		No concentrated flow
C	C1	45.19	31.69	25		0.29	0.32	-		2.91		No outlet. No change.	
	C2		13.5	12			0.22	-		1.40		No outlet. No change.	
D		20.83		16		0.34		-		2.75		No outlet. No change.	
E		11.50		29		0.25		-		0.83		No outlet. No change.	
F		5.24		11		0.38		-		0.99		No outlet. No flow increase.	
SH	SH1	23.50	18.44	-		0.27	0.25	-		-		Multiple outlets. Drainage area reduced by 55%. Flow lower than under pre-development conditions.	
	SH2		5.06	18			0.36	-		0.66		Flow lower than under pre-development conditions.	
FD		7.79		38		0.31		-		0.52		No change.	
TOTAL		**188.29**		**-**		**0.35**		**-**		**-**			

Notes:

(1) Tc and Q_{100} at Pond 2

(2) Tc and Q_{100} at Pond 1

(3) Tc established using Kirpich Method

TABLE 8-3
HYDROLOGIC MODELLING RESULTS - STORMWATER PONDS (24-HR SCS II STORM)
WM - WEST CARLETON ENVIRONMENTAL CENTRE

Storm	Rainfall Depth [mm]	Post Development Conditions									
		Rainfall Volume [m^3]	Pond Peak Inflow [m^3/s]	Rational Method Pond Peak Inflow [m^3/s]	Runoff Volume [m^3]	Calculated Runoff Coefficient (6) / (3)	Peak Pond Outflow [m^3/s]	Maximum Water Level [mASL]	Maximum Water Storage excluding PWPV [m^3]	Total Pond Water Storage [m^3]	Draining Time After Storm [hr]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Drainage Area A (Pond #2) - 48.2 ha, Normal Water Level - 123.4 m, Permanent Water Pool Volume (PWPV) - 4,200 m^3											
1:2 yr	48.2	23,232	1.50	2.06	7,024	0.302	0.10	123.87	3,845	8,045	23
1:5 yr	63.8	30,752	2.94	2.65	12,177	0.396	0.15	124.25	7,247	11,447	31
1:10 yr	74.2	35,764	4.01	3.04	15,954	0.446	0.18	124.53	9,917	14,117	35
1:25 yr	87.3	41,206	5.46	3.88	20,988	0.509	0.22	124.88	13,609	17,809	40
1:50 yr	97.0	46,754	6.57	4.66	24,866	0.532	0.24	125.15	16,534	20,734	44
1:100 yr	106.6	51,381	7.71	5.31	28,805	0.561	0.26	125.40	19,543	23,743	48
Drainage Area B - (Pond #1) - 19.77 ha, Normal Water Level - 124.60 m, Permanent Water Pool Volume (PWPV) - 2,598 m^3											
1:2 yr	48.2	9,529	0.51	0.83	2,606	0.273	0.04	124.88	1,369	3,967	11
1:5 yr	63.8	12,613	1.07	1.06	4,617	0.366	0.08	125.08	2,444	5,042	14
1:10 yr	74.2	14,669	1.49	1.22	6,106	0.416	0.10	125.25	3,391	5,989	17
1:25 yr	87.3	17,259	2.08	1.55	8,104	0.469	0.12	125.47	4,720	7,318	20
1:50 yr	97.0	19,177	2.54	1.87	9,651	0.503	0.13	125.64	5,784	8,382	23
1:100 yr	106.6	21,075	3.00	2.13	11,226	0.533	0.15	125.81	6,890	9,488	25

TABLE 8-4
HYDROLOGIC MODELLING RESULTS - INFILTRATION BASINS (24-HR SCS II STORM)
WM - WEST CARLETON ENVIRONMENTAL CENTRE

Storm	Post-Development Conditions				
	Runoff Volume [m^3]	Maximum Water Level [mASL]	Maximum Water Storage [m^3]	Draining Time After Upstream Pond Empties [hr]	Capacity Up to Emergency Overflow Level [m^3]
(1)	(2)	(3)	(4)	(5)	(6)
Drainage Area A - Infiltration Basin 2 - Bottom 122.00, Overflow Spillway Level - 123.60 mASL					
1:2 yr	7,084	122.05	1,348	5	
1:5 yr	12,448	122.16	3,997	7	
1:10 yr	16,399	122.25	6,381	13	43,592
1:25 yr	21,680	122.38	9,827	24	
1:50 yr	25,760	122.48	12,612	32	
1:100 yr	29,909	122.59	15,530	40	
Drainage Area B - Infiltration Basin 1 - Bottom 123.00 - Overflow Storm Sewer Invert - 124.30 mASL					
1:2 yr	2,728	123.03	525	8	
1:5 yr	4,921	123.06	1,165	9	
1:10 yr	6,558	123.11	2,040	10	25,242
1:25 yr	8,767	123.18	3,370	15	
1:50 yr	10,484	123.24	4,484	18	
1:100 yr	12,238	123.31	5,669	23	

Note: Constant infiltration rate 12 mm/hr

Drawings

TRAPEZOIDAL DRAINAGE DITCH DIMENSIONS

FROM	TO	BOTTOM WIDTH (m)
DB1	DB2	1000
DB2	POND #2	2000
DB3	DB4	1000
DB4	POND #2	2000
DB5	DB6	1000
DB6	POND #1	2000

NOTE :
ALL OTHER DITCHES TO BE TRIANGULAR WITH SIDE SLOPES NO STEEPER THAN 3H : 1V

RICHARDSON SIDE ROAD

WILLIAM MOONEY ROAD

CARP ROAD

SOUTH MARLEY CREEK

HUNTLEY QUARRY

WOODLOT

TRAIL

HOUSE

UNDEFINED FLOW PATH IN FOREST

NEW 1.8m HIGH CHAINLINK FENCE ON PROPERTY LINE WITH NO TRESPASSING SIGNS

100m BUFFER (typ)

3.0m HIGH LITTER FENCE

10.0m HIGH LITTER FENCE

CLEANOUT (Typ)

DB1

DB2

DB3

DB4

DB5

DB6

GRAVEL

STORMWATER POND #2 (LINED) BOTTOM 122.60

SPILLWAY (Typ)

DEPRESSION #5

INFILTRATION BASIN #2 BOTTOM 122.00

DEPRESSION #3

STORMWATER POND #1

147.5 (GRADE BREAK)

JOIN TO EXISTING FENCE

TURNAROUND

ACCESS ROAD (PAVED)

ROCK CHECK DAM (Typ)

EXTEND UPWARDS ALL EXISTING INFRASTRUCTURE THAT IS TO REMAIN (MANHOLES, VALVE BOXES, MONITORING AND GAS WELLS). OVERHEAD HYDRO LINE TO BE RAISED/REPLACED AS REQUIRED.

LIMIT OF FILL

TOP OF FILL CONTOUR (Typ)

LIMIT OF CUT

NOTE
GAS WELLS INSTALLED OVER SIDE SLOPE NOT SHOWN

NOTE
LATERALS/SUBHEADERS OF GAS AND CONDENSATE COLLECTION SYSTEMS NOT SHOWN. ELECTRICAL CABLES SERVICING WELL PUMPS ARE NORMALLY IN COMMON TRENCH WITH CONDENSATE PIPING AND ARE ALSO NOT SHOWN.

EXISTING LANDFILL

WEST LIMIT OF HDPE LINED LANDFILL BASE

PAVED ROAD TO WASTE TRANSFER STATION

PROVIDE 1.2m HIGH RUNOFF DIVERSION BERM ON EAST SIDE OF PROPOSED DITCH

OVERFLOW

LAURYSEN BUILDING MAINTENANCE BUILDING

SHOWROOM

SCALE HOUSE

SCALE (2)

REHABILITATED PIT DEPRESSION #4

INFILTRATION BASIN #1 BOTTOM 123.00

ACCESS ROAD (PAVED)

ENTRANCE GATE

REGION EXISTING DITCH

PROPOSED ROAD WIDENING

RETAINING WALL

BANK SWALLOW PROTECTION AREA

STORMWATER POND #1 (LINED) BOTTOM 126.00

INSPECTION LAYBY AREA

CONNECT TO EXISTING DITCH @137.40

MATCH EXISTING WIDENED ROAD @118.75

RELOCATE PORTION OF AIR INJECTION SYSTEM INTERFERING WITH MRF TRANSFER AREA

NEW 1.8m HIGH CHAINLINK FENCE STARTS HERE

SCALE : 1:2000

0 50 100 150 200m

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WM WASTE MANAGEMENT

PROPOSED FINAL LANDFILL CONTOURS

WEST CARLETON ENVIRONMENTAL CENTRE

DWN BY: T C G
CHK BY: P S B

DATE: JULY 2014
SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORPORATION

DRAWING NO. 131-19416-00 - 4

DRAWING 4

LICENSED PROFESSIONAL ENGINEER
P.S. BRODZIKOWSKI
PROVINCE OF ONTARIO

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SECTION A
GRID LINE 1+090N
4
SCALES
1 : 2000 HORIZONTAL
1 : 300 VERTICAL

SECTION B
GRID LINE 0+800W
4
SCALES
1 : 2000 HORIZONTAL
1 : 300 VERTICAL

SECTION C
GRID LINE 0+250W
4
SCALES
1 : 500 HORIZONTAL
1 : 100 VERTICAL

SECTION D
GRID LINE 0+250W
4
SCALES
1 : 500 HORIZONTAL
1 : 100 VERTICAL

SECTION E
GRID LINE 1+300N
4
SCALES
1 : 500 HORIZONTAL
1 : 100 VERTICAL

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WASTE MANAGEMENT

SECTIONS

WEST CARLETON ENVIRONMENTAL CENTRE

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DATE: JULY 2014
SCALE: SEE BAR SCALE
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DRAWING 9

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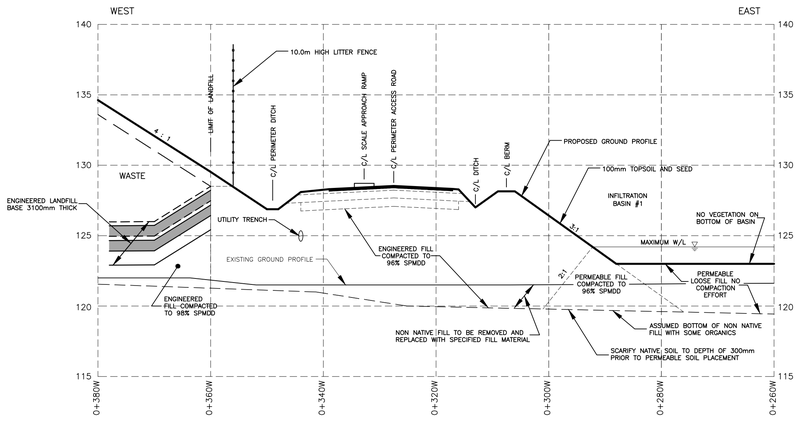
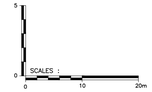
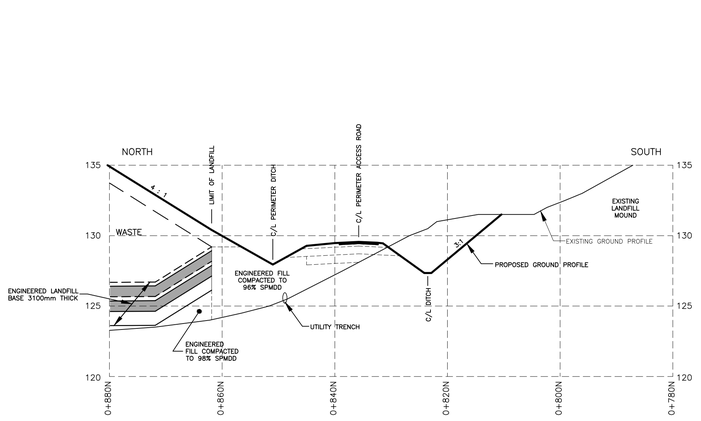


SECTION F
GRID LINE 1+000N
SCALES
1 : 500 HORIZONTAL
1 : 200 VERTICAL





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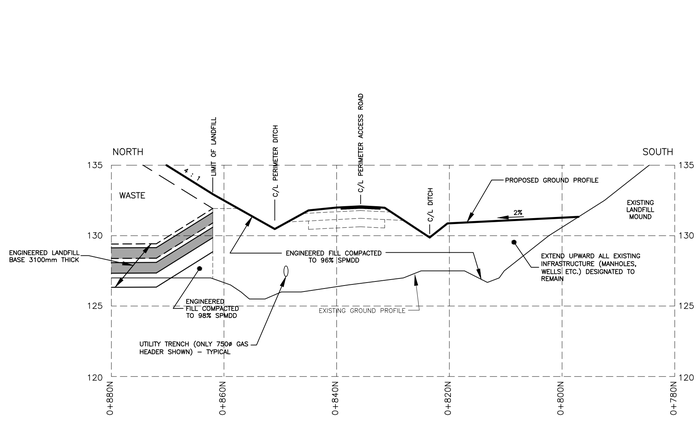

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SCALES
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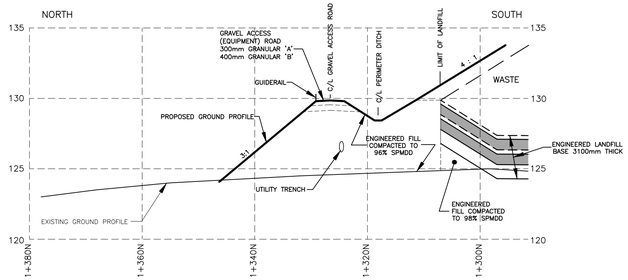

SECTION J
GRID LINE 1+100W
SCALES
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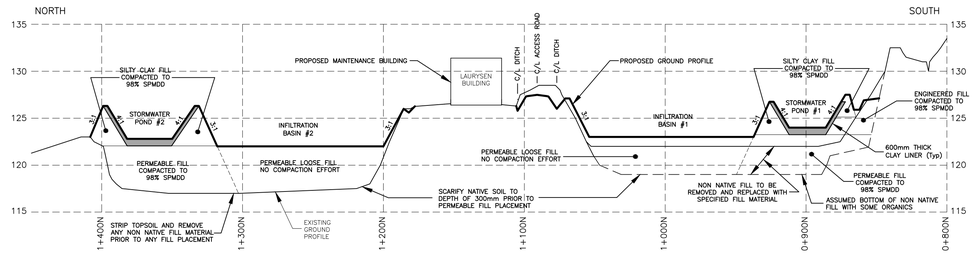

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SCALES
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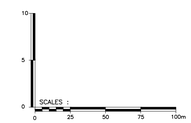
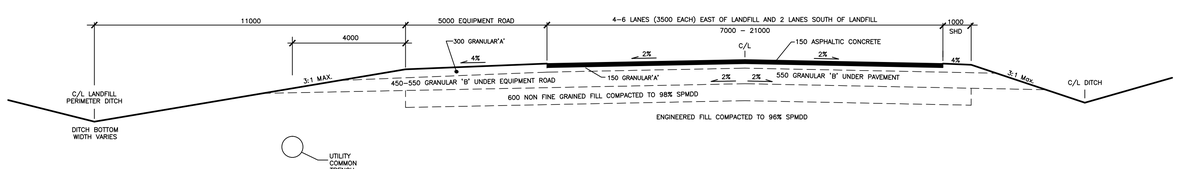
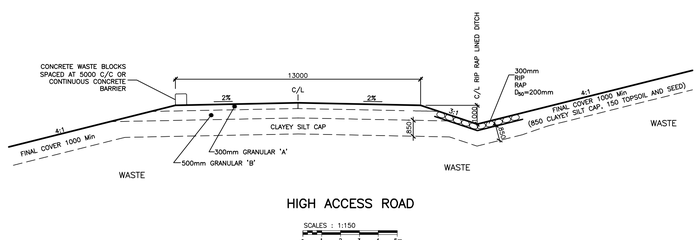


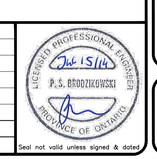


PERIMETER LANDFILL ACCESS ROAD DETAIL



HIGH ACCESS ROAD

DATE	DESCRIPTION
	REVISION / ISSUE



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WASTE MANAGEMENT

SECTIONS

WEST CARLETON ENVIRONMENTAL CENTRE

DWN BY: T C G
CHK BY: P S B
DATE: JULY 2014
SCALE: SEE BAR SCALE

WASTE MANAGEMENT OF CANADA CORPORATION

DRAWING NO. 131-19416-00 - 10

DRAWING 10

G:\2013\GS\13-401 - Environmental\131-19416-00 - Ottawa Landfill Expansion\DRAWINGS FOR D&O\STAMPED DRAWINGS TO MINISTRY JULY 2014\131-19416-10.dwg Jul 09, 2014 - 11:54am

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Appendices

Appendix A

Summary of Modelling Procedure

Appendix A

Stormwater Modelling Procedure Summary

Hydrologic modelling of the stormwater management system is limited to the post development conditions because there will be no off-site discharge from lands encompassing waste disposal area. All runoff originating from landfilling areas will be diverted to infiltration basins and recharged into subsurface groundwater regime.

Post Development Conditions

1. Establish drainage network schematic for each infiltration basin watershed.

2. Define input parameters for SCS Unit Hydrograph Method used by Bentley PondPack model. These include the following parameters:

    a) Subwatershed area.
    b) Time of concentration for each subwatershed which is established within PondPack model using Kirpich equation. This method is conservative and provides relatively short times.
    c) CN curve number for each watershed. Cumulative CN value was established for each subwatershed from conservatively selected CN values corresponding to various applicable land cover features.

3. Enter geometric information for drainage channels as required for hydrograph routing by Modified Puls Method.

4. Establish stormwater pond and infiltration basin dimensions. Use constant infiltration rate of 12 mm/hour recommended by a hydrogeologist for sizing of both infiltration basins.

5. Size outlet structures including emergency overflows for all water storage facilities.

6. Run PondPack model for 24 hour SCS storm (2 to 100 year return period). Verify peak flows and check water levels at each water storage location to ensure compliance with design criteria.

7. Optimize size of water storage facilities and fit them into the overall site design.

In addition to PondPack Modelling, the Rational Method was used to calculate peak flows for all subwatersheds using the following input parameters:

a) subwatershed area;
b) runoff coefficient C;
c) time of concentration (Kirpich Method)
d) rainfall intensity i calculated from Ottawa Intensity Duration Frequency (IDF) data.

The peak flow increase factor was applied to all storms having a return period of more than 10 years. Rational Method peak flows were used for sizing of all proposed culverts.

