Appendix A POTABLE WATER SERVICING ANALYSIS

BOUNDARY CONDITIONS

Boundary Conditions For: 801 Ralph Hennessy Ave.

Date of Boundary Conditions: 2018-Aug-17

Provided Information:

Scenario	Demand	
	L/min	L/s
Average Daily Demand	69.6	1.2
Maximum Daily Demand	174	2.9
Peak Hour	383.4	6.4
Fire Flow #1 Demand	14,000	233.3
Fire Flow #2 Demand	15,000	250.0

Number Of Connections: 1

Location:

BOUNDARY CONDITIONS

Results:

Connection #: 1 Pre-Configuration

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	133.1	59.0
Peak Hour	125.4	48.0
Max Day Plus Fire (14,000) L/min	122.3	43.7
Max Day Plus Fire (15,000) L/min	121.9	43.1

[1]Elevation: **91.600 m**

Connection #: 2 Pre-Configuration

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	132.1	58.5
Peak Hour	125.4	47.4
Max Day Plus Fire (14,000) L/min	112.1	28.6
Max Day Plus Fire (15,000) L/min	110.3	26.0

[1]Elevation: **91.52 m**

Connection #: 1 Post-Configuration

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	147.8	80.0
Peak Hour	145.6	76.9
Max Day Plus Fire (14,000) L/min	143.7	74.1
Max Day Plus Fire (15,000) L/min	143.3	73.6

[1]Elevation: **91.600 m**

BOUNDARY CONDITIONS

Connection #: 2 Post-Configuration

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	147.8	80.0
Peak Hour	145.6	75.1
Max Day Plus Fire (14,000) L/min	138.1	66.3
Max Day Plus Fire (15,000) L/min	137.5	65.4

[1]Elevation: **91.52 m**

Notes:

1) As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:

a) If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.
b) Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building, located downstream of the meter so it is owner maintained.

2) Two connections must be looped within proposed subdivion

Disclaimer

The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation. Fire Flow analysis is a reflection of available flow in the watermain; there may be additional restrictions that occur between the watermain and the hydrant that the model cannot take into account.

Riverside Phase 8 Block 221 - Domestic Water Demand Estimates
- Based on Proposed Richcraft Site Plan (160401422)

Building ID	Units	Population	Daily Rate of Demand	Avg Day Demand (L/min)	Avg Day Demand (L/s)	Max Day Demand (L/min)	Max Day Demand (L/s)	Peak Hour Demand (L/min)	Peak Hour Demand (L/s)
Blocks 1-4	38	102.6	350	24.9	0.42	62.3	1.04	137.2	2.29
Blocks 5-11	60	162	350	39.4	0.66	98.4	1.64	216.6	3.61
Total Site :	**98**	**264.6**		**64.3**	**1.07**	**160.8**	**2.68**	**353.7**	**5.90**

Assumed 2.7p/townhome

Maximum day demand rate = 2.5 x average day demand rate

Peak hour demand rate = 2.2 x maximum day demand rate

Stantec

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 3/30/2020
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 1

Notes: Similar to Block 4

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Wood Frame						1.5	-
2	Determine Ground Floor Area of One Unit	-						58.92	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						6	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						3	-
4	Determine Required Fire Flow	($F = 220 \times C \times A^{1/2}$). Round to nearest 1000 L/min						-	11000
5	Determine Occupancy Charge	Limited Combustible						-15%	9350
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	3.1 to 10	19	3	31-60	Wood Frame or Non-Combustible	18%	3834
		East	10.1 to 20	30	3	61-90	Wood Frame or Non-Combustible	14%	
		South	0 to 3	19	3	31-60	Ordinary or Fire Resistive (Blank Wall)	0%	
		West	20.1 to 30	30	3	61-90	Wood Frame or Non-Combustible	9%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							13000
		Total Required Fire Flow in L/s							216.7
		Required Duration of Fire Flow (hrs)							2.50
		Required Volume of Fire Flow (m^3)							1950

Stantec

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 3/30/2020
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 2

Notes:

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Wood Frame						1.5	-
2	Determine Ground Floor Area of One Unit	-						58.92	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						6	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						3	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	11000
5	Determine Occupancy Charge	Limited Combustible						-15%	9350
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	3.1 to 10	19	3	31-60	Wood Frame or Non-Combustible	18%	3834
		East	10.1 to 20	30	3	61-90	Wood Frame or Non-Combustible	14%	
		South	0 to 3	19	3	31-60	Ordinary or Fire Resistive (Blank Wall)	0%	
		West	20.1 to 30	30	3	61-90	Wood Frame or Non-Combustible	9%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							13000
		Total Required Fire Flow in L/s							216.7
		Required Duration of Fire Flow (hrs)							2.50
		Required Volume of Fire Flow (m^3)							1950

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FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 3/30/2020
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 3

Notes:

<table>
<tr><th>Step</th><th>Task</th><th colspan="6">Notes</th><th>Value Used</th><th>Req'd Fire Flow (L/min)</th></tr>
<tr><td>1</td><td>Determine Type of Construction</td><td colspan="6">Wood Frame</td><td>1.5</td><td>-</td></tr>
<tr><td rowspan="2">2</td><td>Determine Ground Floor Area of One Unit</td><td colspan="6">-</td><td>58.92</td><td>-</td></tr>
<tr><td>Determine Number of Adjoining Units</td><td colspan="6">Includes adjacent wood frame structures separated by 3m or less</td><td>8</td><td>-</td></tr>
<tr><td>3</td><td>Determine Height in Storeys</td><td colspan="6">Does not include floors >50% below grade or open attic space</td><td>3</td><td>-</td></tr>
<tr><td>4</td><td>Determine Required Fire Flow</td><td colspan="6">(F = 220 x C x A$^{1/2}$). Round to nearest 1000 L/min</td><td>-</td><td>12000</td></tr>
<tr><td>5</td><td>Determine Occupancy Charge</td><td colspan="6">Limited Combustible</td><td>-15%</td><td>10200</td></tr>
<tr><td rowspan="4">6</td><td rowspan="4">Determine Sprinkler Reduction</td><td colspan="6">None</td><td>0%</td><td rowspan="4">0</td></tr>
<tr><td colspan="6">Non-Standard Water Supply or N/A</td><td>0%</td></tr>
<tr><td colspan="6">Not Fully Supervised or N/A</td><td>0%</td></tr>
<tr><td colspan="6">% Coverage of Sprinkler System</td><td>0%</td></tr>
<tr><td rowspan="5">7</td><td rowspan="5">Determine Increase for Exposures (Max. 75%)</td><td>Direction</td><td>Exposure Distance (m)</td><td>Exposed Length (m)</td><td>Exposed Height (Stories)</td><td>Length-Height Factor (m x stories)</td><td>Construction of Adjacent Wall</td><td>-</td><td>-</td></tr>
<tr><td>North</td><td>3.1 to 10</td><td>18</td><td>3</td><td>31-60</td><td>Wood Frame or Non-Combustible</td><td>18%</td><td rowspan="4">6018</td></tr>
<tr><td>East</td><td>10.1 to 20</td><td>25</td><td>3</td><td>61-90</td><td>Wood Frame or Non-Combustible</td><td>14%</td></tr>
<tr><td>South</td><td>3.1 to 10</td><td>18</td><td>3</td><td>31-60</td><td>Wood Frame or Non-Combustible</td><td>18%</td></tr>
<tr><td>West</td><td>20.1 to 30</td><td>25</td><td>3</td><td>61-90</td><td>Wood Frame or Non-Combustible</td><td>9%</td></tr>
<tr><td rowspan="4">8</td><td rowspan="4">Determine Final Required Fire Flow</td><td colspan="7">Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min</td><td>16000</td></tr>
<tr><td colspan="7">Total Required Fire Flow in L/s</td><td>266.7</td></tr>
<tr><td colspan="7">Required Duration of Fire Flow (hrs)</td><td>3.50</td></tr>
<tr><td colspan="7">Required Volume of Fire Flow (m^3)</td><td>3360</td></tr>
</table>

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 3/30/2020
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 8

Notes: Similar to Blocks 5-7

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Wood Frame						1.5	-
2	Determine Ground Floor Area of One Unit	-						58.92	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						8	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						3	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	12000
5	Determine Occupancy Charge	Limited Combustible						-15%	10200
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	10.1 to 20	19	3	31-60	Wood Frame or Non-Combustible	13%	5814
		East	3.1 to 10	18	3	31-60	Wood Frame or Non-Combustible	18%	
		South	10.1 to 20	19	3	31-60	Wood Frame or Non-Combustible	13%	
		West	10.1 to 20	18	3	31-60	Wood Frame or Non-Combustible	13%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							16000
		Total Required Fire Flow in L/s							266.7
		Required Duration of Fire Flow (hrs)							3.50
		Required Volume of Fire Flow (m^3)							3360

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FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 3/30/2020
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 9

Notes:

<table>
<tr><th>Step</th><th>Task</th><th colspan="6">Notes</th><th>Value Used</th><th>Req'd Fire Flow (L/min)</th></tr>
<tr><td>1</td><td>Determine Type of Construction</td><td colspan="6">Wood Frame</td><td>1.5</td><td>-</td></tr>
<tr><td rowspan="2">2</td><td>Determine Ground Floor Area of One Unit</td><td colspan="6">-</td><td>58.92</td><td>-</td></tr>
<tr><td>Determine Number of Adjoining Units</td><td colspan="6">Includes adjacent wood frame structures separated by 3m or less</td><td>6</td><td>-</td></tr>
<tr><td>3</td><td>Determine Height in Storeys</td><td colspan="6">Does not include floors >50% below grade or open attic space</td><td>3</td><td>-</td></tr>
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<tr><td>5</td><td>Determine Occupancy Charge</td><td colspan="6">Limited Combustible</td><td>-15%</td><td>9350</td></tr>
<tr><td rowspan="4">6</td><td rowspan="4">Determine Sprinkler Reduction</td><td colspan="6">None</td><td>0%</td><td rowspan="4">0</td></tr>
<tr><td colspan="6">Non-Standard Water Supply or N/A</td><td>0%</td></tr>
<tr><td colspan="6">Not Fully Supervised or N/A</td><td>0%</td></tr>
<tr><td colspan="6">% Coverage of Sprinkler System</td><td>0%</td></tr>
<tr><td rowspan="5">7</td><td rowspan="5">Determine Increase for Exposures (Max. 75%)</td><td>Direction</td><td>Exposure Distance (m)</td><td>Exposed Length (m)</td><td>Exposed Height (Stories)</td><td>Length-Height Factor (m x stories)</td><td>Construction of Adjacent Wall</td><td>-</td><td>-</td></tr>
<tr><td>North</td><td>10.1 to 20</td><td>19</td><td>3</td><td>31-60</td><td>Wood Frame or Non-Combustible</td><td>13%</td><td rowspan="4">3647</td></tr>
<tr><td>East</td><td>0 to 3</td><td>18</td><td>3</td><td>31-60</td><td>Ordinary or Fire Resistive (Blank Wall)</td><td>0%</td></tr>
<tr><td>South</td><td>10.1 to 20</td><td>19</td><td>3</td><td>31-60</td><td>Wood Frame or Non-Combustible</td><td>13%</td></tr>
<tr><td>West</td><td>10.1 to 20</td><td>18</td><td>3</td><td>31-60</td><td>Wood Frame or Non-Combustible</td><td>13%</td></tr>
<tr><td rowspan="4">8</td><td rowspan="4">Determine Final Required Fire Flow</td><td colspan="7">Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min</td><td>13000</td></tr>
<tr><td colspan="7">Total Required Fire Flow in L/s</td><td>216.7</td></tr>
<tr><td colspan="7">Required Duration of Fire Flow (hrs)</td><td>2.50</td></tr>
<tr><td colspan="7">Required Volume of Fire Flow (m^3)</td><td>1950</td></tr>
</table>

Stantec

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 3/30/2020
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 10

Notes:

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Wood Frame						1.5	-
2	Determine Ground Floor Area of One Unit	-						58.92	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						6	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						3	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	11000
5	Determine Occupancy Charge	Limited Combustible						-15%	9350
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	10.1 to 20	19	3	31-60	Wood Frame or Non-Combustible	13%	3647
		East	0 to 3	18	3	31-60	Ordinary or Fire Resistive (Blank Wall)	0%	
		South	10.1 to 20	19	3	31-60	Wood Frame or Non-Combustible	13%	
		West	10.1 to 20	18	3	31-60	Wood Frame or Non-Combustible	13%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							13000
		Total Required Fire Flow in L/s							216.7
		Required Duration of Fire Flow (hrs)							2.50
		Required Volume of Fire Flow (m^3)							1950

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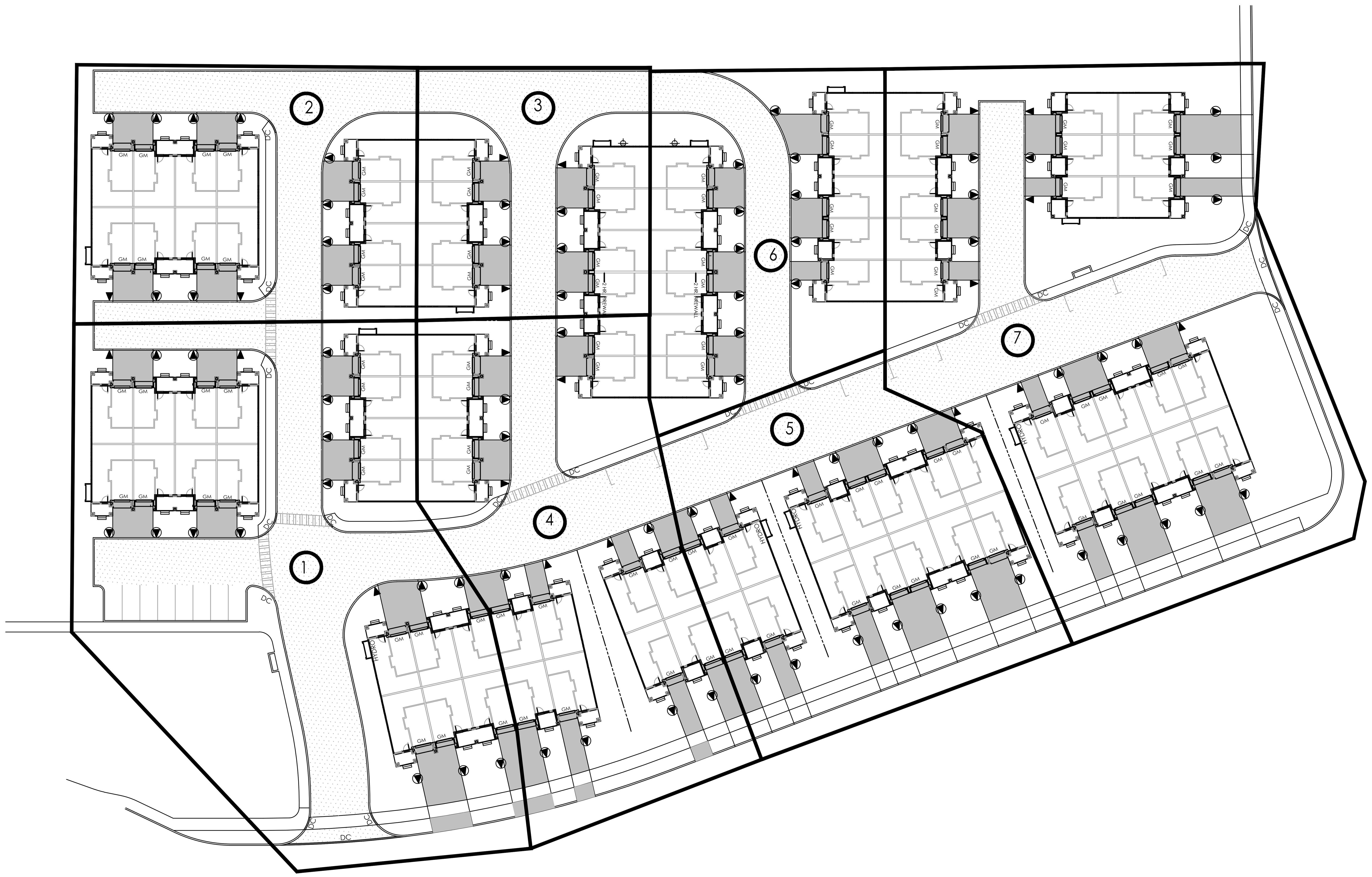
FUS Fire Flow Calculation Sheet

Stantec Project #: 160401422
Project Name: Richcraft Block 221 Riverside
Date: 3/30/2020
Fire Flow Calculation #: 1
Description: Back-to-back Townhomes Block 11

Notes:

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Wood Frame						1.5	-
2	Determine Ground Floor Area of One Unit	-						58.92	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						6	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						3	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	11000
5	Determine Occupancy Charge	Limited Combustible						-15%	9350
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	10.1 to 20	19	3	31-60	Wood Frame or Non-Combustible	13%	4395
		East	10.1 to 20	15	3	31-60	Wood Frame or Non-Combustible	13%	
		South	20.1 to 30	19	3	31-60	Wood Frame or Non-Combustible	8%	
		West	10.1 to 20	15	3	31-60	Wood Frame or Non-Combustible	13%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							14000
		Total Required Fire Flow in L/s							233.3
		Required Duration of Fire Flow (hrs)							3.00
		Required Volume of Fire Flow (m^3)							2520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Riverside Phase 8 Block 221 - Domestic Water Demand Estimates
- Based on Proposed Richcraft Site Plan (160401422)

Building ID	Units	Population	Daily Rate of Demand	Avg Day Demand		Max Day Demand		Peak Hour Demand	
				(L/min)	(L/s)	(L/min)	(L/s)	(L/min)	(L/s)
1	18	48.6	350	11.8	0.20	29.5	0.49	65.0	1.08
2	12	32.4	350	7.9	0.13	19.7	0.33	43.3	0.72
3	8	21.6	350	5.3	0.09	13.1	0.22	28.9	0.48
4	14	37.8	350	9.2	0.15	23.0	0.38	50.5	0.84
5	14	37.8	350	9.2	0.15	23.0	0.38	50.5	0.84
6	11	29.7	350	7.2	0.12	18.0	0.30	39.7	0.66
7	21	56.7	350	13.8	0.23	34.5	0.57	75.8	1.26
Total Site :	**98**	**264.6**		**64.3**	**1.07**	**160.8**	**2.68**	**353.7**	**5.90**

Assumed 2.7p/townhome
Maximum day demand rate = 2.5 x average day demand rate
Peak hour demand rate = 2.2 x maximum day demand rate

Hydraulic Model Results - Average Day Analysis

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
101	0.23	92.54	147.8	78.56	541.66
103	0.15	92.32	147.8	78.87	543.79
104	0.12	92.5	147.8	78.61	542.00
105	0.09	92.45	147.8	78.68	542.48
108	0.13	92.75	147.8	78.26	539.59
113	0.2	91.9	147.8	79.47	547.93
119	0.15	92.1	147.8	79.18	545.93

Pipe Results

ID	From Node	To Node	Length	Diameter	Roughness	Flow	Velocity
			(m)	(mm)		(L/s)	(m/s)
201	501	101	57.51	204	110	0.50	0.02
203	101	103	37.45	204	110	0.27	0.01
204	103	104	33.94	204	110	0.11	0.00
208	108	105	34.65	204	110	0.03	0.00
212	108	113	67.49	204	110	-0.16	0.00
215	113	503	49.77	204	110	-0.57	0.02
226	113	119	33.56	204	110	0.21	0.01
227	105	104	45.29	204	110	0.01	0.00
228	105	119	60.9	204	110	-0.07	0.00
230	103	119	36.56	204	110	0.02	0.00

Hydraulic Model Results -Peak Hour Analysis

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
101	1.26	92.54	145.6	75.42	520.01
103	0.84	92.32	145.59	75.73	522.14
104	0.66	92.5	145.59	75.48	520.42
105	0.48	92.45	145.59	75.55	520.90
108	0.72	92.75	145.59	75.12	517.94
113	1.08	91.9	145.6	76.33	526.28
119	0.84	92.1	145.59	76.05	524.35

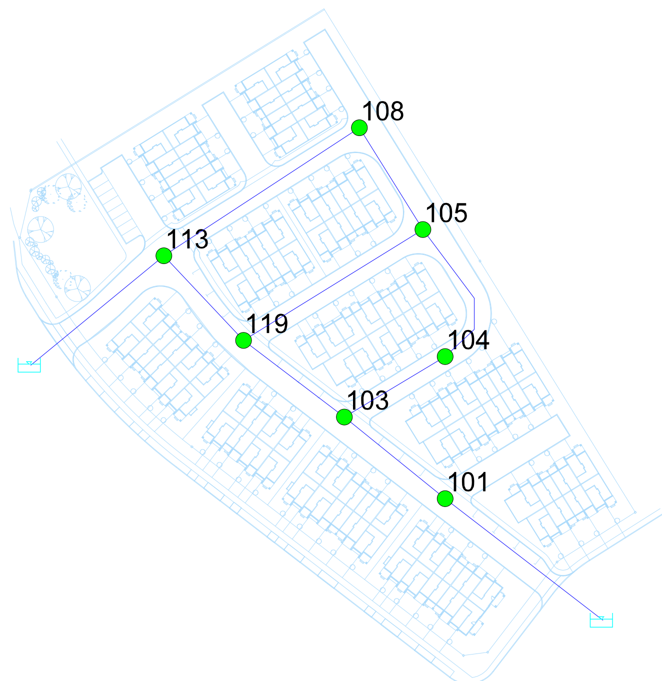
Pipe Results

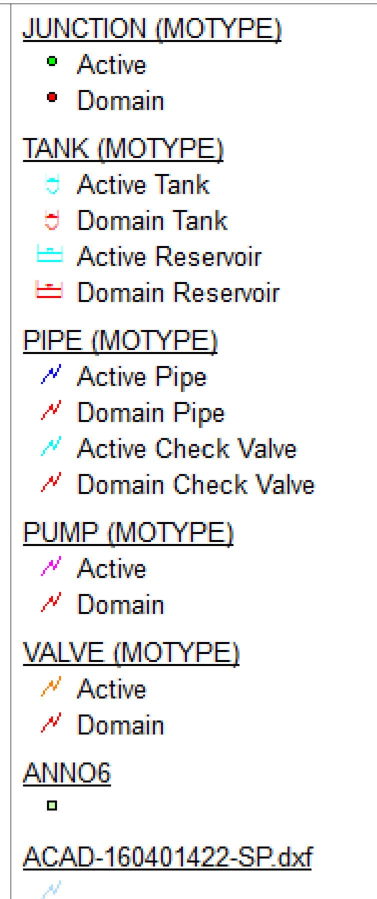
ID	From Node	To Node	Length	Diameter	Roughness	Flow	Velocity
			(m)	(mm)		(L/s)	(m/s)
201	501	101	57.51	204	110	2.75	0.08
203	101	103	37.45	204	110	1.49	0.05
204	103	104	33.94	204	110	0.57	0.02
208	108	105	34.65	204	110	0.17	0.01
212	108	113	67.49	204	110	-0.89	0.03
215	113	503	49.77	204	110	-3.13	0.10
226	113	119	33.56	204	110	1.16	0.04
227	105	104	45.29	204	110	0.09	0.00
228	105	119	60.9	204	110	-0.40	0.01
230	103	119	36.56	204	110	0.08	0.00

Hydraulic Model Results -Fire Flow Analysis (267L/s)

ID	Static Demand	Static Pressure		Static Head	Fire-Flow Demand	Residual Pressure		Available Flow at Hydrant	Available Flow Pressure	
	(L/s)	(psi)	(Kpa)	(m)	(L/s)	(psi)	(Kpa)	(L/s)	(psi)	(Kpa)
101	0.57	65.80	453.68	138.83	267	55.04	379.49	579.61	20	137.90
103	0.38	67.92	468.29	140.10	267	55.31	381.35	560.64	20	137.90
104	0.30	67.96	468.57	140.31	267	50.60	348.88	469.42	20	137.90
105	0.22	68.44	471.88	140.59	267	52.61	362.74	500.79	20	137.90
108	0.33	68.26	470.64	140.77	267	49.42	340.74	453.39	20	137.90
113	0.49	69.97	482.43	141.12	267	58.36	402.38	618.07	20	137.90
119	0.38	68.94	475.33	140.60	267	55.64	383.63	556.31	20	137.90