Settling Velocities for Lined Ponds

Formula to calculate settling velocity is:

$$V_s = \frac{1.2\ Q}{A}$$

Q - is 1:100 year peak pond outflow

A - is water surface area in pond at top of settlement zone i.e. invert of culvert outlet

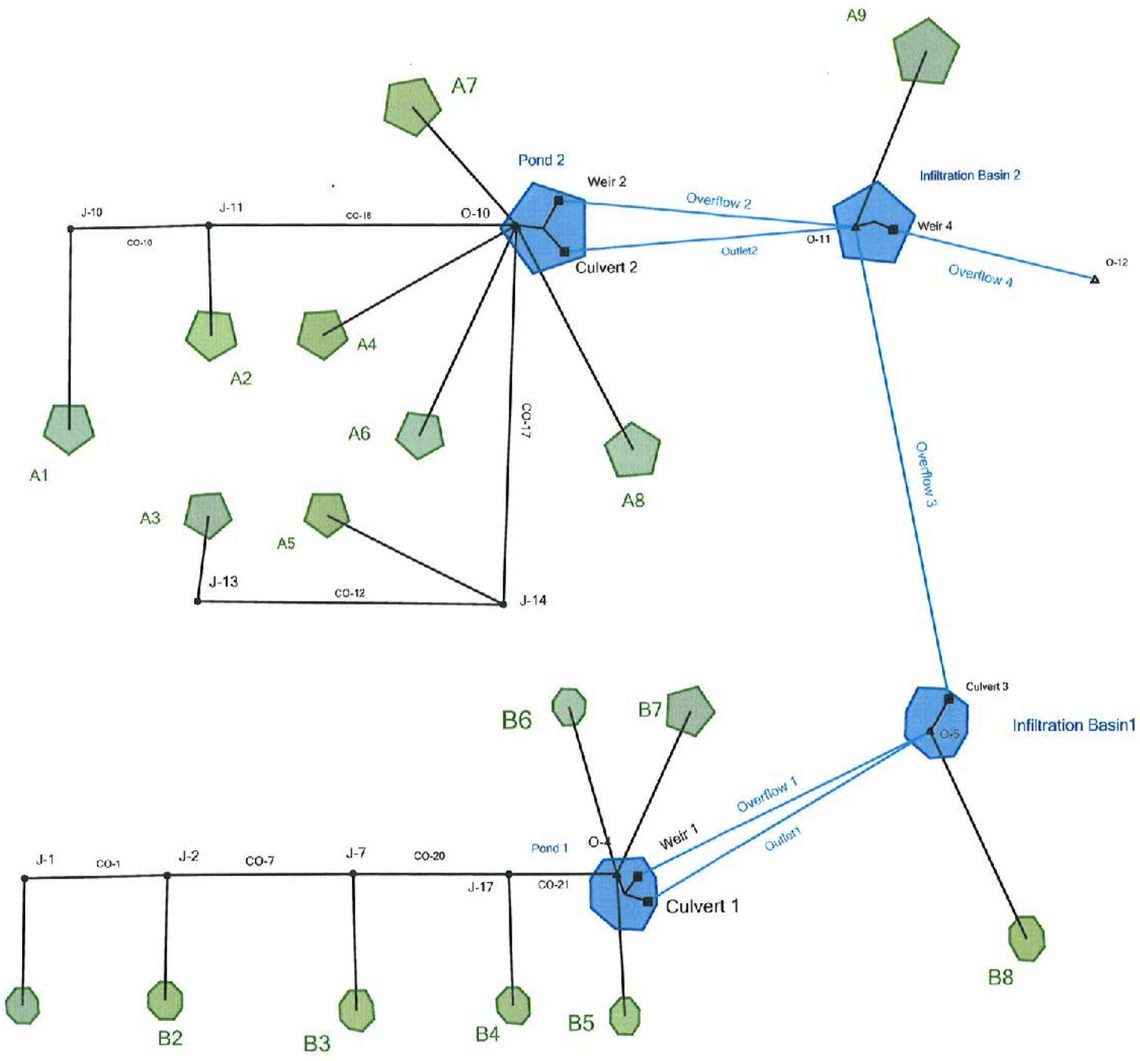
The table below shows calculation results including size of settled particles corresponding to settling velocity V_s

Pond #	Settled Particle Size [Microns]	Q [m^3/s]	A [m^2]	Top of Settlement Zone Elevation [masL]	Calculated V_S [m/s]
1	7	0.15	4,768	124.6	3.78×10^{-5}
2	7	0.26	7,537	123.4	4.14×10^{-5}

Appendix B

Pondpack Printouts – Drainage Areas A & B Post Development

Scenario: Post-Development 1



Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
B1	Post-Development 1	1	39.304	4.000	0.01
B1	Post-Development 2	2	260.430	12.050	0.09
B1	Post-Development 5	5	469.578	12.000	0.17
B1	Post-Development 10	10	625.463	12.000	0.23
B1	Post-Development 25	25	835.319	12.000	0.30
B1	Post-Development 50	50	998.254	12.000	0.36
B1	Post-Development 100	100	1,164.530	12.000	0.42
B2	Post-Development 1	1	81.099	4.000	0.02
B2	Post-Development 2	2	532.187	12.050	0.18
B2	Post-Development 5	5	957.761	12.050	0.33
B2	Post-Development 10	10	1,274.768	12.000	0.44
B2	Post-Development 25	25	1,701.333	12.000	0.60
B2	Post-Development 50	50	2,032.357	12.000	0.72
B2	Post-Development 100	100	2,370.120	12.000	0.84
B3	Post-Development 1	1	91.633	4.000	0.02
B3	Post-Development 2	2	589.981	12.050	0.19
B3	Post-Development 5	5	1,057.917	12.050	0.35
B3	Post-Development 10	10	1,405.903	12.050	0.48
B3	Post-Development 25	25	1,873.697	12.050	0.64
B3	Post-Development 50	50	2,236.521	12.050	0.76
B3	Post-Development 100	100	2,606.481	12.050	0.89
B4	Post-Development 1	1	132.466	4.000	0.03
B4	Post-Development 2	2	806.832	12.050	0.25
B4	Post-Development 5	5	1,431.332	12.050	0.47
B4	Post-Development 10	10	1,893.604	12.050	0.63
B4	Post-Development 25	25	2,513.233	12.050	0.84
B4	Post-Development 50	50	2,992.779	12.050	1.00
B4	Post-Development 100	100	3,481.132	12.050	1.16
B6	Post-Development 1	1	43.523	4.000	0.01
B6	Post-Development 2	2	188.590	11.950	0.08
B6	Post-Development 5	5	310.749	11.950	0.13
B6	Post-Development 10	10	398.220	11.950	0.16
B6	Post-Development 25	25	513.158	11.950	0.21
B6	Post-Development 50	50	600.799	11.950	0.25
B6	Post-Development 100	100	689.175	11.950	0.28
B5	Post-Development 1	1	1.699	4.000	0.00
B5	Post-Development 2	2	40.691	12.000	0.01
B5	Post-Development 5	5	86.904	12.000	0.03
B5	Post-Development 10	10	123.801	11.950	0.05
B5	Post-Development 25	25	175.536	11.950	0.07
B5	Post-Development 50	50	216.907	11.950	0.09
B5	Post-Development 100	100	260.005	11.950	0.11
B8	Post-Development 1	1	2.605	4.000	0.00
B8	Post-Development 2	2	145.039	12.000	0.04
B8	Post-Development 5	5	328.872	12.000	0.12

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
B8	Post-Development 10	10	478.810	12.000	0.18
B8	Post-Development 25	25	691.781	11.950	0.27
B8	Post-Development 50	50	863.720	11.950	0.35
B8	Post-Development 100	100	1,043.816	11.950	0.42
A3	Post-Development 1	1	176.301	4.000	0.04
A3	Post-Development 2	2	939.128	12.100	0.26
A3	Post-Development 5	5	1,620.856	12.100	0.47
A3	Post-Development 10	10	2,119.459	12.100	0.63
A3	Post-Development 25	25	2,782.781	12.100	0.82
A3	Post-Development 50	50	3,293.334	12.100	0.98
A3	Post-Development 100	100	3,811.363	12.100	1.13
A5	Post-Development 1	1	266.065	4.000	0.06
A5	Post-Development 2	2	1,474.826	12.100	0.43
A5	Post-Development 5	5	2,566.979	12.050	0.78
A5	Post-Development 10	10	3,368.714	12.050	1.04
A5	Post-Development 25	25	4,437.816	12.050	1.39
A5	Post-Development 50	50	5,262.091	12.050	1.65
A5	Post-Development 100	100	6,099.392	12.050	1.91
A6	Post-Development 1	1	156.932	4.000	0.03
A6	Post-Development 2	2	884.477	12.050	0.28
A6	Post-Development 5	5	1,544.741	12.050	0.50
A6	Post-Development 10	10	2,030.176	12.050	0.67
A6	Post-Development 25	25	2,678.094	12.050	0.89
A6	Post-Development 50	50	3,177.971	12.050	1.05
A6	Post-Development 100	100	3,686.004	12.050	1.22
A1	Post-Development 1	1	133.316	4.000	0.03
A1	Post-Development 2	2	783.839	12.050	0.25
A1	Post-Development 5	5	1,380.814	12.050	0.45
A1	Post-Development 10	10	1,821.396	12.050	0.61
A1	Post-Development 25	25	2,410.811	12.050	0.81
A1	Post-Development 50	50	2,866.316	12.050	0.96
A1	Post-Development 100	100	3,329.778	12.050	1.11
A2	Post-Development 1	1	184.626	4.000	0.04
A2	Post-Development 2	2	1,058.116	12.050	0.33
A2	Post-Development 5	5	1,854.329	12.050	0.61
A2	Post-Development 10	10	2,440.572	12.050	0.81
A2	Post-Development 25	25	3,223.760	12.050	1.07
A2	Post-Development 50	50	3,828.438	12.050	1.27
A2	Post-Development 100	100	4,443.225	12.050	1.48
A4	Post-Development 1	1	185.334	4.000	0.04
A4	Post-Development 2	2	1,070.547	12.100	0.30
A4	Post-Development 5	5	1,879.389	12.100	0.55
A4	Post-Development 10	10	2,475.374	12.100	0.73
A4	Post-Development 25	25	3,271.983	12.100	0.97
A4	Post-Development 50	50	3,887.223	12.100	1.15

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
A4	Post-Development 100	100	4,512.912	12.100	1.33
A7	Post-Development 1	1	63.373	4.000	0.01
A7	Post-Development 2	2	274.673	11.950	0.11
A7	Post-Development 5	5	452.532	11.950	0.19
A7	Post-Development 10	10	579.957	11.950	0.24
A7	Post-Development 25	25	747.310	11.950	0.31
A7	Post-Development 50	50	874.962	11.950	0.36
A7	Post-Development 100	100	1,003.662	11.950	0.41
A9	Post-Development 1	1	3.228	4.000	0.00
A9	Post-Development 2	2	178.594	12.000	0.05
A9	Post-Development 5	5	404.959	12.000	0.15
A9	Post-Development 10	10	589.557	12.000	0.22
A9	Post-Development 25	25	851.827	11.950	0.33
A9	Post-Development 50	50	1,063.524	11.950	0.43
A9	Post-Development 100	100	1,285.273	11.950	0.52
B7	Post-Development 1	1	46.468	4.000	0.01
B7	Post-Development 2	2	186.891	11.950	0.08
B7	Post-Development 5	5	302.339	11.950	0.13
B7	Post-Development 10	10	384.373	11.950	0.16
B7	Post-Development 25	25	491.580	11.950	0.20
B7	Post-Development 50	50	573.048	11.950	0.23
B7	Post-Development 100	100	655.025	11.950	0.27
A8	Post-Development 1	1	129.776	4.000	0.02
A8	Post-Development 2	2	538.133	12.100	0.16
A8	Post-Development 5	5	877.114	12.050	0.27
A8	Post-Development 10	10	1,118.799	12.050	0.34
A8	Post-Development 25	25	1,435.324	12.050	0.44
A8	Post-Development 50	50	1,676.159	12.050	0.51
A8	Post-Development 100	100	1,918.721	12.050	0.58

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
J-1	Post-Development 1	1	39.304	4.000	0.01
J-1	Post-Development 2	2	260.430	12.050	0.09
J-1	Post-Development 5	5	469.578	12.000	0.17
J-1	Post-Development 10	10	625.463	12.000	0.23
J-1	Post-Development 25	25	835.319	12.000	0.30
J-1	Post-Development 50	50	998.254	12.000	0.36
J-1	Post-Development 100	100	1,164.530	12.000	0.42
J-2	Post-Development 1	1	120.403	4.000	0.03
J-2	Post-Development 2	2	792.617	12.050	0.23
J-2	Post-Development 5	5	1,427.339	12.050	0.46

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
J-2	Post-Development 10	10	1,900.230	12.050	0.62
J-2	Post-Development 25	25	2,536.651	12.050	0.84
J-2	Post-Development 50	50	3,030.610	12.050	1.01
J-2	Post-Development 100	100	3,534.650	12.050	1.18
J-7	Post-Development 1	1	212.037	4.050	0.05
J-7	Post-Development 2	2	1,382.598	12.100	0.36
J-7	Post-Development 5	5	2,485.256	12.100	0.72
J-7	Post-Development 10	10	3,306.162	12.050	0.99
J-7	Post-Development 25	25	4,410.349	12.050	1.36
J-7	Post-Development 50	50	5,267.132	12.050	1.65
J-7	Post-Development 100	100	6,141.131	12.050	1.95
J-10	Post-Development 1	1	133.316	4.000	0.03
J-10	Post-Development 2	2	783.839	12.050	0.25
J-10	Post-Development 5	5	1,380.814	12.050	0.45
J-10	Post-Development 10	10	1,821.396	12.050	0.61
J-10	Post-Development 25	25	2,410.811	12.050	0.81
J-10	Post-Development 50	50	2,866.316	12.050	0.96
J-10	Post-Development 100	100	3,329.778	12.050	1.11
J-11	Post-Development 1	1	317.942	4.000	0.07
J-11	Post-Development 2	2	1,841.954	12.100	0.53
J-11	Post-Development 5	5	3,235.143	12.050	0.98
J-11	Post-Development 10	10	4,261.969	12.050	1.33
J-11	Post-Development 25	25	5,634.571	12.050	1.78
J-11	Post-Development 50	50	6,694.754	12.050	2.13
J-11	Post-Development 100	100	7,773.003	12.050	2.49
J-13	Post-Development 1	1	176.301	4.000	0.04
J-13	Post-Development 2	2	939.128	12.100	0.26
J-13	Post-Development 5	5	1,620.856	12.100	0.47
J-13	Post-Development 10	10	2,119.459	12.100	0.63
J-13	Post-Development 25	25	2,782.781	12.100	0.82
J-13	Post-Development 50	50	3,293.334	12.100	0.98
J-13	Post-Development 100	100	3,811.363	12.100	1.13
J-14	Post-Development 1	1	442.337	4.000	0.09
J-14	Post-Development 2	2	2,413.955	12.100	0.64
J-14	Post-Development 5	5	4,187.835	12.100	1.18
J-14	Post-Development 10	10	5,488.173	12.100	1.58
J-14	Post-Development 25	25	7,220.569	12.100	2.11
J-14	Post-Development 50	50	8,555.425	12.100	2.50
J-14	Post-Development 100	100	9,910.783	12.100	2.91
O-12	Post-Development 1	1	0.000	0.000	0.00
O-12	Post-Development 2	2	0.000	0.000	0.00
O-12	Post-Development 5	5	0.000	0.000	0.00
O-12	Post-Development 10	10	0.000	0.000	0.00
O-12	Post-Development 25	25	0.000	0.000	0.00
O-12	Post-Development 50	50	0.000	0.000	0.00

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)
O-12	Post-Development 100	100	0.000	0.000	0.00
J-17	Post-Development 1	1	344.474	4.050	0.08
J-17	Post-Development 2	2	2,189.430	12.100	0.49
J-17	Post-Development 5	5	3,916.588	12.100	1.04
J-17	Post-Development 10	10	5,199.766	12.100	1.45
J-17	Post-Development 25	25	6,923.582	12.100	2.00
J-17	Post-Development 50	50	8,259.911	12.100	2.42
J-17	Post-Development 100	100	9,622.263	12.100	2.85

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)	Maximum Water Surface Elevation (m)	Maximum Pond Storage (m^3)
Pond 1 (IN)	Post-Development 1	1	436.164	4.000	0.09	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 1	1	426.876	5.350	0.00	124.68	2,992.977
Pond 1 (IN)	Post-Development 2	2	2,605.631	12.150	0.51	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 2	2	2,582.949	15.400	0.04	124.88	3,967.417
Pond 1 (IN)	Post-Development 5	5	4,616.580	12.150	1.07	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 5	5	4,591.860	14.450	0.08	125.08	5,042.154
Pond 1 (IN)	Post-Development 10	10	6,106.160	12.100	1.49	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 10	10	6,079.712	14.600	0.10	125.25	5,989.070
Pond 1 (IN)	Post-Development 25	25	8,103.885	12.100	2.08	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 25	25	8,074.945	14.800	0.12	125.47	7,317.894
Pond 1 (IN)	Post-Development 50	50	9,650.664	12.100	2.54	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 50	50	9,619.856	15.000	0.13	125.64	8,382.155

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)	Maximum Water Surface Elevation (m)	Maximum Pond Storage (m^3)
Pond 1 (IN)	Post-Development 100	100	11,226.469	12.100	3.00	(N/A)	(N/A)
Pond 1 (OUT)	Post-Development 100	100	11,193.734	15.150	0.15	125.81	9,488.267
Infiltration Basin1 (IN)	Post-Development 1	1	429.482	5.350	0.00	(N/A)	(N/A)
Infiltration Basin1 (OUT)	Post-Development 1	1	0.000	0.000	0.00	123.00	50.829
Infiltration Basin1 (IN)	Post-Development 2	2	2,727.988	15.100	0.05	(N/A)	(N/A)
Infiltration Basin1 (OUT)	Post-Development 2	2	0.000	0.000	0.00	123.03	524.711
Infiltration Basin1 (IN)	Post-Development 5	5	4,920.732	12.000	0.13	(N/A)	(N/A)
Infiltration Basin1 (OUT)	Post-Development 5	5	0.000	0.000	0.00	123.06	1,164.700
Infiltration Basin1 (IN)	Post-Development 10	10	6,558.493	12.000	0.20	(N/A)	(N/A)
Infiltration Basin1 (OUT)	Post-Development 10	10	0.000	0.000	0.00	123.11	2,040.455
Infiltration Basin1 (IN)	Post-Development 25	25	8,766.726	12.000	0.30	(N/A)	(N/A)
Infiltration Basin1 (OUT)	Post-Development 25	25	0.000	0.000	0.00	123.18	3,370.441
Infiltration Basin1 (IN)	Post-Development 50	50	10,483.576	12.000	0.39	(N/A)	(N/A)
Infiltration Basin1 (OUT)	Post-Development 50	50	0.000	0.000	0.00	123.24	4,483.774
Infiltration Basin1 (IN)	Post-Development 100	100	12,237.550	11.950	0.48	(N/A)	(N/A)
Infiltration Basin1 (OUT)	Post-Development 100	100	0.000	0.000	0.00	123.31	5,669.231
Pond 2 (IN)	Post-Development 1	1	1,295.666	4.000	0.25	(N/A)	(N/A)

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)	Maximum Water Surface Elevation (m)	Maximum Pond Storage (m^3)
Pond 2 (OUT)	Post-Development 1	1	1,228.215	5.200	0.02	123.55	5,377.426
Pond 2 (IN)	Post-Development 2	2	7,023.711	12.150	1.50	(N/A)	(N/A)
Pond 2 (OUT)	Post-Development 2	2	6,905.374	15.700	0.10	123.87	8,045.212
Pond 2 (IN)	Post-Development 5	5	12,176.754	12.150	2.94	(N/A)	(N/A)
Pond 2 (OUT)	Post-Development 5	5	12,042.702	15.950	0.15	124.25	11,447.227
Pond 2 (IN)	Post-Development 10	10	15,954.419	12.100	4.01	(N/A)	(N/A)
Pond 2 (OUT)	Post-Development 10	10	15,809.295	16.100	0.18	124.53	14,117.647
Pond 2 (IN)	Post-Development 25	25	20,987.852	12.100	5.46	(N/A)	(N/A)
Pond 2 (OUT)	Post-Development 25	25	20,828.485	16.400	0.22	124.88	17,809.569
Pond 2 (IN)	Post-Development 50	50	24,866.495	12.100	6.58	(N/A)	(N/A)
Pond 2 (OUT)	Post-Development 50	50	24,696.226	16.700	0.24	125.15	20,734.756
Pond 2 (IN)	Post-Development 100	100	28,805.057	12.100	7.71	(N/A)	(N/A)
Pond 2 (OUT)	Post-Development 100	100	28,623.886	16.800	0.26	125.40	23,742.911
Infiltration Basin 2 (IN)	Post-Development 1	1	1,231.415	5.200	0.02	(N/A)	(N/A)
Infiltration Basin 2 (OUT)	Post-Development 1	1	0.000	0.000	0.00	122.01	156.337
Infiltration Basin 2 (IN)	Post-Development 2	2	7,083.969	15.300	0.11	(N/A)	(N/A)
Infiltration Basin 2 (OUT)	Post-Development 2	2	0.000	0.000	0.00	122.05	1,347.599

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (m^3)	Time to Peak (hours)	Peak Flow (m^3/s)	Maximum Water Surface Elevation (m)	Maximum Pond Storage (m^3)
Infiltration Basin 2 (IN)	Post-Development 5	5	12,447.661	12.000	0.16	(N/A)	(N/A)
Infiltration Basin 2 (OUT)	Post-Development 5	5	0.000	0.000	0.00	122.16	3,996.583
Infiltration Basin 2 (IN)	Post-Development 10	10	16,398.852	12.000	0.26	(N/A)	(N/A)
Infiltration Basin 2 (OUT)	Post-Development 10	10	0.000	0.000	0.00	122.25	6,381.230
Infiltration Basin 2 (IN)	Post-Development 25	25	21,680.284	12.000	0.41	(N/A)	(N/A)
Infiltration Basin 2 (OUT)	Post-Development 25	25	0.000	0.000	0.00	122.38	9,827.333
Infiltration Basin 2 (IN)	Post-Development 50	50	25,759.750	12.000	0.52	(N/A)	(N/A)
Infiltration Basin 2 (OUT)	Post-Development 50	50	0.000	0.000	0.00	122.48	12,611.927
Infiltration Basin 2 (IN)	Post-Development 100	100	29,909.159	11.950	0.63	(N/A)	(N/A)
Infiltration Basin 2 (OUT)	Post-Development 100	100	0.000	0.000	0.00	122.59	15,530.431

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.248 hours
Area (User Defined)	5.750 ha

Computational Time Increment	0.033 hours
Time to Peak (Computed)	12.032 hours
Flow (Peak, Computed)	1.12 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	1.11 m³/s

Drainage Area	
SCS CN (Composite)	80.900
Area (User Defined)	5.750 ha
Maximum Retention (Pervious)	60.0 mm
Maximum Retention (Pervious, 20 percent)	12.0 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	57.9 mm
Runoff Volume (Pervious)	3,329.496 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	3,329.778 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.248 hours
Computational Time Increment	0.033 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.84 m³/s
Unit peak time, Tp	0.165 hours
Unit receding limb, Tr	0.661 hours
Total unit time, Tb	0.826 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	110.00 m
Slope	0.050 m/m
Tc Multiplier	2.000
Average Velocity	0.40 m/s
Segment Time of Concentration	0.077 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	70.00 m
Slope	0.250 m/m
Tc Multiplier	2.000
Average Velocity	0.67 m/s
Segment Time of Concentration	0.029 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	290.00 m
Slope	0.006 m/m
Tc Multiplier	0.750
Average Velocity	0.57 m/s
Segment Time of Concentration	0.142 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.248 hours

Modified Puls Results Summary	
Length (Channel)	430.00 m
Travel Time (Channel)	0.091 hours
Number of Sections	1
Length (Section)	430.00 m
Flow (Weighted)	0.39 m³/s
Overflow Channel	No Overflow Data
Elevation (Overflow)	130.11 m

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Starting Water Surface)	128.91 m
Volume (Starting, per section)	0.000 m³
Flow (Out Starting)	0.00 m³/s
Infiltration (Starting, per section)	0.00 m³/s
Flow (Total Out Starting)	0.00 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	1.11 m³/s	Time to Peak (In)	12.050 hours
Flow (Peak Out)	1.05 m³/s	Time to Peak (Out)	12.100 hours

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	3,329.776 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	3,329.776 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.0 %

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.250 hours
Area (User Defined)	7.590 ha

Computational Time Increment	0.033 hours
Time to Peak (Computed)	12.058 hours
Flow (Peak, Computed)	1.48 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	1.48 m³/s

Drainage Area	
SCS CN (Composite)	81.200
Area (User Defined)	7.590 ha
Maximum Retention (Pervious)	58.8 mm
Maximum Retention (Pervious, 20 percent)	11.8 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	58.5 mm
Runoff Volume (Pervious)	4,443.191 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	4,443.225 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.250 hours
Computational Time Increment	0.033 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.41 m³/s
Unit peak time, Tp	0.167 hours
Unit receding limb, Tr	0.666 hours
Total unit time, Tb	0.833 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	140.00 m
Slope	0.050 m/m
Tc Multiplier	2.000
Average Velocity	0.42 m/s
Segment Time of Concentration	0.092 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	80.00 m
Slope	0.250 m/m
Tc Multiplier	2.000
Average Velocity	0.69 m/s
Segment Time of Concentration	0.032 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	220.00 m
Slope	0.004 m/m
Tc Multiplier	0.750
Average Velocity	0.49 m/s
Segment Time of Concentration	0.125 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.250 hours

Modified Puls Results Summary	
Length (Channel)	400.00 m
Travel Time (Channel)	0.142 hours
Number of Sections	1
Length (Section)	400.00 m
Flow (Weighted)	0.87 m³/s
Overflow Channel	No Overflow Data
Elevation (Overflow)	128.16 m

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Starting Water Surface)	126.96 m
Volume (Starting, per section)	0.000 m³
Flow (Out Starting)	0.00 m³/s
Infiltration (Starting, per section)	0.00 m³/s
Flow (Total Out Starting)	0.00 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.49 m³/s	Time to Peak (In)	12.050 hours
Flow (Peak Out)	2.19 m³/s	Time to Peak (Out)	12.150 hours

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	7,773.002 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	7,773.002 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.0 %

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.324 hours
Area (User Defined)	6.300 ha

Computational Time Increment	0.043 hours
Time to Peak (Computed)	12.094 hours
Flow (Peak, Computed)	1.14 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	1.13 m^3/s

Drainage Area	
SCS CN (Composite)	82.100
Area (User Defined)	6.300 ha
Maximum Retention (Pervious)	55.4 mm
Maximum Retention (Pervious, 20 percent)	11.1 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	60.5 mm
Runoff Volume (Pervious)	3,809.572 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	3,811.363 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.324 hours
Computational Time Increment	0.043 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.54 m^3/s
Unit peak time, Tp	0.216 hours
Unit receding limb, Tr	0.864 hours
Total unit time, Tb	1.080 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	105.00 m
Slope	0.050 m/m
Tc Multiplier	2.000
Average Velocity	0.39 m/s
Segment Time of Concentration	0.074 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	70.00 m
Slope	0.250 m/m
Tc Multiplier	2.000
Average Velocity	0.67 m/s
Segment Time of Concentration	0.029 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	460.00 m
Slope	0.004 m/m
Tc Multiplier	0.750
Average Velocity	0.58 m/s
Segment Time of Concentration	0.221 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.324 hours

Modified Puls Results Summary	
Length (Channel)	215.00 m
Travel Time (Channel)	0.099 hours
Number of Sections	1
Length (Section)	215.00 m
Flow (Weighted)	0.41 m³/s
Overflow Channel	No Overflow Data
Elevation (Overflow)	129.88 m

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Starting Water Surface)	128.68 m
Volume (Starting, per section)	0.000 m³
Flow (Out Starting)	0.00 m³/s
Infiltration (Starting, per section)	0.00 m³/s
Flow (Total Out Starting)	0.00 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	1.13 m³/s	Time to Peak (In)	12.100 hours
Flow (Peak Out)	1.07 m³/s	Time to Peak (Out)	12.150 hours

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	3,811.376 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	3,811.376 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.0 %

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.320 hours
Area (User Defined)	7.740 ha

Computational Time Increment	0.043 hours
Time to Peak (Computed)	12.073 hours
Flow (Peak, Computed)	1.35 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	1.33 m^3/s

Drainage Area	
SCS CN (Composite)	81.100
Area (User Defined)	7.740 ha
Maximum Retention (Pervious)	59.2 mm
Maximum Retention (Pervious, 20 percent)	11.8 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	58.3 mm
Runoff Volume (Pervious)	4,514.567 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	4,512.912 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.320 hours
Computational Time Increment	0.043 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.92 m^3/s
Unit peak time, Tp	0.213 hours
Unit receding limb, Tr	0.853 hours
Total unit time, Tb	1.066 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	150.00 m
Slope	0.050 m/m
Tc Multiplier	2.000
Average Velocity	0.43 m/s
Segment Time of Concentration	0.097 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	80.00 m
Slope	0.250 m/m
Tc Multiplier	2.000
Average Velocity	0.69 m/s
Segment Time of Concentration	0.032 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	400.00 m
Slope	0.005 m/m
Tc Multiplier	0.750
Average Velocity	0.58 m/s
Segment Time of Concentration	0.190 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.320 hours

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.286 hours
Area (User Defined)	10.270 ha

Computational Time Increment	0.038 hours
Time to Peak (Computed)	12.071 hours
Flow (Peak, Computed)	1.93 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	1.91 m^3/s

Drainage Area	
SCS CN (Composite)	81.600
Area (User Defined)	10.270 ha
Maximum Retention (Pervious)	57.3 mm
Maximum Retention (Pervious, 20 percent)	11.5 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	59.4 mm
Runoff Volume (Pervious)	6,099.708 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	6,099.392 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.286 hours
Computational Time Increment	0.038 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.85 m^3/s
Unit peak time, Tp	0.190 hours
Unit receding limb, Tr	0.762 hours
Total unit time, Tb	0.952 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	100.00 m
Slope	0.050 m/m
Tc Multiplier	2.000
Average Velocity	0.39 m/s
Segment Time of Concentration	0.071 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	160.00 m
Slope	0.015 m/m
Tc Multiplier	0.750
Average Velocity	0.73 m/s
Segment Time of Concentration	0.061 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	290.00 m
Slope	0.080 m/m
Tc Multiplier	0.750
Average Velocity	1.59 m/s
Segment Time of Concentration	0.051 hours

Segment #4: Kirpich (TN)	
Hydraulic Length	170.00 m
Slope	0.004 m/m
Tc Multiplier	0.750
Average Velocity	0.46 m/s
Segment Time of Concentration	0.103 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.286 hours

Modified Puls Results Summary	
Length (Channel)	490.00 m
Travel Time (Channel)	0.154 hours
Number of Sections	1
Length (Section)	490.00 m
Flow (Weighted)	1.04 m³/s
Overflow Channel	No Overflow Data
Elevation (Overflow)	128.94 m

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Starting Water Surface)	127.74 m
Volume (Starting, per section)	0.000 m³
Flow (Out Starting)	0.00 m³/s
Infiltration (Starting, per section)	0.00 m³/s
Flow (Total Out Starting)	0.00 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.91 m³/s	Time to Peak (In)	12.100 hours
Flow (Peak Out)	2.57 m³/s	Time to Peak (Out)	12.150 hours

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	9,910.780 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	9,910.780 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.0 %

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.255 hours
Area (User Defined)	6.250 ha

Computational Time Increment	0.034 hours
Time to Peak (Computed)	12.051 hours
Flow (Peak, Computed)	1.22 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	1.22 m^3/s

Drainage Area	
SCS CN (Composite)	81.400
Area (User Defined)	6.250 ha
Maximum Retention (Pervious)	58.0 mm
Maximum Retention (Pervious, 20 percent)	11.6 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	59.0 mm
Runoff Volume (Pervious)	3,685.372 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	3,686.004 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.255 hours
Computational Time Increment	0.034 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.95 m^3/s
Unit peak time, Tp	0.170 hours
Unit receding limb, Tr	0.679 hours
Total unit time, Tb	0.849 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	150.00 m
Slope	0.050 m/m
Tc Multiplier	2.000
Average Velocity	0.43 m/s
Segment Time of Concentration	0.097 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	85.00 m
Slope	0.250 m/m
Tc Multiplier	2.000
Average Velocity	0.70 m/s
Segment Time of Concentration	0.034 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	250.00 m
Slope	0.006 m/m
Tc Multiplier	0.750
Average Velocity	0.56 m/s
Segment Time of Concentration	0.123 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.255 hours

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	1.500 ha

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.42 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.41 m³/s

Drainage Area	
SCS CN (Composite)	85.000
Area (User Defined)	1.500 ha
Maximum Retention (Pervious)	44.8 mm
Maximum Retention (Pervious, 20 percent)	9.0 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	66.9 mm
Runoff Volume (Pervious)	1,003.741 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,003.662 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.19 m³/s
Unit peak time, Tp	0.067 hours
Unit receding limb, Tr	0.267 hours
Total unit time, Tb	0.333 hours

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.302 hours
Area (User Defined)	2.800 ha

Computational Time Increment	0.040 hours
Time to Peak (Computed)	12.084 hours
Flow (Peak, Computed)	0.59 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	0.58 m^3/s

Drainage Area	
SCS CN (Composite)	85.700
Area (User Defined)	2.800 ha
Maximum Retention (Pervious)	42.4 mm
Maximum Retention (Pervious, 20 percent)	8.5 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	68.5 mm
Runoff Volume (Pervious)	1,918.732 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,918.721 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.302 hours
Computational Time Increment	0.040 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.73 m^3/s
Unit peak time, Tp	0.201 hours
Unit receding limb, Tr	0.806 hours
Total unit time, Tb	1.007 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	240.00 m
Slope	0.003 m/m
Tc Multiplier	0.750
Average Velocity	0.43 m/s
Segment Time of Concentration	0.155 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	250.00 m
Slope	0.005 m/m
Tc Multiplier	0.750
Average Velocity	0.53 m/s
Segment Time of Concentration	0.131 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	50.00 m
Slope	0.050 m/m
Tc Multiplier	0.750
Average Velocity	0.89 m/s
Segment Time of Concentration	0.016 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.302 hours

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	3.460 ha

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.947 hours
Flow (Peak, Computed)	0.52 m³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.52 m³/s

Drainage Area	
SCS CN (Composite)	70.000
Area (User Defined)	3.460 ha
Maximum Retention (Pervious)	108.9 mm
Maximum Retention (Pervious, 20 percent)	21.8 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	37.2 mm
Runoff Volume (Pervious)	1,285.498 m³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,285.273 m³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.74 m³/s
Unit peak time, Tp	0.067 hours
Unit receding limb, Tr	0.267 hours
Total unit time, Tb	0.333 hours

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.188 hours
Area (User Defined)	2.110 ha

Computational Time Increment	0.025 hours
Time to Peak (Computed)	12.009 hours
Flow (Peak, Computed)	0.43 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.42 m^3/s

Drainage Area	
SCS CN (Composite)	79.600
Area (User Defined)	2.110 ha
Maximum Retention (Pervious)	65.1 mm
Maximum Retention (Pervious, 20 percent)	13.0 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	55.2 mm
Runoff Volume (Pervious)	1,164.532 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,164.530 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.188 hours
Computational Time Increment	0.025 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.89 m^3/s
Unit peak time, Tp	0.125 hours
Unit receding limb, Tr	0.500 hours
Total unit time, Tb	0.625 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	340.00 m
Slope	0.012 m/m
Tc Multiplier	0.750
Average Velocity	0.79 m/s
Segment Time of Concentration	0.119 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	100.00 m
Slope	0.004 m/m
Tc Multiplier	0.750
Average Velocity	0.40 m/s
Segment Time of Concentration	0.069 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.188 hours

Modified Puls Results Summary	
Length (Channel)	250.00 m
Travel Time (Channel)	0.134 hours
Number of Sections	1
Length (Section)	250.00 m
Flow (Weighted)	0.14 m³/s
Overflow Channel	No Overflow Data
Elevation (Overflow)	131.36 m

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Starting Water Surface)	130.36 m
Volume (Starting, per section)	0.000 m³
Flow (Out Starting)	0.00 m³/s
Infiltration (Starting, per section)	0.00 m³/s
Flow (Total Out Starting)	0.00 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	0.42 m³/s	Time to Peak (In)	12.000 hours
Flow (Peak Out)	0.36 m³/s	Time to Peak (Out)	12.100 hours

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	1,164.534 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	1,164.534 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.0 %

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.203 hours
Area (User Defined)	4.280 ha

Computational Time Increment	0.027 hours
Time to Peak (Computed)	12.012 hours
Flow (Peak, Computed)	0.85 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	0.84 m^3/s

Drainage Area	
SCS CN (Composite)	79.700
Area (User Defined)	4.280 ha
Maximum Retention (Pervious)	64.7 mm
Maximum Retention (Pervious, 20 percent)	12.9 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	55.4 mm
Runoff Volume (Pervious)	2,371.010 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	2,370.120 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.203 hours
Computational Time Increment	0.027 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.67 m^3/s
Unit peak time, Tp	0.136 hours
Unit receding limb, Tr	0.542 hours
Total unit time, Tb	0.678 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	75.00 m
Slope	0.286 m/m
Tc Multiplier	2.000
Average Velocity	0.71 m/s
Segment Time of Concentration	0.029 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	25.00 m
Slope	0.020 m/m
Tc Multiplier	2.000
Average Velocity	0.20 m/s
Segment Time of Concentration	0.035 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	250.00 m
Slope	0.004 m/m
Tc Multiplier	0.750
Average Velocity	0.50 m/s
Segment Time of Concentration	0.139 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.203 hours

Modified Puls Results Summary	
Length (Channel)	250.00 m
Travel Time (Channel)	0.103 hours
Number of Sections	1
Length (Section)	250.00 m
Flow (Weighted)	0.41 m³/s
Overflow Channel	No Overflow Data
Elevation (Overflow)	130.28 m

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Starting Water Surface)	129.28 m
Volume (Starting, per section)	0.000 m³
Flow (Out Starting)	0.00 m³/s
Infiltration (Starting, per section)	0.00 m³/s
Flow (Total Out Starting)	0.00 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	1.18 m³/s	Time to Peak (In)	12.050 hours
Flow (Peak Out)	1.09 m³/s	Time to Peak (Out)	12.100 hours

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	3,534.656 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	3,534.656 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.0 %

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.234 hours
Area (User Defined)	4.670 ha

Computational Time Increment	0.031 hours
Time to Peak (Computed)	12.020 hours
Flow (Peak, Computed)	0.89 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	0.89 m^3/s

Drainage Area	
SCS CN (Composite)	79.900
Area (User Defined)	4.670 ha
Maximum Retention (Pervious)	63.9 mm
Maximum Retention (Pervious, 20 percent)	12.8 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	55.8 mm
Runoff Volume (Pervious)	2,606.385 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	2,606.481 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.234 hours
Computational Time Increment	0.031 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.59 m^3/s
Unit peak time, Tp	0.156 hours
Unit receding limb, Tr	0.623 hours
Total unit time, Tb	0.779 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	10.00 m
Slope	0.050 m/m
Tc Multiplier	2.000
Average Velocity	0.23 m/s
Segment Time of Concentration	0.012 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	140.00 m
Slope	0.285 m/m
Tc Multiplier	2.000
Average Velocity	0.82 m/s
Segment Time of Concentration	0.047 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	25.00 m
Slope	0.020 m/m
Tc Multiplier	2.000
Average Velocity	0.20 m/s
Segment Time of Concentration	0.035 hours

Segment #4: Kirpich (TN)	
Hydraulic Length	250.00 m
Slope	0.004 m/m
Tc Multiplier	0.750
Average Velocity	0.50 m/s
Segment Time of Concentration	0.139 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.234 hours

Modified Puls Results Summary	
Length (Channel)	310.00 m
Travel Time (Channel)	0.103 hours
Number of Sections	1
Length (Section)	310.00 m
Flow (Weighted)	0.68 m³/s
Overflow Channel	No Overflow Data
Elevation (Overflow)	129.21 m

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Starting Water Surface)	128.21 m
Volume (Starting, per section)	0.000 m³
Flow (Out Starting)	0.00 m³/s
Infiltration (Starting, per section)	0.00 m³/s
Flow (Total Out Starting)	0.00 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	1.95 m³/s	Time to Peak (In)	12.050 hours
Flow (Peak Out)	1.79 m³/s	Time to Peak (Out)	12.100 hours

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	6,141.144 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	6,141.144 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.0 %

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.246 hours
Area (User Defined)	6.100 ha

Computational Time Increment	0.033 hours
Time to Peak (Computed)	12.036 hours
Flow (Peak, Computed)	1.17 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	1.16 m^3/s

Drainage Area	
SCS CN (Composite)	80.500
Area (User Defined)	6.100 ha
Maximum Retention (Pervious)	61.5 mm
Maximum Retention (Pervious, 20 percent)	12.3 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	57.1 mm
Runoff Volume (Pervious)	3,480.797 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	3,481.132 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.246 hours
Computational Time Increment	0.033 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.97 m^3/s
Unit peak time, Tp	0.164 hours
Unit receding limb, Tr	0.656 hours
Total unit time, Tb	0.820 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	13.00 m
Slope	0.050 m/m
Tc Multiplier	2.000
Average Velocity	0.24 m/s
Segment Time of Concentration	0.015 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	140.00 m
Slope	0.285 m/m
Tc Multiplier	2.000
Average Velocity	0.82 m/s
Segment Time of Concentration	0.047 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	25.00 m
Slope	0.020 m/m
Tc Multiplier	2.000
Average Velocity	0.20 m/s
Segment Time of Concentration	0.035 hours

Segment #4: Kirpich (TN)	
Hydraulic Length	255.00 m
Slope	0.004 m/m
Tc Multiplier	0.750
Average Velocity	0.50 m/s
Segment Time of Concentration	0.141 hours

Segment #5: Kirpich (TN)	
Hydraulic Length	55.00 m
Slope	0.013 m/m
Tc Multiplier	0.200
Average Velocity	2.02 m/s
Segment Time of Concentration	0.008 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.246 hours

Modified Puls Results Summary	
Length (Channel)	165.00 m
Travel Time (Channel)	0.056 hours
Number of Sections	1
Length (Section)	165.00 m
Flow (Weighted)	1.01 m³/s
Overflow Channel	No Overflow Data
Elevation (Overflow)	127.40 m

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Starting Water Surface)	126.40 m
Volume (Starting, per section)	0.000 m³
Flow (Out Starting)	0.00 m³/s
Infiltration (Starting, per section)	0.00 m³/s
Flow (Total Out Starting)	0.00 m³/s
Time Increment	0.050 hours

Inflow/Outflow Hydrograph Summary			
Flow (Peak In)	2.85 m³/s	Time to Peak (In)	12.100 hours
Flow (Peak Out)	2.78 m³/s	Time to Peak (Out)	12.100 hours

Mass Balance (m³)	
Volume (Initial)	0.000 m³
Volume (Total Inflow)	9,622.263 m³
Volume (Total Infiltration)	0.000 m³
Volume (Total Outlet Outflow)	9,622.263 m³
Volume (Retained)	0.000 m³
Volume (Unrouted)	0.000 m³
Error (Mass Balance)	0.0 %

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.106 hours
Area (User Defined)	0.640 ha

Computational Time Increment	0.014 hours
Time to Peak (Computed)	11.942 hours
Flow (Peak, Computed)	0.11 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.11 m^3/s

Drainage Area	
SCS CN (Composite)	72.000
Area (User Defined)	0.640 ha
Maximum Retention (Pervious)	98.8 mm
Maximum Retention (Pervious, 20 percent)	19.8 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	40.6 mm
Runoff Volume (Pervious)	260.041 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	260.005 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.106 hours
Computational Time Increment	0.014 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.48 m^3/s
Unit peak time, Tp	0.071 hours
Unit receding limb, Tr	0.283 hours
Total unit time, Tb	0.353 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	20.00 m
Slope	0.285 m/m
Tc Multiplier	2.000
Average Velocity	0.53 m/s
Segment Time of Concentration	0.011 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	165.00 m
Slope	0.005 m/m
Tc Multiplier	0.750
Average Velocity	0.48 m/s
Segment Time of Concentration	0.095 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.106 hours

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	1.030 ha

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.933 hours
Flow (Peak, Computed)	0.29 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.28 m^3/s

Drainage Area	
SCS CN (Composite)	85.000
Area (User Defined)	1.030 ha
Maximum Retention (Pervious)	44.8 mm
Maximum Retention (Pervious, 20 percent)	9.0 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	66.9 mm
Runoff Volume (Pervious)	689.236 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	689.175 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.82 m^3/s
Unit peak time, Tp	0.067 hours
Unit receding limb, Tr	0.267 hours
Total unit time, Tb	0.333 hours