160401422-HYDRAULIC ANALYSIS RESULTS-2019-09-04-PIPE ID

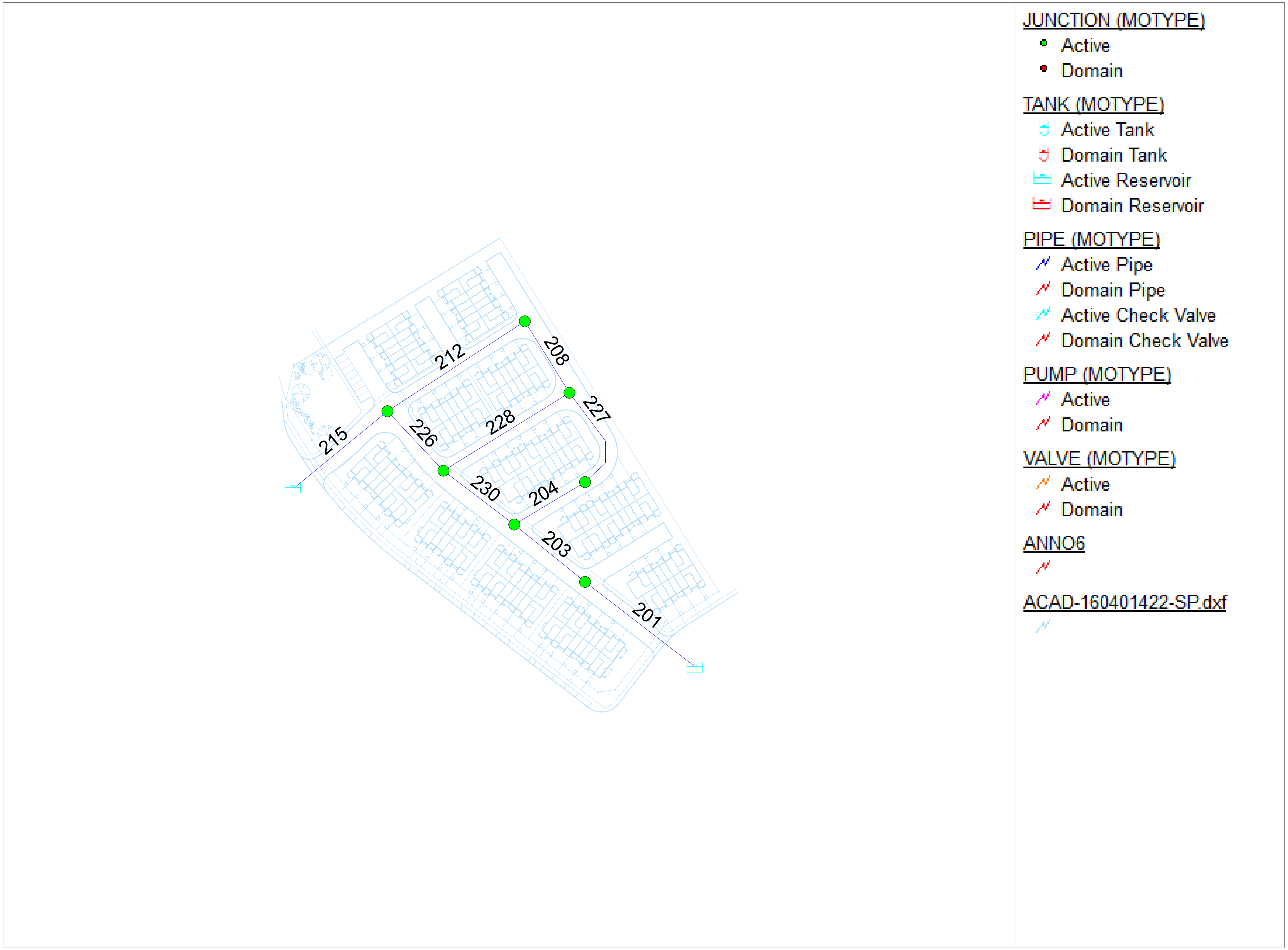




Prepared By:

Date: 9/12/2019 3:07:28 PM

160401422-HYDRAULIC ANALYSIS RESULTS-2019-09-04-PIPE ID



Prepared By:

Date: 9/12/2019 3:08:59 PM

Appendix B STORMWATER MANAGEMENT CALCULATIONS

B.1 Storm Sewer Design Sheet

B.2 PCSWMM Model Input

B.3 J.L. Richards RSDC Phase 8 Excerpts

B.1 STORM SEWER DESIGN SHEET

Stantec	BLOCK 221		STORM SEWER DESIGN SHEET (City of Ottawa)	DESIGN PARAMETERS							
	DATE:	2020-03-26		I = a / (t+b)^c	(As per City of Ottawa Guidelines, 2012)						
					1:2 yr	1:5 yr	1:10 yr	1:100 yr			
	REVISION:	1		a =	732.951	998.071	1174.184	1735.688	MANNING'S n =	0.013	BEDDING CLASS = B
	DESIGNED BY:	MJS	FILE NUMBER: 160401422	b =	6.199	6.053	6.014	6.014	MINIMUM COVER:	2.00	m
	CHECKED BY:	TR		c =	0.810	0.814	0.816	0.820	TIME OF ENTRY	10	min

LOCATION			DRAINAGE AREA																								
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (2-YEAR) (ha)	AREA (5-YEAR) (ha)	AREA (10-YEAR) (ha)	AREA (100-YEAR) (ha)	AREA (ROOF) (ha)	C (2-YEAR) (-)	C (5-YEAR) (-)	C (10-YEAR) (-)	C (100-YEAR) (-)	A x C (2-YEAR) (ha)	ACCUM AxC (2YR) (ha)	A x C (5-YEAR) (ha)	ACCUM. AxC (5YR) (ha)	A x C (10-YEAR) (ha)	ACCUM. AxC (10YR) (ha)	A x C (100-YEAR) (ha)	ACCUM. AxC (100YR) (ha)	T of C (min)	$I_{2\text{-YEAR}}$ (mm/h)	$I_{5\text{-YEAR}}$ (mm/h)	$I_{10\text{-YEAR}}$ (mm/h)	$I_{100\text{-YEAR}}$ (mm/h)	$Q_{CONTROL}$ (L/s)	ACCUM. $Q_{CONTROL}$ (L/s)	Q_{ACT} (CIA/360) (L/s)
	105	104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0
L104A	104	100	0.30	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.232	0.232	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	49.4
																				10.65							
L103A	103	102	0.08	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.060	0.060	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	12.8
																				10.65							
	108	107	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0
																				10.00							
	109	107	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0
																				10.00							
	107	102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0
																				10.00							
L102A, L102B	102	101	0.58	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.435	0.495	0.000	0.000	0.000	0.000	0.000	0.000	10.65	74.39	100.87	118.23	172.81	0.0	0.0	102.4
																				11.69							
	106	101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	0.0
																				10.00							
L101A	101	100	0.36	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.277	0.772	0.000	0.000	0.000	0.000	0.000	0.000	11.69	70.89	96.06	112.56	164.49	0.0	0.0	152.1
																				12.09							
L100A, L100B	100	534A	0.21	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.118	1.122	0.000	0.000	0.000	0.000	0.000	0.000	12.09	69.61	94.31	110.51	161.47	0.0	0.0	216.9
																				12.94							

LOCATION			PIPE SELECTION												
AREA ID NUMBER	FROM M.H.	TO M.H.	LENGTH (m)	PIPE WIDTH OR DIAMETE (mm)	PIPE HEIGHT (mm)	PIPE SHAPE (-)	MATERIAL (-)	CLASS (-)	SLOPE %	Q_{CAP} (FULL) (L/s)	% FULL (-)	VEL. (FULL) (m/s)	VEL. (ACT) (m/s)	TIME OF FLOW (min)
	105	104	31.5	300	300	CIRCULAR	PVC	-	0.50	68.0	**0.00%**	0.97	0.00	0.00
L104A	104	100	35.0	375	375	CIRCULAR	PVC	-	0.50	116.6	**42.39%**	1.11	0.90	0.65
L103A	103	102	31.1	300	300	CIRCULAR	PVC	-	1.00	96.2	**13.35%**	1.37	0.79	0.65
	108	107	29.0	250	250	CIRCULAR	HDPE	-	0.50	42.5	**0.00%**	0.86	0.00	0.00
	109	107	28.4	250	250	CIRCULAR	HDPE	-	0.50	42.9	**0.00%**	0.86	0.00	0.00
	107	102	46.6	300	300	CIRCULAR	PVC	-	0.50	68.0	**0.00%**	0.97	0.00	0.00
L102A, L102B	102	101	74.0	375	375	CIRCULAR	PVC	-	0.60	127.7	**80.17%**	1.21	1.19	1.03
	106	101	60.3	300	300	CIRCULAR	PVC	-	0.50	68.0	**0.00%**	0.97	0.00	0.00
L101A	101	100	29.7	450	450	CIRCULAR	CONCRETE	-	0.50	210.3	**72.31%**	1.28	1.22	0.40
L100A, L100B	100	534A	43.9	600	600	CIRCULAR	CONCRETE	-	0.15	248.1	**87.45%**	0.85	0.86	0.85
				600	600									

B.2 PCSWMM MODEL INPUT

```
[TITLE]


[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           LPS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
LINK_OFFSETS         ELEVATION
MIN_SLOPE            0
ALLOW_PONDING        YES
SKIP_STEADY_STATE    NO
START_DATE           09/14/2011
START_TIME           00:00:00
REPORT_START_DATE    09/14/2011
REPORT_START_TIME    00:00:00
END_DATE             09/15/2011
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         5
INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  D-W
VARIABLE_STEP        0
LENGTHENING_STEP     0
MIN_SURFAREA         0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              4

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
CONSTANT      0.0
DRY_ONLY      NO

[RAINGAGES]
;;              Rain      Time   Snow   Data
;;Name          Type      Intrvl Catch  Source
```



```
;;-------------- --------- ------ ------ ----------
RG1              INTENSITY 0:10   1.0    TIMESERIES 100yr3hrChicago

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- -------- -------- --------
L100A            RG1              L100A-S          0.192499 50       45       3        0

L100B            RG1              L100B-S          0.013655 74.286   9        3        0

L101A            RG1              L101A-S          0.3551   82.857   157      3        0

L102A            RG1              L102A-S          0.282    78.571   110      3        0

L102B            RG1              L102B-S          0.2983   78.571   96       3        0

L103A            RG1              L103A-S          0.0761   84.286   21       3        0

L104A            RG1              L104A-S          0.294902 82.857   126      3        0

UNC-1            RG1              OF3              0.030041 0        60       3        0

UNC-2            RG1              OF2              0.103563 38.571   78       3        0


[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo    PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
L100A            0.013      0.25       1.57       4.67       0          OUTLET
L100B            0.013      0.25       1.57       4.67       0          OUTLET
L101A            0.013      0.25       1.57       4.67       0          OUTLET
L102A            0.013      0.25       1.57       4.67       0          OUTLET
L102B            0.013      0.25       1.57       4.67       0          OUTLET
L103A            0.013      0.25       1.57       4.67       0          OUTLET
L104A            0.013      0.25       1.57       4.67       0          OUTLET
UNC-1            0.013      0.25       1.57       4.67       0          PERVIOUS   100
UNC-2            0.013      0.25       1.57       4.67       0          PERVIOUS   100

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
L100A            76.2       13.2       4.17       7          0
L100B            76.2       13.2       4.17       7          0
L101A            76.2       13.2       4.17       7          0
L102A            76.2       13.2       4.17       7          0
L102B            76.2       13.2       4.17       7          0
L103A            76.2       13.2       4.17       7          0
```

```
L104A            76.2       13.2       4.17       7          0
UNC-1            76.2       13.2       4.17       7          0
UNC-2            76.2       13.2       4.17       7          0

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
OF1              87.44      FIXED        88.39            NO
OF2              0          FREE                          NO
OF3              0          FREE                          NO
OF4              92.62      FREE                          NO
OF5              91.6       FREE                          NO
OF6              91.49      FREE                          NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve                                      Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                                     Frac.
Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- --------
----------------------
100              87.506   4.392    0.884    FUNCTIONAL 0        0        0        0        0
101              88.202   4.057    0.188    FUNCTIONAL 0        0        0        0        0
102              88.571   4.065    0        FUNCTIONAL 0        0        0        0        0
103              89.065   3.735    0        FUNCTIONAL 0        0        0        0        0
104              88.66    3.66     0        FUNCTIONAL 0        0        0        0        0
105              88.878   3.564    0        FUNCTIONAL 0        0        0        0        0
106              88.687   3.841    0        FUNCTIONAL 0        0        0        0        0
107              88.879   4.985    0        FUNCTIONAL 0        0        0        0        0
L100A-S          88.97    3.02     0        TABULAR    L100AS                     0        0
L100B-S          90.29    1.73     0        TABULAR    L100BS                     0        0
L100D-S          91.66    0.35     0        FUNCTIONAL 0        0        0        0        0
L101A-S          90.56    1.73     0        FUNCTIONAL 0        0        0        0        0
L102A-S          90.76    1.73     0        FUNCTIONAL 0        0        0        0        0
L102B-S          90.97    1.73     0        FUNCTIONAL 0        0        0        0        0
L103A-S          91.17    1.73     0        FUNCTIONAL 0        0        0        0        0
L103B-S          92.8     0.35     0        FUNCTIONAL 0        0        0        0        0
L104A-S          90.53    1.73     0        FUNCTIONAL 0        0        0        0        0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.
Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow
Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ----------
----------
1                L103B-S          OF4              16.442     0.013      92.8       92.62      0          0
```



```
10               L100B-S          OF5              14.753     0.013      91.67      91.6       0          0

2                L103B-S          L103A-S          18.208     0.013      92.8       92.55      0          0

3                L103A-S          L102B-S          36.993     0.013      92.55      92.35      0          0

4                L102B-S          L102A-S          35.983     0.013      92.35      92.14      0          0

5                L102A-S          L101A-S          34.758     0.013      92.14      91.94      0          0

6                L104A-S          L100D-S          15.984     0.013      91.91      91.66      0          0

7                L101A-S          L100D-S          23.263     0.013      91.94      91.66      0          0

Pipe_1           100              OF1              43.9       0.013      87.506     87.44      0          0

Pipe_13          105              104              31.5       0.013      89.178     89.02      0          0

Pipe_16          106              101              60.3       0.013      88.967     88.67      0          0

Pipe_17          107              102              46.6       0.013      89.149     88.916     0          0

Pipe_3           104              100              35         0.013      88.577     88.405     0          0

Pipe_6           101              100              29.7       0.013      88.322     88.175     0          0

Pipe_7           102              101              74         0.013      88.841     88.397     0          0

Pipe_8           103              102              31.323     0.013      89.35      89.04      0          0

[ORIFICES]
;;               Inlet            Outlet           Orifice      Crest      Disch.     Flap Open/Close
;;Name           Node             Node             Type         Height     Coeff.     Gate Time
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- ----------
L100A-IC         L100A-S          100              SIDE         88.97      0.572      NO   0

[WEIRS]
;;               Inlet            Outlet           Weir         Crest      Disch.     Flap End      End

;;Name           Node             Node             Type         Height     Coeff.     Gate Con.     Coeff.
  Surcharge  RoadWidth  RoadSurf
;;-------------- ---------------- ---------------- ------------ ---------- ---------- ---- --------
---------- ---------- ---------- ----------
18               L100A-S          OF6              ROADWAY      91.64      1.67       NO   0        0
  YES        6          PAVED
19               L100D-S          L100A-S          TRANSVERSE   91.66      1.67       NO   0        0
  YES
```

```
[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet           Qcoeff/
Flap
;;Name           Node             Node             Height     Type             QTable           Qexpon
Gate
;;-------------- ---------------- ---------------- ---------- ---------------- ---------------- ----------
----
L100B-IC         L100B-S          100              90.29      FUNCTIONAL/HEAD  5.716            0.5
NO
L101A-IC         L101A-S          101              90.56      FUNCTIONAL/HEAD  5.005            0.5
NO
L102A-IC         L102A-S          102              90.76      FUNCTIONAL/HEAD  5.005            0.5
NO
L102B-IC         L102B-S          102              90.97      FUNCTIONAL/HEAD  5.005            0.5
NO
L103A-IC         L103A-S          103              91.17      FUNCTIONAL/HEAD  5.005            0.5
NO
L104A-IC         L104A-S          104              90.53      FUNCTIONAL/HEAD  5.005            0.5
NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
1                IRREGULAR    PrivateRoad-8.0m-B 0        0          0          1
10               IRREGULAR    PrivateRoad-8.0m-A 0        0          0          1
2                IRREGULAR    PrivateRoad-8.0m-B 0        0          0          1
3                IRREGULAR    PrivateRoad-8.0m-B 0        0          0          1
4                IRREGULAR    PrivateRoad-8.0m-B 0        0          0          1
5                IRREGULAR    PrivateRoad-8.0m-B 0        0          0          1
6                IRREGULAR    PrivateRoad-7.0m 0          0          0          1
7                IRREGULAR    PrivateRoad-7.0m 0          0          0          1
Pipe_1           CIRCULAR     0.6              0          0          0          1
Pipe_13          CIRCULAR     0.3              0          0          0          1
Pipe_16          CIRCULAR     0.3              0          0          0          1
Pipe_17          CIRCULAR     0.3              0          0          0          1
Pipe_3           CIRCULAR     0.375            0          0          0          1
Pipe_6           CIRCULAR     0.45             0          0          0          1
Pipe_7           CIRCULAR     0.375            0          0          0          1
Pipe_8           CIRCULAR     0.3              0          0          0          1
L100A-IC         CIRCULAR     0.108            0          0          0
18               RECT_OPEN    0.35             1          0          0
19               RECT_OPEN    1                4          0          0

[TRANSECTS]

;Full street, width = 5.5m, curb = 0.15m , cross-slope = 0.03m/m, bank-slope = 0.02m/m, bank-height = 0.23m.
NC 0.02     0.02     0.013
```



```
X1 8.5mROW          7        1.5      7        0.0      0.0      0.0      0.0      0.0
GR 0.18     0        0.15     1.5      0        1.5      0.08     4.25     0        7
GR 0.15     7        0.18     8.5

;Half street, width = 2.75m, curb = 0.15m , cross-slope = 0.03m/m, bank-slope = 0.02m/m, bank-height =
0.18m.
NC 0.02     0.02     0.013
X1 8.5mROW_half     4        0.0      2.75     0.0      0.0      0.0      0.0      0.0
GR 0.08     0        0        2.75     0.15     2.75     0.18     4.25

;Full CS13m, road width = 7.0m, Road slope = 1.0%
NC 0.02     0.02     0.013
X1 PrivateRoad-7.0m 7        3        10       0.0      0.0      0.0      0.0      0.0
GR 0.29     0        0.17     3        0.09     3        0        10       0.08     10
GR 0.11     13       0.16     16

;Road width = 8.0m, Road slope - 1.8%
NC 0.02     0.02     0.013
X1 PrivateRoad-8.0m-A 6        2        10       0.0      0.0      0.0      0.0      0.0
GR 0.11     0        0.08     2        0        2        0.16     10       0.24     10
GR 0.3      13

;Full CS13m, road width = 8.5m,Road slope = 2.5%
NC 0.02     0.02     0.013
X1 PrivateRoad-8.0m-B 7        2.7      11.2     0.0      0.0      0.0      0.0      0.0
GR 0.16     0        0.12     1.2      0.08     2.7      0        2.7      0.22     11.2
GR 0.27     11.2     0.38     14

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------
Pipe_1           0          1.32       0          NO         0
Pipe_13          0          1.32       0          NO         0
Pipe_17          0          1.32       0          NO         0
Pipe_3           0          0.06       0          NO         0
Pipe_6           0          1.32       0          NO         0
Pipe_7           0          0.06       0          NO         0
Pipe_8           0          0.02       0          NO         0

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
513-IC           Rating     0          0
513-IC                      1.38       12
513-IC                      1.73       12

515-IC           Rating     0          0
515-IC                      1.38       4
```

```
515-IC                       1.73       4

516-IC           Rating      0          0
516-IC                       1.38       7
516-IC                       1.73       7

L100B-IC         Rating      0          0
L100B-IC                     1.38       7
L100B-IC                     1.73       0

L101A-IC         Rating      0          0
L101A-IC                     1.38       6
L101A-IC                     1.73       0

L102A-IC         Rating      0          0
L102A-IC                     1.38       6
L102A-IC                     1.73       0

L102B-IC         Rating      0          0
L102B-IC                     1.38       6
L102B-IC                     1.73       0

L103A-IC         Rating      0          0
L103A-IC                     1.38       6
L103A-IC                     1.73       0

L104A-IC         Rating      0          0
L104A-IC                     1.38       6
L104A-IC                     1.73       0

ROW              Rating      0          0
ROW                          1.8        14
ROW                          2.15       14

L100AS           Storage     0          0
L100AS                       1.38       0.36
L100AS                       1.47       306.94
L100AS                       2.67       613
L100AS                       2.86       613

L100BS           Storage     0          0
L100BS                       1.38       0.72
L100BS                       1.3801     0
L100BS                       1.73       0

L101AS           Storage     0          0
L101AS                       1.38       0.72
L101AS                       1.3801     0
```



```
L101AS                       1.73       0

L102AS           Storage     0          0
L102AS                       1.38       0.72
L102AS                       1.3801     0
L102AS                       1.73       0

L102BS           Storage     0          0
L102BS                       1.38       0.72
L102BS                       1.3801     0
L102BS                       1.73       0

L103AS           Storage     0          0
L103AS                       1.38       0.72
L103AS                       1.3801     0
L103AS                       1.73       0

L104AS           Storage     0          0
L104AS                       1.38       0.72
L104AS                       1.3801     0
L104AS                       1.73       0

[TIMESERIES]
;;Name           Date       Time       Value
;;-------------- ---------- ---------- ----------
100yr+20_3hr_chicago             0:10       7.254876
100yr+20_3hr_chicago             0:20       9.050628
100yr+20_3hr_chicago             0:30       12.19056
100yr+20_3hr_chicago             0:40       19.162668
100yr+20_3hr_chicago             0:50       48.785964
100yr+20_3hr_chicago             1:00       214.2708
100yr+20_3hr_chicago             1:10       64.858236
100yr+20_3hr_chicago             1:20       32.78244
100yr+20_3hr_chicago             1:30       21.888468
100yr+20_3hr_chicago             1:40       16.484304
100yr+20_3hr_chicago             1:50       13.270512
100yr+20_3hr_chicago             2:00       11.142252
100yr+20_3hr_chicago             2:10       9.628668
100yr+20_3hr_chicago             2:20       8.496264
100yr+20_3hr_chicago             2:30       7.616376
100yr+20_3hr_chicago             2:40       6.912348
100yr+20_3hr_chicago             2:50       6.335736
100yr+20_3hr_chicago             3:00       5.854452

100yr12hrChicago            0:20       1.59416
100yr12hrChicago            0:40       1.7318
100yr12hrChicago            1:00       1.89884
100yr12hrChicago            1:20       2.10633
```

B.3 PCSWMM MODEL OUTPUT

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------


****************
Analysis Options
****************
Flow Units ............... LPS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Starting Date ............ 09/14/2011 00:00:00
Ending Date .............. 09/15/2011 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:01:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... NO
Maximum Trials ........... 8
Number of Threads ........ 4
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         0.118        71.665
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.020        12.120
Surface Runoff ...........         0.097        59.144
Final Storage ............         0.002         1.149
Continuity Error (%) .....        -1.044


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.097         0.974
```



```
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.097         0.973
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.001         0.014
Final Stored Volume ......         0.001         0.014
Continuity Error (%) .....         0.066


*************************
Highest Continuity Errors
*************************
Node 103 (1.22%)


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     5.00 sec
Average Time Step           :     5.00 sec
Maximum Time Step           :     5.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.05