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.091 hours
Area (User Defined)	0.940 ha

Computational Time Increment	0.012 hours
Time to Peak (Computed)	11.929 hours
Flow (Peak, Computed)	0.28 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.27 m^3/s

Drainage Area	
SCS CN (Composite)	86.200
Area (User Defined)	0.940 ha
Maximum Retention (Pervious)	40.7 mm
Maximum Retention (Pervious, 20 percent)	8.1 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	69.7 mm
Runoff Volume (Pervious)	655.080 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	655.025 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.091 hours
Computational Time Increment	0.012 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.82 m^3/s
Unit peak time, Tp	0.060 hours
Unit receding limb, Tr	0.242 hours
Total unit time, Tb	0.302 hours

Time of Concentration Results

Segment #1: Kirpich (TN)	
Hydraulic Length	25.00 m
Slope	0.010 m/m
Tc Multiplier	0.400
Average Velocity	0.76 m/s
Segment Time of Concentration	0.009 hours

Segment #2: Kirpich (TN)	
Hydraulic Length	170.00 m
Slope	0.010 m/m
Tc Multiplier	0.750
Average Velocity	0.63 m/s
Segment Time of Concentration	0.075 hours

Segment #3: Kirpich (TN)	
Hydraulic Length	30.00 m
Slope	0.005 m/m
Tc Multiplier	0.200
Average Velocity	1.22 m/s
Segment Time of Concentration	0.007 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.091 hours

Storm Event	100YR 24hr SCS II
Return Event	100 years
Duration	144.000 hours
Depth	106.6 mm
Time of Concentration (Composite)	0.100 hours
Area (User Defined)	2.810 ha

Computational Time Increment	0.013 hours
Time to Peak (Computed)	11.947 hours
Flow (Peak, Computed)	0.43 m^3/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	11.950 hours
Flow (Peak Interpolated Output)	0.42 m^3/s

Drainage Area	
SCS CN (Composite)	70.000
Area (User Defined)	2.810 ha
Maximum Retention (Pervious)	108.9 mm
Maximum Retention (Pervious, 20 percent)	21.8 mm

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	37.2 mm
Runoff Volume (Pervious)	1,044.003 m^3

Hydrograph Volume (Area under Hydrograph curve)	
Volume	1,043.816 m^3

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.100 hours
Computational Time Increment	0.013 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	2.23 m^3/s
Unit peak time, Tp	0.067 hours
Unit receding limb, Tr	0.267 hours
Total unit time, Tb	0.333 hours

```
              Length
        .--Top---- B ----------.
W       |                      |
i       |     .------b2------.  |
d       A     b1             |  C
t       |     `----Bottom----'  |
h       |                      |
        `----------D-----------'
        Diagram Not to Scale
```

Pond Volume Calculation for Trapezoidal Basin	
Trapezoid Top Elevation	126.75 m
Trapezoid Top Length (A to C)	172.00 m
Trapezoid Top Width (B to D)	48.00 m
Trapezoid Bottom Elevation	124.00 m
Trapezoid Bottom Length	150.00 m
Trapezoid Bottom Width	26.00 m

Pond Volume Calculation for Trapezoidal Basin	
Trapezoid Width Offset (B to b2)	11.00 m
Trapezoid Length Offset (A to b1)	11.00 m
Trapezoid Vertical Increment	0.10 m

Elevation (m)	Planimeter (m^2)	Area (ha)	A1+A2+sqr (A1*A2) (ha)	Volume (m^3)	Volume (Total) (m^3)
124.00	0.0	0.390	0.000	0.000	0.000
124.10	0.0	0.404	1.191	397.059	397.059
124.20	0.0	0.418	1.234	411.246	808.304
124.30	0.0	0.433	1.277	425.602	1,233.907
124.40	0.0	0.447	1.320	440.072	1,673.979
124.50	0.0	0.462	1.364	454.655	2,128.606
124.60	0.0	0.477	1.408	469.380	2,597.986
124.70	0.0	0.492	1.453	484.218	3,082.204
124.80	0.0	0.507	1.498	499.198	3,581.401
124.90	0.0	0.522	1.543	514.291	4,095.720
125.00	0.0	0.537	1.589	529.525	4,625.245
125.10	0.0	0.553	1.635	544.901	5,170.146
125.20	0.0	0.568	1.681	560.390	5,730.509

Subsection: Trapezoidal Volume
Label: Pond 1

Return Event: 100 years
Storm Event: 100YR 24hr SCS II

Elevation (m)	Planimeter (m^2)	Area (ha)	A1+A2+sqr (A1*A2) (ha)	Volume (m^3)	Volume (Total) (m^3)
125.30	0.0	0.584	1.728	575.993	6,306.530
125.40	0.0	0.600	1.775	591.737	6,898.267
125.50	0.0	0.616	1.823	607.623	7,505.862
125.60	0.0	0.632	1.871	623.622	8,129.483
125.70	0.0	0.648	1.919	639.734	8,769.246
125.80	0.0	0.664	1.968	655.988	9,425.234
125.90	0.0	0.681	2.017	672.384	10,097.618
126.00	0.0	0.697	2.067	688.892	10,786.510
126.10	0.0	0.714	2.117	705.543	11,492.052
126.20	0.0	0.731	2.167	722.306	12,214.358
126.30	0.0	0.748	2.218	739.211	12,953.541
126.40	0.0	0.765	2.269	756.230	13,709.771
126.50	0.0	0.782	2.320	773.390	14,483.161
126.60	0.0	0.799	2.372	790.663	15,273.795
126.75	0.0	0.826	2.437	1,218.644	16,492.468

Structure ID: Culvert 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	291.0 mm
Length	20.00 m
Length (Computed Barrel)	20.00 m
Slope (Computed)	0.005 m/m

Outlet Control Data	
Manning's n	0.013
Ke	0.900
Kb	0.033
Kr	0.900
Convergence Tolerance	0.00 m

Inlet Control Data	
Equation Form	Form 1
K	0.0098
M	2.0000
C	0.0398
Y	0.6700
T1 ratio (HW/D)	1.158
T2 ratio (HW/D)	1.304
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	124.94 m	T1 Flow	0.07 m³/s
T2 Elevation	124.98 m	T2 Flow	0.08 m³/s

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	124.60 m
Volume (Initial)	2,597.986 m³
Flow (Initial Outlet)	0.00 m³/s
Flow (Initial Infiltration)	0.00 m³/s
Flow (Initial, Total)	0.00 m³/s
Time Increment	0.050 hours

Elevation (m)	Outflow (m³/s)	Storage (m³)	Area (ha)	Infiltration (m³/s)	Flow (Total) (m³/s)	2S/t + O (m³/s)
124.00	0.00	0.000	0.390	0.00	0.00	0.00
124.05	0.00	196.757	0.397	0.00	0.00	2.19
124.10	0.00	397.051	0.404	0.00	0.00	4.41
124.15	0.00	600.897	0.411	0.00	0.00	6.68
124.20	0.00	808.310	0.418	0.00	0.00	8.98
124.25	0.00	1,019.308	0.426	0.00	0.00	11.33
124.30	0.00	1,233.906	0.433	0.00	0.00	13.71
124.35	0.00	1,452.120	0.440	0.00	0.00	16.13
124.40	0.00	1,673.966	0.447	0.00	0.00	18.60
124.45	0.00	1,899.460	0.455	0.00	0.00	21.11
124.50	0.00	2,128.618	0.462	0.00	0.00	23.65
124.55	0.00	2,361.457	0.469	0.00	0.00	26.24
124.60	0.00	2,597.991	0.477	0.00	0.00	28.87
124.65	0.00	2,838.237	0.484	0.00	0.00	31.54
124.70	0.01	3,082.212	0.492	0.00	0.01	34.25
124.75	0.01	3,329.930	0.499	0.00	0.01	37.01
124.80	0.02	3,581.409	0.507	0.00	0.02	39.82
124.85	0.04	3,836.663	0.514	0.00	0.04	42.67
124.90	0.05	4,095.710	0.522	0.00	0.05	45.56
124.95	0.06	4,358.565	0.530	0.00	0.06	48.49
125.00	0.07	4,625.244	0.537	0.00	0.07	51.47
125.05	0.08	4,895.763	0.545	0.00	0.08	54.48
125.10	0.09	5,170.138	0.553	0.00	0.09	57.53
125.15	0.09	5,448.384	0.560	0.00	0.09	60.63
125.20	0.10	5,730.520	0.568	0.00	0.10	63.77
125.25	0.10	6,016.559	0.576	0.00	0.10	66.95
125.30	0.11	6,306.518	0.584	0.00	0.11	70.18
125.35	0.11	6,600.413	0.592	0.00	0.11	73.45
125.40	0.12	6,898.260	0.600	0.00	0.12	76.76
125.45	0.12	7,200.075	0.608	0.00	0.12	80.12
125.50	0.12	7,505.875	0.616	0.00	0.12	83.52
125.55	0.13	7,815.674	0.624	0.00	0.13	86.97
125.60	0.13	8,129.490	0.632	0.00	0.13	90.46
125.65	0.14	8,447.337	0.640	0.00	0.14	93.99
125.70	0.14	8,769.233	0.648	0.00	0.14	97.58
125.75	0.14	9,095.192	0.656	0.00	0.14	101.20

Elevation (m)	Outflow (m^3/s)	Storage (m^3)	Area (ha)	Infiltration (m^3/s)	Flow (Total) (m^3/s)	2S/t + O (m^3/s)
125.80	0.15	9,425.232	0.664	0.00	0.15	104.87
125.85	0.15	9,759.367	0.672	0.00	0.15	108.59
125.90	0.21	10,097.615	0.681	0.00	0.21	112.41
125.95	0.33	10,439.990	0.689	0.00	0.33	116.33
126.00	0.49	10,786.510	0.697	0.00	0.49	120.34
126.05	0.69	11,137.190	0.706	0.00	0.69	124.44
126.10	0.93	11,492.046	0.714	0.00	0.93	128.62
126.15	1.22	11,851.093	0.722	0.00	1.22	132.90
126.20	1.54	12,214.349	0.731	0.00	1.54	137.26
126.25	1.91	12,581.829	0.739	0.00	1.91	141.71
126.30	2.32	12,953.549	0.748	0.00	2.32	146.24
126.35	2.77	13,329.525	0.756	0.00	2.77	150.87
126.40	3.26	13,709.773	0.765	0.00	3.26	155.59
126.45	3.80	14,094.308	0.773	0.00	3.80	160.41
126.50	4.39	14,483.149	0.782	0.00	4.39	165.31
126.55	5.02	14,876.309	0.791	0.00	5.02	170.32
126.60	5.71	15,273.805	0.799	0.00	5.71	175.41
126.65	6.44	15,675.651	0.808	0.00	6.44	180.61
126.70	7.22	16,081.861	0.817	0.00	7.22	185.90
126.75	8.05	16,492.460	0.826	0.00	8.05	191.30

```
            Length
     .--Top---- B ----------.
W    |                      |
i    |    .------b2------.  |
d    A    b1             |  C
t    |    `----Bottom----'  |
h    |                      |
     `----------D-----------'
       Diagram Not to Scale
```

Pond Volume Calculation for Trapezoidal Basin	
Trapezoid Top Elevation	126.30 m
Trapezoid Top Length (A to C)	228.00 m
Trapezoid Top Width (B to D)	62.00 m
Trapezoid Bottom Elevation	122.80 m
Trapezoid Bottom Length	200.00 m
Trapezoid Bottom Width	32.00 m

Pond Volume Calculation for Trapezoidal Basin	
Trapezoid Width Offset (B to b2)	15.00 m
Trapezoid Length Offset (A to b1)	14.00 m
Trapezoid Vertical Increment	0.10 m

Elevation (m)	Planimeter (m^2)	Area (ha)	A1+A2+sqr (A1*A2) (ha)	Volume (m^3)	Volume (Total) (m^3)
122.80	0.0	0.640	0.000	0.000	0.000
122.90	0.0	0.660	1.950	649.872	649.872
123.00	0.0	0.680	2.009	669.693	1,319.565
123.10	0.0	0.700	2.069	689.685	2,009.250
123.20	0.0	0.720	2.129	709.790	2,719.040
123.30	0.0	0.740	2.190	730.037	3,449.077
123.40	0.0	0.761	2.251	750.425	4,199.502
123.50	0.0	0.781	2.313	770.954	4,970.484
123.60	0.0	0.802	2.375	791.626	5,762.082
123.70	0.0	0.823	2.437	812.410	6,574.520
123.80	0.0	0.844	2.500	833.365	7,407.885
123.90	0.0	0.865	2.563	854.433	8,262.318
124.00	0.0	0.886	2.627	875.642	9,137.960

Subsection: Trapezoidal Volume
Label: Pond 2

Return Event: 100 years
Storm Event: 100YR 24hr SCS II

Elevation (m)	Planimeter (m^2)	Area (ha)	A1+A2+sqr (A1*A2) (ha)	Volume (m^3)	Volume (Total) (m^3)
124.10	0.0	0.908	2.691	896.993	10,034.952
124.20	0.0	0.929	2.755	918.485	10,953.438
124.30	0.0	0.951	2.820	940.091	11,893.557
124.40	0.0	0.973	2.886	961.867	12,855.423
124.50	0.0	0.995	2.951	983.756	13,839.179
124.60	0.0	1.017	3.017	1,005.786	14,844.965
124.70	0.0	1.039	3.084	1,027.958	15,872.923
124.80	0.0	1.061	3.151	1,050.272	16,923.223
124.90	0.0	1.084	3.218	1,072.727	17,995.951
125.00	0.0	1.107	3.286	1,095.296	19,091.246
125.10	0.0	1.129	3.354	1,118.034	20,209.280
125.20	0.0	1.152	3.423	1,140.886	21,350.166
125.30	0.0	1.175	3.492	1,163.879	22,514.045
125.40	0.0	1.199	3.561	1,187.014	23,701.031
125.50	0.0	1.222	3.631	1,210.290	24,911.321
125.60	0.0	1.245	3.701	1,233.680	26,145.001
125.70	0.0	1.269	3.772	1,257.240	27,402.241
125.80	0.0	1.293	3.843	1,280.913	28,683.125
125.90	0.0	1.317	3.914	1,304.727	29,987.852
126.00	0.0	1.341	3.986	1,328.683	31,316.535
126.10	0.0	1.365	4.058	1,352.781	32,669.316
126.20	0.0	1.389	4.131	1,376.992	34,046.307
126.30	0.0	1.414	4.204	1,401.372	35,447.680

Structure ID: Culvert 2 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	327.0 mm
Length	20.00 m
Length (Computed Barrel)	20.00 m
Slope (Computed)	0.005 m/m

Outlet Control Data	
Manning's n	0.013
Ke	0.900
Kb	0.028
Kr	0.900
Convergence Tolerance	0.00 m

Inlet Control Data	
Equation Form	Form 1
K	0.0098
M	2.0000
C	0.0398
Y	0.6700
T1 ratio (HW/D)	1.158
T2 ratio (HW/D)	1.304
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	123.78 m	T1 Flow	0.09 m³/s
T2 Elevation	123.83 m	T2 Flow	0.11 m³/s

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	123.40 m
Volume (Initial)	4,199.502 m³
Flow (Initial Outlet)	0.00 m³/s
Flow (Initial Infiltration)	0.00 m³/s
Flow (Initial, Total)	0.00 m³/s
Time Increment	0.050 hours

Elevation (m)	Outflow (m³/s)	Storage (m³)	Area (ha)	Infiltration (m³/s)	Flow (Total) (m³/s)	2S/t + O (m³/s)
122.80	0.00	0.000	0.640	0.00	0.00	0.00
122.85	0.00	322.459	0.650	0.00	0.00	3.58
122.90	0.00	649.861	0.660	0.00	0.00	7.22
122.95	0.00	982.223	0.670	0.00	0.00	10.91
123.00	0.00	1,319.562	0.680	0.00	0.00	14.66
123.05	0.00	1,661.895	0.690	0.00	0.00	18.47
123.10	0.00	2,009.240	0.700	0.00	0.00	22.32
123.15	0.00	2,361.614	0.710	0.00	0.00	26.24
123.20	0.00	2,719.033	0.720	0.00	0.00	30.21
123.25	0.00	3,081.516	0.730	0.00	0.00	34.24
123.30	0.00	3,449.078	0.740	0.00	0.00	38.32
123.35	0.00	3,821.738	0.750	0.00	0.00	42.46
123.40	0.00	4,199.512	0.761	0.00	0.00	46.66
123.45	0.00	4,582.418	0.771	0.00	0.00	50.92
123.50	0.01	4,970.472	0.781	0.00	0.01	55.23
123.55	0.02	5,363.693	0.792	0.00	0.02	59.61
123.60	0.03	5,762.095	0.802	0.00	0.03	64.05
123.65	0.04	6,165.699	0.812	0.00	0.04	68.55
123.70	0.05	6,574.519	0.823	0.00	0.05	73.10
123.75	0.07	6,988.573	0.833	0.00	0.07	77.72
123.80	0.09	7,407.880	0.844	0.00	0.09	82.40
123.85	0.10	7,832.454	0.854	0.00	0.10	87.13
123.90	0.11	8,262.315	0.865	0.00	0.11	91.91
123.95	0.12	8,697.478	0.876	0.00	0.12	96.75
124.00	0.12	9,137.962	0.886	0.00	0.12	101.65
124.05	0.13	9,583.783	0.897	0.00	0.13	106.62
124.10	0.13	10,034.958	0.908	0.00	0.13	111.63
124.15	0.14	10,491.504	0.918	0.00	0.14	116.71
124.20	0.15	10,953.440	0.929	0.00	0.15	121.85
124.25	0.15	11,420.780	0.940	0.00	0.15	127.05
124.30	0.16	11,893.544	0.951	0.00	0.16	132.31
124.35	0.16	12,371.748	0.962	0.00	0.16	137.63
124.40	0.17	12,855.409	0.973	0.00	0.17	143.01
124.45	0.17	13,344.545	0.984	0.00	0.17	148.45
124.50	0.18	13,839.172	0.995	0.00	0.18	153.95
124.55	0.18	14,339.307	1.006	0.00	0.18	159.51

Elevation (m)	Outflow (m^3/s)	Storage (m^3)	Area (ha)	Infiltration (m^3/s)	Flow (Total) (m^3/s)	2S/t + O (m^3/s)
124.60	0.19	14,844.969	1.017	0.00	0.19	165.13
124.65	0.19	15,356.173	1.028	0.00	0.19	170.82
124.70	0.20	15,872.937	1.039	0.00	0.20	176.56
124.75	0.20	16,395.278	1.050	0.00	0.20	182.37
124.80	0.21	16,923.215	1.061	0.00	0.21	188.24
124.85	0.21	17,456.761	1.073	0.00	0.21	194.18
124.90	0.22	17,995.938	1.084	0.00	0.22	200.17
124.95	0.22	18,540.759	1.095	0.00	0.22	206.23
125.00	0.22	19,091.244	1.107	0.00	0.22	212.35
125.05	0.23	19,647.408	1.118	0.00	0.23	218.53
125.10	0.23	20,209.270	1.129	0.00	0.23	224.78
125.15	0.24	20,776.846	1.141	0.00	0.24	231.09
125.20	0.24	21,350.154	1.152	0.00	0.24	237.46
125.25	0.24	21,929.210	1.164	0.00	0.24	243.90
125.30	0.25	22,514.032	1.175	0.00	0.25	250.40
125.35	0.25	23,104.636	1.187	0.00	0.25	256.97
125.40	0.26	23,701.042	1.199	0.00	0.26	263.60
125.45	0.37	24,303.263	1.210	0.00	0.37	270.41
125.50	0.59	24,911.320	1.222	0.00	0.59	277.38
125.55	0.88	25,525.227	1.234	0.00	0.88	284.50
125.60	1.24	26,145.004	1.245	0.00	1.24	291.74
125.65	1.66	26,770.666	1.257	0.00	1.66	299.11
125.70	2.14	27,402.231	1.269	0.00	2.14	306.61
125.75	2.68	28,039.716	1.281	0.00	2.68	314.23
125.80	3.27	28,683.139	1.293	0.00	3.27	321.97
125.85	3.92	29,332.515	1.305	0.00	3.92	329.84
125.90	4.63	29,987.863	1.317	0.00	4.63	337.83
125.95	5.40	30,649.199	1.329	0.00	5.40	345.94
126.00	6.22	31,316.543	1.341	0.00	6.22	354.18
126.05	7.10	31,989.907	1.353	0.00	7.10	362.55
126.10	8.04	32,669.313	1.365	0.00	8.04	371.03
126.15	9.04	33,354.775	1.377	0.00	9.04	379.65
126.20	10.10	34,046.312	1.389	0.00	10.10	388.39
126.25	11.22	34,743.940	1.401	0.00	11.22	397.26
126.30	12.40	35,447.677	1.414	0.00	12.40	406.26

```
          Length
    .--Top---- B ----------.
W   |                      |
i   |    .------b2------.  |
d   A    b1             |  C
t   |    `----Bottom----'  |
h   |                      |
    `----------D-----------'
     Diagram Not to Scale
```

Pond Volume Calculation for Trapezoidal Basin	
Trapezoid Top Elevation	126.75 m
Trapezoid Top Length (A to C)	180.50 m
Trapezoid Top Width (B to D)	138.50 m
Trapezoid Bottom Elevation	123.00 m
Trapezoid Bottom Length	158.00 m
Trapezoid Bottom Width	116.00 m

Pond Volume Calculation for Trapezoidal Basin	
Trapezoid Width Offset (B to b2)	11.25 m
Trapezoid Length Offset (A to b1)	11.25 m
Trapezoid Vertical Increment	0.10 m

Elevation (m)	Planimeter (m^2)	Area (ha)	A1+A2+sqr (A1*A2) (ha)	Volume (m^3)	Volume (Total) (m^3)
123.00	0.0	1.833	0.000	0.000	0.000
123.10	0.0	1.849	5.523	1,841.020	1,841.020
123.20	0.0	1.866	5.573	1,857.557	3,698.577
123.30	0.0	1.882	5.622	1,874.122	5,572.699
123.40	0.0	1.899	5.672	1,890.772	7,463.500
123.50	0.0	1.916	5.723	1,907.508	9,371.007
123.60	0.0	1.933	5.773	1,924.300	11,295.307
123.70	0.0	1.950	5.824	1,941.176	13,236.483
123.80	0.0	1.967	5.874	1,958.138	15,194.622
123.90	0.0	1.984	5.925	1,975.157	17,169.778
124.00	0.0	2.001	5.977	1,992.232	19,162.010
124.10	0.0	2.018	6.028	2,009.392	21,171.402
124.20	0.0	2.035	6.080	2,026.637	23,198.010

Subsection: Trapezoidal Volume
Label: Infiltration Basin1

Return Event: 100 years
Storm Event: 100YR 24hr SCS II

Elevation (m)	Planimeter (m^2)	Area (ha)	A1+A2+sqr (A1*A2) (ha)	Volume (m^3)	Volume (Total) (m^3)
124.30	0.0	2.053	6.132	2,043.938	25,241.948
124.40	0.0	2.070	6.184	2,061.297	27,303.245
124.50	0.0	2.088	6.236	2,078.740	29,381.985
124.60	0.0	2.105	6.289	2,096.268	31,478.281
124.70	0.0	2.123	6.342	2,113.853	33,592.133
124.80	0.0	2.140	6.395	2,131.522	35,723.656
124.90	0.0	2.158	6.448	2,149.277	37,872.933
125.00	0.0	2.176	6.501	2,167.060	40,039.992
125.10	0.0	2.194	6.555	2,184.956	42,224.949
125.20	0.0	2.212	6.609	2,202.909	44,427.858
125.30	0.0	2.230	6.663	2,220.919	46,648.776
125.40	0.0	2.248	6.717	2,239.013	48,887.818
125.50	0.0	2.266	6.772	2,257.192	51,145.010
125.60	0.0	2.285	6.826	2,275.429	53,420.439
125.70	0.0	2.303	6.881	2,293.750	55,714.160
125.80	0.0	2.321	6.936	2,312.127	58,026.287
125.90	0.0	2.340	6.992	2,330.590	60,356.877
126.00	0.0	2.358	7.047	2,349.109	62,705.986
126.10	0.0	2.377	7.103	2,367.713	65,073.699
126.20	0.0	2.396	7.159	2,386.374	67,460.101
126.30	0.0	2.415	7.215	2,405.120	69,865.221
126.40	0.0	2.433	7.272	2,423.950	72,289.171
126.50	0.0	2.452	7.328	2,442.838	74,732.009
126.60	0.0	2.471	7.385	2,461.782	77,193.790
126.75	0.0	2.500	7.457	3,728.394	80,922.185

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	12.0000 mm/h

Initial Conditions	
Elevation (Water Surface, Initial)	123.00 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.00 m³/s
Flow (Initial Infiltration)	0.00 m³/s
Flow (Initial, Total)	0.00 m³/s
Time Increment	0.050 hours

Elevation (m)	Outflow (m³/s)	Storage (m³)	Area (ha)	Infiltration (m³/s)	Flow (Total) (m³/s)	2S/t + O (m³/s)
123.00	0.00	0.000	1.833	0.00	0.00	0.00
123.05	0.00	918.456	1.841	0.06	0.06	10.27
123.10	0.00	1,841.032	1.849	0.06	0.06	20.52
123.15	0.00	2,767.735	1.858	0.06	0.06	30.81
123.20	0.00	3,698.576	1.866	0.06	0.06	41.16
123.25	0.00	4,633.562	1.874	0.06	0.06	51.55
123.30	0.00	5,572.704	1.882	0.06	0.06	61.98
123.35	0.00	6,516.009	1.891	0.06	0.06	72.46
123.40	0.00	7,463.487	1.899	0.06	0.06	82.99
123.45	0.00	8,415.148	1.908	0.06	0.06	93.57
123.50	0.00	9,370.999	1.916	0.06	0.06	104.19
123.55	0.00	10,331.051	1.924	0.06	0.06	114.85
123.60	0.00	11,295.311	1.933	0.06	0.06	125.57
123.65	0.00	12,263.790	1.941	0.06	0.06	136.33
123.70	0.00	13,236.495	1.950	0.06	0.06	147.14
123.75	0.00	14,213.436	1.958	0.07	0.07	157.99
123.80	0.00	15,194.623	1.967	0.07	0.07	168.89
123.85	0.00	16,180.063	1.975	0.07	0.07	179.84
123.90	0.00	17,169.767	1.984	0.07	0.07	190.84
123.95	0.00	18,163.742	1.992	0.07	0.07	201.89
124.00	0.00	19,161.998	2.001	0.07	0.07	212.98
124.05	0.00	20,164.545	2.009	0.07	0.07	224.12
124.10	0.00	21,171.390	2.018	0.07	0.07	235.30
124.15	0.00	22,182.544	2.027	0.07	0.07	246.54
124.20	0.00	23,198.014	2.035	0.07	0.07	257.82
124.25	0.00	24,217.811	2.044	0.07	0.07	269.15
124.30	0.00	25,241.942	2.053	0.07	0.07	280.53
124.35	0.00	26,270.417	2.061	0.07	0.07	291.96
124.40	0.01	27,303.246	2.070	0.07	0.08	303.45
124.45	0.02	28,340.436	2.079	0.07	0.09	314.98
124.50	0.03	29,381.998	2.088	0.07	0.10	326.56
124.55	0.04	30,427.939	2.096	0.07	0.11	338.20
124.60	0.06	31,478.270	2.105	0.07	0.13	349.89
124.65	0.07	32,532.998	2.114	0.07	0.14	361.62
124.70	0.09	33,592.133	2.123	0.07	0.16	373.41

Elevation (m)	Outflow (m^3/s)	Storage (m^3)	Area (ha)	Infiltration (m^3/s)	Flow (Total) (m^3/s)	2S/t + O (m^3/s)
124.75	0.11	34,655.685	2.132	0.07	0.18	385.25
124.80	0.13	35,723.661	2.140	0.07	0.20	397.13
124.85	0.15	36,796.072	2.149	0.07	0.22	409.07
124.90	0.17	37,872.925	2.158	0.07	0.24	421.05
124.95	0.17	38,954.231	2.167	0.07	0.24	433.07
125.00	0.17	40,039.997	2.176	0.07	0.24	445.13
125.05	0.17	41,130.233	2.185	0.07	0.24	457.25
125.10	0.17	42,224.949	2.194	0.07	0.25	469.41
125.15	0.18	43,324.152	2.203	0.07	0.25	481.63
125.20	0.18	44,427.853	2.212	0.07	0.25	493.89
125.25	0.18	45,536.059	2.221	0.07	0.25	506.21
125.30	0.18	46,648.781	2.230	0.07	0.26	518.58
125.35	0.18	47,766.026	2.239	0.07	0.26	530.99
125.40	0.19	48,887.804	2.248	0.07	0.26	543.46
125.45	0.19	50,014.125	2.257	0.08	0.26	555.98
125.50	0.19	51,144.996	2.266	0.08	0.27	568.54
125.55	0.19	52,280.428	2.275	0.08	0.27	581.16
125.60	0.19	53,420.428	2.285	0.08	0.27	593.83
125.65	0.20	54,565.007	2.294	0.08	0.27	606.55
125.70	0.20	55,714.172	2.303	0.08	0.28	619.32
125.75	0.20	56,867.934	2.312	0.08	0.28	632.14
125.80	0.20	58,026.300	2.321	0.08	0.28	645.02
125.85	0.21	59,189.280	2.331	0.08	0.28	657.94
125.90	0.21	60,356.884	2.340	0.08	0.29	670.92
125.95	0.21	61,529.119	2.349	0.08	0.29	683.94
126.00	0.21	62,705.996	2.358	0.08	0.29	697.02
126.05	0.21	63,887.522	2.368	0.08	0.29	710.15
126.10	0.22	65,073.708	2.377	0.08	0.30	723.34
126.15	0.22	66,264.561	2.386	0.08	0.30	736.57
126.20	0.22	67,460.091	2.396	0.08	0.30	749.86
126.25	0.22	68,660.308	2.405	0.08	0.30	763.19
126.30	0.22	69,865.219	2.415	0.08	0.30	776.58
126.35	0.23	71,074.835	2.424	0.08	0.31	790.03
126.40	0.23	72,289.163	2.433	0.08	0.31	803.52
126.45	0.23	73,508.214	2.443	0.08	0.31	817.07
126.50	0.23	74,731.995	2.452	0.08	0.31	830.67
126.55	0.23	75,960.517	2.462	0.08	0.32	844.32
126.60	0.24	77,193.787	2.471	0.08	0.32	858.03
126.65	0.24	78,431.815	2.481	0.08	0.32	871.78
126.70	0.24	79,674.611	2.490	0.08	0.32	885.60
126.75	0.24	80,922.182	2.500	0.08	0.32	899.46

```
            Length
    .--Top---- B ----------.
W   |                      |
i   |    .------b2------.  |
d   A    b1             |  C
t   |    `----Bottom----'  |
h   |                      |
    `----------D-----------'
      Diagram Not to Scale
```

Pond Volume Calculation for Trapezoidal Basin	
Trapezoid Top Elevation	124.50 m
Trapezoid Top Length (A to C)	232.00 m
Trapezoid Top Width (B to D)	133.00 m
Trapezoid Bottom Elevation	122.00 m
Trapezoid Bottom Length	217.00 m
Trapezoid Bottom Width	118.00 m

Pond Volume Calculation for Trapezoidal Basin	
Trapezoid Width Offset (B to b2)	7.50 m
Trapezoid Length Offset (A to b1)	7.50 m
Trapezoid Vertical Increment	0.10 m

Elevation (m)	Planimeter (m^2)	Area (ha)	A1+A2+sqr (A1*A2) (ha)	Volume (m^3)	Volume (Total) (m^3)
122.00	0.0	2.561	0.000	0.000	0.000
122.10	0.0	2.581	7.712	2,570.660	2,570.660
122.20	0.0	2.601	7.773	2,590.822	5,161.481
122.30	0.0	2.621	7.833	2,611.068	7,772.578
122.40	0.0	2.642	7.894	2,631.400	10,403.977
122.50	0.0	2.662	7.955	2,651.788	13,055.737
122.60	0.0	2.682	8.017	2,672.232	15,727.998
122.70	0.0	2.703	8.078	2,692.762	18,420.760
122.80	0.0	2.724	8.140	2,713.377	21,134.137
122.90	0.0	2.744	8.202	2,734.048	23,868.185
123.00	0.0	2.765	8.264	2,754.804	26,622.989
123.10	0.0	2.786	8.327	2,775.617	29,398.607
123.20	0.0	2.807	8.390	2,796.515	32,195.122

Subsection: Trapezoidal Volume
Label: Infiltration Basin 2

Return Event: 100 years
Storm Event: 100YR 24hr SCS II

Elevation (m)	Planimeter (m^2)	Area (ha)	A1+A2+sqr (A1*A2) (ha)	Volume (m^3)	Volume (Total) (m^3)
123.30	0.0	2.828	8.452	2,817.470	35,012.620
123.40	0.0	2.849	8.516	2,838.509	37,851.129
123.50	0.0	2.870	8.579	2,859.633	40,710.734
123.60	0.0	2.891	8.642	2,880.814	43,591.548
123.70	0.0	2.913	8.706	2,902.052	46,493.600
123.80	0.0	2.934	8.770	2,923.375	49,416.975
123.90	0.0	2.955	8.834	2,944.782	52,361.757
124.00	0.0	2.977	8.899	2,966.246	55,328.003
124.10	0.0	2.999	8.963	2,987.795	58,315.770
124.20	0.0	3.020	9.028	3,009.401	61,325.171
124.30	0.0	3.042	9.093	3,031.064	64,356.235
124.40	0.0	3.064	9.159	3,052.839	67,409.074
124.50	0.0	3.086	9.224	3,074.671	70,483.745

Infiltration	
Infiltration Method (Computed)	Average Infiltration Rate
Infiltration Rate (Average)	12.0000 mm/h

Initial Conditions	
Elevation (Water Surface, Initial)	122.00 m
Volume (Initial)	0.000 m³
Flow (Initial Outlet)	0.00 m³/s
Flow (Initial Infiltration)	0.00 m³/s
Flow (Initial, Total)	0.00 m³/s
Time Increment	0.050 hours

Elevation (m)	Outflow (m³/s)	Storage (m³)	Area (ha)	Infiltration (m³/s)	Flow (Total) (m³/s)	2S/t + O (m³/s)
122.00	0.00	0.000	2.561	0.00	0.00	0.00
122.05	0.00	1,282.814	2.571	0.09	0.09	14.34
122.10	0.00	2,570.661	2.581	0.09	0.09	28.65
122.15	0.00	3,863.552	2.591	0.09	0.09	43.01
122.20	0.00	5,161.495	2.601	0.09	0.09	57.44
122.25	0.00	6,464.499	2.611	0.09	0.09	71.91
122.30	0.00	7,772.572	2.621	0.09	0.09	86.45
122.35	0.00	9,085.725	2.631	0.09	0.09	101.04
122.40	0.00	10,403.966	2.642	0.09	0.09	115.69
122.45	0.00	11,727.303	2.652	0.09	0.09	130.39
122.50	0.00	13,055.747	2.662	0.09	0.09	145.15
122.55	0.00	14,389.306	2.672	0.09	0.09	159.97
122.60	0.00	15,727.989	2.682	0.09	0.09	174.84
122.65	0.00	17,071.804	2.693	0.09	0.09	189.78
122.70	0.00	18,420.762	2.703	0.09	0.09	204.77
122.75	0.00	19,774.871	2.713	0.09	0.09	219.81
122.80	0.00	21,134.139	2.724	0.09	0.09	234.91
122.85	0.00	22,498.577	2.734	0.09	0.09	250.08
122.90	0.00	23,868.193	2.744	0.09	0.09	265.29
122.95	0.00	25,242.996	2.755	0.09	0.09	280.57
123.00	0.00	26,622.994	2.765	0.09	0.09	295.90
123.05	0.00	28,008.198	2.776	0.09	0.09	311.29
123.10	0.00	29,398.616	2.786	0.09	0.09	326.74
123.15	0.00	30,794.256	2.797	0.09	0.09	342.25
123.20	0.00	32,195.129	2.807	0.09	0.09	357.82
123.25	0.00	33,601.243	2.817	0.09	0.09	373.44
123.30	0.00	35,012.607	2.828	0.09	0.09	389.12
123.35	0.00	36,429.229	2.839	0.09	0.09	404.86
123.40	0.00	37,851.120	2.849	0.09	0.09	420.66
123.45	0.00	39,278.288	2.860	0.10	0.10	436.52
123.50	0.00	40,710.742	2.870	0.10	0.10	452.44
123.55	0.00	42,148.490	2.881	0.10	0.10	468.41
123.60	0.00	43,591.543	2.891	0.10	0.10	484.45
123.65	0.08	45,039.909	2.902	0.10	0.17	500.62
123.70	0.22	46,493.596	2.913	0.10	0.32	516.92

Elevation (m)	Outflow (m^3/s)	Storage (m^3)	Area (ha)	Infiltration (m^3/s)	Flow (Total) (m^3/s)	2S/t + O (m^3/s)
123.75	0.43	47,952.615	2.923	0.10	0.52	533.33
123.80	0.68	49,416.974	2.934	0.10	0.77	549.85
123.85	0.97	50,886.682	2.945	0.10	1.07	566.48
123.90	1.32	52,361.747	2.955	0.10	1.42	583.22
123.95	1.71	53,842.180	2.966	0.10	1.81	600.06
124.00	2.15	55,327.989	2.977	0.10	2.25	617.00
124.05	2.64	56,819.183	2.988	0.10	2.74	634.06
124.10	3.17	58,315.770	2.999	0.10	3.27	651.22
124.15	3.75	59,817.761	3.009	0.10	3.85	668.50
124.20	4.39	61,325.164	3.020	0.10	4.49	685.88
124.25	5.07	62,837.988	3.031	0.10	5.17	703.37
124.30	5.80	64,356.241	3.042	0.10	5.90	720.97
124.35	6.59	65,879.934	3.053	0.10	6.69	738.69
124.40	7.42	67,409.075	3.064	0.10	7.52	756.51
124.45	8.31	68,943.673	3.075	0.10	8.41	774.46
124.50	9.26	70,483.736	3.086	0.10	9.36	792.51

Appendix C

Stormwater Management Performance Assessment

Appendix C

Stormwater Management Performance Assessment

This appendix outlines decision making criteria related to operation of the stormwater management (SWM) system. It includes performance assessment of the SWM ponds, disposal of secondary drainage layer (SDL) water and construction water into the SWM conveyance/holding system. Decision making criteria are presented in the following flow charts. The following field and laboratory sampling information shall be read in conjunction with the flow charts.

1. Sampling Locations

- Stormwater Pond Inlet
- Stormwater Pond Content
- Stormwater Pond Outlet (only if outlet valve open).
- SDL sampling port near Pumping Station PS6.
- Construction water-variable locations.