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

---------------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total      Total       Total     Peak  Runoff
                           Precip      Runon       Evap      Infil     Runoff      Runoff   Runoff   Coeff
Subcatchment                   mm         mm         mm         mm         mm    10^6 ltr      LPS
---------------------------------------------------------------------------------------------------------
L100A                       71.66       0.00       0.00      22.64      48.86        0.09    73.93   0.682
L100B                       71.66       0.00       0.00      11.29      60.09        0.01     6.49   0.839
L101A                       71.66       0.00       0.00       7.53      63.51        0.23   171.28   0.886
L102A                       71.66       0.00       0.00       9.44      61.69        0.17   134.40   0.861
```

L102B	71.66	0.00	0.00	9.46	61.64	0.18	141.55	0.860
L103A	71.66	0.00	0.00	6.92	64.05	0.05	36.64	0.894
L104A	71.66	0.00	0.00	7.53	63.51	0.19	142.20	0.886
UNC-1	71.66	0.00	0.00	44.02	30.43	0.01	12.29	0.425
UNC-2	71.66	0.00	0.00	31.01	41.36	0.04	44.62	0.577

****
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
OF1	OUTFALL	0.95	0.95	88.39	0 00:00	0.95
OF2	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
OF3	OUTFALL	0.00	0.00	0.00	0 00:00	0.00
OF4	OUTFALL	0.00	0.00	92.62	0 00:00	0.00
OF5	OUTFALL	0.00	0.00	91.60	0 00:00	0.00
OF6	OUTFALL	0.00	0.00	91.49	0 00:00	0.00
100	STORAGE	0.89	0.89	88.40	0 01:13	0.89
101	STORAGE	0.19	0.23	88.43	0 01:10	0.23
102	STORAGE	0.28	0.36	88.93	0 01:10	0.36
103	STORAGE	0.28	0.34	89.40	0 01:10	0.34
104	STORAGE	0.01	0.05	88.71	0 01:10	0.05
105	STORAGE	0.00	0.00	88.88	0 00:00	0.00
106	STORAGE	0.00	0.00	88.69	0 00:00	0.00
107	STORAGE	0.00	0.00	88.88	0 00:00	0.00
L100A-S	STORAGE	0.49	2.60	91.57	0 01:41	2.60
L100B-S	STORAGE	0.01	0.88	91.17	0 01:11	0.87
L100D-S	STORAGE	0.00	0.20	91.86	0 01:10	0.20
L101A-S	STORAGE	0.15	1.48	92.04	0 01:10	1.48
L102A-S	STORAGE	0.13	1.51	92.27	0 01:10	1.51
L102B-S	STORAGE	0.13	1.48	92.45	0 01:10	1.48
L103A-S	STORAGE	0.05	1.44	92.61	0 01:10	1.44
L103B-S	STORAGE	0.00	0.00	92.80	0 00:00	0.00
L104A-S	STORAGE	0.13	1.44	91.97	0 01:10	1.44

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow LPS	Maximum Total Inflow LPS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OF1	OUTFALL	0.00	70.27	0 01:13	0	0.931	0.000
OF2	OUTFALL	44.62	44.62	0 01:10	0.0428	0.0428	0.000
OF3	OUTFALL	12.29	12.29	0 01:10	0.00914	0.00914	0.000
OF4	OUTFALL	0.00	0.00	0 00:00	0	0	0.000 ltr
OF5	OUTFALL	0.00	0.00	0 00:00	0	0	0.000 ltr
OF6	OUTFALL	0.00	0.00	0 00:00	0	0	0.000 ltr
100	STORAGE	0.00	70.25	0 01:13	0	0.929	-0.000
101	STORAGE	0.00	24.31	0 01:10	0	0.192	0.006
102	STORAGE	0.00	18.23	0 01:10	0	0.132	0.257
103	STORAGE	0.00	6.00	0 01:10	0	0.028	1.231
104	STORAGE	0.00	6.01	0 01:10	0	0.0533	0.017
105	STORAGE	0.00	0.00	0 00:00	0	0	0.000 ltr
106	STORAGE	0.00	0.00	0 00:00	0	0	0.000 ltr
107	STORAGE	0.00	0.00	0 00:00	0	0	0.000 ltr
L100A-S	STORAGE	73.93	652.41	0 01:10	0.094	0.671	0.026
L100B-S	STORAGE	6.49	6.49	0 01:10	0.00821	0.00821	-0.049
L100D-S	STORAGE	0.00	588.21	0 01:10	0	0.577	0.105
L101A-S	STORAGE	171.28	459.09	0 01:10	0.226	0.5	-0.041
L102A-S	STORAGE	134.40	298.37	0 01:10	0.174	0.326	-0.028
L102B-S	STORAGE	141.55	171.88	0 01:10	0.184	0.205	-0.092
L103A-S	STORAGE	36.64	36.64	0 01:10	0.0487	0.0487	0.184
L103B-S	STORAGE	0.00	0.00	0 00:00	0	0	0.000 ltr
L104A-S	STORAGE	142.20	142.20	0 01:10	0.187	0.187	-0.192

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

	Average	Avg	Evap Exfil	Maximum	Max	Time of Max	Maximum

Storage Unit	Volume 1000 m3	Pcnt Full	Pcnt Loss	Pcnt Loss	Volume 1000 m3	Pcnt Full	Occurrence days	hr:min	Outflow LPS
100	0.000	0	0	0	0.000	0	0	00:00	70.27
101	0.000	0	0	0	0.000	0	0	00:00	24.31
102	0.000	0	0	0	0.000	0	0	00:00	18.23
103	0.000	0	0	0	0.000	0	0	00:00	6.00
104	0.000	0	0	0	0.000	0	0	00:00	6.01
105	0.000	0	0	0	0.000	0	0	00:00	0.00
106	0.000	0	0	0	0.000	0	0	00:00	0.00
107	0.000	0	0	0	0.000	0	0	00:00	0.00
L100A-S	0.063	8	0	0	0.522	67	0	01:41	37.03
L100B-S	0.000	0	0	0	0.000	40	0	01:11	5.35
L100D-S	0.000	0	0	0	0.000	0	0	00:00	581.08
L101A-S	0.000	0	0	0	0.000	0	0	00:00	458.43
L102A-S	0.000	0	0	0	0.000	0	0	00:00	295.03
L102B-S	0.000	0	0	0	0.000	0	0	00:00	170.26
L103A-S	0.000	0	0	0	0.000	0	0	00:00	36.35
L103B-S	0.000	0	0	0	0.000	0	0	00:00	0.00
L104A-S	0.000	0	0	0	0.000	0	0	00:00	141.96

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow LPS	Max Flow LPS	Total Volume 10^6 ltr
OF1	88.33	12.19	70.27	0.931
OF2	6.50	7.63	44.62	0.043
OF3	3.81	2.78	12.29	0.009
OF4	0.00	0.00	0.00	0.000
OF5	0.00	0.00	0.00	0.000
OF6	0.00	0.00	0.00	0.000
System	16.44	22.60	125.48	0.982

****
Link Flow Summary
****

Link	Type	Maximum |Flow| LPS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
1	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
10	CHANNEL	0.00	0	00:00	0.00	0.00	0.00
2	CHANNEL	0.00	0	00:00	0.00	0.00	0.07
3	CHANNEL	30.35	0	01:10	0.25	0.00	0.21
4	CHANNEL	164.16	0	01:10	0.60	0.02	0.30
5	CHANNEL	288.89	0	01:10	0.84	0.04	0.33
6	CHANNEL	135.95	0	01:10	0.45	0.02	0.44
7	CHANNEL	452.35	0	01:10	0.66	0.06	0.51
Pipe_1	CONDUIT	70.27	0	01:13	0.25	0.30	1.00
Pipe_13	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
Pipe_16	CONDUIT	0.00	0	00:00	0.00	0.00	0.00
Pipe_17	CONDUIT	0.00	0	00:00	0.00	0.00	0.03
Pipe_3	CONDUIT	6.01	0	01:10	0.66	0.04	0.14
Pipe_6	CONDUIT	24.31	0	01:10	0.46	0.12	0.37
Pipe_7	CONDUIT	18.23	0	01:11	0.86	0.13	0.25
Pipe_8	CONDUIT	6.00	0	01:10	0.76	0.06	0.17
L100A-IC	ORIFICE	37.03	0	01:41			1.00
18	WEIR	0.00	0	00:00			0.00
19	WEIR	581.08	0	01:10			0.20
L100B-IC	DUMMY	5.35	0	01:11			
L101A-IC	DUMMY	6.09	0	01:10			
L102A-IC	DUMMY	6.14	0	01:10			
L102B-IC	DUMMY	6.09	0	01:10			
L103A-IC	DUMMY	6.00	0	01:10			
L104A-IC	DUMMY	6.01	0	01:10			

****
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
1	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	1.00	0.98	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	1.00	0.94	0.04	0.00	0.02	0.00	0.00	0.00	0.96	0.00
4	1.00	0.94	0.00	0.00	0.06	0.00	0.00	0.00	0.06	0.00
5	1.00	0.92	0.02	0.00	0.01	0.00	0.00	0.05	0.92	0.00
6	1.00	0.92	0.02	0.00	0.04	0.03	0.00	0.00	0.96	0.00
7	1.00	0.92	0.00	0.00	0.01	0.07	0.00	0.00	0.03	0.00
Pipe_1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
Pipe_13	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Pipe_16	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe_17	1.00	0.93	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipe_3	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
Pipe_6	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.10	0.00
Pipe_7	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
Pipe_8	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00

****
Conduit Surcharge Summary
****

Conduit	--------- Hours Full --------- Both Ends	Upstream	Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
Pipe_1	24.00	24.00	24.00	0.01	0.01

Analysis begun on: Mon Mar 30 10:30:40 2020
Analysis ended on: Mon Mar 30 10:30:48 2020
Total elapsed time: 00:00:08

B.4 J.L. RICHARDS RSDC PHASE 8 EXCERPTS

Table 22a: Dry Pond - SWMHYMO Summary Results (1:5 year)

Simulation Results (1:5 year)					
Dry Pond Number	Major System Inflow into Dry Pond (L/s)	Minor System Outflow from Dry Pond (L/s)	Over[1] Topping Flow from Dry Pond (L/s)	Storage[2] Used (m^3)	Water Level (m)
1-P	82	14	0	50	91.21
2-P	81	18	0	45	91.02
4-P	142	31	0	77	90.40

Note[1]: Denotes overtopping flows from dry ponds (if any) directed to Earl Armstrong Road and Spratt Road.
Note[2]: Denotes maximum storage used by the dry ponds.
Note[3]: Climate Change Event (20% increase) applied to 3-hour Chicago design storm.

Table 22b: Dry Pond - SWMHYMO Summary Results (Extreme Events)

Dry Pond	Simulation Results (Extreme Events)									
	1:100 Year Storm Event					Climate Change Event[3] (20% increase of the 1:100 Year Storm)				
	Major System Inflow into Dry Pond (L/s)	Minor System Outflow from Dry Pond (L/s)	Over[1] Topping from Dry Pond (L/s)	Storage[2] Used (m^3)	Water Level (m)	Major System Inflow into Dry Pond (L/s)	Minor System Outflow from Dry Pond (L/s)	Over[1] Topping from Dry Pond (L/s)	Storage[2] Used (m^3)	Water Level (m)
1-P	199	15	0	350	91.59	528	17	212	1,030	92.15
2-P	372	21	0	747	91.87	895	22	871	927	92.00
4-P	1,419	37	0	2,041	91.25	2,656	39	1,616	2,864	91.48

Note[1]: Denotes overtopping flows from dry ponds (if any) directed to Earl Armstrong Road and Spratt Road.
Note[2]: Denotes maximum storage used by the dry ponds.
Note[3]: Climate Change Event (20% increase) applied to 3-hour Chicago design storm.

The above simulation results (refer to Appendix ‘E9’ for modelling files) indicate the following (refer to Appendix ‘E11’ for summary tables):

- Under a 1:5 year design storm, major system inflows of 82 L/s, 81 L/s and 142 L/s were found to cascade to Dry Pond 1P, 2-P and 4-P, respectively. Under this storm event, maximum storages of 50 m^3, 45 m^3, and 77 m^3 were found to have been utilized at the aforementioned ponds. As a result, maximum pond outflows to the minor system of 14 L/s, 18 L/s and 31 L/s were estimated for Dry Pond 1-P, 2-P and 4-P, respectively;

RIVERSIDE SOUTH - PHASE 8
Part of 980 Earl Armstrong Road

JLR No. 21464-08

Stage-Storage-Discharge Relationship Dry Pond 2-P

Orifice Equation:

$$Q = CA\sqrt{2gh}$$

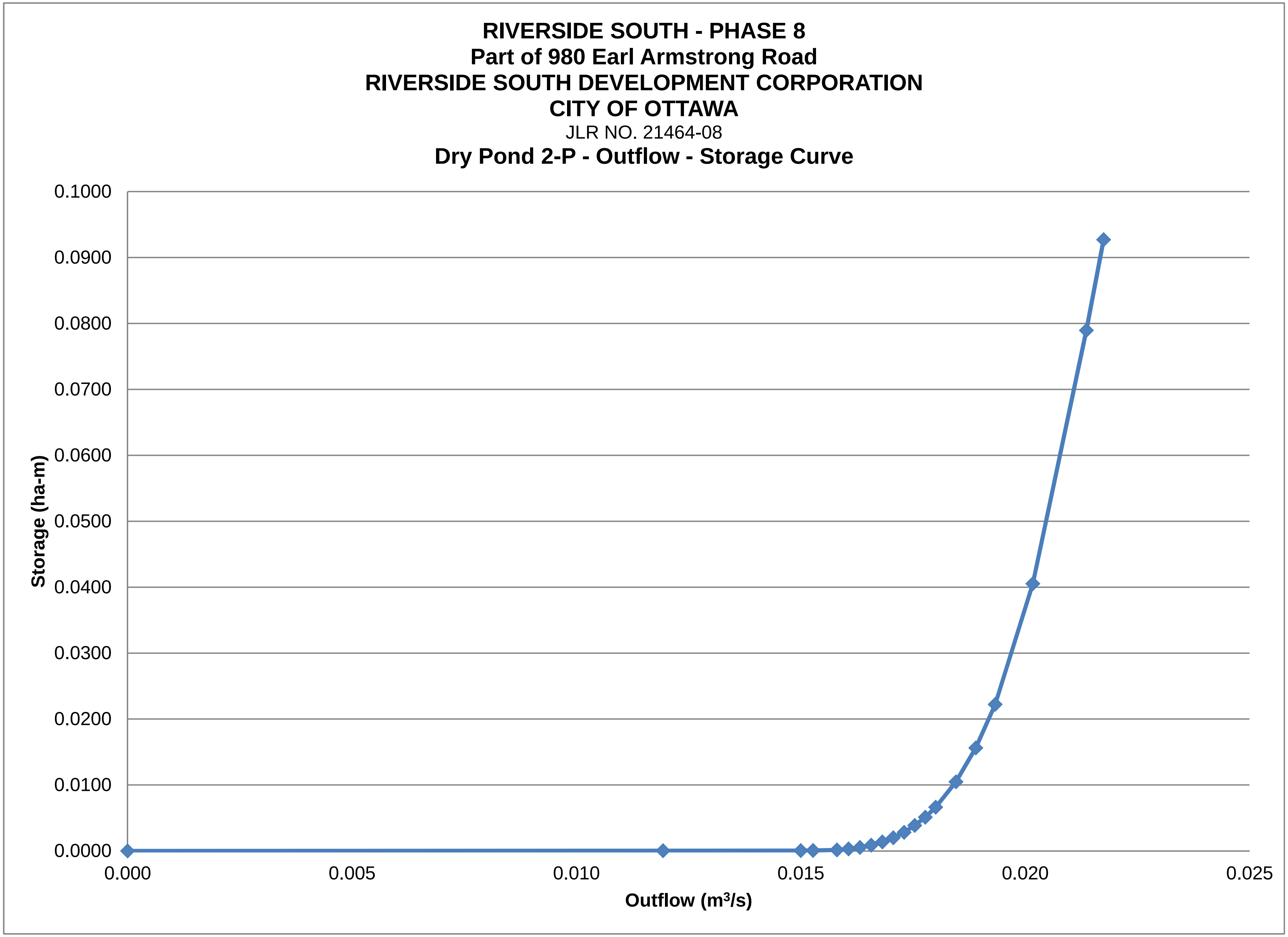
Q-Flow (m^3/s)
C-Discharge Coefficient
A-Orifice Area (m^2)
h-Head Above Orifice (m)

Table 1: Orifice Characteristics

Description	Orifice
Invert Elevation (m)	89.10
Diameter (m)	0.078
Springline Elevation (m)	89.14
Area (m^2)	0.005
Discharge Coefficient, C	0.61

Table 2: Dry Pond 2-P - Stage-Storage-Discharge Curve

Description	Elevation (m)	Depth (m)	Storage (m^3)	Discharge (m^3/s)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	89.10		0.00	0.000	0.00000	***Invert***	From Catch Basin Geometry
	90.00		0.33	0.012	0.00003		
	90.50	0.00	0.52	0.015	0.00005	***T/G***	
DRY POND STORAGE	90.55	0.05	0.56	0.015	0.00006		From AutoCAD Civil 3D
	90.65	0.15	1.55	0.016	0.00016		
	90.70	0.20	2.95	0.016	0.00030		
	90.75	0.25	5.27	0.016	0.00053		
	90.80	0.30	8.73	0.017	0.00087		
	90.85	0.35	13.56	0.017	0.00136		
	90.90	0.40	19.98	0.017	0.00200		
	90.95	0.45	28.23	0.017	0.00282		
	91.00	0.50	38.53	0.018	0.00385		
	91.05	0.55	51.12	0.018	0.00511		
	91.10	0.60	66.21	0.018	0.00662		
	91.20	0.70	104.83	0.018	0.01048		
	91.30	0.80	156.23	0.019	0.01562		
	91.40	0.90	222.22	0.019	0.02222		
	91.60	1.10	405.30	0.020	0.04053		
	91.90	1.40	789.54	0.021	0.078954		
	92.00	1.50	927.11	0.022	0.092711		


RIVERSIDE SOUTH - PHASE 8
Part of 980 Earl Armstrong Road
RIVERSIDE SOUTH DEVELOPMENT CORPORATION
CITY OF OTTAWA
JLR NO. 21464-08
Dry Pond 2-P - Outflow - Storage Curve
Storage (ha-m)
0.1000
0.0900
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
0.000
0.005
0.010
0.015
0.020
0.025
Outflow (m³/s)

RIVERSIDE SOUTH - PHASE 8

Part of 980 Earl Armstrong Road
RIVERSIDE SOUTH DEVELOPMENT CORPORATION
CITY OF OTTAWA

JLR NO. 21464-08

Street Ponding Area P45 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3): 88.69
Top of Grate Elevation (T/G) (m): 91.31

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	89.16
Diameter (m)	0.094
Springline Elevation (m)	89.21
Area (m^2)	0.007
Discharge Coefficient, C	0.61

Orifice Equation:

$$Q = CA\sqrt{2gh}$$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	89.160			0.0000	0.0000	0.0000	0.00	0.0000	**Invert**	From Geometry
	90.935			0.0245	0.0000	0.0245	1.11	0.0001		
	91.310	0.000		0.0270	0.0000	0.0270	1.34	0.0001	**T/G**	
STATIC STORAGE[1]	91.370	0.060		0.0274	0.0000	0.0274	16.54	0.0017		From AutoCAD Civil 3D
	91.510	0.200		0.0283	0.0000	0.0283	52.02	0.0052		
	91.560	0.250		0.0286	0.0000	0.0286	64.69	0.0065		
	91.570	0.260		0.0286	0.0000	0.0286	67.22	0.0067		
	91.605	0.295		0.0288	0.0000	0.0288	76.09	0.0076		
	91.630	0.320		0.0290	0.0000	0.0290	82.43	0.0082		
	91.660	0.350	0.000	0.0292	0.0000	0.0292	90.03	0.0090	**Spill**	
DYNAMIC STORAGE[2]	91.675	0.365	0.015	0.0292	0.0008	0.0301	101.00	0.0101		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	91.685	0.375	0.025	0.0293	0.0033	0.0326	109.80	0.0110		
	91.700	0.390	0.040	0.0294	0.0115	0.0409	123.93	0.0124		
	91.710	0.400	0.050	0.0295	0.0208	0.0503	133.97	0.0134		
	91.720	0.410	0.060	0.0295	0.0338	0.0633	144.53	0.0145		
	91.730	0.420	0.070	0.0296	0.0510	0.0806	155.61	0.0156		