2. Water Quality Based on Field Sampling

Level 1

- conductivity < 1,000 µS/cm

Level 2

- 1,000 µS/cm < conductivity < 2,000 µS/cm

Level 3

- conductivity > 2,000 µS/cm
- 6.5 < pH < 9.0
- dissolved oxygen (DO) < 3 mg/L May through October
  <5 mg/L November to April

3. Water Quality Based on Laboratory Sample

Elevated:

- conductivity between 1,000 and 2,000 µS/cm
- TDS between 600 and 1,200 mg/L
- chloride between 150 and 250 mg/L
- sodium between 110 and 200 mg/L

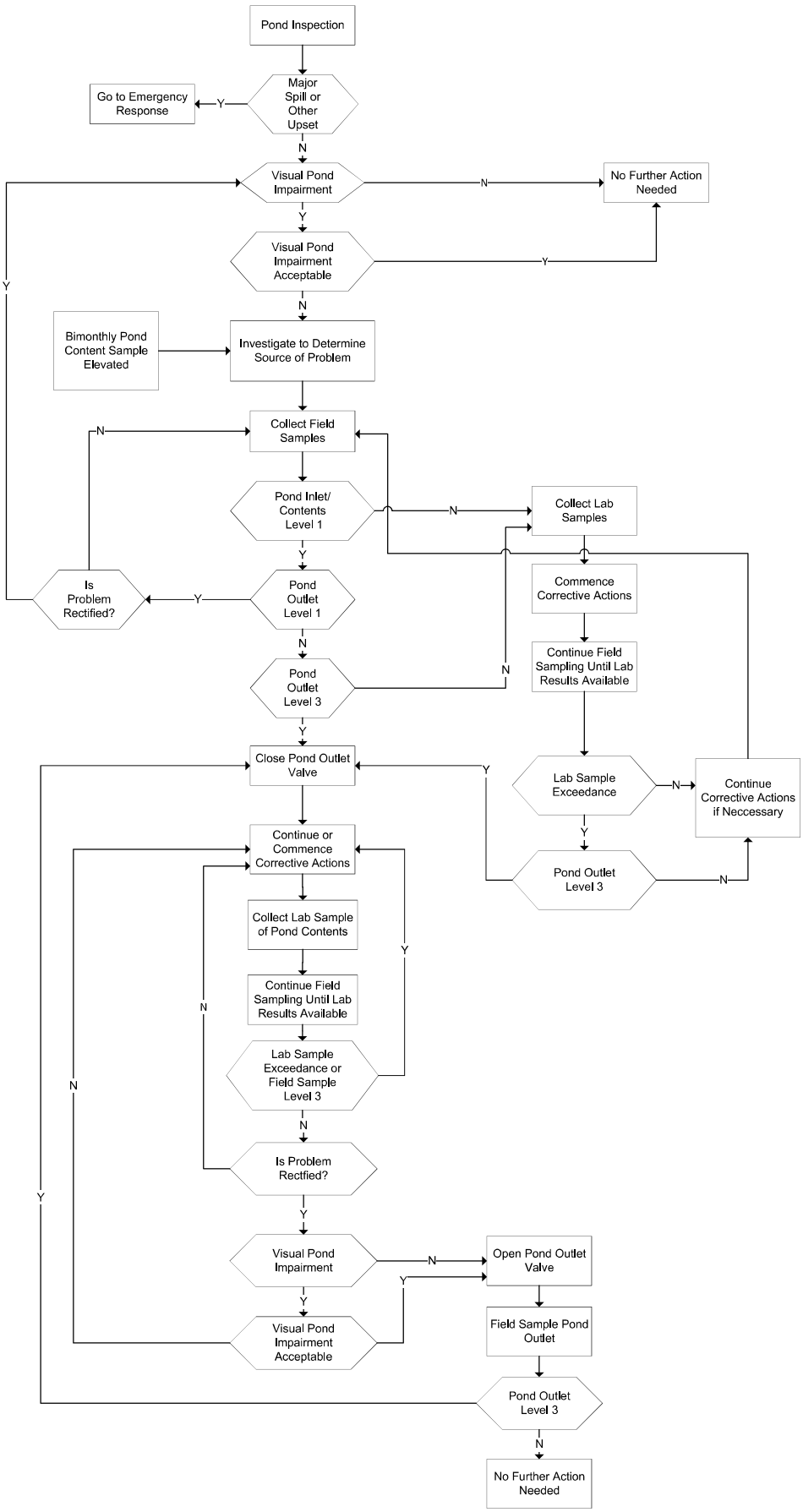
Exceedance:

- conductivity > 2,000 µS/cm
- TDS > 1,200 mg/L
- chloride > 250 mg/L
- sodium > 200 mg/L

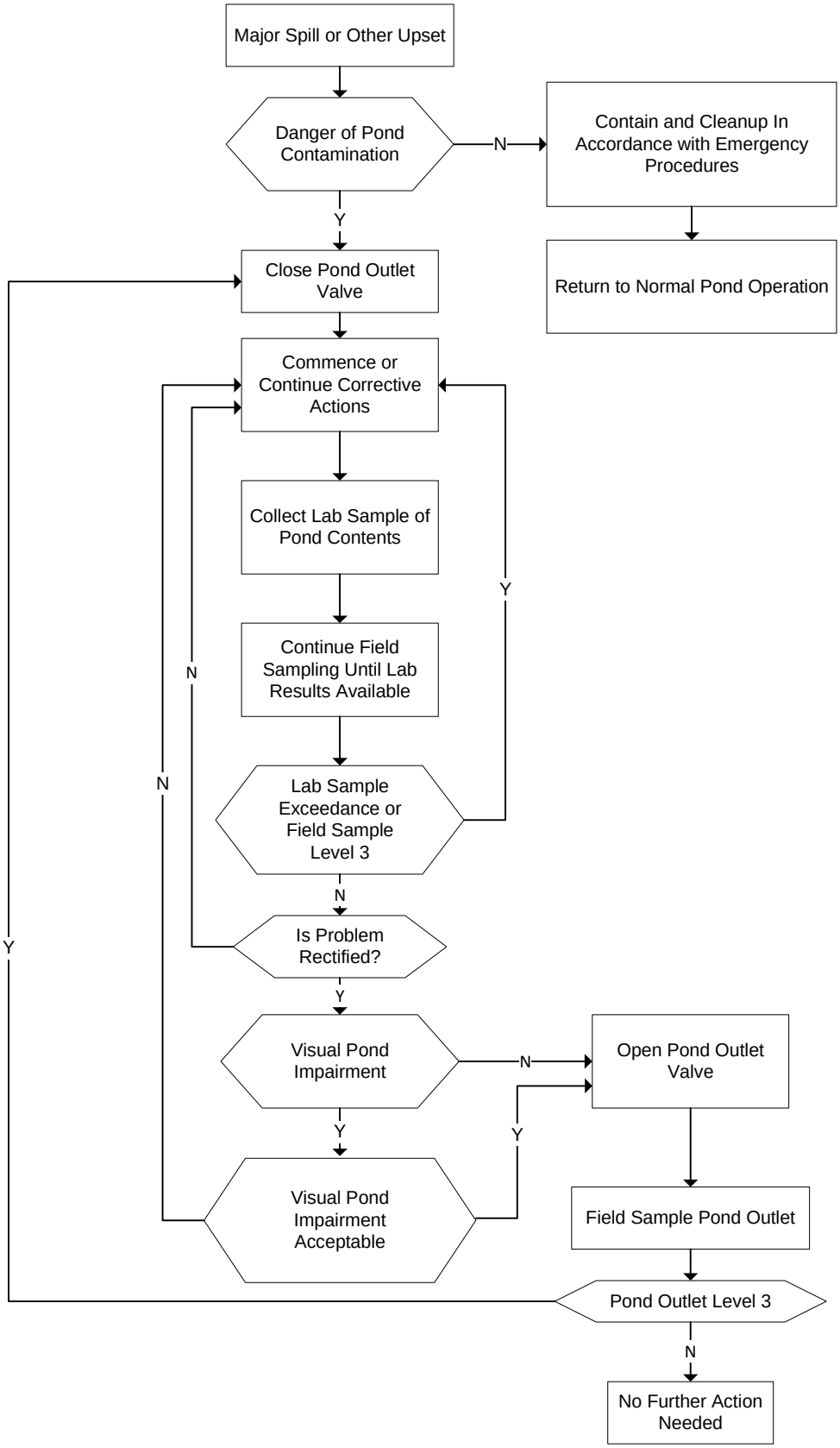
Increased turbidity shall not be considered as visual impairment of surface water. In case of a spill, indicator parameters should be revised/added based on the nature of spilled liquid.

Corrective actions will always depend on the nature of the problem. Usually it will require fixing the source of the problem such as leachate seep, exposed waste, spill, etc. If the pond contents are contaminated, corrective measures may include in-situ treatment, dilution (mixing to agitate contents, floating aerator and/or other measures to prevent stagnation), containment with booms, removal of floating material and removal of pond contents for treatment on-site or off-site.

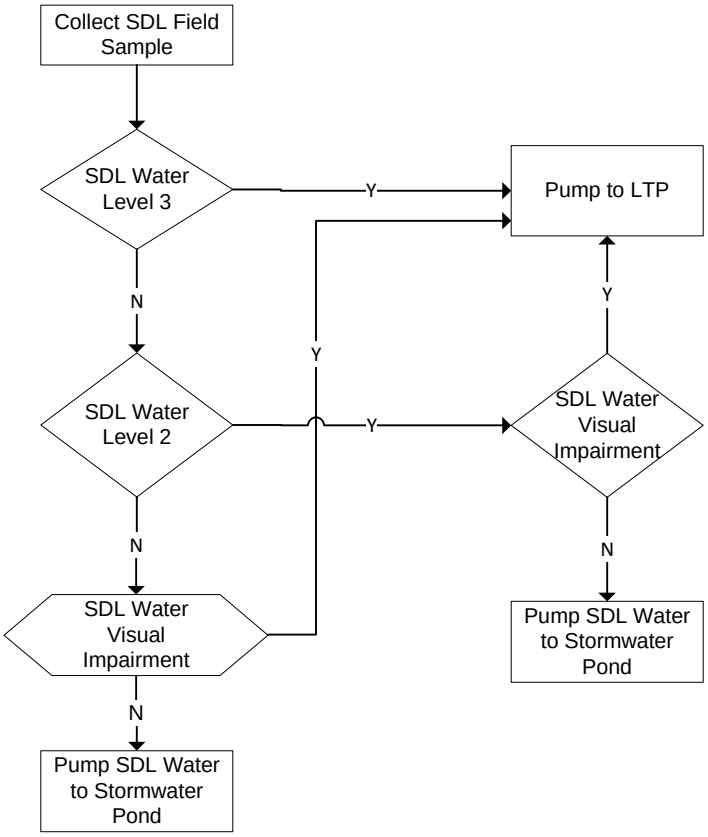
A - Regular Pond Operation



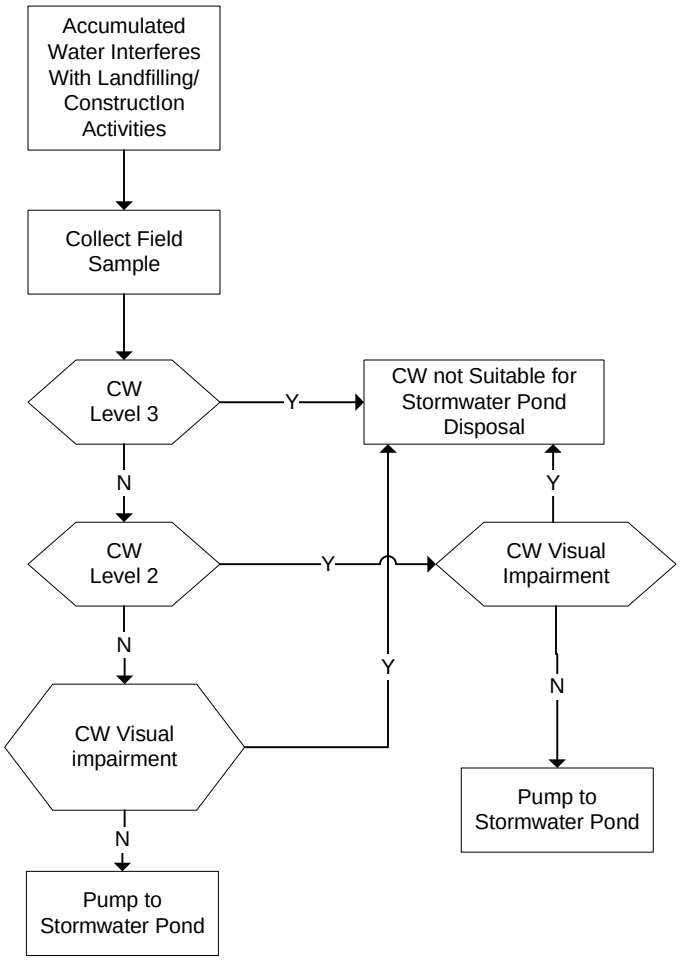
B - Stormwater Pond Emergency Response



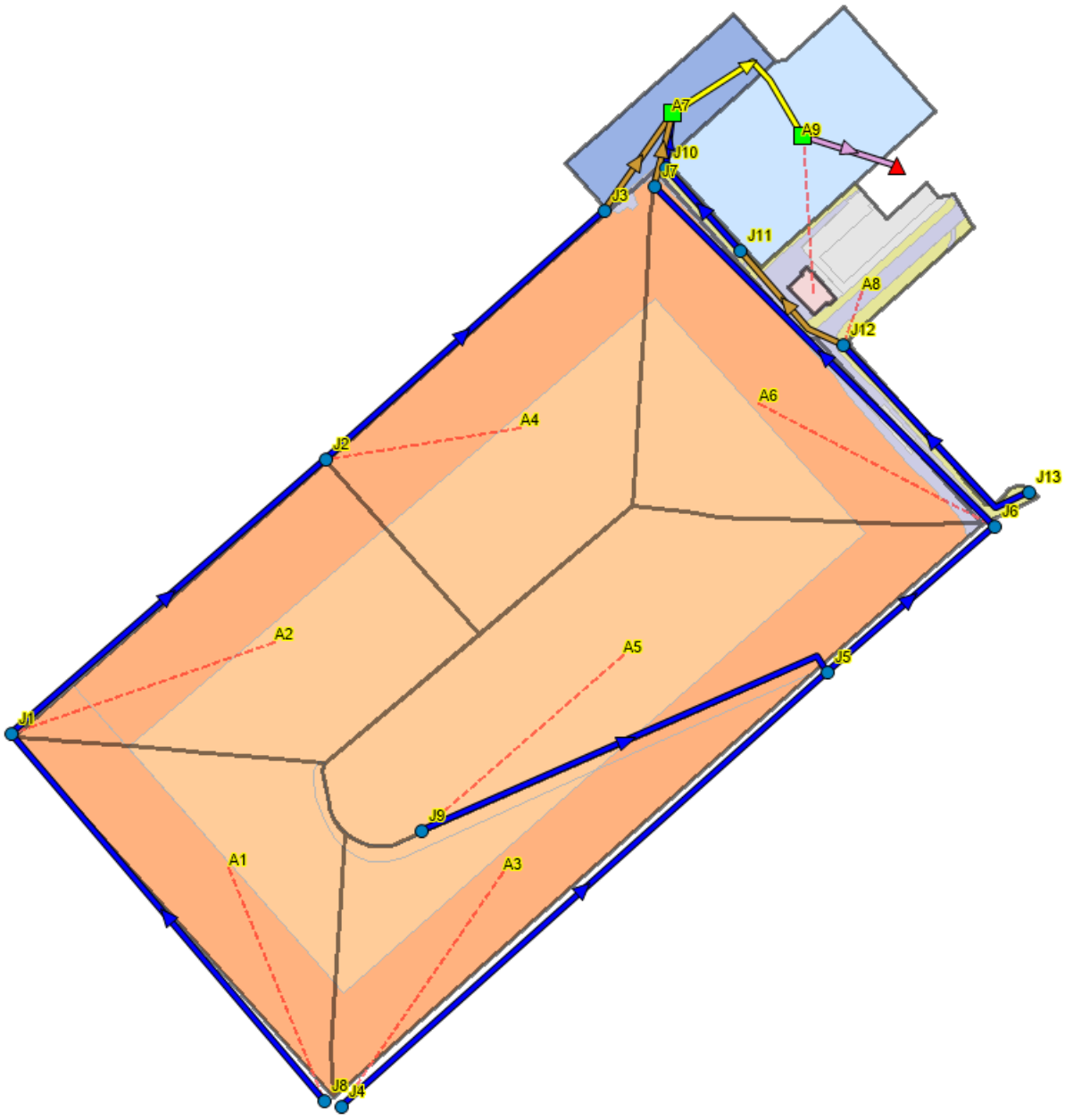
C - Handling of Secondary Drainage Layer (SDL) Water



D - Construction DewaterIng
(Handling of Construction Water (CW))



PCSWMM Output



EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.4)

****
Element Count
****
Number of rain gages 17
Number of subcatchments ... 10
Number of nodes 19
Number of links 16
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
100yr_3hr_Chicago	100yr_3hr_Chicago	INTENSITY	10 min.
100yr_3hr_Chicago_Climate_Change	100yr_3hr_Chicago_Increase_20percent	INTENSITY	10 min.
100yr_6hr_Chicago	100yr_6hr_Chicago	INTENSITY	10 min.
100yr_6hr_Chicago_Climate_Change	100yr_6hr_Chicago_Increase_20percent	INTENSITY	10 min.
100yr-24hr-SCS_Type_II	100yr-24hr-SCS_Type_II	INTENSITY	15 min.
10yr_3hr_Chicago	10yr_3hr_Chicago	INTENSITY	10 min.
10yr_6hr_Chicago	10yr_6hr_Chicago	INTENSITY	10 min.
25mm_3hr_Chicago	25mm_3hr_Chicago	INTENSITY	10 min.
25mm_4hr_Chicago	25mm_4hr_Chicago	INTENSITY	10 min.
25yr_3hr_Chicago	25yr_3hr_Chicago	INTENSITY	10 min.
25yr_6hr_Chicago	25yr_6hr_Chicago	INTENSITY	10 min.
2yr_3hr_Chicago	2yr_3hr_Chicago	INTENSITY	10 min.
2yr_6hr_Chicago	2yr_6hr_Chicago	INTENSITY	10 min.
50yr_3hr_Chicago	50yr_3hr_Chicago	INTENSITY	10 min.
50yr_6hr_Chicago	50yr_6hr_Chicago	INTENSITY	10 min.
5yr_3hr_Chicago	5yr_3hr_Chicago	INTENSITY	10 min.
5yr_6hr_Chicago	5yr_6hr_Chicago	INTENSITY	10 min.

****
Subcatchment Summary
****

Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
A1	5.77	294.14	0.00	15.0000	100yr-24hr-SCS_Type_II	J8
A2	7.43	330.04	0.00	15.0000	100yr-24hr-SCS_Type_II	J1
A3	6.11	313.17	0.00	15.0000	100yr-24hr-SCS_Type_II	J4
A4	7.95	353.19	0.00	15.0000	100yr-24hr-SCS_Type_II	J2
A5	10.33	574.07	0.00	5.0000	100yr-24hr-SCS_Type_II	J9
A6	6.43	268.04	0.00	15.0000	100yr-24hr-SCS_Type_II	J6
A7	1.51	1006.13	0.00	0.5000	100yr-24hr-SCS_Type_II	Pond#2
A8	2.69	335.96	0.00	3.5000	100yr-24hr-SCS_Type_II	J12
A8_MB	0.11	31.83	0.00	2.0000	100yr-24hr-SCS_Type_II	IB2
A9	3.53	2353.07	0.00	0.5000	100yr-24hr-SCS_Type_II	IB2

****
Node Summary
****

Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow

J1	JUNCTION	128.89	3.00	0.0
J10	JUNCTION	124.70	3.00	0.0
J11	JUNCTION	125.14	3.01	0.0
J12	JUNCTION	125.60	3.00	1000.0
J13	JUNCTION	130.80	3.00	0.0
J14	JUNCTION	126.21	3.00	0.0
J15	JUNCTION	0.00	126.60	0.0
J2	JUNCTION	127.05	3.00	0.0
J3	JUNCTION	125.22	3.00	0.0
J4	JUNCTION	131.51	3.00	0.0
J5	JUNCTION	128.95	3.00	0.0
J6	JUNCTION	127.74	3.00	0.0
J7	JUNCTION	125.02	3.09	0.0
J8	JUNCTION	131.51	3.00	0.0
J9	JUNCTION	150.00	3.00	0.0
OF1	OUTFALL	0.00	0.00	0.0
OF2	OUTFALL	122.00	0.00	0.0
IB2	STORAGE	122.00	2.50	0.0
Pond#2	STORAGE	122.80	3.50	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	Pond#2	IB2	CONDUIT	25.0	0.4000	0.0130
C10	J9	J5	CONDUIT	465.6	4.5257	0.0350
C11	J13	J12	CONDUIT	267.5	1.9445	0.0350
C12	J12	J11	CONDUIT	146.2	0.3831	0.0120
C13	J11	J10	CONDUIT	115.3	0.3816	0.0350
C14	J10	Pond#2	CONDUIT	5.0	41.0817	0.0350
C15	J14	J15	CONDUIT	51.1	1.1930	0.0350
C2	J1	J2	CONDUIT	428.6	0.4293	0.0350
C3	J2	J3	CONDUIT	385.0	0.4753	0.0350
C4	J3	Pond#2	CONDUIT	25.0	0.8800	0.0240
C5	J4	J5	CONDUIT	671.5	0.3812	0.0350
C6	J5	J6	CONDUIT	229.6	0.5269	0.0350
C7	J6	J7	CONDUIT	495.6	0.5489	0.0350
C8	J7	Pond#2	CONDUIT	24.0	0.7917	0.0240
C9	J8	J1	CONDUIT	497.1	0.5270	0.0350
OL1	IB2	OF2	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	CIRCULAR	0.33	0.08	0.08	0.33	1	0.08
C10	TRIANGULAR	1.10	1.65	0.44	3.00	1	5.83
C11	TRIANGULAR	1.10	4.95	0.53	9.00	1	12.99
C12	CIRCULAR	0.60	0.28	0.15	0.60	1	0.41
C13	TRIANGULAR	1.10	1.65	0.44	3.00	1	1.69
C14	TRIANGULAR	1.10	1.65	0.44	3.00	1	17.58
C15	TRIANGULAR	1.00	4.00	0.49	8.00	1	7.71
C2	TRAPEZOIDAL	1.10	4.73	0.59	7.60	1	6.26
C3	TRAPEZOIDAL	1.10	5.83	0.65	8.60	1	8.63
C4	ARCH	0.82	0.74	0.25	1.15	2	1.14
C5	TRAPEZOIDAL	1.10	4.18	0.56	7.10	1	5.01
C6	TRAPEZOIDAL	1.10	5.28	0.62	8.10	1	8.00
C7	TRAPEZOIDAL	1.10	5.83	0.65	8.60	1	9.27
C8	ARCH	0.82	0.74	0.25	1.15	2	1.08
C9	TRIANGULAR	1.10	1.65	0.44	3.00	1	1.99

```
****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... CURVE_NUMBER
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 11/10/2013 00:00:00
Ending Date .............. 11/14/2013 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 2
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         5.802       111.900
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         2.663        51.358
Surface Runoff ...........         3.078        59.370
Final Storage ............         0.066         1.271
Continuity Error (%) .....        -0.089


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         3.078        30.785
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         2.679        26.786
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.420         4.202
Final Stored Volume ......         0.820         8.197
Continuity Error (%) .....         0.009


***************************
Time-Step Critical Elements
***************************
None


*******************************
Highest Flow Instability Indexes
```

```
********************************
Link C4 (2)
Link OL1 (2)


********************************
Most Frequent Nonconverging Nodes
********************************
Convergence obtained at all time steps.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
% of Time in Steady State   :     0.00
Average Iterations per Step :     2.00
% of Steps Not Converging   :     0.00
Time Step Frequencies       :
    1.000 -  0.871 sec      :   100.00 %
    0.871 -  0.758 sec      :     0.00 %
    0.758 -  0.660 sec      :     0.00 %
    0.660 -  0.574 sec      :     0.00 %
    0.574 -  0.500 sec      :     0.00 %


***************************
Subcatchment Runoff Summary
***************************
```