	91.740	0.430	0.080	0.0296	0.0729	0.1025	167.22	0.0167		
	91.750	0.440	0.090	0.0297	0.0998	0.1294	179.37	0.0179		
	91.765	0.455	0.105	0.0298	0.1505	0.1802	198.63	0.0199		
	91.810	0.500	0.150	0.0300	0.3895	0.4195	264.12	0.0264		

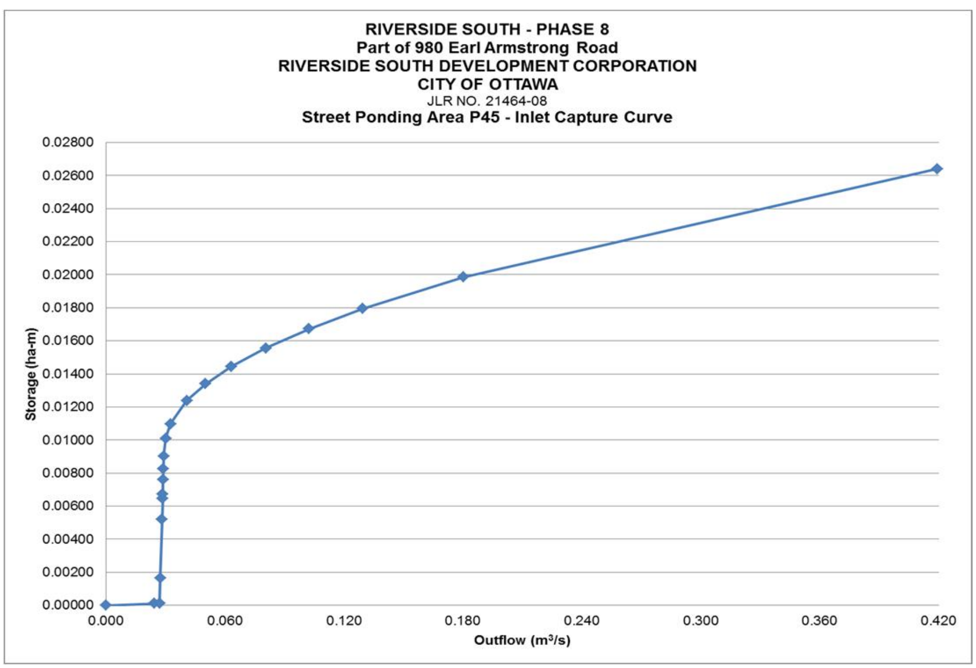
Note:

1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D

2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4

3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).

4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract 0 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P45

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.350	m
Distance (U/S High Point to D/S Spill Point)	110.0	m
Longitudinal Slope (U/S High Point to LP)	1.0	%
Longitudinal Slope (LP to D/S Spill Point)	1.5	%
Distance (LP to U/S High Point)	85.9	m
Road Width	11.0	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.15	m
Street Crown	0.1650	m

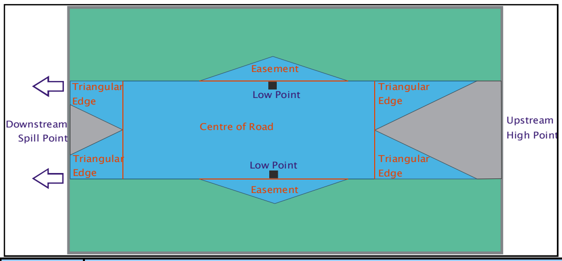
Calculated Results

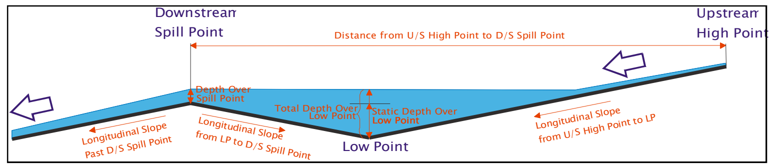
Maximum Volume of Static Ponding	93.4	m^3
Maximum Volume of Dynamic Storage	170.7	m^3
Maximum Total Volume	264.1	m^3
Maximum Area of Static Ponding	855.7	m^2
Maximum Area of Dynamic Storage	948.1	m^2
Maximum Total Area	1803.8	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$\text{Area}_{(\text{triangular pyramid})} = \text{Length} \times \text{Width} / 2$ $\text{Area}_{(\text{rectangular prism})} = \text{Length} \times \text{Width}$

$\text{Volume}_{(\text{triangular pyramid})} = \text{Area} \times \text{Height} / 3$ $\text{Volume}_{(\text{rectangular prism})} = \text{Area} \times \text{Height}$





Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.350	62.59	94.53	140.34	211.98	137.93	208.33	855.71	3.44	24.56	9.20	5.20	37.10	9.20	88.69

TOP OF GRATE ELEVATION: 91.31 m
SPILL POINT ELEVATION: 91.66 m
DEPTH OVER LOW POINT: 0.350 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 88.69 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 88.69 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 88.69 - 88.69 = 0 m^3

Calculation Sheet: Routing Through Typical Road Ponding Area P45

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.350	m
Distance (U/S High Point to D/S Spill Point)	110.0	m
Longitudinal Slope (U/S High Point to LP)	1.0	%
Longitudinal Slope (LP to D/S Spill Point)	1.5	%
Longitudinal Slope (past D/S Spill Point)	0.3	%
Road Width	11.0	m
Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	2.0	%
Curb Height	0.15	m
Manning's Roughness for Road / Sidewalk	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Calculated Results

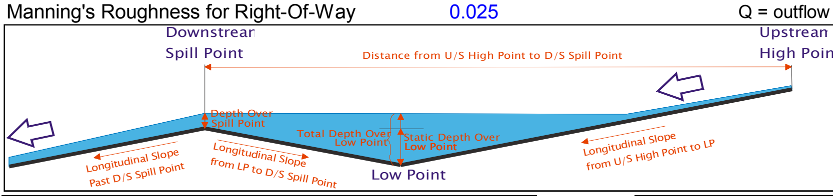
Friction Slope	0.15	% (per XPSWMM Simulations)
Maximum Inflow	0.262	m^3/s
Maximum Capture	0.058	m^3/s
Maximum Overflow	0.040	m^3/s
Maximum Storage Used	148.47	m^3
Maximum Water Depth	0.414	m

Note: Routing calculations performed based on the Modified Puls Method continuity equation, where 2S2/Δt + Q2 = (I1 + I2) + (2S2/Δt - Q1), and:

I = inflow (m^3/s)

S/Δt = storage over one time step (m^3/s)

Q = outflow [capture and overflow] (m^3/s)



Refer to Storage and Overflow Calculation Sheets for details of other calculations.

Depth Over Low Point (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)	2S/Δt + Q (m^3/s)
0.025	0.03	0.050	0.000	0.051
0.030	0.05	0.051	0.000	0.051

Time (h)	Inflow (m^3/s)	2S/Δt + Q (m^3/s)	Depth (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)
0.42	0.003	0.003	0.000	0.00	0.003	0.000
0.50	0.003	0.003	0.000	0.00	0.003	0.000

FOR THE 1:100 YEAR STORM EVENT

$Q_{CASCADE}$ = 0.000 m^3/s [From SWMHYMO model depth above spill point (dynamic depth) interpolated between highlighted points]

STATIC DEPTH: h_s = 0.290 m [Based on storage volume used - SWMHYMO]

DYNAMIC DEPTH: h_d = 0.000 m

TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d$ = 0.290 m

RIVERSIDE SOUTH - PHASE 8

Part of 980 Earl Armstrong Road
RIVERSIDE SOUTH DEVELOPMENT CORPORATION
CITY OF OTTAWA
JLR NO. 21464-08

Street Ponding Area P21 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3):	31.40
Top of Grate Elevation (T/G) (m):	92.53

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	90.38
Diameter (m)	0.180
Springline Elevation (m)	90.47
Area (m^2)	0.026
Discharge Coefficient, C	0.61

Orifice Equation: $Q = CA\sqrt{2gh}$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	90.380			0.0000	0.0000	0.0000	0.00	0.0000	Invert	From Geometry
	92.155			0.0895	0.0000	0.0895	1.11	0.0001		
	92.530	0.000		0.0990	0.0000	0.0990	1.34	0.0001	T/G	
STATIC STORAGE[1]	92.590	0.060		0.1004	0.0000	0.1004	10.76	0.0011		From AutoCAD Civil 3D
	92.730	0.200	0.000	0.1037	0.0000	0.1037	32.74	0.0033	Spill	
DYNAMIC STORAGE[2]	92.780	0.250	0.050	0.1048	0.0208	0.1256	68.31	0.0068		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	92.790	0.260	0.060	0.1051	0.0338	0.1389	77.90	0.0078		
	92.815	0.285	0.085	0.1056	0.0856	0.1913	105.44	0.0105		
	92.825	0.295	0.095	0.1059	0.1152	0.2211	117.93	0.0118		
	92.860	0.330	0.130	0.1066	0.2659	0.3726	168.27	0.0168		
	92.870	0.340	0.140	0.1069	0.3241	0.4309	184.66	0.0185		
	92.875	0.345	0.145	0.1070	0.3558	0.4628	193.20	0.0193		
	92.885	0.355	0.155	0.1072	0.4254	0.5326	211.01	0.0211		
	92.905	0.375	0.175	0.1076	0.6114	0.7191	249.54	0.0250		
	92.925	0.395	0.195	0.1081	0.8562	0.9642	292.06	0.0292		
	92.940	0.410	0.210	0.1084	1.0663	1.1747	326.66	0.0327		
	92.965	0.435	0.235	0.1090	1.4689	1.5779	389.70	0.0390		
	92.985	0.455	0.255	0.1094	1.8398	1.9492	444.27	0.0444		
	93.010	0.480	0.280	0.1099	2.3670	2.4769	516.24	0.0516		
	93.030	0.500	0.300	0.1104	2.8412	2.9516	577.67	0.0578		

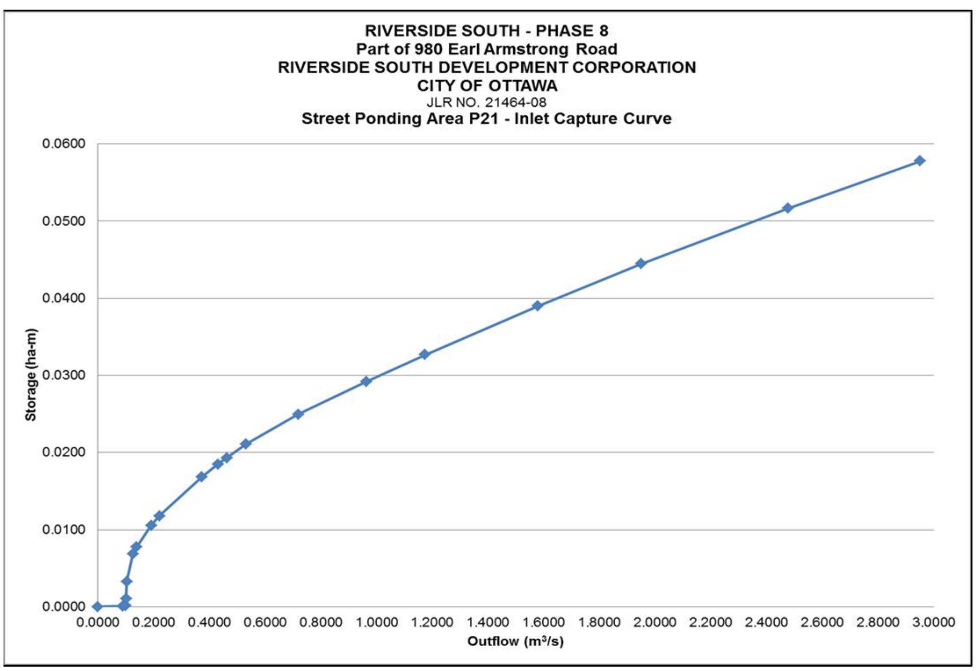
Note:

1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D

2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4

3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).

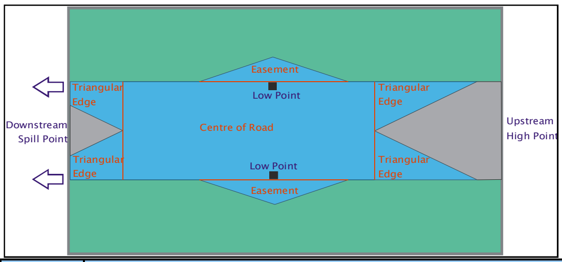
4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract 4.80 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P21

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.200	m
Distance (U/S High Point to D/S Spill Point)	97.4	m
Longitudinal Slope (U/S High Point to LP)	0.5	%
Longitudinal Slope (LP to D/S Spill Point)	0.5	%
Distance (LP to U/S High Point)	57.4	m
Road Width	11.0	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.15	m
Street Crown	0.1650	m



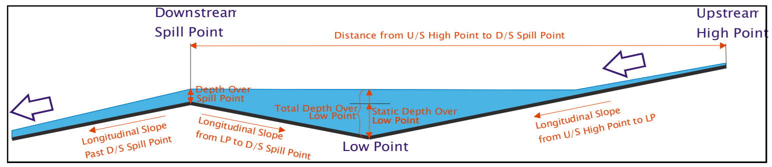
Calculated Results

Maximum Volume of Static Ponding	36.2	m^3
Maximum Volume of Dynamic Storage	546.3	m^3
Maximum Total Volume	582.5	m^3
Maximum Area of Static Ponding	567.0	m^2
Maximum Area of Dynamic Storage	2688.8	m^2
Maximum Total Area	3255.8	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$\text{Area}_{(\text{triangular pyramid})} = \text{Length} \times \text{Width} / 2$ $\quad$ $\text{Area}_{(\text{rectangular prism})} = \text{Length} \times \text{Width}$

$\text{Volume}_{(\text{triangular pyramid})} = \text{Area} \times \text{Height} / 3$ $\quad$ $\text{Volume}_{(\text{rectangular prism})} = \text{Area} \times \text{Height}$



Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.200	181.50	181.50	77.00	77.00	25.00	25.00	567.00	9.98	7.70	0.42	9.98	7.70	0.42	36.20

TOP OF GRATE ELEVATION: 92.53 m
SPILL POINT ELEVATION: 92.73 m
DEPTH OVER LOW POINT: 0.200 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 31.40 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 36.20 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 36.20 - 31.40 = 4.80 m^3

Calculation Sheet: Routing Through Typical Road Ponding Area P21

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.200	m
Distance (U/S High Point to D/S Spill Point)	97.4	m
Longitudinal Slope (U/S High Point to LP)	0.5	%
Longitudinal Slope (LP to D/S Spill Point)	0.5	%
Longitudinal Slope (past D/S Spill Point)	0.5	%
Road Width	11.0	m
Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	2.0	%
Curb Height	0.15	m
Manning's Roughness for Road / Sidewalk	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Calculated Results

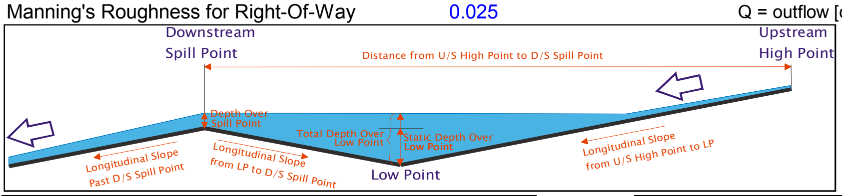
Friction Slope	0.15	% (per XPSWMM Simulations)
Maximum Inflow	0.262	m^3/s
Maximum Capture	0.056	m^3/s
Maximum Overflow	0.096	m^3/s
Maximum Storage Used	114.60	m^3
Maximum Water Depth	0.289	m

Note: Routing calculations performed based on the Modified Puls Method continuity equation, where $2S2/\Delta t + Q2 = (I1 + I2) + (2S2/\Delta t - Q1)$, and:

I = inflow (m^3/s)

$S/\Delta t$ = storage over one time step (m^3/s)

Q = outflow [capture and overflow] (m^3/s)



Refer to Storage and Overflow Calculation Sheets for details of other calculations.

Depth Over Low Point (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)
0.300	129.28	0.056	0.132	1.050
0.305	136.04	0.056	0.150	1.113

Time (h)	Inflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)	Depth (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)
5.00	0.000	0.000	0.000	0.00	0.000	0.000
5.08	0.000	0.000	0.000	0.00	0.000	0.000

FOR THE 1:100 YEAR STORM EVENT

$Q_{CASCADE}$ = 0.143 m^3/s [From SWMHYMO model depth above spill point (dynamic depth) interpolated between highlighted points]

STATIC DEPTH: $h_s = 0.200$ m

DYNAMIC DEPTH: $h_d = 0.103$ m

TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d = 0.303$ m

RIVERSIDE SOUTH - PHASE 8

Part of 980 Earl Armstrong Road
RIVERSIDE SOUTH DEVELOPMENT CORPORATION
CITY OF OTTAWA

JLR NO. 21464-08

Street Ponding Area P24-1 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3):	11.40
Top of Grate Elevation (T/G) (m):	92.53

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	90.46
Diameter (m)	0.122
Springline Elevation (m)	90.52
Area (m^2)	0.012
Discharge Coefficient, C	0.61

Orifice Equation: $Q = CA\sqrt{2gh}$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	90.460			0.0000	0.0000	0.0000	0.00	0.0000	Invert	From Geometry
	91.460			0.0308	0.0000	0.0308	0.65	0.0001		
	92.235			0.0416	0.0000	0.0416	1.15	0.0001		
	92.530	0.000		0.0450	0.0000	0.0450	1.34	0.0001	T/G	
STATIC STORAGE[1]	92.590	0.060		0.0457	0.0000	0.0457	5.90	0.0006		From AutoCAD Civil 3D
	92.680	0.150	0.000	0.0466	0.0000	0.0466	12.74	0.0013	Spill	
DYNAMIC STORAGE[2]	92.740	0.210	0.060	0.0473	0.0338	0.0811	29.12	0.0029		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	92.770	0.240	0.090	0.0476	0.0998	0.1474	43.02	0.0043		
	92.780	0.250	0.100	0.0477	0.1321	0.1798	48.56	0.0049		
	92.785	0.255	0.105	0.0478	0.1505	0.1982	51.50	0.0052		
	92.795	0.265	0.115	0.0479	0.1918	0.2397	57.78	0.0058		
	92.815	0.285	0.135	0.0481	0.3036	0.3517	71.92	0.0072		
	92.835	0.305	0.155	0.0483	0.458	0.5058	88.42	0.0088		
	92.850	0.320	0.170	0.0485	0.5911	0.6395	102.50	0.0102		
	92.860	0.330	0.180	0.0486	0.6892	0.7378	112.74	0.0113		
	92.875	0.345	0.195	0.0487	0.8510	0.8997	129.43	0.0129		
	92.920	0.390	0.240	0.0492	1.4499	1.4991	189.06	0.0189		
	92.955	0.425	0.275	0.0495	2.0442	2.0937	244.27	0.0244		
	93.000	0.470	0.320	0.0500	2.9901	3.0401	327.09	0.0327		
	93.030	0.500	0.350	0.0503	3.7430	3.7933	389.70	0.0390		

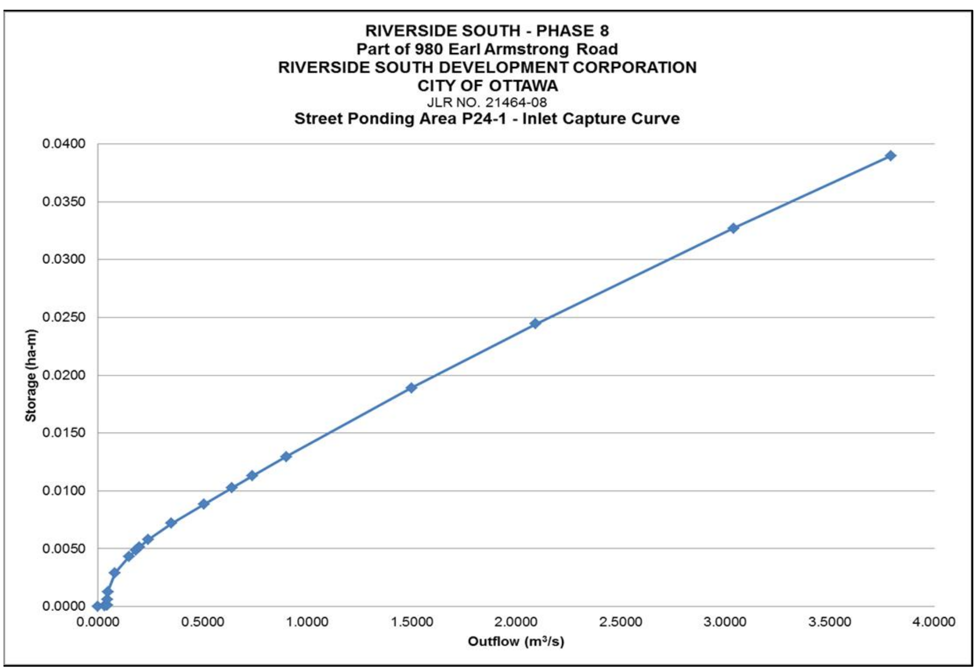
Note:

1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D

2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4

3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).

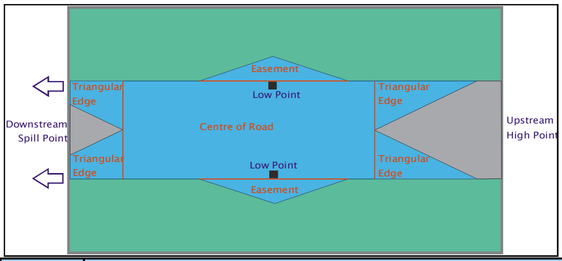
4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract -0.84 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P24-1

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.150	m
Distance (U/S High Point to D/S Spill Point)	49.5	m
Longitudinal Slope (U/S High Point to LP)	1.2	%
Longitudinal Slope (LP to D/S Spill Point)	0.5	%
Distance (LP to U/S High Point)	19.5	m
Road Width	8.5	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.15	m
Street Crown	0.1275	m



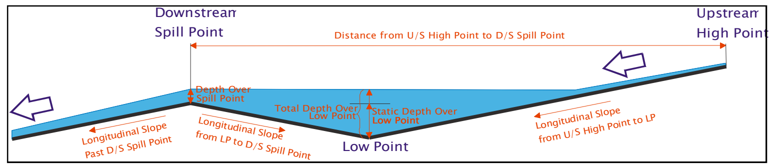
Calculated Results

Maximum Volume of Static Ponding	10.6	m^3
Maximum Volume of Dynamic Storage	378.3	m^3
Maximum Total Volume	388.9	m^3
Maximum Area of Static Ponding	207.2	m^2
Maximum Area of Dynamic Storage	1427.6	m^2
Maximum Total Area	1634.8	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$Area_{(triangular\ pyramid)}$ = Length x Width / 2 $Area_{(rectangular\ prism)}$ = Length x Width

$Volume_{(triangular\ pyramid)}$ = Area x Height / 3 $Volume_{(rectangular\ prism)}$ = Area x Height



Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.150	108.38	44.78	38.25	15.81	0.00	0.00	207.21	4.61	2.87	0.00	1.90	1.19	0.00	10.56

TOP OF GRATE ELEVATION: 92.53 m
SPILL POINT ELEVATION: 92.68 m
DEPTH OVER LOW POINT: 0.150 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 11.40 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 10.56 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 10.56 - 11.40 = -0.84 m^3

Calculation Sheet: Routing Through Typical Road Ponding Area P24-1

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.150	m
Distance (U/S High Point to D/S Spill Point)	49.5	m
Longitudinal Slope (U/S High Point to LP)	1.2	%
Longitudinal Slope (LP to D/S Spill Point)	0.5	%
Longitudinal Slope (past D/S Spill Point)	0.6	%
Road Width	8.5	m
Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	2.0	%
Curb Height	0.15	m
Manning's Roughness for Road / Sidewalk	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Calculated Results

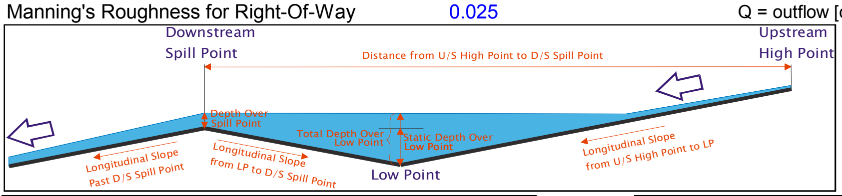
Friction Slope	0.15	% (per XPSWMM Simulations)
Maximum Inflow	0.262	m^3/s
Maximum Capture	0.055	m^3/s
Maximum Overflow	0.184	m^3/s
Maximum Storage Used	55.80	m^3
Maximum Water Depth	0.263	m

Note: Routing calculations performed based on the Modified Puls Method continuity equation, where $2S2/\Delta t + Q2 = (I1 + I2) + (2S2/\Delta t - Q1)$, and:

I = inflow (m^3/s)

$S/\Delta t$ = storage over one time step (m^3/s)

Q = outflow [capture and overflow] (m^3/s)



Refer to Storage and Overflow Calculation Sheets for details of other calculations.

Depth Over Low Point (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)
0.270	60.27	0.055	0.215	0.672
0.275	63.74	0.055	0.240	0.720

Time (h)	Inflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)	Depth (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)
4.50	0.000	0.000	0.000	0.00	0.000	0.000
4.58	0.000	0.000	0.000	0.00	0.000	0.000

FOR THE 1:100 YEAR STORM EVENT

$Q_{CASCADE} = 0.228\ m^3/s$ [From SWMHYMO model depth above spill point (dynamic depth) interpolated between highlighted points]

STATIC DEPTH: $h_s = 0.150$ m

DYNAMIC DEPTH: $h_d = 0.123$ m

TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d = 0.273$ m

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CITY OF OTTAWA
JLR NO. 21464-08

Street Ponding Area P24-2 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3): 13.90
Top of Grate Elevation (T/G) (m): 92.47

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	90.40
Diameter (m)	0.135
Springline Elevation (m)	90.47
Area (m^2)	0.014
Discharge Coefficient, C	0.61

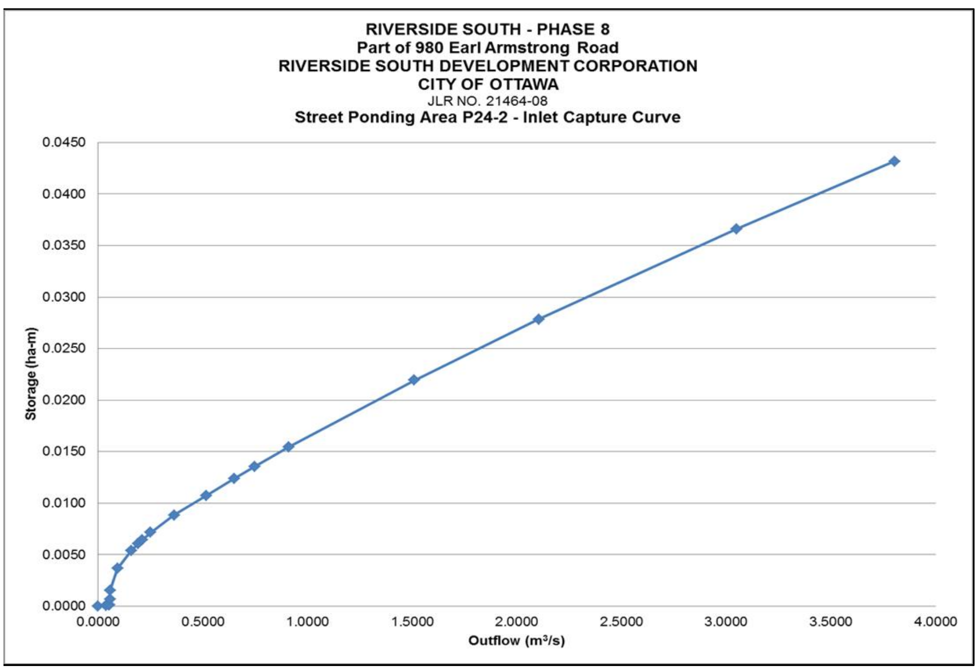
Orifice Equation: $Q = CA\sqrt{2gh}$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	90.400			0.0000	0.0000	0.0000	0.00	0.0000	Invert	From Geometry
	91.400			0.0375	0.0000	0.0375	0.65	0.0001		
	92.175			0.0508	0.0000	0.0508	1.15	0.0001		
	92.470	0.000		0.0550	0.0000	0.0550	1.34	0.0001	T/G	
STATIC STORAGE[1]	92.530	0.060		0.0558	0.0000	0.0558	6.90	0.0007		From AutoCAD Civil 3D
	92.620	0.150	0.000	0.0570	0.0000	0.0570	15.24	0.0015	Spill	
DYNAMIC STORAGE[2]	92.680	0.210	0.060	0.0578	0.0338	0.0916	36.60	0.0037		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	92.710	0.240	0.090	0.0582	0.0998	0.1580	53.75	0.0054		
	92.720	0.250	0.100	0.0583	0.1321	0.1904	60.44	0.0060		
	92.725	0.255	0.105	0.0584	0.1505	0.2089	63.99	0.0064		
	92.735	0.265	0.115	0.0585	0.1918	0.2503	71.49	0.0071		
	92.755	0.285	0.135	0.0588	0.3036	0.3624	88.22	0.0088		
	92.775	0.305	0.155	0.0590	0.458	0.5166	107.50	0.0108		
	92.790	0.320	0.170	0.0592	0.5911	0.6503	123.79	0.0124		
	92.800	0.330	0.180	0.0594	0.6892	0.7486	135.57	0.0136		
	92.815	0.345	0.195	0.0595	0.8510	0.9106	154.43	0.0154		
	92.860	0.390	0.240	0.0601	1.4499	1.5101	219.14	0.0219		
	92.895	0.425	0.275	0.0606	2.0442	2.1047	278.37	0.0278		
	92.940	0.470	0.320	0.0611	2.9901	3.0512	366.04	0.0366		
	92.970	0.500	0.350	0.0615	3.7430	3.8045	431.69	0.0432		

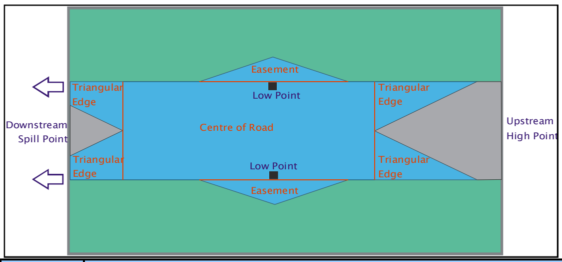
Note:
1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D
2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4
3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).
4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract -0.20 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P24-2

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.150	m
Distance (U/S High Point to D/S Spill Point)	65.1	m
Longitudinal Slope (U/S High Point to LP)	0.6	%
Longitudinal Slope (LP to D/S Spill Point)	0.5	%
Distance (LP to U/S High Point)	35.1	m
Road Width	8.5	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.15	m
Street Crown	0.1275	m



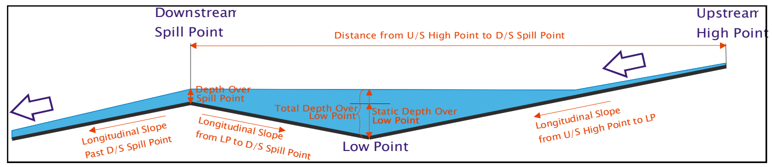
Calculated Results

Maximum Volume of Static Ponding	13.7	m^3
Maximum Volume of Dynamic Storage	417.8	m^3
Maximum Total Volume	431.5	m^3
Maximum Area of Static Ponding	268.8	m^2
Maximum Area of Dynamic Storage	1950.8	m^2
Maximum Total Area	2219.6	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$\text{Area}_{(\text{triangular pyramid})}$ = Length x Width / 2 $\text{Area}_{(\text{rectangular prism})}$ = Length x Width

$\text{Volume}_{(\text{triangular pyramid})}$ = Area x Height / 3 $\text{Volume}_{(\text{rectangular prism})}$ = Area x Height



Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.150	108.38	90.31	38.25	31.88	0.00	0.00	268.81	4.61	2.87	0.00	3.84	2.39	0.00	13.70

TOP OF GRATE ELEVATION: 92.47 m
SPILL POINT ELEVATION: 92.62 m
DEPTH OVER LOW POINT: 0.150 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 13.90 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 13.70 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 13.70 - 13.90 = -0.20 m^3

Calculation Sheet: Routing Through Typical Road Ponding Area P24-2

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.150	m
Distance (U/S High Point to D/S Spill Point)	65.1	m
Longitudinal Slope (U/S High Point to LP)	0.6	%
Longitudinal Slope (LP to D/S Spill Point)	0.5	%
Longitudinal Slope (past D/S Spill Point)	0.7	%
Road Width	8.5	m
Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	2.0	%
Curb Height	0.15	m
Manning's Roughness for Road / Sidewalk	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Calculated Results

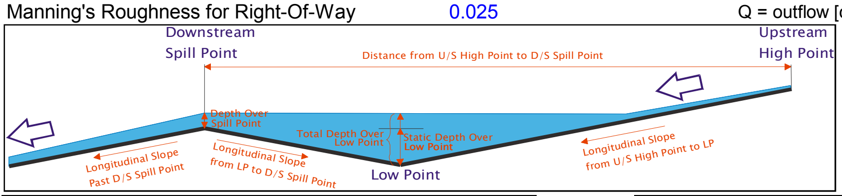
Friction Slope	0.15	% (per XPSWMM Simulations)
Maximum Inflow	0.262	m^3/s
Maximum Capture	0.055	m^3/s
Maximum Overflow	0.163	m^3/s
Maximum Storage Used	66.09	m^3
Maximum Water Depth	0.258	m

Note: Routing calculations performed based on the Modified Puls Method continuity equation, where $2S2/\Delta t + Q2 = (I1 + I2) + (2S2/\Delta t - Q1)$, and:

I = inflow (m^3/s)

$S/\Delta t$ = storage over one time step (m^3/s)

Q = outflow [capture and overflow] (m^3/s)



Refer to Storage and Overflow Calculation Sheets for details of other calculations.

Depth Over Low Point (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)
0.260	67.47	0.055	0.170	0.675
0.265	71.29	0.055	0.192	0.722

Time (h)	Inflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)	Depth (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)
4.33	0.000	0.000	0.000	0.00	0.000	0.000
4.42	0.000	0.000	0.000	0.00	0.000	0.000

FOR THE 1:100 YEAR STORM EVENT

$Q_{CASCADE} = 0.186\ m^3/s$ [From SWMHYMO model depth above spill point (dynamic depth) interpolated between highlighted points]

STATIC DEPTH: $h_s = 0.150$ m

DYNAMIC DEPTH: $h_d = 0.114$ m

TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d = 0.264$ m

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CITY OF OTTAWA
JLR NO. 21464-08

Street Ponding Area P25 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3): 31.00
Top of Grate Elevation (T/G) (m): 92.32

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	90.25
Diameter (m)	0.089
Springline Elevation (m)	90.29
Area (m^2)	0.006
Discharge Coefficient, C	0.61

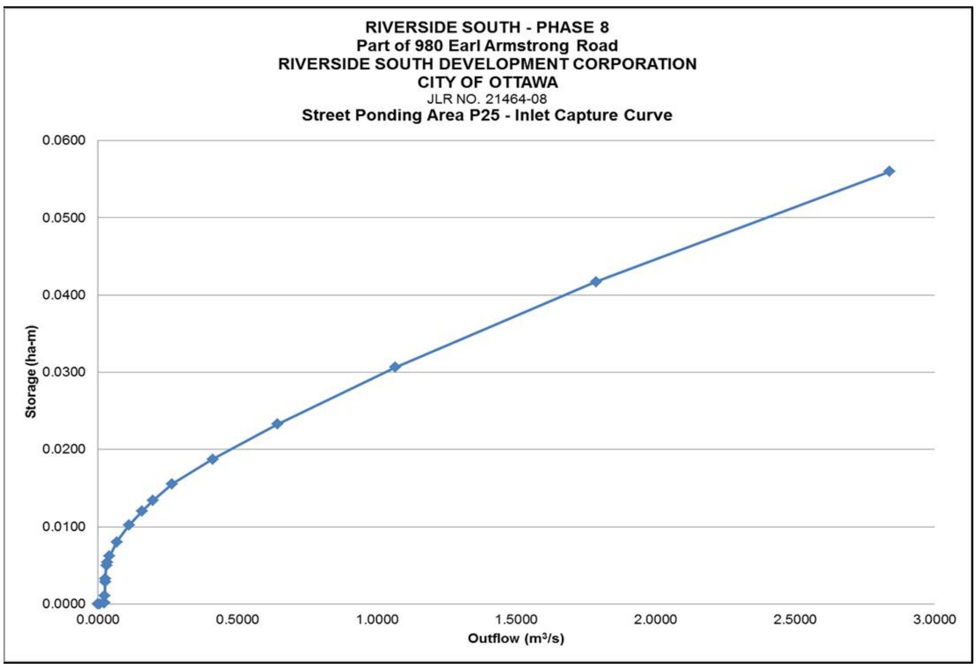
Orifice Equation: $Q = CA\sqrt{2gh}$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	90.250			0.0000	0.0000	0.0000	0.00	0.0000	Invert	From Geometry
	90.450			0.0066	0.0000	0.0066	0.13	0.0000		
	92.025			0.0222	0.0000	0.0222	1.15	0.0001		
	92.320	0.000		0.0240	0.0000	0.0240	1.34	0.0001	T/G	
STATIC STORAGE[1]	92.380	0.060		0.0244	0.0000	0.0244	10.64	0.0011		From AutoCAD Civil 3D
	92.495	0.175		0.0250	0.0000	0.0250	28.46	0.0028		
	92.520	0.200	0.000	0.0252	0.0000	0.0252	32.34	0.0032	Spill	
DYNAMIC STORAGE[2]	92.550	0.230	0.030	0.0253	0.0053	0.0307	50.00	0.0050		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	92.555	0.235	0.035	0.0254	0.0080	0.0334	53.76	0.0054		
	92.565	0.245	0.045	0.0254	0.0157	0.0411	61.84	0.0062		
	92.585	0.265	0.065	0.0255	0.0419	0.0674	80.24	0.0080		
	92.605	0.285	0.085	0.0256	0.0856	0.1113	101.82	0.0102		
	92.620	0.300	0.100	0.0257	0.1321	0.1578	120.23	0.0120		
	92.630	0.310	0.110	0.0258	0.1703	0.1961	133.59	0.0134		
	92.645	0.325	0.125	0.0259	0.2405	0.2663	155.28	0.0155		
	92.665	0.345	0.145	0.0260	0.3847	0.4107	187.33	0.0187		
	92.690	0.370	0.170	0.0261	0.6176	0.6437	232.61	0.0233		
	92.725	0.405	0.205	0.0263	1.0398	1.0661	306.31	0.0306		
	92.770	0.450	0.250	0.0265	1.7594	1.7860	417.00	0.0417		
	92.820	0.500	0.300	0.0268	2.8123	2.8391	559.53	0.0560		

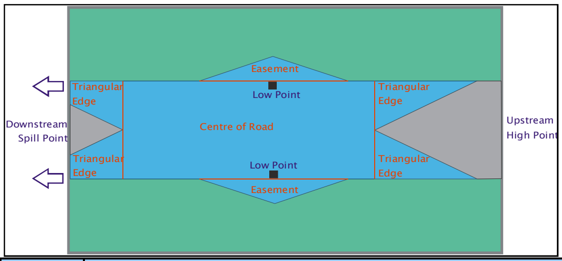
Note:
1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D
2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4
3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).
4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract 1.49 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P25

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.200	m
Distance (U/S High Point to D/S Spill Point)	80.0	m
Longitudinal Slope (U/S High Point to LP)	0.7	%
Longitudinal Slope (LP to D/S Spill Point)	0.5	%
Distance (LP to U/S High Point)	40.7	m
Road Width	8.5	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.11	m
Street Crown	0.1275	m



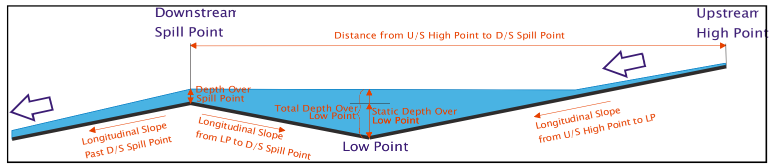
Calculated Results

Maximum Volume of Static Ponding	31.8	m^3
Maximum Volume of Dynamic Storage	529.2	m^3
Maximum Total Volume	561.0	m^3
Maximum Area of Static Ponding	511.8	m^2
Maximum Area of Dynamic Storage	2230.9	m^2
Maximum Total Area	2742.7	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$\text{Area}_{(\text{triangular pyramid})} = \text{Length} \times \text{Width} / 2$ $\quad \text{Area}_{(\text{rectangular prism})} = \text{Length} \times \text{Width}$

$\text{Volume}_{(\text{triangular pyramid})} = \text{Area} \times \text{Height} / 3$ $\quad \text{Volume}_{(\text{rectangular prism})} = \text{Area} \times \text{Height}$



Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.200	106.25	73.23	120.83	83.28	75.92	52.32	511.83	4.52	12.08	2.23	3.11	8.33	2.23	32.49

TOP OF GRATE ELEVATION: 92.32 m
SPILL POINT ELEVATION: 92.52 m
DEPTH OVER LOW POINT: 0.200 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 31.00 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 32.49 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 32.49 - 31.00 = 1.49 m^3

Calculation Sheet: Routing Through Typical Road Ponding Area P25

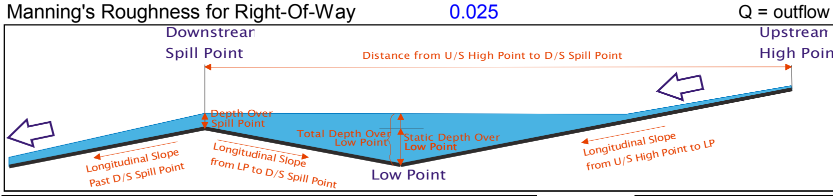
User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.200	m
Distance (U/S High Point to D/S Spill Point)	80.0	m
Longitudinal Slope (U/S High Point to LP)	0.7	%
Longitudinal Slope (LP to D/S Spill Point)	0.5	%
Longitudinal Slope (past D/S Spill Point)	0.7	%
Road Width	8.5	m
Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	2.0	%
Curb Height	0.11	m
Manning's Roughness for Road / Sidewalk	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Calculated Results

Friction Slope	0.15	% (per XPSWMM Simulations)
Maximum Inflow	0.262	m^3/s
Maximum Capture	0.056	m^3/s
Maximum Overflow	0.104	m^3/s
Maximum Storage Used	110.86	m^3
Maximum Water Depth	0.291	m

Note: Routing calculations performed based on the Modified Puls Method continuity equation, where $2S2/\Delta t + Q2 = (I1 + I2) + (2S2/\Delta t - Q1)$, and:
I = inflow (m^3/s)
$S/\Delta t$ = storage over one time step (m^3/s)
Q = outflow [capture and overflow] (m^3/s)



Refer to Storage and Overflow Calculation Sheets for details of other calculations.

Depth Over Low Point (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)
0.300	121.72	0.056	0.132	1.000
0.305	128.30	0.056	0.150	1.062

Time (h)	Inflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)	Depth (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)
5.00	0.000	0.000	0.000	0.00	0.000	0.000
5.08	0.000	0.000	0.000	0.00	0.000	0.000

FOR THE 1:100 YEAR STORM EVENT