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
A1	111.90	0.00	0.00	52.23	0.00	58.50	58.50	3.37	0.78	0.523
A2	111.90	0.00	0.00	52.33	0.00	58.39	58.39	4.34	0.93	0.522
A3	111.90	0.00	0.00	52.23	0.00	58.50	58.50	3.57	0.83	0.523
A4	111.90	0.00	0.00	52.33	0.00	58.39	58.39	4.64	1.00	0.522
A5	111.90	0.00	0.00	52.60	0.00	58.11	58.11	6.00	1.05	0.519
A6	111.90	0.00	0.00	52.39	0.00	58.34	58.34	3.75	0.77	0.521
A7	111.90	0.00	0.00	35.89	0.00	74.98	74.98	1.13	0.39	0.670
A8	111.90	0.00	0.00	34.93	0.00	75.86	75.86	2.04	0.56	0.678
A8_MB	111.90	0.00	0.00	5.14	0.00	102.47	102.47	0.12	0.04	0.916
A9	111.90	0.00	0.00	59.29	0.00	51.49	51.49	1.82	0.60	0.460

```
******************
Node Depth Summary
******************
```

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
J1	JUNCTION	0.03	0.58	129.47	0 12:07	0.57
J10	JUNCTION	0.10	0.63	125.33	0 18:25	0.63
J11	JUNCTION	0.05	0.66	125.80	0 12:09	0.66
J12	JUNCTION	0.12	0.73	126.33	0 12:08	0.73
J13	JUNCTION	0.00	0.00	130.80	0 00:00	0.00
J14	JUNCTION	0.00	0.00	126.21	0 00:00	0.00
J15	JUNCTION	0.00	0.00	0.00	0 00:00	0.00
J2	JUNCTION	0.02	0.56	127.61	0 12:08	0.56
J3	JUNCTION	0.03	0.77	125.99	0 12:16	0.77

J4	JUNCTION	0.02	0.51	132.02	0	12:04	0.51
J5	JUNCTION	0.02	0.50	129.45	0	12:11	0.50
J6	JUNCTION	0.02	0.53	128.27	0	12:12	0.52
J7	JUNCTION	0.05	0.73	125.75	0	12:22	0.73
J8	JUNCTION	0.06	0.88	132.39	0	12:03	0.87
J9	JUNCTION	0.04	0.61	150.61	0	12:01	0.61
OF1	OUTFALL	0.00	0.00	0.00	0	00:00	0.00
OF2	OUTFALL	0.00	0.00	122.00	0	00:00	0.00
IB2	STORAGE	0.35	0.59	122.59	2	01:58	0.59
Pond#2	STORAGE	1.17	2.53	125.33	0	18:25	2.53

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent	
J1	JUNCTION	0.930	1.525	0 12:01	4.34	7.72	0.029	
J10	JUNCTION	0.000	0.351	0 12:09	0	2.04	0.272	
J11	JUNCTION	0.000	0.351	0 12:08	0	2.03	-0.318	
J12	JUNCTION	0.557	0.557	0 12:00	2.04	2.04	0.236	
J13	JUNCTION	0.000	0.000	0 00:00	0	0	0.000	ltr
J14	JUNCTION	0.000	0.000	0 00:00	0	0	0.000	ltr
J15	JUNCTION	0.000	0.000	0 00:00	0	0	0.000	ltr
J2	JUNCTION	0.995	2.189	0 12:04	4.64	12.4	-0.189	
J3	JUNCTION	0.000	2.121	0 12:08	0	12.4	0.309	
J4	JUNCTION	0.832	0.832	0 12:00	3.57	3.57	-0.712	
J5	JUNCTION	0.000	1.677	0 12:04	0	9.61	0.381	
J6	JUNCTION	0.774	2.024	0 12:09	3.75	13.3	-0.325	
J7	JUNCTION	0.000	1.988	0 12:12	0	13.4	0.400	
J8	JUNCTION	0.783	0.783	0 12:00	3.37	3.37	-0.210	
J9	JUNCTION	1.048	1.048	0 12:00	6	6	-0.168	
OF1	OUTFALL	0.000	0.000	0 00:00	0	0	0.000	ltr
OF2	OUTFALL	0.000	0.089	2 01:58	0	26.8	0.000	
IB2	STORAGE	0.640	0.659	0 12:00	1.94	30.5	-0.001	
Pond#2	STORAGE	0.394	4.168	0 12:18	1.13	33	-0.043	

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 m³	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m³	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS

IB2	9.024	12.8	0.0	0.0	15.483	21.9	2	01:58	0.089
Pond#2	9.359	26.4	0.0	0.0	22.884	64.5	0	18:25	0.242

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
OF1	0.00	0.000	0.000	0.000
OF2	91.77	0.084	0.089	26.786
System	45.89	0.084	0.089	26.786

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	0.242	0	18:25	2.88	3.14	1.00
C10	CONDUIT	1.029	0	12:02	2.97	0.18	0.48
C11	CONDUIT	0.000	0	00:00	0.00	0.00	0.33
C12	CONDUIT	0.351	0	12:08	1.24	0.85	1.00
C13	CONDUIT	0.351	0	12:09	1.22	0.21	0.42
C14	CONDUIT	0.351	0	12:09	0.97	0.02	0.79
C15	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
C2	CONDUIT	1.396	0	12:07	0.91	0.22	0.52
C3	CONDUIT	2.121	0	12:08	1.00	0.25	0.60
C4	CONDUIT	1.939	0	12:16	1.55	0.85	0.74
C5	CONDUIT	0.722	0	12:07	0.74	0.14	0.45
C6	CONDUIT	1.476	0	12:11	0.94	0.18	0.47
C7	CONDUIT	1.988	0	12:12	1.04	0.21	0.56
C8	CONDUIT	1.803	0	12:22	1.50	0.83	0.71
C9	CONDUIT	0.694	0	12:04	0.98	0.35	0.66
OL1	DUMMY	0.089	2	01:58			

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
C1	1.00	0.10	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.00
C10	1.00	0.11	0.00	0.00	0.68	0.22	0.00	0.00	0.00	0.00
C11	1.00	0.09	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C12	1.00	0.10	0.54	0.00	0.36	0.00	0.00	0.00	0.00	0.88
C13	1.00	0.10	0.00	0.00	0.90	0.00	0.00	0.00	0.15	0.00
C14	1.00	0.00	0.10	0.00	0.90	0.00	0.00	0.00	0.69	0.00
C15	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C2	1.00	0.11	0.13	0.00	0.76	0.00	0.00	0.00	0.71	0.00
C3	1.00	0.11	0.00	0.00	0.89	0.00	0.00	0.00	0.64	0.00
C4	1.00	0.11	0.00	0.00	0.15	0.00	0.00	0.74	0.00	0.16
C5	1.00	0.11	0.00	0.00	0.89	0.00	0.00	0.00	0.12	0.00

C6	1.00	0.11	0.00	0.00	0.89	0.00	0.00	0.00	0.88	0.00
C7	1.00	0.11	0.00	0.00	0.89	0.00	0.00	0.00	0.70	0.00
C8	1.00	0.11	0.00	0.00	0.18	0.00	0.00	0.70	0.00	0.06
C9	1.00	0.11	0.00	0.00	0.89	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

	Hours Full			Hours Above Full	Hours Capacity
Conduit	Both Ends	Upstream	Dnstream	Normal Flow	Limited
C1	17.32	39.48	17.32	39.80	17.32
C12	0.20	0.20	0.62	0.01	0.01
C14	0.01	0.01	34.99	0.01	0.01

Analysis begun on: Thu Feb 5 09:59:05 2026
Analysis ended on: Thu Feb 5 09:59:10 2026
Total elapsed time: 00:00:05

Waste Management of Canada Limited
West Carleton Environmental Center
Environmental Assessment (EA)
Compliance Monitoring Report (CMR) for 2023

EA File: 02-08-02

March 1st, 2024

Submitted by:

Waste Management of Canada Corporation

Table of Contents

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4.0 Additional Environmental and Planning Approvals....2
5.0 EA Compliance Monitoring Program Framework....2
6.0 Construction Update....3

1.0 Introduction

The Minister of Environment and Climate Change (Minister) approved the amended West Carleton Environmental Center (WCEC) Environmental Assessment (EA) for the Waste Management of Canada Corporation (WMCC) on September 5, 2013. The Minister's Notice of Approval (Approval) to proceed with the Undertaking, issued under Section 9 of the Environmental Assessment Act (EAA), dictates the conditions of the Approval of the Undertaking that must be adhered to by WMCC.

Condition 4.1 of the Approval required WMCC to prepare and submit to the Director (Director) of the Environmental Assessment and Approvals Branch (EAAB) of the Ministry of Environment and Climate Change (MECP) an EA Compliance Monitoring Program (CMP) for the public record.

Condition 4.2 of the Approval requires WMCC to submit the CMP to the Director within one year of the date of the Approval or 60 days before commencement of construction whichever is earlier. WMCC submitted the CMP to the Director on September 5, 2014 and an updated CMP on June 30, 2015, and another update in April 2016.

Condition 4.3 indicates that the CMP shall include the monitoring of the proponent's implementation of the undertaking in accordance with the EA and the conditions in the Approval with respect to mitigation measures, public consultation, and additional studies and work required. The CMP shall also include monitoring of compliance with all commitments made in the EA and the approval process of the EA with respect to mitigation measures, public consultation, and additional studies and work required.

Condition 4.4 states that the CMP must include an implementation schedule.

Condition 4.5 notes that the Director may require the proponent to amend the CMP, and that the proponent must carry out the CMP, as may be amended by the Director.

Condition 4.6 states that the proponent shall make the CMP available to the MECP or its designate upon request in a timely manner when the MECP requests.

This document serves as the WCEC EA CMP and includes information on the following matters:

- A restatement of the conditions from the Minister's Approval of the WCEC EA;
- A restatement of WMCC's commitments from the amended WCEC EA document; and
- A framework for reporting on the EA CMP and an annual Compliance Monitoring Report (CMR). This CMR covers the compliance activities that occurred during calendar year 2022.

2.0 EA Notice of Approval Conditions

The Approval for the WCEC included a number of conditions of approval. Table 1 includes the proposed format of the EA CMR that will document WMCC's compliance with the Approval conditions. WMCC will provide the status of compliance with each condition of approval in the annual CMR.

3.0 EA Commitments and Monitoring

The amended WCEC EA document includes a chapter on Environmental Commitments and Monitoring (Chapter 8). To ensure that proposed mitigation measures set out in WCEC EA address the predicted effects for each discipline, WMCC developed monitoring strategies of each discipline to enable ongoing monitoring of potential environmental effects during facility construction, operation, and maintenance.

WMCC developed monitoring strategies for each discipline as part of the detailed impact assessments carried out in the EA to ensure that:

- Predicted net effects are not exceeded;
- Unexpected negative effects are addressed; and
- Predicted mitigation effects are realized.

Table 1 summarizes the EA commitments and monitoring for each discipline from the detailed impact assessments carried out in the EA.

4.0 Additional Environmental and Planning Approvals

As indicated in the amended WCEC EA, WMCC will obtain other approvals, including the Environmental Compliance Approval (ECA), Environmental Protection Act (EPA) Section 27 approval for waste disposal sites, Ontario Water Resources Act (OWRA) Section 53 approvals for the storm water management and leachate treatment facilities, and Planning Act for a zoning by-law amendment and site plan approval.

Table 1 summarizes the additional environmental and planning approvals, including the Environmental Compliance Approval (ECA), Environmental Protection Act (EPA) Section 27 approval for waste disposal sites, Ontario Water Resources Act (OWRA) Section 53 approvals for the storm water management and leachate treatment facilities, and Planning Act for a zoning by-law amendment and site plan approval.

5.0 EA Compliance Monitoring Program Framework

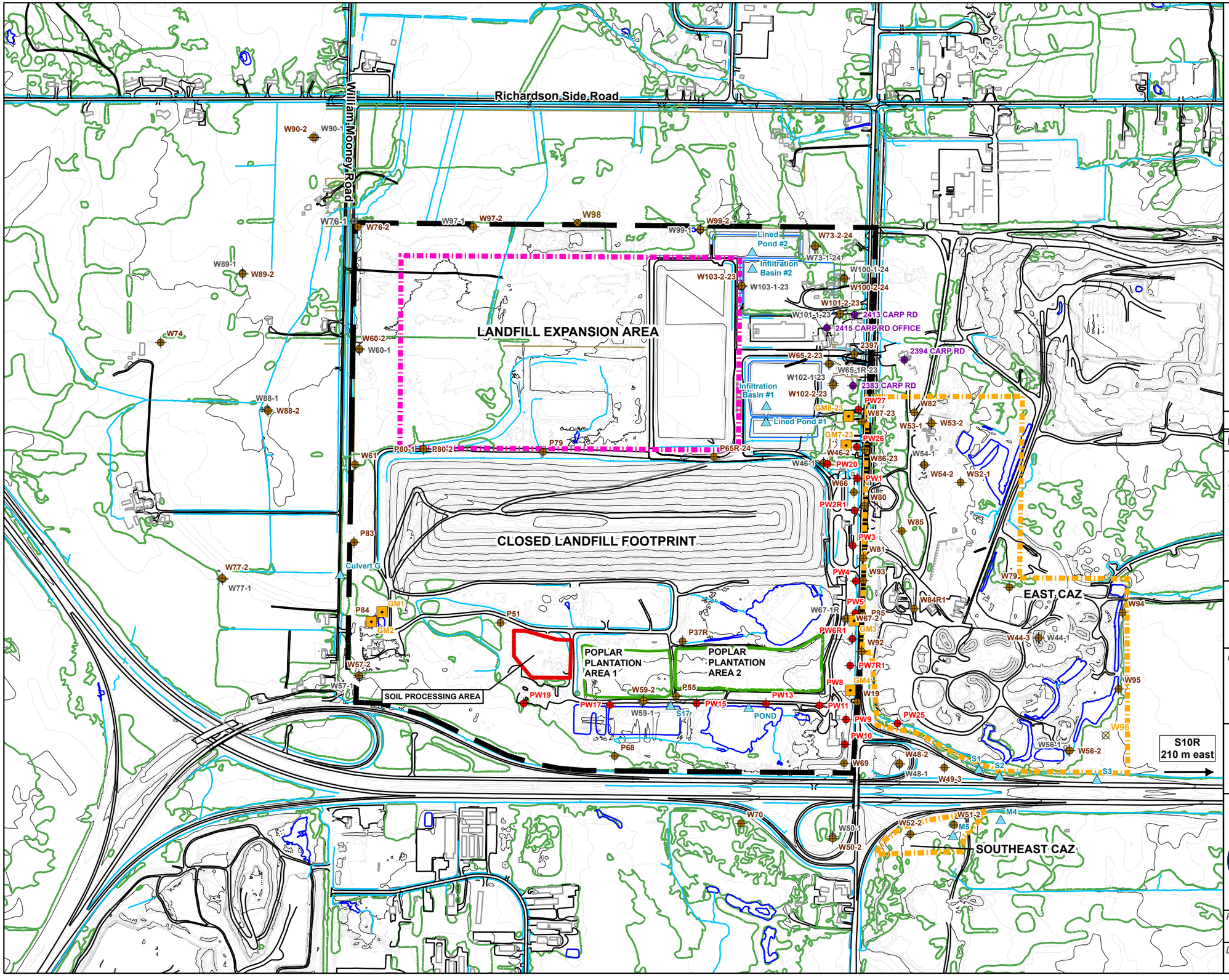
The EA CMP will consist of an annual report submitted to the Director on or before March 31 of each year. The EA CMR will document the activities conducted by WMCC over the prior calendar year (i.e., January to December). WMCC will submit an initial CMR for the WCEC in March 2014 for the calendar

year 2013. As per the EA Approval conditions, WMCC will provide the CMR to the Director of the EAAB for the public record.

6.0 Construction Update

Road construction had started to widen Carp Rd, the first phase was completed Dec 22, 2022, the remainder of the road construction was to be completed in the spring of 2023, the completion date has been extended until summer 2024 due to hold ups on the Hydro and Bell installations. The first phase of the landfill expansion project started in June 2023 this include infrastructure, storm water ponds, main access and internal road systems, cell construction. The next portion of phase 1 will start in 2024 and will be completed by 2025 this will include main cell liner construction (weather permitting), scale-house construction, paving, screening berms and landscaping.

Normal operations of our transfer station and soil pad will continue until opening of the new site.



LEGEND

- Site Boundary
- Landfill Expansion Area
- Poplar Forest
- Soil Treatment Pad
- CAZ Boundary
- Deep Bedrock Well
- Overburden - Shallow Bedrock Well
- Purge Well
- Water Supply
- Surface Water
- Gas Monitor
- Overburden - Shallow Bedrock Well (Decommissioned, To be Replaced)

Note:
All maps and data are projected in UTM Nad83 CSRS Zone 18

REV.	DESCRIPTION	YY/MM/DD	BY	CHK
1				

REFERENCES

PROPRIETARY INFORMATION MAY NOT BE REPRODUCED OR DIVULGED WITHOUT PRIOR WRITTEN CONSENT OF BLUMETRIC ENVIRONMENTAL INC.
DO NOT SCALE DRAWING.
THIS DRAWING MAY HAVE BEEN REDUCED. ALL SCALE NOTATIONS INDICATED ARE BASED ON 11"x17" FORMAT DRAWINGS.

0 100 200 400 Meters

CLIENT

WASTE MANAGEMENT

PROJECT

West Carleton Environmental Centre – 2024 Annual Report

TITLE

Spring 2024 Site Plan and Monitoring Locations

BluMetric Environmental
1682 Woodward Drive
Ottawa, ON K2C 3R8
TEL: (613) 839-3053
FAX: (613) 839-5376
Email: info@blumetric.ca
Web: http://www.blumetric.ca

PROJECT #	DATE
240129	March 07, 2025

DRAWN	CHECKED	FIG NO.	REV
GM	CM	03A	1

D:\SP\BluMetric Environmental\Geomatics - GIS\GIS_PROJECTS\PROJECTS\WM\Ottawa\PROJECTS\240129- WM - WCEC EMP 2024\APRX\2025-03-07\240129-WM-WestCarleton2024.aprx

Table 1: Summary of Landfill Monitoring Program

Waste Management of Canada Corporation - West Carleton Environmental Centre

Monitor Locations[1,2]	Parameters	Monitoring Frequency
Overburden/Shallow Bedrock		
P37R, P51, P55, P65R-24, P68, P79, P80-1, P80-2, P83, P84, W44-3, W50-2, W51-2, W52-2, W53-1, W53-2, W54-2, W56-2, W57-2, W59-2, W60-2, W61, W65-2-23, W70, W73-2-24, W74, W76-2, W77-2, W79, W82, W86-23, W87-23, W88-2, W89-2, W90-2, W94, W95, W96-24, WS2-1, PW15, PW17, PW19, PW26, PW27, W97-2, W98/W98-24, W99-2, W100-2-24, W101-2-23, W102-2-23, W103-2-23	Groundwater Elevation	Twice each year, in Spring & Fall
PW1, PW2R1, PW3, PW4, PW5, PW6R1, PW7R1, PW8, PW9, PW10, PW11, PW13, PW20, PW25, PW26, PW27, W19, W46-2, W48-2, W49-3, W65-2-23, W66, W67-2, W69, W80, W81, W82, W84R1, W85, W86-23, W92, W93, P85	Groundwater Elevation	Once each month
P65R-24, P79, P80-1, W57-2, W60-2, W61, W70, W74, W76-2, W77-2, W87-23, W88-2, W97-2, W98/W98-24, W99-2, W103-2-23	General/Inorganics	Once each year, in Spring
W44-3, W48-2, W51-2, W52-2, W53-1, W53-2, W56-2, W65-2-23, W73-2-24, W79, W82, W85, W94, W95, W96-24, WS2-1, W100-2-24, W101-2-23, W102-2-23, 2383 Carp Road[3], 2394 Carp Road (1985 well), 2397 Carp Road, 2415 Carp Road (office well), 2413 Carp Road**	General/Inorganics	Twice each year, in Spring and Fall
PW1, PW2R1, PW3, PW4, PW5, PW6R1, PW7R1, PW8*, PW9, PW10, PW20, PW26, PW27	General/Inorganics	Once each year, in Spring
W44-3, W48-2, W53-1[4], W53-2, W65-2-23, W73-2-24, W79, W82[4], W85, W87-23, WS2-1, PW1, PW2R1, PW3, PW20, PW26, PW27, W97-2, W98/W98-24, W99-2, W100-2-24, W101-2-23, W102-2-23, W103-2-23, 2383 Carp Road[3,5], 2394 Carp Road (1985 well)[5], 2397 Carp Road[5], 2415 Carp Road (office well)[5], 2413 Carp Road[5]**	VOCs	Once each year, in Spring
W44-3, W48-2, W53-1, W53-2, W65-2-23, W73-2-24, W79, W82, W85, W87-23, WS2-1, W97-2, W98/W98-24, W99-2, W100-2-24	1,4 Dioxane	Once each year, in Spring
Deep Bedrock		
W44-1, W46-1, W48-1, W50-1, W54-1, W56-1, W57-1, W59-1, W60-1, W65-1R-23, W67-1R, W73-1-24, W76-1/W76-1-24, W77-1, W88-1, W89-1, W90-1, W97-1, W99-1, W100-1-24, W101-1-23, W102-1-23, W103-1-23	Groundwater Elevation	Twice each year, in Spring & Fall
Surface Water		
S17, Pond, S1, S2, S3, Infiltration Basin #1[6], Infiltration Basin #2[6]	Surface water Elevation	Twice each year, in Spring & Fall
S1, S3, S10R, M4, M5, Culvert G	Surface Water Quality	Twice each year, in Spring & Fall
Infiltration Basin #1[6], Infiltration Basin #2[6]	Surface Water Quality, VOCs	Quarterly (March, June, September, December)
Lined Pond #1[6], Lined Pond #2[6]	Chloride, Sodium, pH, TDS, Conductivity	Once every two months
Leachate		
P3, PW8	General/Inorganics, VOCs, 1,4 Dioxane	Once each year, in Spring
P-LCS[7], S-LCS[7]	Annual Expansion Leachate General/Inorganics list, VOCs, 1,4 Dioxane	Once each year, in Spring
P-LCS[7], S-LCS[7]	Reduced Expansion Leachate General/Inorganics list	Twice per year, in summer and fall

Notes:

1 - Information regarding decommissioning, conversion, and replacement activities prior to 2024 is provided in previous annual monitoring reports.

2 - Replacement monitors from 2024 are denoted by '-24'. Monitoring and sampling in spring and fall 2024 was completed at the monitor that existed at the time of the monitoring event (i.e. at the former well or replacement well, depending on timing of the monitoring event and replacement drilling). Monitor W96 was abandoned in October 2020 and was not replaced until after the spring 2024 sampling event.

3 - Supply well 2383 Carp Road was destroyed between the spring and fall monitoring event in 2024 and will be replaced in 2025.

4 - Sample frequency increased to twice per year (spring and fall) as defined in the CAP done in addition to the EMP requirements.

5 - Sampling for VOC annually (spring) added in follow up to the CAP done in addition to the EMP requirements.

6 - Locations were not constructed for most of 2024 so monitoring began in November 2024.

7 - New landfill monitoring locations, not monitored in 2024.

* - Also designated as a leachate monitoring location (PW8 location).

** - Monitored for one year only (fall 2015 - spring 2016) to characterise background water quality .

Table 2: Water Levels - Overburden/Shallow Bedrock, Deep Bedrock and Surface Water
Waste Management of Canada Corporation - West Carleton Environmental Centre

Location	Reference Elevation*				2024 Water Levels			
	Spring 2024		Fall 2024		13-May-24		04-Nov-24	
	Type	(m asl)	Type	(m asl)	(m bref)	(m asl)	(m bref)	(m asl)
W99-2	TPVC	123.33	TPVC	123.33	1.51	121.82	2.06	121.27
W100-2-24	TOC	118.31	TOC	118.31	2.85	115.46	3.13	115.18
W101-2-23	TOC	122.25	TOC	122.25	6.74	115.51	7.06	115.20
W102-2-23	TOC	124.70	TOC	124.70	8.55	116.15	8.71	115.99
W103-2-23	TOC	127.09	TOC	127.09	8.93	118.16	9.09	118.00
WS2-1	TOC	116.62	TOC	116.62	4.80	111.82	5.10	111.53
PW1	TOC	127.40	TOC	127.40	11.23	116.16	10.69	116.71
PW2R1	TOC	128.37	TOC	128.37	11.83	116.55	11.10	117.28
PW3	TOC	128.18	TOC	128.18	13.70	114.49	13.09	115.09
PW4	TOC	128.71	TOC	128.71	12.81	115.90	12.65	116.06
PW5	TOC	128.25	TOC	128.25	11.45	116.80	11.07	117.19
PW6R1	TOC	129.84	TOC	129.84	13.15	116.68	12.76	117.08
PW7R1	TOC	133.14	TOC	133.14	15.93	117.21	15.94	117.21
PW8	TOC	131.61	TOC	131.61	14.21	117.40	14.91	116.70
PW9	TOC	127.02	TOC	127.02	9.52	117.51	10.68	116.34
PW10	TOC	127.15	TOC	127.15	8.05	119.10	10.72	116.43
PW11	TOC	125.69	TOC	125.69	5.49	120.20	6.99	118.70
PW13	TOC	124.13	TOC	124.13	1.80	122.32	2.76	121.37
PW15	TOC	124.39	TOC	124.39	1.09	123.30	1.71	122.68
PW17	TOC	127.46	TOC	127.46	2.72	124.74	3.24	124.22
PW19	TOC	128.69	TOC	128.69	3.12	125.58	4.05	124.64
PW20	TOC	131.18	TOC	131.18	17.21	113.97	17.18	114.00
PW25	TOC	118.65	TOC	118.65	1.41	117.25	2.18	116.48
PW26	TOC	127.59	TOC	127.59	11.49	116.11	11.45	116.14
PW27	TOC	124.59	TOC	124.59	8.64	115.95	8.78	115.82
Deep Bedrock Monitoring Locations								
W44-1	TOC	114.70	TOC	114.70	12.13	102.57	12.22	102.48
W46-1	TOC	131.04	TOC	131.04	13.66	117.39	13.35	117.69
W48-1	TOC	120.44	TOC	120.44	4.04	116.40	4.02	116.43
W50-1	TOC	123.49	TOC	123.49	14.69	108.81	14.18	109.32
W54-1	TOC	117.03	TOC	117.03	10.59	106.44	10.85	106.18
W56-1	TOC	115.33	TOC	115.33	21.16	94.17	21.17	94.16
W57-1	TOC	129.87	TOC	129.87	1.92	127.95	2.25	127.62
W59-1	TOC	126.94	TOC	126.94	2.05	124.89	2.79	124.15
W60-1	TOC	125.34	TOC	125.34	1.69	123.65	2.04	123.30
W65-1R-23	TOC	127.06	TOC	127.06	11.12	115.94	11.30	115.77
W67-1R	TOC	128.05	TOC	128.05	16.68	111.37	16.55	111.50
W73-1-24	TOC	119.99	TOC	119.99	20.55	99.44	13.86	106.13
W76-1/W76-1-24	TOC	124.24	TOC	124.13	1.80	122.44	2.64	121.50
W77-1	TOC	129.48	TOC	129.48	2.30	127.19	2.67	126.82
W88-1	TPVC	125.06	TPVC	125.06	0.99	124.07	1.35	123.71
W89-1	TOC	124.50	TOC	124.50	0.57	123.93	1.00	123.50
W90-1	TOC	123.07	TOC	123.07	1.71	121.36	1.75	121.32
W97-1	TOC	122.95	TOC	122.95	0.56	122.39	1.39	121.56
W99-1	TOC	123.49	TOC	123.49	1.73	121.76	2.25	121.24
W100-1-24	TOC	118.28	TOC	118.28	17.92	100.36	16.35	101.93
W101-1-23	TOC	122.51	TOC	122.51	7.08	115.43	7.38	115.13
W102-1-23	TOC	124.63	TOC	124.63	8.48	116.14	8.63	116.00
W103-1-23	TOC	127.07	TOC	127.07	24.25	102.82	23.97	103.10
Surface Water Monitoring Locations								
S17	SW (surveyed)	-	SW (surveyed)	-	-	124.07	-	124.01
S1	SW (Culvert)	115.37	SW (Culvert)	115.37	0.81	114.56	0.85	114.52
S2	SW (T-post)	114.05	SW (T-post)	114.05	0.67	113.38	0.695	113.35
S3	SW (T-post)	111.02	SW (T-post)	111.02	0.44	110.58	Dry	-
Pond	SW (surveyed)	-	SW (surveyed)	-	-	123.66	-	122.43
Infiltration Basin #1	SW (surveyed)	-	SW (surveyed)	-	-	-	Dry	-
Infiltration Basin #2	SW (surveyed)	-	SW (surveyed)	-	-	-	Dry	-

Notes:
-1 - denotes deeper interval of multilevel monitoring well location
-2 - denotes shallower interval of multilevel monitoring well location
* - reference elevations based on site surveys completed in 2024 by BluMetric
m asl - metres above sea level
m bref - metres below reference elevation
TOC - top of casing
TPVC - top of PVC riser
" - " - no value

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Ontario

Ministry of the Environment and Climate Change
Ministère de l'Environnement et de l'Action en matière de changement climatique

ENVIRONMENTAL COMPLIANCE APPROVAL
NUMBER 2948-A9VNS2
Issue Date: June 2, 2016

Waste Management of Canada Corporation
2301 Carp Rd
Ottawa, Ontario
K0A 1L0

Site Location: West Carleton Environmental Centre
2301 Carp Rd
Lot 3 & 4, Concession 3, City of Ottawa

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act , R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:

Establishment of a stormwater management facility to service a total of 67.97 ha drainage area (19.77 ha of the northern side of the closed landfill site and 48.2 ha of the new landfill site) of the West Carleton Environmental Centre located in Lots 3 and 4, Concession 1, City of Ottawa, designed to provide quantity and quality control by attenuating peak stormwater runoff from storm events up to 1:100 year return frequency at or below pre-development levels, consisting of the following:

PROPOSED WORKS:

Stormwater management facility to service a total of 19.77 ha drainage area of the northern side of the closed landfill site consisting of the following:

Perimeter Ditch:

One (1) approximately 1,100 m long perimeter ditch running along the north side of the closed landfill site, having variable depths ranging from 1.0 m to 2.4 m with an average horizontal slope of 0.48 %, and 3H:1V side slopes discharging collected stormwater to the Stormwater Management Pond #1 (SWM Pond #1) described below;

Stormwater Management Pond #1 (SWM Pond #1)

One (1) stormwater management pond **(SWM Pond #1**) located at the southeast side of the new landfill site, lined with 600 mm thick clay liner covered with geotextile and gravel, providing a storage capacity of 2,598 m 3 at a depth of 0.6 m, equipped with one (1) 300 mm diameter outlet pipe complete with isolation valve, one (1) 3.0 m bottom width overflow spillway at elevation of 125.85 m amsl discharging to the infiltration basin #1 described below;

Infiltration Basin #1:

One (1) infiltration basin (**Infiltration Basin #1**) with an infiltration rate of 12 mm/hr, located at the southeast side of the new landfill site, having an approximate bottom length of 158 m, bottom width of 116 m, and side slopes of 3H:1V, providing a storage capacity of 25,242 m 3 at a depth of approximately 1.3 m (at elevation of 124.3 m amsl), discharging through one (1) approximately 140 m long 300 mm diameter overflow storm sewer to the infiltration basin #2 described below; and

Including all controls and associated appurtenances.

Stormwater management facility to service a total of 48.2 ha drainage area of the new landfill site consisting of the following:

Perimeter Ditches:

One (1) approximately 1,350 m long perimeter ditch running along the south side and east side of the new landfill site, having variable depths ranging from 1.0 m to 1.8 m with an average horizontal slope of 0.5 %, and 3H:1V side slopes discharging collected stormwater to the stormwater management pond #2 (**SWM Pond #2**) described below;

One (1) approximately 1,300 m long perimeter ditch running along the west side and north side of the new landfill site, having variable depths ranging from 1.0 m to 1.6 m with an average horizontal slope of 0.5 %, and 3H:1V side slopes discharging collected stormwater to the stormwater management pond #2 (**SWM Pond #2**) described below;

Stormwater Management Pond #2 (SWM Pond #2)

One (1) stormwater management pond #2 (**SWM Pond #2**) located at the northeast side of the new landfill site, lined with 600 mm thick clay liner covered with geotextile and gravel, providing a storage capacity of 4,200 m 3 at a depth of 0.6 m, equipped with one (1) 350 mm diameter outlet pipe complete with isolation valve and one (1) 6.0 m bottom width overflow spillway at elevation of 125.40 m amsl discharging to the infiltration basin #2 described below;

Infiltration Basin #2:

One (1) infiltration basin (**Infiltration Basin #2**) with an infiltration rate of 12 mm/hr, located at the northeast side of the new landfill site, having an approximate bottom length of 217 m, bottom width of 118m, and side slopes of 3H:1V, providing a storage capacity of 43,592 m 3 at a depth of approximately 1.4 m (at elevation of 123.4 m amsl); and

Including all controls and associated appurtenances.

All in accordance with the documentation listed in Schedule 'A'.

For the purpose of this environmental compliance approval, the following definitions apply:

"Approval" means this entire document and any schedules attached to it, and the application;

"CBOD5" means five day carbonaceous (nitrification inhibited) biochemical oxygen demand measured in an unfiltered sample;

"Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes

of Part II.1 of the EPA.

"District Manager" means the District Manager of the Ottawa District Office;

"EPA" means the Environmental Protection Act , R.S.O. 1990, c.E.19, as amended;

"Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;

“Owner” means Waste Management of Canada Corporation and its successors and assignees;

“OWRA” means the Ontario Water Resources Act , R.S.O. 1990, c. O.40, as amended;

"Substantial Completion" has the same meaning as "substantial performance" in the Construction Lien Act ; and

“Works” means the sewage works described in the Owner’s application and this Approval and includes the Proposed Works.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL PROVISIONS

(1) The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.

(2) Except as otherwise provided by these conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the application for approval of the Works.

(3) Where there is a conflict between a provision of any submitted document referred to in this Approval and the conditions of this Approval, the conditions in this Approval shall take precedence, and where there is a conflict between the listed submitted documents in the schedule, the document bearing the most recent date shall prevail.

(4) Where there is a conflict between the documents listed in the Schedule and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

(5) The conditions of this Approval are severable. If any condition of this Approval, or the application of any condition of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

The approval issued by this Approval will cease to apply to those parts of the Works which have not been constructed within ten (10) years of the date of this Approval.

3. CHANGE OF OWNER

(1) The Owner shall notify the District Manager and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

(a) change of Owner;

(b) change of address of the Owner;

(c) change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the Business Names Act , R.S.O. 1990, c.B17 shall be included in the notification to the District Manager; and

(d) change of name of the corporation where the Owner is or at any time becomes a corporation, and a copy of the most current information filed under the Corporations Information Act , R.S.O. 1990, c. C39 shall be included in the notification to the District Manager.

(2) In the event of any change in Ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding Owner of the existence of this Approval, and a copy of such notice shall be forwarded to the District Manager and the Director.

4. UPON THE SUBSTANTIAL COMPLETION OF THE WORKS

(1) Within one (1) year of the Substantial Completion of the Proposed Works, a set of as-built drawings showing the Works “as constructed” shall be prepared. These drawings shall be kept up to date through revisions undertaken from time to time and a copy shall be retained at the Works or at operational office of the Owner for the operational life of the Works.

5. STORMWATER MONITORING

(1) The Owner shall collect stormwater grab samples from the following sampling point at a **quarterly frequency** (**March, June, September,** and **December NOTE***) and analysed for the following parameters listed below:

Table 1 - Stormwater Monitoring Sampling Point: Infiltration Basin #1 and Infiltration Basin #2		
Parameters	**Parameters**	**Field Parameters**
Alkalinity	Sulphate	Conductivity
Calcium	Total Ammonia Nitrogen	Dissolved Oxygen
Chemical Oxygen Demand	Total Suspended Solids	Flow Rate (Estimate)
Chloride	Total Dissolved Solids	pH
Conductivity	Total Kjeldahl Nitrogen	Temperature.
Dissolved Organic Carbon (DOC)	Un-ionized Ammonia	
Hardness	Barium	
Magnesium	Boron	
Nitrite as Nitrogen	Chromium (total, Cr6+, Cr3+)	
Nitrite as Nitrogen	Iron	
pH	Lead	
Potassium	Manganese	
Sodium	VOC	

*** Note:** Grab samples shall be collected from the Infiltration Basin #2 after a rainfall event causing a stormwater runoff flow into the pond.

(2) The methods and protocols for sampling, analysis and recording shall conform, in order of precedence, to the methods and protocols specified in the following:

(a) the Ministry's Procedure F-10-1, “Procedures for Sampling and Analysis Requirements for Municipal and Private Sewage Treatment Works (Liquid Waste Streams Only), as amended from time to time by more recently published editions;
(b) the Ministry's publication "Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater" (January 1999), ISBN 0-7778-1880-9, as amended from time to time by more recently published editions; and,
(c) the publication "Standard Methods for the Examination of Water and Wastewater" (21st edition), as amended from time to time by more recently published editions.

(3) The Owner shall retain for a minimum of five (5) years from the date of their creation, all records and information related to or resulting from the monitoring activities required by this Approval.

6. OPERATION AND MAINTENANCE .

(1) The Owner shall inspect the Works at least once a year and, if necessary, clean and maintain the Works to prevent the excessive buildup of sediments and/or vegetation.

(2) The Owner shall maintain a logbook to record the results of these inspections and any cleaning and maintenance operations undertaken, and shall keep the logbook at operational office of the Owner for inspection by the Ministry. The logbook shall include the following:

(a) the name of the Works;
(b) the date and results of each inspection, maintenance and cleaning, including an estimate of the quantity of any materials removed; and
(c) the date of each spill within the catchment area, including follow-up actions / remedial measures undertaken.

7. REPORTING

(1) The Owner shall, upon request, make all manuals, plans, records, data, procedures and supporting documentation available to Ministry staff.

(2) The Owner shall prepare and submit a performance report to the District Manager on an annual basis within ninety (90) days following the end of the period being reported upon. The first such report shall cover the first annual period following the commencement of operation of the works and subsequent reports shall be submitted to cover successive annual periods following thereafter. The reports shall contain, but shall not be limited to, the following information:

(a) a summary and interpretation of all monitoring data collected under Condition 5, including an overview of the success and adequacy of the Works;
(b) a summary of any actions taken to implement the remedial and contingency action plan;
(c) a summary of all maintenance carried out on any major structure, equipment, apparatus, mechanism or thing forming part of the Works;
(d) a description of any operational issues encountered and corrective actions taken; and
(e) any other information the District Manager requires from time to time.

SCHEDULE 'A'

I. *PROPOSED WORKS:*

1. Application for Environmental Compliance Approval submitted by Waste Management of Canada Corporation dated August 20, 2014 and design specifications and engineering drawings prepared by WSP Canada Inc., Owen Sound, Ontario.

2. "Environmental Monitoring Program Reports, WCEC" dated July 2014, prepared by WESA, a division of BluMetric Environmental Inc., Ottawa, Ontario.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are built and operated in the manner in which they were described for review and upon which approval was granted. This condition is also included to emphasize the precedence of Conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review. The condition also advises the Owners their responsibility to notify any person they authorized to carry out work pursuant to this Approval the existence of this Approval.

2. Condition 2 is included to ensure that the Works are constructed in a timely manner so that standards applicable at the time of Approval of the Works are still applicable at the time of construction, to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to the approved works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included to ensure that the Works are constructed in accordance with the approval and that record drawings of the Works “as constructed” are maintained for future references.

5. Condition 5 is included to enable the Owner to evaluate and demonstrate the performance of the Works, on a continual basis, so that the Works are properly operated and maintained at a level which is consistent with the design objectives and effluent objectives specified in the Approval and that the Works does not cause any impairment to the receiving watercourse.

6. Condition 6 is included to require that the Works be properly operated, maintained, funded, staffed and equipped such that the environment is protected and deterioration, loss, injury or damage to any person or property is prevented. As well, the inclusion of a comprehensive operations manual governing all significant areas of operation, maintenance and repair is prepared, implemented and kept up-to-date by the owner and made available to the Ministry. Such a manual is an integral part of the operation of the Works. Its compilation and use should assist the Owner in staff training, in proper plant operation and in identifying and planning for contingencies during possible abnormal conditions. The manual will also act as a benchmark for Ministry staff when reviewing the Owner's operation of the work.

7. Condition 7 is included to provide a performance record for future references, to ensure that the Ministry is made aware of problems as they arise, and to provide a compliance record for all the terms and conditions outlined in this Approval, so that the Ministry can work with the Owner in resolving any problems in a timely manner.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me, the Environmental Review Tribunal and in accordance with Section 47 of the Environmental Bill of Rights, 1993 , S.O. 1993, c. 28 (Environmental Bill of Rights), the Environmental Commissioner, within 15 days after receipt of this Notice, require a hearing by the Tribunal. The Environmental Commissioner will place notice of your appeal on the Environmental Registry. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

1. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

The Notice should also include:

3. The name of the appellant;
4. The address of the appellant;
5. The environmental compliance approval number;
6. The date of the environmental compliance approval;
7. The name of the Director, and;
8. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Environmental Commissioner
1075 Bay Street, Suite 605
Toronto, Ontario
M5S 2B1

AND

The Director appointed for the purposes of Part II.1 of the Environmental Protection Act
Ministry of the Environment and Climate Change
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

*** Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

This instrument is subject to Section 38 of the Environmental Bill of Rights, 1993, that allows residents of Ontario to seek leave to appeal the decision on this instrument. Residents of Ontario may seek leave to appeal within 15 days from the date this decision is placed on the Environmental Registry. By accessing the Environmental Registry at www.ebr.gov.on.ca , you can determine when the leave to

appeal period ends.

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 2nd day of June, 2016

Fariha Pannu, P.Eng.
Director
appointed for the purposes of Part II.1 of
the *Environmental Protection Act*

SH/
c: District Manager, MOECC Ottawa
Peter Brodzikowski, WSP Canada Inc.