$Q_{CASCADE}$ = 0.143 m^3/s [From SWMHYMO model depth above spill point (dynamic depth) interpolated between highlighted points]
STATIC DEPTH: h_s = 0.200 m
DYNAMIC DEPTH: h_d = 0.103 m
TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d$ = 0.303 m

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CITY OF OTTAWA
JLR NO. 21464-08

Street Ponding Area P26 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3):	30.10
Top of Grate Elevation (T/G) (m):	92.22

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	90.15
Diameter (m)	0.077
Springline Elevation (m)	90.19
Area (m^2)	0.005
Discharge Coefficient, C	0.61

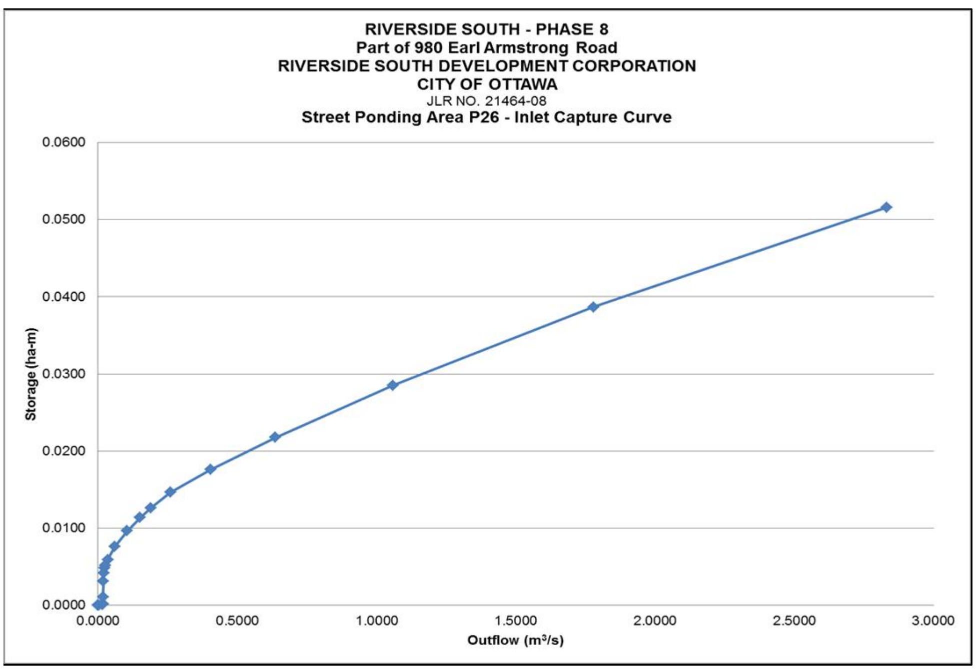
Orifice Equation: $Q = CA\sqrt{2gh}$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	90.150			0.0000	0.0000	0.0000	0.00	0.0000	Invert	From Geometry
	90.350			0.0051	0.0000	0.0051	0.13	0.0000		
	91.925			0.0166	0.0000	0.0166	1.15	0.0001		
	92.220	0.000		0.0180	0.0000	0.0180	1.34	0.0001	T/G	
STATIC STORAGE[1]	92.280	0.060		0.0183	0.0000	0.0183	10.37	0.0010		From AutoCAD Civil 3D
	92.420	0.200	0.000	0.0189	0.0000	0.0189	31.44	0.0031	Spill	
DYNAMIC STORAGE[2]	92.440	0.220	0.020	0.0189	0.0018	0.0208	41.46	0.0041		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	92.450	0.230	0.030	0.0190	0.0053	0.0243	48.07	0.0048		
	92.455	0.235	0.035	0.0190	0.0080	0.0271	51.61	0.0052		
	92.465	0.245	0.045	0.0191	0.0157	0.0348	59.20	0.0059		
	92.485	0.265	0.065	0.0191	0.0419	0.0610	76.44	0.0076		
	92.505	0.285	0.085	0.0192	0.0856	0.1049	96.60	0.0097		
	92.520	0.300	0.100	0.0193	0.1321	0.1514	113.74	0.0114		
	92.530	0.310	0.110	0.0193	0.1703	0.1897	126.15	0.0126		
	92.545	0.325	0.125	0.0194	0.2405	0.2599	146.25	0.0146		
	92.565	0.345	0.145	0.0195	0.3847	0.4042	175.87	0.0176		
	92.590	0.370	0.170	0.0196	0.6176	0.6372	217.59	0.0218		
	92.625	0.405	0.205	0.0197	1.0398	1.0595	285.25	0.0285		
	92.670	0.450	0.250	0.0199	1.7594	1.7793	386.37	0.0386		
	92.720	0.500	0.300	0.0201	2.8123	2.8324	515.80	0.0516		

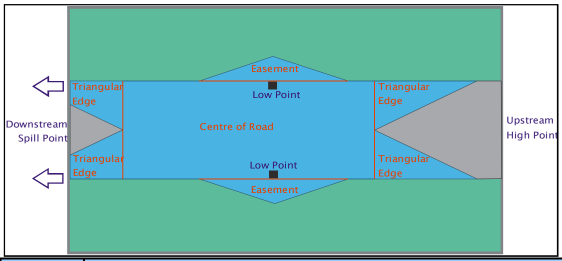
Note:
1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D
2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4
3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).
4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract 1.24 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P26

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.200	m
Distance (U/S High Point to D/S Spill Point)	80.1	m
Longitudinal Slope (U/S High Point to LP)	0.7	%
Longitudinal Slope (LP to D/S Spill Point)	0.6	%
Distance (LP to U/S High Point)	45.6	m
Road Width	8.5	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.11	m
Street Crown	0.1275	m



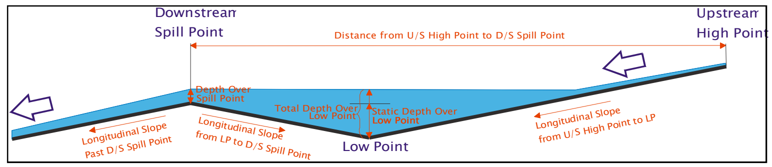
Calculated Results

Maximum Volume of Static Ponding	31.1	m^3
Maximum Volume of Dynamic Storage	485.9	m^3
Maximum Total Volume	517.0	m^3
Maximum Area of Static Ponding	500.6	m^2
Maximum Area of Dynamic Storage	2244.6	m^2
Maximum Total Area	2745.2	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$\text{Area}_{\text{(triangular pyramid)}} = \text{Length} \times \text{Width} / 2$ $\text{Area}_{\text{(rectangular prism)}} = \text{Length} \times \text{Width}$

$\text{Volume}_{\text{(triangular pyramid)}} = \text{Area} \times \text{Height} / 3$ $\text{Volume}_{\text{(rectangular prism)}} = \text{Area} \times \text{Height}$



Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.200	93.43	82.10	106.25	93.37	66.76	58.67	500.58	3.97	10.63	1.96	3.49	9.34	1.96	31.34

TOP OF GRATE ELEVATION: 92.22 m
SPILL POINT ELEVATION: 92.42 m
DEPTH OVER LOW POINT: 0.200 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 30.10 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 31.34 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 31.34 - 30.10 = 1.24 m^3

Calculation Sheet: Routing Through Typical Road Ponding Area P26

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.200	m
Distance (U/S High Point to D/S Spill Point)	80.1	m
Longitudinal Slope (U/S High Point to LP)	0.7	%
Longitudinal Slope (LP to D/S Spill Point)	0.6	%
Longitudinal Slope (past D/S Spill Point)	0.6	%
Road Width	8.5	m
Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	2.0	%
Curb Height	0.11	m
Manning's Roughness for Road / Sidewalk	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Calculated Results

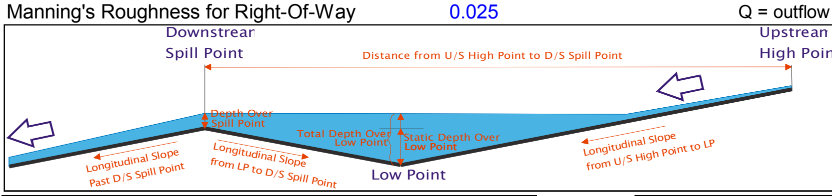
Friction Slope	0.15	% (per XPSWMM Simulations)
Maximum Inflow	0.262	m^3/s
Maximum Capture	0.056	m^3/s
Maximum Overflow	0.112	m^3/s
Maximum Storage Used	107.73	m^3
Maximum Water Depth	0.294	m

Note: Routing calculations performed based on the Modified Puls Method continuity equation, where $2S2/\Delta t + Q2 = (I1 + I2) + (2S2/\Delta t - Q1)$, and:

I = inflow (m^3/s)

$S/\Delta t$ = storage over one time step (m^3/s)

Q = outflow [capture and overflow] (m^3/s)



Refer to Storage and Overflow Calculation Sheets for details of other calculations.

Depth Over Low Point (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)
0.260	73.10	0.055	0.034	0.576
0.265	77.68	0.055	0.042	0.615

Time (h)	Inflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)	Depth (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)
4.33	0.000	0.000	0.000	0.00	0.000	0.000
4.42	0.000	0.000	0.000	0.00	0.000	0.000

FOR THE 1:100 YEAR STORM EVENT

$Q_{CASCADE}$ = 0.034 m^3/s [From SWMHYMO model depth above spill point (dynamic depth) interpolated between highlighted points]

STATIC DEPTH: h_s = 0.200 m

DYNAMIC DEPTH: h_d = 0.060 m

TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d$ = 0.260 m

RIVERSIDE SOUTH - PHASE 8
Part of 980 Earl Armstrong Road
RIVERSIDE SOUTH DEVELOPMENT CORPORATION
CITY OF OTTAWA
JLR NO. 21464-08

Street Ponding Area P27 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3): 31.30
Top of Grate Elevation (T/G) (m): 92.12

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	90.05
Diameter (m)	0.083
Springline Elevation (m)	90.09
Area (m^2)	0.005
Discharge Coefficient, C	0.61

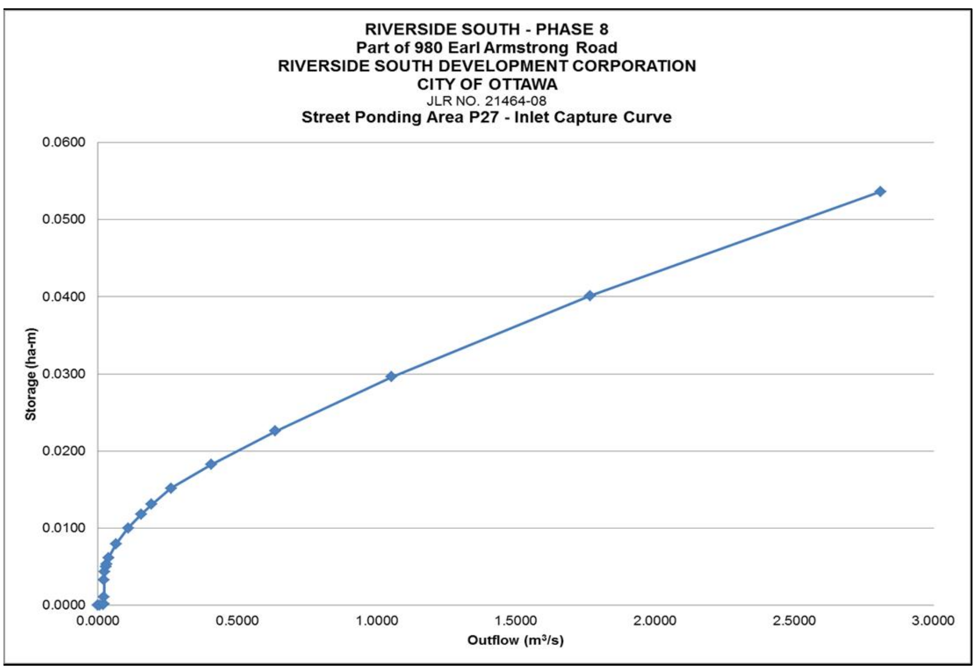
Orifice Equation: $Q = CA\sqrt{2gh}$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	90.050			0.0000	0.0000	0.0000	0.00	0.0000	***Invert***	From Geometry
	90.250			0.0059	0.0000	0.0059	0.13	0.0000		
	91.825			0.0194	0.0000	0.0194	1.15	0.0001		
	92.120	0.000		0.0210	0.0000	0.0210	1.34	0.0001	***T/G***	
STATIC STORAGE[1]	92.180	0.060		0.0213	0.0000	0.0213	10.73	0.0011		From AutoCAD Civil 3D
	92.320	0.200	0.000	0.0220	0.0000	0.0220	32.64	0.0033	***Spill***	
DYNAMIC STORAGE[2]	92.340	0.220	0.020	0.0221	0.0018	0.0239	43.04	0.0043		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	92.350	0.230	0.030	0.0222	0.0053	0.0275	49.88	0.0050		
	92.355	0.235	0.035	0.0222	0.0080	0.0302	53.54	0.0054		
	92.365	0.245	0.045	0.0222	0.0157	0.0379	61.39	0.0061		
	92.385	0.265	0.065	0.0223	0.0419	0.0642	79.23	0.0079		
	92.405	0.285	0.085	0.0224	0.0856	0.1081	100.09	0.0100		
	92.420	0.300	0.100	0.0225	0.1321	0.1546	117.84	0.0118		
	92.430	0.310	0.110	0.0225	0.1703	0.1929	130.70	0.0131		
	92.445	0.325	0.125	0.0226	0.2401	0.2628	151.53	0.0152		
	92.465	0.345	0.145	0.0227	0.3833	0.4060	182.25	0.0182		
	92.490	0.370	0.170	0.0228	0.6141	0.6369	225.58	0.0226		
	92.525	0.405	0.205	0.0230	1.0321	1.0551	295.92	0.0296		
	92.570	0.450	0.250	0.0232	1.7446	1.7678	401.34	0.0401		
	92.620	0.500	0.300	0.0234	2.7875	2.8109	536.45	0.0536		

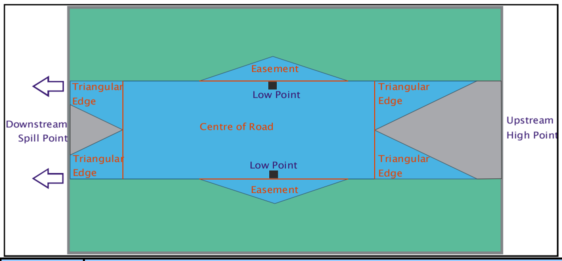
Note:
1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D
2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4
3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).
4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract 1.25 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P27

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.200	m
Distance (U/S High Point to D/S Spill Point)	84.0	m
Longitudinal Slope (U/S High Point to LP)	0.6	%
Longitudinal Slope (LP to D/S Spill Point)	0.6	%
Distance (LP to U/S High Point)	47.6	m
Road Width	8.5	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.12	m
Street Crown	0.1275	m



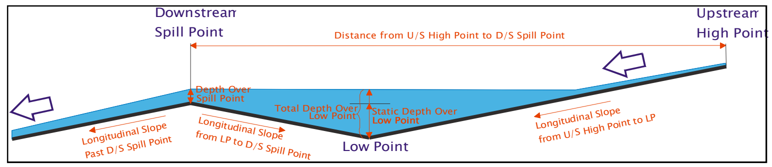
Calculated Results

Maximum Volume of Static Ponding	32.3	m^3
Maximum Volume of Dynamic Storage	505.4	m^3
Maximum Total Volume	537.7	m^3
Maximum Area of Static Ponding	517.4	m^2
Maximum Area of Dynamic Storage	2339.8	m^2
Maximum Total Area	2857.2	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$Area_{(triangular\ pyramid)}$ = Length x Width / 2 $Area_{(rectangular\ prism)}$ = Length x Width

$Volume_{(triangular\ pyramid)}$ = Area x Height / 3 $Volume_{(rectangular\ prism)}$ = Area x Height



Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.200	98.52	86.01	112.05	97.82	65.68	57.34	517.42	4.19	11.20	1.86	3.66	9.78	1.86	32.55

TOP OF GRATE ELEVATION: 92.12 m
SPILL POINT ELEVATION: 92.32 m
DEPTH OVER LOW POINT: 0.200 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 31.30 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 32.55 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 32.55 - 31.30 = 1.25 m^3

Calculation Sheet: Routing Through Typical Road Ponding Area P27

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.200	m
Distance (U/S High Point to D/S Spill Point)	84.0	m
Longitudinal Slope (U/S High Point to LP)	0.6	%
Longitudinal Slope (LP to D/S Spill Point)	0.6	%
Longitudinal Slope (past D/S Spill Point)	0.5	%
Road Width	8.5	m
Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	2.0	%
Curb Height	0.12	m
Manning's Roughness for Road / Sidewalk	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Calculated Results

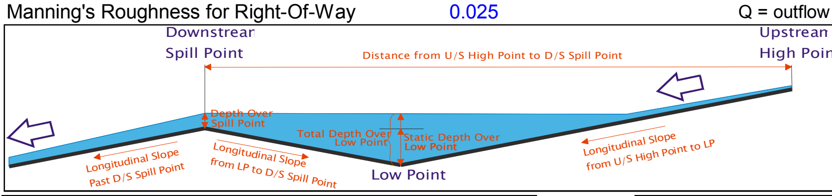
Friction Slope	0.15	% (per XPSWMM Simulations)
Maximum Inflow	0.262	m^3/s
Maximum Capture	0.056	m^3/s
Maximum Overflow	0.107	m^3/s
Maximum Storage Used	109.80	m^3
Maximum Water Depth	0.292	m

Note: Routing calculations performed based on the Modified Puls Method continuity equation, where 2S2/Δt + Q2 = (I1 + I2) + (2S2/Δt - Q1), and:

I = inflow (m^3/s)

S/Δt = storage over one time step (m^3/s)

Q = outflow [capture and overflow] (m^3/s)



Refer to Storage and Overflow Calculation Sheets for details of other calculations.

Depth Over Low Point (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)	2S/Δt + Q (m^3/s)
0.265	80.48	0.055	0.042	0.634
0.270	85.40	0.055	0.051	0.676

Time (h)	Inflow (m^3/s)	2S/Δt + Q (m^3/s)	Depth (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)
4.42	0.000	0.000	0.000	0.00	0.000	0.000
4.50	0.000	0.000	0.000	0.00	0.000	0.000

FOR THE 1:100 YEAR STORM EVENT

$Q_{CASCADE}$ = 0.043 m^3/s [From SWMHYMO model depth above spill point (dynamic depth) interpolated between highlighted points]

STATIC DEPTH: $h_s = 0.200$ m

DYNAMIC DEPTH: $h_d = 0.066$ m

TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d = 0.266$ m

RIVERSIDE SOUTH - PHASE 8

Part of 980 Earl Armstrong Road
RIVERSIDE SOUTH DEVELOPMENT CORPORATION
CITY OF OTTAWA
JLR NO. 21464-08

Street Ponding Area P28 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3): 66.40
Top of Grate Elevation (T/G) (m): 91.87

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	89.80
Diameter (m)	0.108
Springline Elevation (m)	89.85
Area (m^2)	0.009
Discharge Coefficient, C	0.61

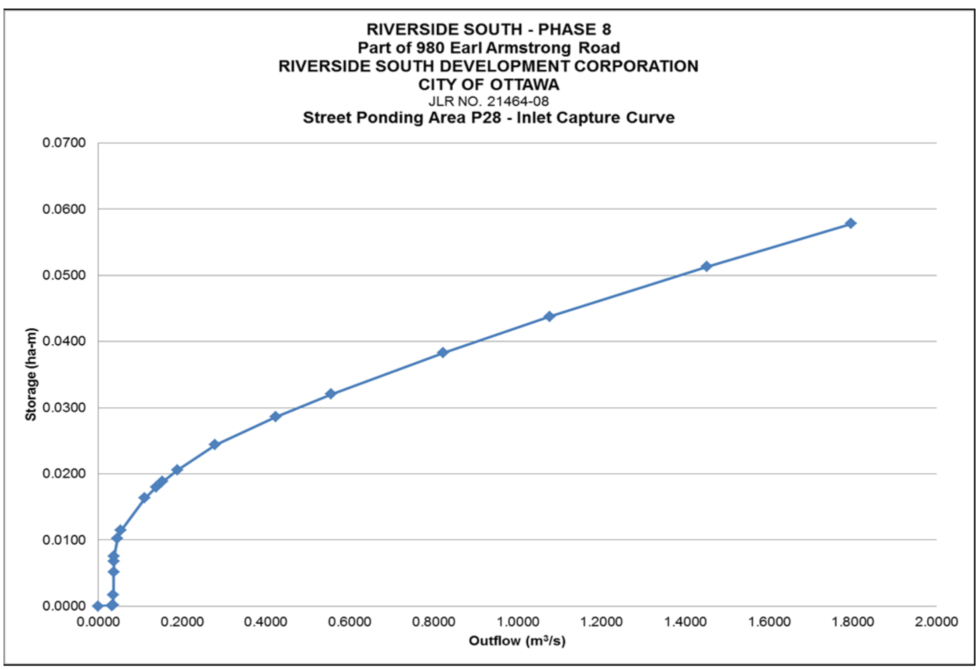
Orifice Equation: $Q = CA\sqrt{2gh}$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	89.800			0.0000	0.0000	0.0000	0.00	0.0000	Invert	From Geometry
	91.575			0.0323	0.0000	0.0323	1.15	0.0001		
	91.870	0.000		0.0350	0.0000	0.0350	1.34	0.0001	T/G	
STATIC STORAGE[1]	91.930	0.060		0.0355	0.0000	0.0355	17.28	0.0017		From AutoCAD Civil 3D
	92.060	0.190		0.0366	0.0000	0.0366	51.80	0.0052		
	92.120	0.250	0.000	0.0371	0.0000	0.0371	67.74	0.0068	Spill	
DYNAMIC STORAGE[2]	92.130	0.260	0.010	0.0372	0.0003	0.0375	75.64	0.0076		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	92.155	0.285	0.035	0.0374	0.0080	0.0454	102.23	0.0102		
	92.165	0.295	0.045	0.0375	0.0157	0.0532	114.30	0.0114		
	92.200	0.330	0.080	0.0378	0.0729	0.1106	163.48	0.0163		
	92.210	0.340	0.090	0.0378	0.0998	0.1376	179.59	0.0180		
	92.215	0.345	0.095	0.0379	0.1152	0.1531	188.00	0.0188		
	92.225	0.355	0.105	0.0380	0.1505	0.1884	205.56	0.0206		
	92.245	0.375	0.125	0.0381	0.2404	0.2785	243.66	0.0244		
	92.265	0.395	0.145	0.0383	0.3844	0.4227	285.82	0.0286		
	92.280	0.410	0.160	0.0384	0.5174	0.5558	320.17	0.0320		
	92.305	0.435	0.185	0.0386	0.7836	0.8222	382.78	0.0383		
	92.325	0.455	0.205	0.0387	1.0385	1.0772	437.84	0.0438		
	92.350	0.480	0.230	0.0389	1.4121	1.4511	512.85	0.0513		
	92.370	0.500	0.250	0.0391	1.7569	1.7960	577.91	0.0578		

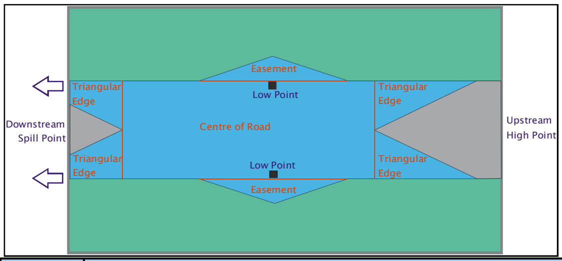
Note:
1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D
2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4
3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).
4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract 3.56 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P28

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.250	m
Distance (U/S High Point to D/S Spill Point)	130.9	m
Longitudinal Slope (U/S High Point to LP)	0.5	%
Longitudinal Slope (LP to D/S Spill Point)	0.6	%
Distance (LP to U/S High Point)	89.9	m
Road Width	8.5	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.11	m
Street Crown	0.1275	m



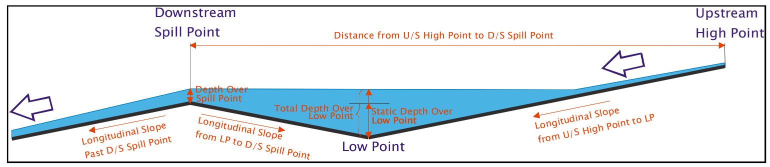
Calculated Results

Maximum Volume of Static Ponding	71.5	m^3
Maximum Volume of Dynamic Storage	510.0	m^3
Maximum Total Volume	581.5	m^3
Maximum Area of Static Ponding	920.2	m^2
Maximum Area of Dynamic Storage	2730.1	m^2
Maximum Total Area	3650.3	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$Area_{(triangular\ pyramid)}$ = Length x Width / 2 $Area_{(rectangular\ prism)}$ = Length x Width

$Volume_{(triangular\ pyramid)}$ = Area x Height / 3 $Volume_{(rectangular\ prism)}$ = Area x Height



Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.250	88.83	108.38	170.70	208.25	154.97	189.06	920.19	3.78	21.34	7.10	4.61	26.03	7.10	69.96

TOP OF GRATE ELEVATION: 91.87 m
SPILL POINT ELEVATION: 92.12 m
DEPTH OVER LOW POINT: 0.250 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 66.40 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 69.96 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 69.96 - 66.40 = 3.56 m^3

Calculation Sheet: Routing Through Typical Road Ponding Area P28

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.250	m
Distance (U/S High Point to D/S Spill Point)	130.9	m
Longitudinal Slope (U/S High Point to LP)	0.5	%
Longitudinal Slope (LP to D/S Spill Point)	0.6	%
Longitudinal Slope (past D/S Spill Point)	0.5	%
Road Width	8.5	m
Road Cross-Slope	3.0	%
Right-of-Way Cross-Slope	2.0	%
Curb Height	0.11	m
Manning's Roughness for Road / Sidewalk	0.013	
Manning's Roughness for Right-Of-Way	0.025	

Calculated Results

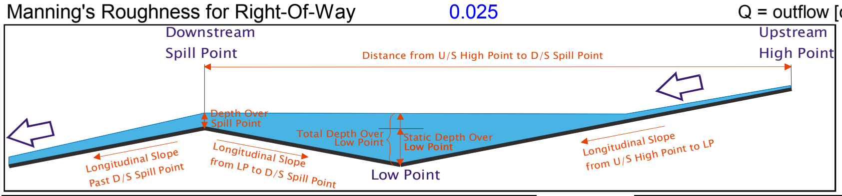
Friction Slope	0.15	% (per XPSWMM Simulations)
Maximum Inflow	0.262	m^3/s
Maximum Capture	0.056	m^3/s
Maximum Overflow	0.044	m^3/s
Maximum Storage Used	146.33	m^3
Maximum Water Depth	0.316	m

Note: Routing calculations performed based on the Modified Puls Method continuity equation, where $2S2/\Delta t + Q2 = (I1 + I2) + (2S2/\Delta t - Q1)$, and:

I = inflow (m^3/s)

$S/\Delta t$ = storage over one time step (m^3/s)

Q = outflow [capture and overflow] (m^3/s)



Refer to Storage and Overflow Calculation Sheets for details of other calculations.

Depth Over Low Point (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)
0.335	174.97	0.057	0.086	1.309
0.340	183.15	0.057	0.100	1.377

Time (h)	Inflow (m^3/s)	$2S/\Delta t + Q$ (m^3/s)	Depth (m)	Storage (m^3)	Capture (m^3/s)	Overflow (m^3/s)
5.58	0.000	0.000	0.000	0.00	0.000	0.000
5.67	0.000	0.000	0.000	0.00	0.000	0.000

FOR THE 1:100 YEAR STORM EVENT

$Q_{CASCADE}$ = 0.091 m^3/s [From SWMHYMO model depth above spill point (dynamic depth) interpolated between highlighted points]

STATIC DEPTH: h_s = 0.250 m

DYNAMIC DEPTH: h_d = 0.090 m

TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d$ = 0.340 m

RIVERSIDE SOUTH - PHASE 8
Part of 980 Earl Armstrong Road
RIVERSIDE SOUTH DEVELOPMENT CORPORATION
CITY OF OTTAWA
JLR NO. 21464-08

Street Ponding Area P29 - Stage-Storage-Discharge Calculations

Available Static Storage (m^3): 62.70
Top of Grate Elevation (T/G) (m): 91.87

Table 1: Orifice Characteristics

Orifice	
Invert Elevation (m)	89.80
Diameter (m)	0.087
Springline Elevation (m)	89.84
Area (m^2)	0.006
Discharge Coefficient, C	0.61

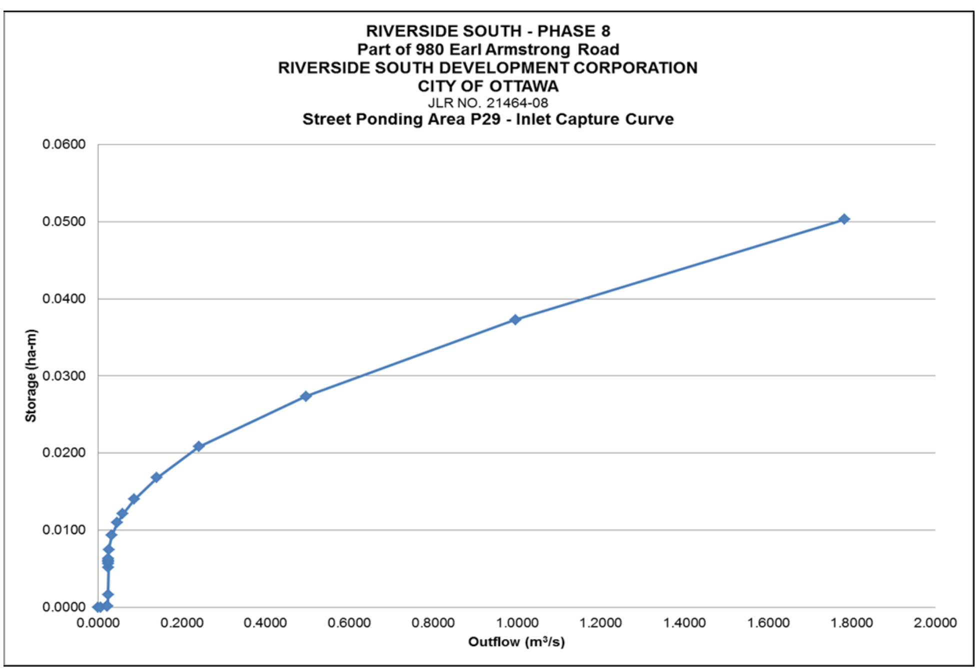
Orifice Equation: $Q = CA\sqrt{2gh}$

Q = Discharge (m^3/s)
C = Discharge Coefficient
A = Orifice Area (m^2)
h = Head Above Orifice (m)

Table 2: Stage-Storage Discharge-Calculation

Description	Elevation (m)	Depth over Low Point (m)	Depth over Spill Point (m)	Orifice Discharge (m^3/s)	Overflow[3] (m^3/s)	Total Outflow (m^3/s)	Storage[4] (m^3)	Storage (ha-m)	Note	Comment
CATCH BASIN MANHOLE STORAGE	89.800			0.0000	0.0000	0.0000	0.00	0.0000	Invert	From Geometry
	90.000			0.0064	0.0000	0.0064	0.13	0.0000		
	91.575			0.0213	0.0000	0.0213	1.15	0.0001		
	91.870	0.000		0.0230	0.0000	0.0230	1.34	0.0001	T/G	
STATIC STORAGE[1]	91.930	0.060		0.0233	0.0000	0.0233	16.39	0.0016		From AutoCAD Civil 3D
	92.070	0.200		0.0241	0.0000	0.0241	51.50	0.0051		
	92.090	0.220		0.0242	0.0000	0.0242	56.52	0.0057		
	92.100	0.230		0.0243	0.0000	0.0243	59.02	0.0059		
	92.105	0.235		0.0243	0.0000	0.0243	60.28	0.0060		
	92.115	0.245		0.0244	0.0000	0.0244	62.79	0.0063		
	92.120	0.250	0.000	0.0244	0.0000	0.0244	64.04	0.0064	Spill	
DYNAMIC STORAGE[2]	92.135	0.265	0.015	0.0245	0.0008	0.0253	74.81	0.0075		From Spreadsheet part of Technical Bulletin ISDTB-2012-4
	92.155	0.285	0.035	0.0246	0.0080	0.0326	93.47	0.0093		
	92.170	0.300	0.050	0.0246	0.0208	0.0455	109.45	0.0109		
	92.180	0.310	0.060	0.0247	0.0338	0.0585	121.07	0.0121		
	92.195	0.325	0.075	0.0248	0.0613	0.0861	139.97	0.0140		
	92.215	0.345	0.095	0.0249	0.1152	0.1401	168.02	0.0168		
	92.240	0.370	0.120	0.0250	0.2152	0.2402	207.91	0.0208		
	92.275	0.405	0.155	0.0252	0.4709	0.4961	273.20	0.0273		
	92.320	0.450	0.200	0.0254	0.9712	0.9966	372.71	0.0373		
	92.370	0.500	0.250	0.0257	1.7569	1.7826	502.66	0.0503		

Note:
1) Static storage was developed based on the road geometry and Volumes obtainbed from AutoCAD Civil 3D
2) Storage above spill point elevation (Dynamic Storage) was developed using the spreadsheet provided as part of Technical Bulletin ISDTB-2012-4
3) Overflow (cascading flow) was calculated using same spreadsheet listed in item (2).
4) Storage above spill point elevation was adjusted to account for ponding in the atypical roadway section (i.e., non-straight roadway section). The conservative approach assumed to subtract -5.19 m^3 of storage from the storage volume calculated in the approved spreadsheet listed in item (2).



Calculation Sheet: Storage In Typical Road Ponding Area P29

User Input Characteristics

Depth of Static Ponding Over Low Point (LP)	0.250	m
Distance (U/S High Point to D/S Spill Point)	77.0	m
Longitudinal Slope (U/S High Point to LP)	0.8	%
Longitudinal Slope (LP to D/S Spill Point)	0.6	%
Distance (LP to U/S High Point)	36.7	m
Road Width	8.5	m
Road Cross-Slope	0.030	m/m
Right-of-Way Cross-Slope	0.020	m/m
Curb Height	0.11	m
Street Crown	0.1275	m

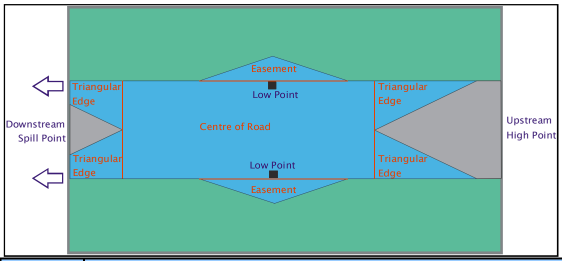
Calculated Results

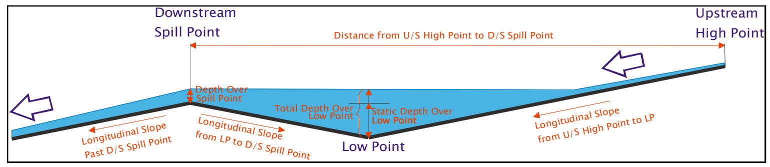
Maximum Volume of Static Ponding	55.8	m^3
Maximum Volume of Dynamic Storage	441.6	m^3
Maximum Total Volume	497.5	m^3
Maximum Area of Static Ponding	718.5	m^2
Maximum Area of Dynamic Storage	1847.6	m^2
Maximum Total Area	2566.1	m^2

Note: Storage calculations performed based on the geometry of the road, where volumes within the triangular edge and easement sections are calculated as triangular pyramids, the volume within the centre of the road is calculated as a series of rectangular prisms, and:

$Area_{(triangular\ pyramid)}$ = Length x Width / 2 $Area_{(rectangular\ prism)}$ = Length x Width

$Volume_{(triangular\ pyramid)}$ = Area x Height / 3 $Volume_{(rectangular\ prism)}$ = Area x Height





Depth Over Low Point (m)	Surface Area (m^2)							Volume (m^3)						
	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total	From Low Point to D/S Spill Point			From Low Point to U/S High Point			Total
	Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement		Triangular Edge	Centre of Road	Easement	Triangular Edge	Centre of Road	Easement	
0.250	87.40	66.59	167.94	127.96	152.47	116.17	718.54	3.71	20.99	6.99	2.83	16.00	6.99	57.51

TOP OF GRATE ELEVATION: 91.87 m
SPILL POINT ELEVATION: 92.12 m
DEPTH OVER LOW POINT: 0.250 m
CALCULATED STORAGE VOLUME AT SPILL POINT ELEVATION AND GIVEN DEPTH OVER LOW POINT USING AUTOCAD CIVIL 3D: 62.70 m^3
CALCULATION SHEET AT SPILL POINT ELEVATION: 57.51 m^3
CALCULATION SHEET STORAGE VOLUME ADJUSTMENTS: 57.51 - 62.70 = -5.19 m^3

RIVERSIDE SOUTH PHASE 8

Markdale Terrace Sidewalk Flow Conveyance Capacity

Ponding Area - P29

JLR No. 21464-08

Prepared by: I. Dzeparoski

Checked by: G. Forget, P.Eng.

Flow over Embankment Equation (MTO Drainage Manual):

$$\boxed{Q_o = 0.55 k_t C L H_o^{1.5}}$$

Q_o - Total Overflow, m^3/s

k_t - Submergence Factor (MTO Design Chart 2.47)

C - discharge coefficient (MTO Design Chart 2.09)

L - length of overflow along embankment, m

H_o - average upstream flow depth, m

Target Flow: 1:100 Year Design Storm PeakFlow *(Q_{100} = 350 L/s)*

Table 1: Flow Over Embankment (Paved)

k_t	*C*	*h/B*	*L* (m)	H_o (m)	*Elevation (m)*	Q_o (m^3/s)	Q_o (L/s)
1.0	2.90	0.00	6.7	0.02	92.14	0.03	30
1.0	2.90	0.01	13.3	0.04	92.16	0.17	170
1.0	2.90	0.01	20.0	0.06	92.18	0.47	469
1.0	2.91	0.01	26.6	0.08	92.20	0.97	965
1.0	2.92	0.02	33.3	0.10	92.22	1.69	1692

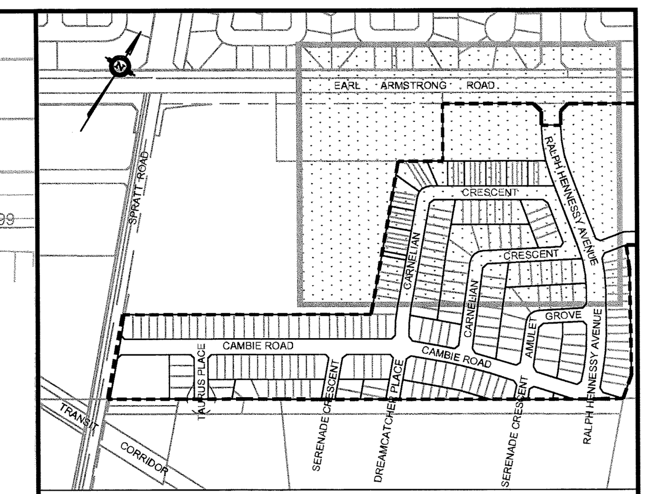
FOR THE 1:100 YEAR STORM EVENT

$Q_{CASCADE}$ = 0.350 m^3/s [From Flow Over Embankment calculation, interpolated between highlighted points]

STATIC DEPTH: h_s = 0.250 m

DYNAMIC DEPTH: h_d = 0.052 m

TOTAL DEPTH FOR PONDING AREA: $h_T = h_s + h_d$ = 0.302 m



KEY PLAN, N.T.S.

LEGEND:

MAX. WATER LEVEL (STATIC)

9	352	PONDING AREA NUMBER / 100YR PONDING AREA (m²)
0.20	26.5	PONDING DEPTH (STATIC) / PONDING VOLUME (100YR STATIC)
92.07		MAX. WATER LEVEL (STATIC)
92.18		MAX. WATER LEVEL (100YR STATIC + DYNAMIC)
20		CAPTURE RATE (L/s)

No.	ISSUE / REVISION	DD/MM/YY
7	ISSUED TO CITY FOR REFERENCE FOR MARKDALE TERRACE REDESIGN	30/06/16
6	ISSUED TO CITY FOR REVIEW - 4TH SUBMISSION - ISSUED FOR TENDER	27/11/15
5	ISSUED TO CITY FOR REVIEW - 3RD SUBMISSION	14/10/15
4	ISSUED TO CITY FOR REVIEW - 2ND SUBMISSION	31/07/15
3	ISSUED TO CITY FOR REVIEW - REAR YARD BERM TO ACCOMMODATE NOISE WALL ADDENDUM	30/04/15
2	ISSUED TO CITY FOR REVIEW - 1ST SUBMISSION	05/03/15
1	ISSUED TO CLIENT FOR REVIEW	27/02/15

VERIFY SHEET SIZE AND SCALES. BAR TO THE RIGHT IS 25mm IF THIS IS A FULL SIZE DRAWING. 0 25mm

SCALE: 1:500

CLIENT:

Riverside South

Riverside South Development Corporation (RSDC)
2193 Arch Street
Ottawa, ON
K1G 2H5
(613) 731-6331

CONSULTANT:

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS
www.jlrichards.ca

CONSULTANT:

PROFESSIONAL STAMP

LICENSED PROFESSIONAL ENGINEER
K.R. FERREY MORENO
100122432
June 29, 2016
PROVINCE OF ONTARIO

PROJECT NORTH

PROJECT:

RIVERSIDE SOUTH DEVELOPMENT CORPORATION
RIVERSIDE SOUTH PHASE 8

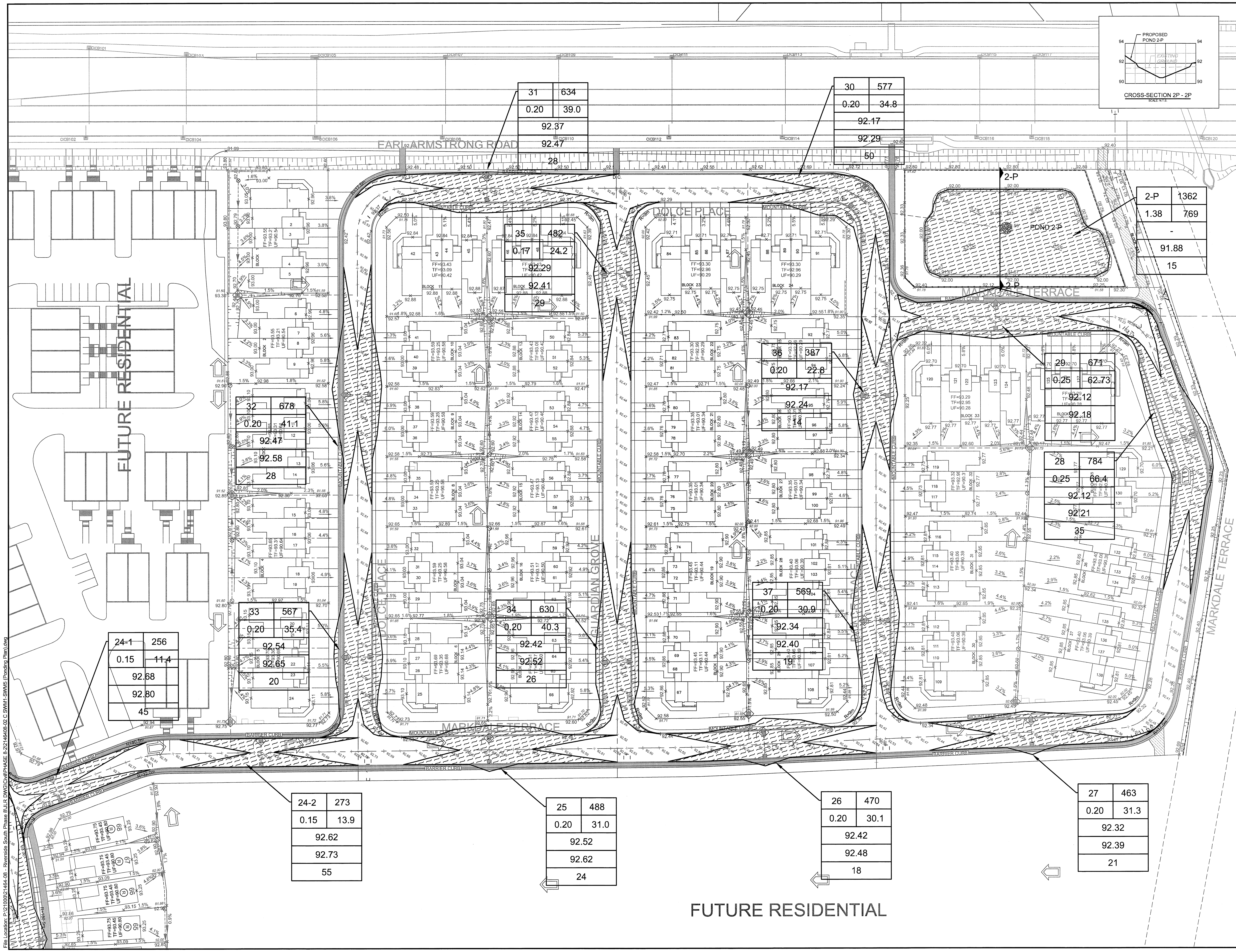
PART OF 980 EARL ARMSTRONG ROAD

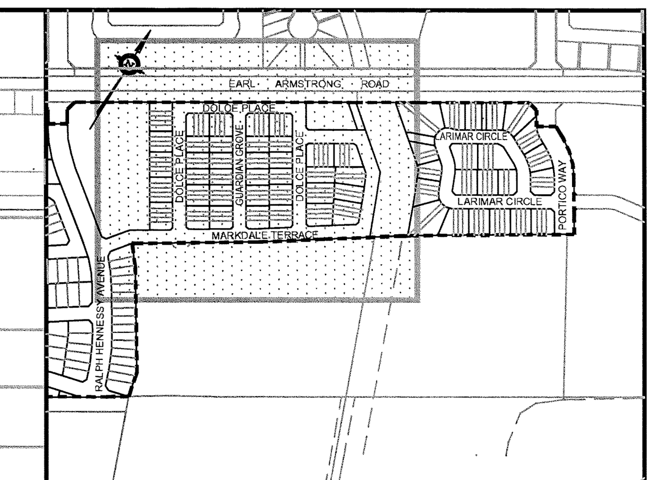
DRAWING:

PONDING PLAN

DESIGN:	C.S.		
DRAWN:	S.K.	DRAWING #:	
CHECKED:	L.D.		SWM3
JLR #:	21464-08		

PLOT DATE: June 29, 2016 8:59:56 AM





KEY PLAN, N.T.S.

LEGEND:

- MAX. WATER LEVEL (STATIC)
- PONDING DEPTH (STATIC)
- PONDING AREA NUMBER
- 100YR PONDING AREA (m²)
- PONDING VOLUME (100YR STATIC)
- MAX. WATER LEVEL (STATIC)
- MAX. WATER LEVEL (100YR STATIC + DYNAMIC)
- CAPTURE RATE (L/s)

9	352
0.20	26.5
92.07	
92.18	
20	

No.	ISSUE / REVISION	DD/MM/YY
10	ISSUED FOR FINAL CITY APPROVAL (MARKDALE) ISSUED FOR CONSTRUCTION	20/10/16
9	ISSUED TO CITY FOR REVIEW MARKDALE TERRACE REDESIGN	30/06/16
8	ISSUED FOR CONSTRUCTION REVISION TO TOWNHOUSE DRIVEWAYS	11/02/16
7	ISSUED FOR CONSTRUCTION	17/12/15
6	ISSUED TO CITY FOR REVIEW - 4TH SUBMISSION - ISSUED FOR TENDER	27/11/15
5	ISSUED TO CITY FOR REVIEW - 3RD SUBMISSION	14/10/15
4	ISSUED TO CITY FOR REVIEW - 2ND SUBMISSION	31/07/15
3	ISSUED TO CITY FOR REVIEW - REAR YARD BERM TO ACCOMMODATE NOISE WALL ADDENDUM	30/04/15
2	ISSUED TO CITY FOR REVIEW - 1ST SUBMISSION	05/03/15

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SCALE: 1:500

CLIENT:

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Riverside South Development Corporation (RSDC)
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Ottawa, ON
K1G 2H5
(613) 731-6331

CONSULTANT:

J.L.Richards
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CONSULTANT:

PROFESSIONAL STAMP

LICENSED PROFESSIONAL ENGINEER
K.R. FERREY MORENO
100122432
Oct 20, 2016
PROVINCE OF ONTARIO

PROJECT NORTH

PROJECT:

RIVERSIDE SOUTH DEVELOPMENT CORPORATION
RIVERSIDE SOUTH PHASE 8

PART OF 980 EARL ARMSTRONG ROAD

DRAWING:

PONDING PLAN

DESIGN:	C.S.	
DRAWN:	S.K.	DRAWING #:
CHECKED:	K.F.	SWM4
JLR #:	21464-08	

PLOT DATE: October 24, 2016 10:34:27 AM

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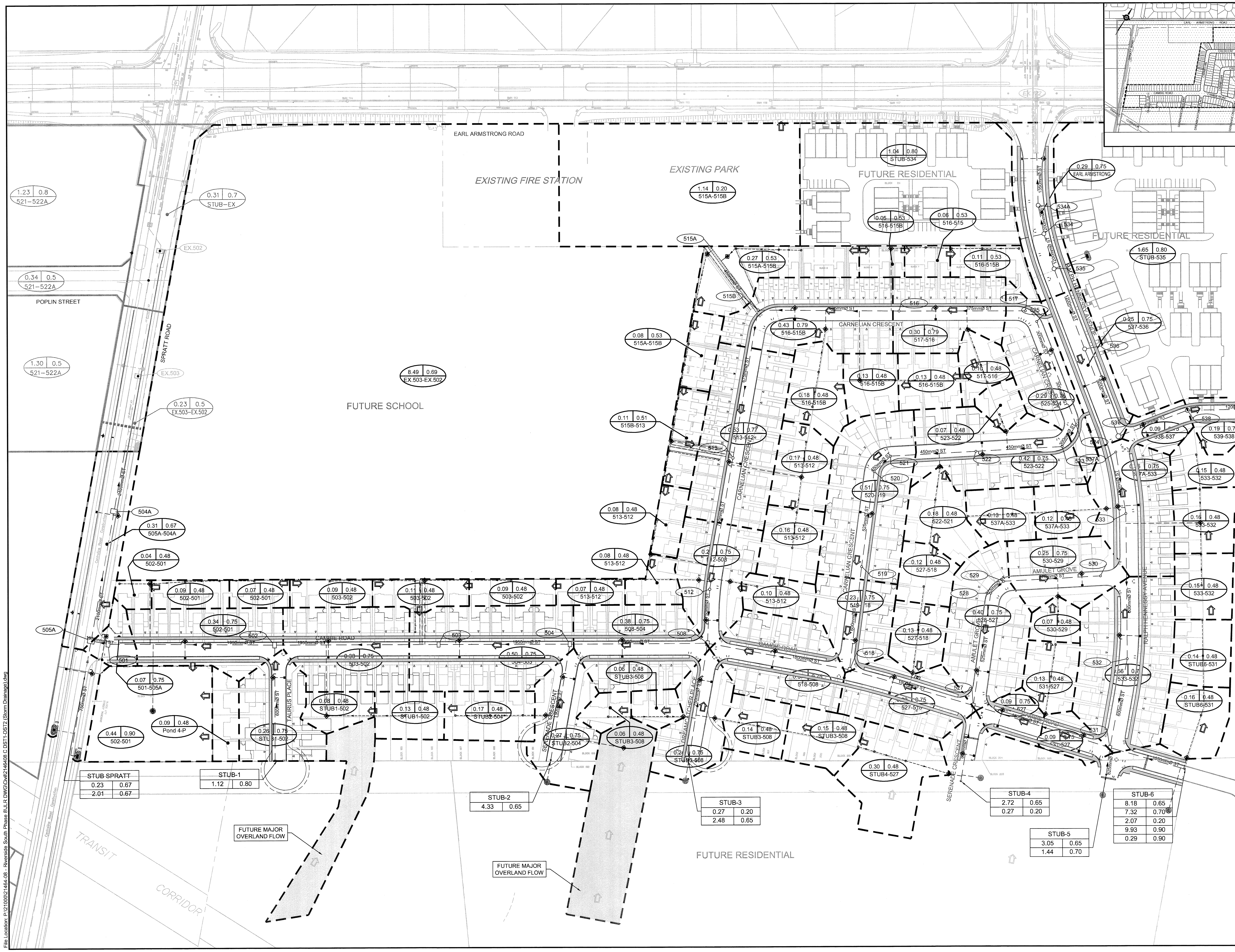

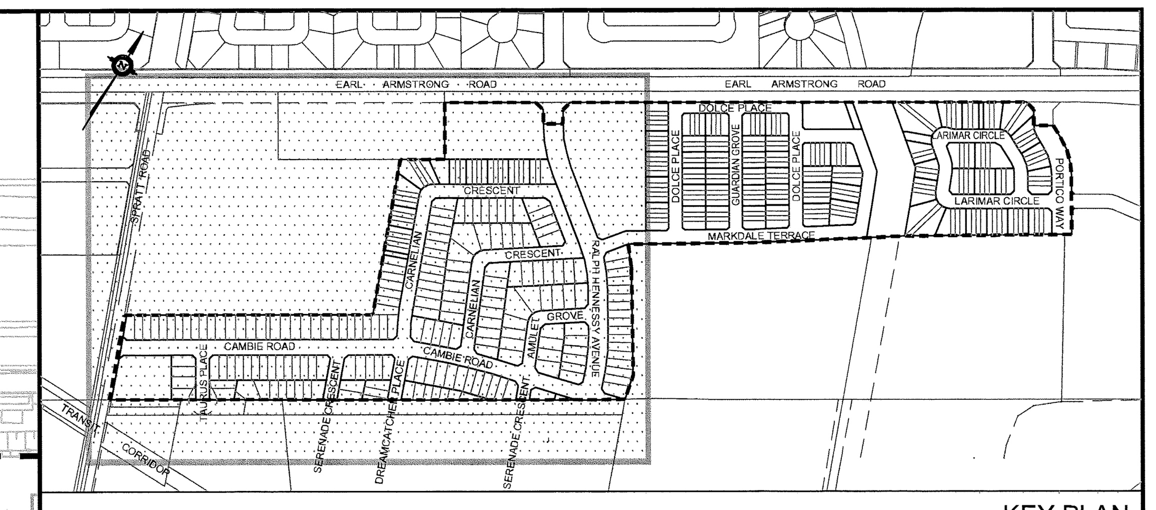

LEGEND:

DRAINAGE BOUNDARY

AREA IN HECTARES
RUNOFF COEFFICIENT
PIPE REACH UPSTREAM MAINTENANCE HOLE TO DOWNSTREAM MAINTENANCE HOLE

0.16	0.72
532-541	

PMH 509	
0.27	0.20
2.48	0.65

DESIGN SHEET/MODELING PLUG-FLOW LABEL
RUNOFF COEFFICIENT
TRIBUTARY AREAS IN HECTARES

No.	ISSUE / REVISION	DD/MM/YY
9	ISSUED TO CITY FOR REFERENCE FOR MARKDALE TERRACE REDESIGN	30/06/16
8	ISSUED FOR CONSTRUCTION REVISION TO TOWNHOUSE DRIVEWAYS	11/02/16
7	ISSUED FOR CONSTRUCTION	17/12/15
6	ISSUED TO CITY FOR REVIEW - 4TH SUBMISSION - ISSUED FOR TENDER	27/11/15
5	ISSUED TO CITY FOR REVIEW - 3RD SUBMISSION	14/10/15
4	ISSUED TO CITY FOR REVIEW - 2ND SUBMISSION	31/07/15
3	ISSUED TO CITY FOR REVIEW - REAR YARD BERM TO ACCOMMODATE NOISE WALL ADDENDUM	30/04/15
2	ISSUED TO CITY FOR REVIEW - 1ST SUBMISSION	05/03/15

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SCALE: 1:1000

CLIENT:
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Riverside South Development Corporation (RDSC)
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K1G 2H5
(613) 731-6331

CONSULTANT:
J.L.Richards
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CONSULTANT:

PROFESSIONAL STAMP
LICENSED PROFESSIONAL ENGINEER
K.R. FERREY MORENO
100122432
June 30, 2016
PROVINCE OF ONTARIO

PROJECT NORTH

PROJECT:
RIVERSIDE SOUTH DEVELOPMENT CORPORATION
RIVERSIDE SOUTH PHASE 8
PART OF 980 EARL ARMSTRONG ROAD

DRAWING:
STORM DRAINAGE PLAN

DESIGN:	C.S.		
DRAWN:	S.K.	DRAWING #:	DST1
CHECKED:	L.D.		
JLR #:	21464-08		

PLOT DATE: June 29, 2016 4:54:05 PM

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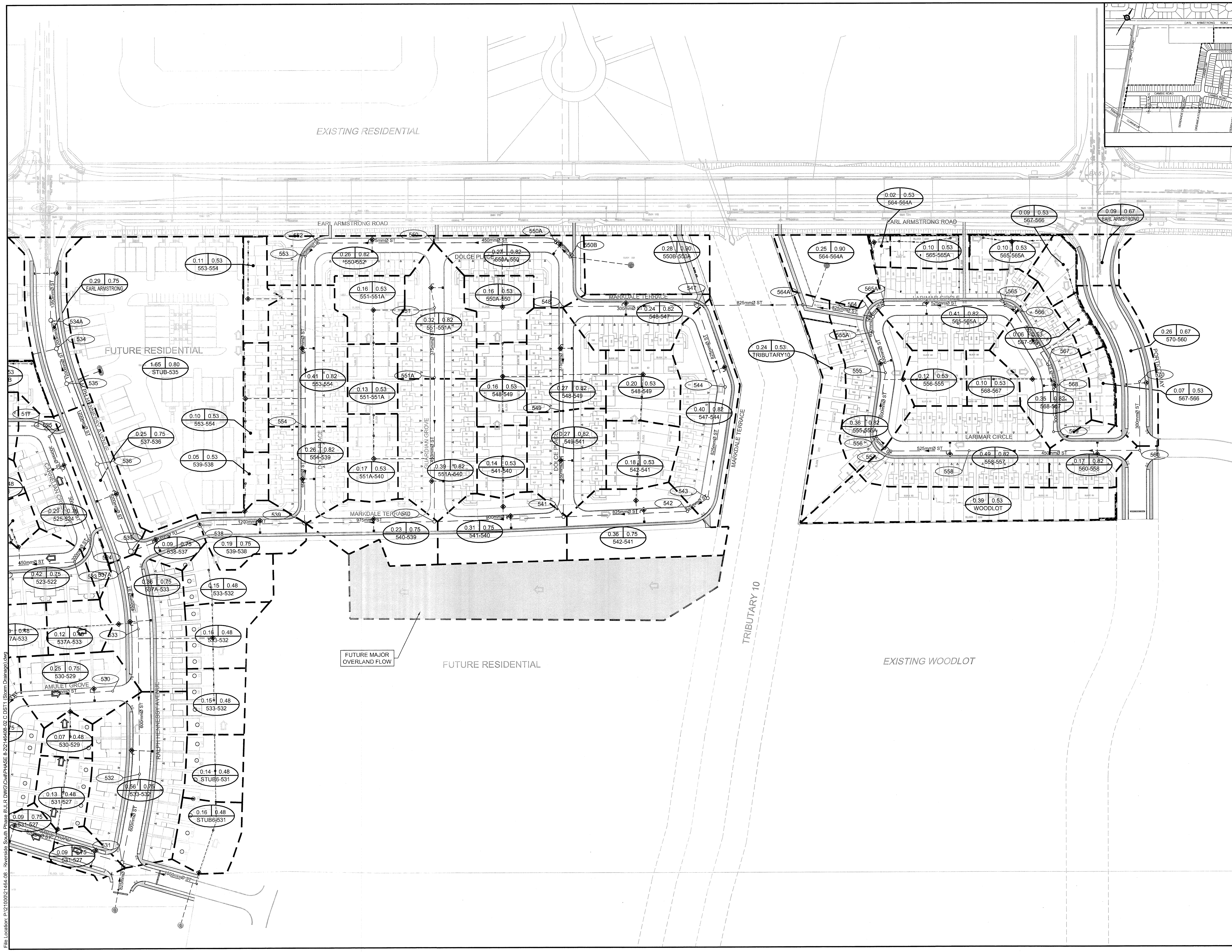

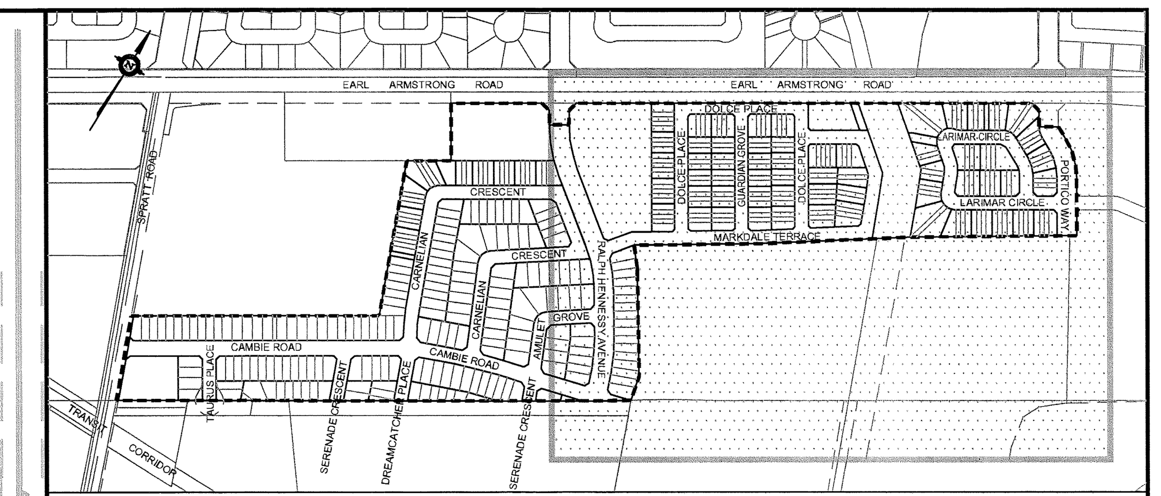

KEY PLAN

LEGEND:

DRAINAGE BOUNDARY

AREA IN HECTARES
RUNOFF COEFFICIENT
PIPE REACH UPSTREAM MAINTENANCE HOLE TO DOWNSTREAM MAINTENANCE HOLE

0.16	0.72
532-541	

DESIGN SHEET/MODELING PLUG-FLOW LABEL
RUNOFF COEFFICIENT
TRIBUTARY AREAS IN HECTARES

PMH 509	
0.27	0.20
2.48	0.65

No.	ISSUE / REVISION	DD/MM/YY
10	ISSUED FOR FINAL CITY APPROVAL (MARKDALE) ISSUED FOR CONSTRUCTION	20/10/16
9	ISSUED TO CITY FOR REVIEW MARKDALE TERRACE REDESIGN	30/06/16
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4	ISSUED TO CITY FOR REVIEW - 2ND SUBMISSION	31/07/15
3	ISSUED TO CITY FOR REVIEW - REAR YARD BERM TO ACCOMMODATE NOISE WALL ADDENDUM	30/04/15
2	ISSUED TO CITY FOR REVIEW - 1ST SUBMISSION	05/03/15

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SCALE: 1:1000

CLIENT:

Riverside South

Riverside South Development Corporation (RDSC)
2193 Arch Street
Ottawa, ON
K1G 2H5
(613) 731-6331

CONSULTANT:

J.L.Richards
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CONSULTANT:

PROFESSIONAL STAMP

LICENSED PROFESSIONAL ENGINEER
K.R. FERREY MORENO
100122432
Oct 20, 2016
PROVINCE OF ONTARIO

PROJECT NORTH

PROJECT:

RIVERSIDE SOUTH DEVELOPMENT CORPORATION
RIVERSIDE SOUTH PHASE 8

PART OF 980 EARL ARMSTRONG ROAD

DRAWING:

STORM DRAINAGE PLAN

DESIGN: C.S.
DRAWN: S.K.
CHECKED: K.F.
JLR #: 21464-08
DRAWING #: DST2

PLOT DATE: October 21, 2016 1:06:33 PM

Appendix C SANITARY SEWER CALCULATIONS

C.1 Sanitary Sewer Design Sheet

C.2 Sanitary Excerpts

C.1 SANITARY SEWER DESIGN SHEET

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

Stantec

SUBDIVISION: **Block 221**

DATE: 3/26/2020
REVISION: 1
DESIGNED BY: MJS
CHECKED BY: TR

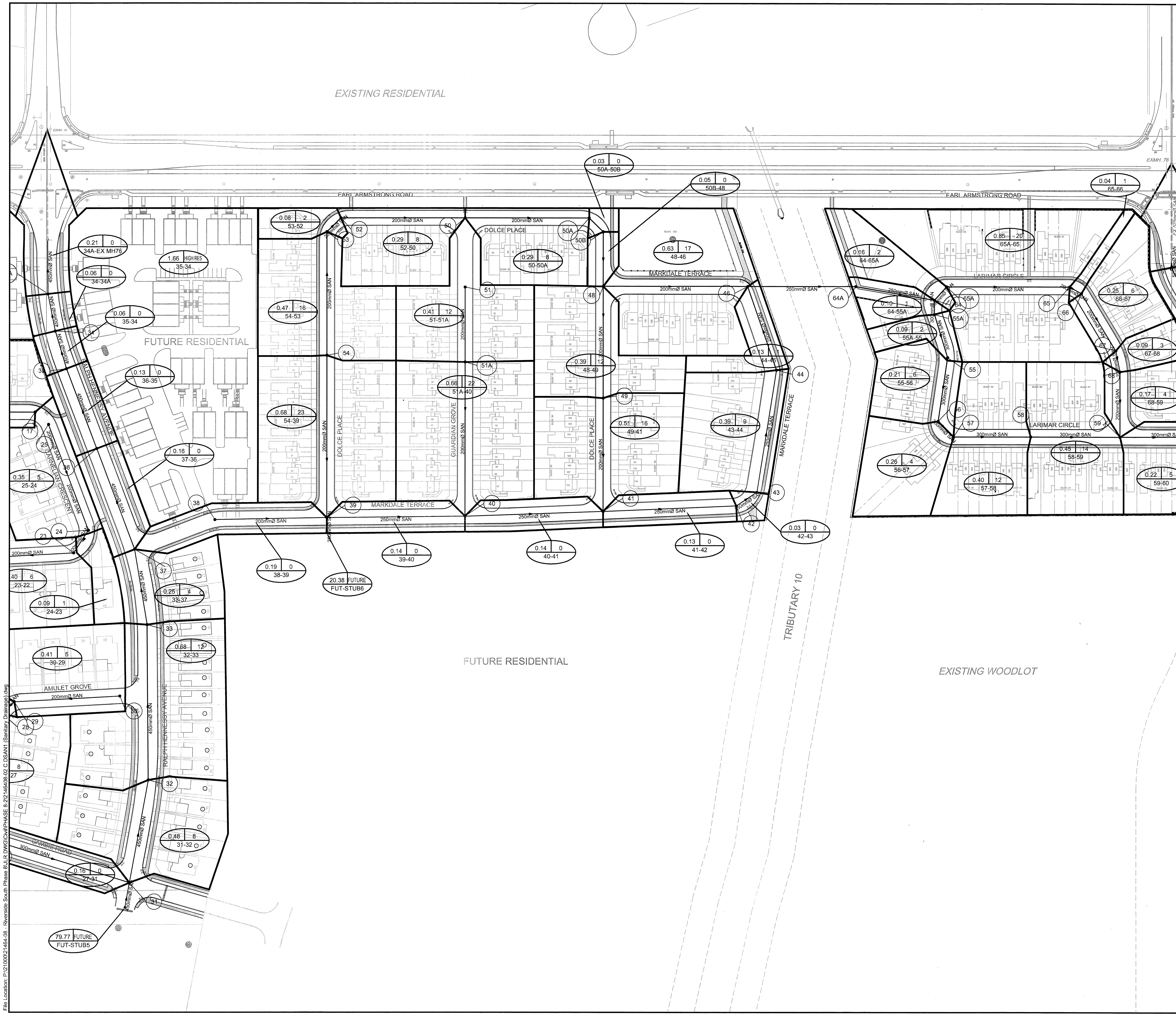
FILE NUMBER: 160401422

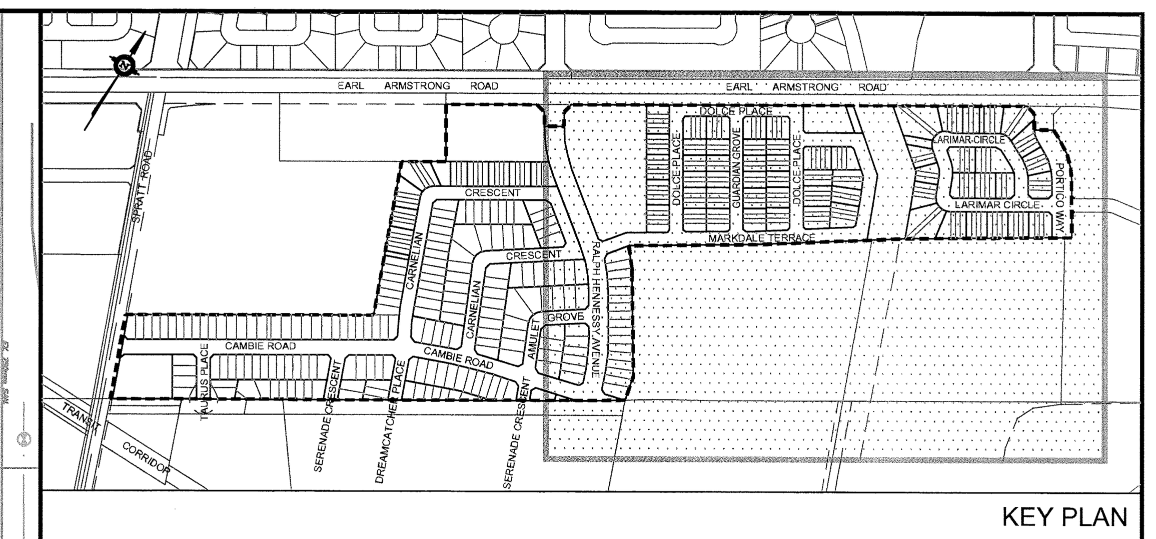
DESIGN PARAMETERS

MAX PEAK FACTOR (RES.)=	4.0	AVG. DAILY FLOW / PERSON	280 l/p/day	MINIMUM VELOCITY	0.60 m/s
MIN PEAK FACTOR (RES.)=	2.0	COMMERCIAL	28,000 l/ha/day	MAXIMUM VELOCITY	3.00 m/s
PEAKING FACTOR (INDUSTRIAL):	2.4	INDUSTRIAL (HEAVY)	55,000 l/ha/day	MANNINGS n	0.013
PEAKING FACTOR (ICI >20%):	1.5	INDUSTRIAL (LIGHT)	35,000 l/ha/day	BEDDING CLASS	B
PERSONS / SINGLE	3.4	INSTITUTIONAL	28,000 l/ha/day	MINIMUM COVER	2.50 m
PERSONS / TOWNHOME	2.7	INFILTRATION	0.33 l/s/Ha	HARMON CORRECTION FACTOR	0.8
PERSONS / APARTMENT	1.8				

LOCATION			RESIDENTIAL AREA AND POPULATION									COMMERCIAL		INDUSTRIAL (L)		INDUSTRIAL (H)		INSTITUTIONAL		GREEN / UNUSED		C+I+I	INFILTRATION			TOTAL	PIPE								
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (ha)	UNITS SINGLE	UNITS TOWN	UNITS APT	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	FLOW (l/s)	LENGTH (m)	DIA (mm)	MATERIAL	CLASS	SLOPE (%)	CAP. (FULL) (l/s)	CAP. V PEAK FLOW (%)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
R2A	2	1	0.14	0	14	0	38	0.14	38	3.67	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.14	0.14	0.0	0.5	97.0	200	PVC	SDR 35	0.50	23.6	**2.10%**	0.74	0.26
R13A	13	12	0.11	0	8	0	22	0.11	22	3.70	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.11	0.11	0.0	0.3	30.0	200	PVC	SDR 35	0.65	27.0	**1.09%**	0.85	0.24
R15A	15	14	0.07	0	4	0	11	0.07	11	3.73	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.07	0.07	0.0	0.2	30.0	200	PVC	SDR 35	0.65	27.0	**0.57%**	0.85	0.18
R14A	14	12	0.08	0	4	0	11	0.16	22	3.70	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.08	0.16	0.1	0.3	33.6	200	PVC	SDR 35	0.65	27.0	**1.15%**	0.85	0.24
R12A	12	5	0.07	0	4	0	11	0.33	54	3.65	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.07	0.33	0.1	0.7	35.3	200	PVC	SDR 35	0.50	23.6	**3.16%**	0.74	0.28
R11A	11	10	0.04	0	3	0	8	0.04	8	3.74	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.04	0.04	0.0	0.1	26.2	200	PVC	SDR 35	0.65	27.0	**0.41%**	0.85	0.18
R10A	10	9	0.11	0	5	0	14	0.15	22	3.70	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.11	0.15	0.0	0.3	34.2	200	PVC	SDR 35	0.65	27.0	**1.14%**	0.85	0.24
R18A	18	9	0.12	0	8	0	22	0.12	22	3.70	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.12	0.12	0.0	0.3	39.5	200	PVC	SDR 35	0.50	23.6	**1.26%**	0.74	0.21
R9A	9	8	0.11	0	5	0	14	0.37	57	3.64	0.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.11	0.37	0.1	0.8	37.2	200	PVC	SDR 35	0.50	23.6	**3.35%**	0.74	0.28
R17A	17	8	0.16	0	11	0	30	0.16	30	3.68	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.16	0.16	0.1	0.4	53.4	200	PVC	SDR 35	0.50	23.6	**1.72%**	0.74	0.24
R8A	8	7	0.11	0	5	0	14	0.65	100	3.59	1.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.11	0.65	0.2	1.4	36.7	200	PVC	SDR 35	0.50	23.6	**5.83%**	0.74	0.34
R16A	16	7	0.21	0	14	0	38	0.21	38	3.67	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.21	0.21	0.1	0.5	59.1	200	PVC	SDR 35	0.50	23.6	**2.20%**	0.74	0.26
R7A	7	5	0.07	0	4	0	11	0.93	149	3.55	1.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.07	0.93	0.3	2.0	33.1	200	PVC	SDR 35	0.50	23.6	**8.54%**	0.74	0.38
R6A	6	5	0.16	0	4	0	11	0.16	11	3.73	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.16	0.16	0.1	0.2	30.0	200	PVC	SDR 35	0.65	27.0	**0.68%**	0.85	0.21
R5A	5	4	0.04	0	0	0	0	1.47	213	3.51	2.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.04	1.47	0.5	2.9	32.7	200	PVC	SDR 35	0.50	23.6	**12.31%**	0.74	0.42
R4A	4	3	0.04	0	5	0	14	1.51	227	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.04	1.51	0.5	3.1	37.6	200	PVC	SDR 35	0.50	23.6	**12.99%**	0.74	0.42
R3A	3	1	0.00	0	0	0	0	1.51	227	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	1.51	0.5	3.1	8.3	200	PVC	SDR 35	1.00	33.4	**9.19%**	1.05	0.55
	1	35	0.00	0	0	0	0	1.65	265	3.48	3.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	1.65	0.5	3.5	14.5	200	PVC	SDR 35	0.32	18.9	**18.66%**	0.60	0.38
																												200							

C.2 SANITARY EXCERPTS





KEY PLAN

LEGEND:

DRAINAGE BOUNDARY

AREA IN HECTARES

NUMBER OF UNITS

PIPE REACH UPSTREAM MAINTENANCE HOLE TO DOWNSTREAM MAINTENANCE HOLE

No.	ISSUE / REVISION	DD/MM/YY
10	ISSUED FOR FINAL CITY APPROVAL (MARKDALE) ISSUED FOR CONSTRUCTION	20/10/16
9	ISSUED TO CITY FOR REVIEW MARKDALE TERRACE REDESIGN	30/06/16
8	ISSUED FOR CONSTRUCTION REVISION TO TOWNHOUSE DRIVEWAYS	11/02/16
7	ISSUED FOR CONSTRUCTION	17/12/15
6	ISSUED TO CITY FOR REVIEW - 4TH SUBMISSION - ISSUED FOR TENDER	27/11/15
5	ISSUED TO CITY FOR REVIEW - 3RD SUBMISSION	14/10/15
4	ISSUED TO CITY FOR REVIEW - 2ND SUBMISSION	31/07/15
3	ISSUED TO CITY FOR REVIEW - REAR YARD BERM TO ACCOMMODATE NOISE WALL ADDENDUM	30/04/15
2	ISSUED TO CITY FOR REVIEW - 1ST SUBMISSION	05/03/15

VERIFY SHEET SIZE AND SCALES. BAR TO THE RIGHT IS 25mm IF THIS IS A FULL SIZE DRAWING. 0 25mm

SCALE: 1:1000

CLIENT:

Riverside South

Riverside South Development Corporation (RDSC)
2193 Arch Street
Ottawa, ON
K1G 2H5
(613) 731-6331

CONSULTANT:

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS
www.jlrichards.ca

CONSULTANT:

PROFESSIONAL STAMP

LICENSED PROFESSIONAL ENGINEER
K.R. FERREY MORENO
100122432
Oct 20, 2016
PROVINCE OF ONTARIO

PROJECT NORTH

PROJECT:

RIVERSIDE SOUTH DEVELOPMENT CORPORATION
RIVERSIDE SOUTH PHASE 8

PART OF 980 EARL ARMSTRONG ROAD

DRAWING:

SANITARY DRAINAGE PLAN

DESIGN: C.S.
DRAWN: S.K.
CHECKED: K.F.
JLR #: 21464-08

DRAWING #: DSAN2

PLOT DATE: October 24, 2016 10:49:02 AM

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

RIVERSIDE SOUTH PHASE 8

Part of 980 Earl Armstrong Road

CITY OF OTTAWA

RIVERSIDE SOUTH DEVELOPMENT CORPORATION

JLR No. 21464-08

SANITARY SEWER DESIGN SHEET

Designed by: H.M./J.W.
Checked by: K.F./L.D.

Date : October 2016

Low Density	3.2 pers/unit;	22	unit/ha*	Average Residential Flow =	350	L/cap/day
Medium Density	2.4 pers/unit;	38	unit/ha*	Infiltration =	0.280	L/s/ha
High Density	1.9 pers/unit;	60	unit/ha	Inst./ Commercial =	50000	L/ha/day
* Note as per the RSCISSU, populations for low and medium densities are based on 70% of the total area				Manning's Coeff. N =	0.013	

Denotes Future External Lands

STREET	M.H. # FR.	M.H. # TO	NUMBER OF UNITS SING.	NUMBER OF UNITS MULT.	NUMBER OF UNITS HIGH DENS.	NUMBER OF UNITS AREA ha	LOW Area	LOW Pop.	LOW Cumm. Pop.	MEDIUM Area	MEDIUM Pop.	MEDIUM Cumm. Pop.	HIGH Area	HIGH Pop.	HIGH Cumm. Pop.	TOTAL AREA ha	TOTAL POPUL. Peop.	CUMULATIVE AREA ha	CUMULATIVE POPUL. peop.	PEAKING FACTOR	RES. FLOW l/s	INSTITUTIONAL / COMMERICAL AREA ha	CUMM. AREA ha	INST./ COMM. FLOW l/s	PARK / ROAD AREA ha	CUMM. AREA ha	INFILTRATION AREA ha	CUMM. AREA ha	PEAK EXTR. l/s	PEAK DES. l/s	SEWER DATA DIA. mm	SLOPE %	CAPAC. l/s	VEL. m/s	LENGTH m	RESIDUAL CAP. l/s	UPSTREAM Center Line	UPSTREAM Obvert	UPSTREAM Invert	UPSTREAM Cover	DOWNSTREAM Center Line	DOWNSTREAM Obvert Drop	DOWNSTREAM Obvert	DOWNSTREAM Invert	DOWNSTREAM Cover
OUTLET TO EX SAN MH 2 ON SPRATT ROAD																																													
Spratt Road	EXT	Stub8					74.04	3649	3649	43.97	2807	2807	3.35	382	382	121.36	6,838	121.36	6,838	3.12	86.32	11.09	11.09	9.63	14.54	14.54	146.99	146.99	41.16	137.11															
Spratt Road	Stub8	1A							3649			2807			382	0.00	0	121.36	6,838	3.12	86.32		11.09	9.63		14.54	0.00	146.99	41.16	137.11	525	0.12	155.4	0.70	18.2	18.31	92.01	87.176	86.643	4.83	91.63		87.154	86.621	4.48
Spratt Road	1A	3A							3649			2807			382	0.00	0	121.36	6,838	3.12	86.32		11.09	9.63	0.30	14.84	0.30	147.29	41.24	137.19	525	0.12	155.4	0.70	115.0	18.23	91.63	87.154	86.621	4.48	91.40		87.016	86.483	4.38
Spratt Road	3A	EX 2							3649			2807			382	0.00	0	121.36	6,838	3.12	86.32		11.09	9.63	0.29	15.13	0.29	147.58	41.32	**137.27**	525	0.14	167.9	0.75	114.8	30.60	91.40	87.016	86.483	4.38	91.35		86.855	86.322	4.49
																																											EX 2	86.322	
OUTLET TO EX SAN MH 76 ON SHORELINE DRIVE																																													
Cambie Road	1	2	9			0.97			0			0			0	0.97	29	0.97	29	4.00	0.47		0.00	0.00		0.00	0.97	0.97	0.27	0.74	200	0.65	27.6	0.85	100.5	26.85	91.54	89.253	89.050	2.29	91.62		88.600	88.397	3.02
Taurus Place (External)	EXT	Stub1							0			0	1.12	128	128	1.12	128	1.12	128	4.00	2.07		0.00	0.00		0.00	1.12	1.12	0.31	2.38															
Taurus Place	Stub1	2	7			0.39			0			0			128	0.39	22	1.51	150	4.00	2.43		0.00	0.00		0.00	0.39	1.51	0.42	2.85	200	0.35	20.2	0.62	69.1	17.39	91.80	88.901	88.698	2.90	91.62	0.060	88.660	88.457	2.96
Cambie Road	2	3	17			0.84			0			0			128	0.84	54	3.32	233	4.00	3.78		0.00	0.00		0.00	0.84	3.32	0.93	4.71	200	0.35	20.2	0.62	96.5	15.53	91.62	88.600	88.397	3.02	91.64		88.262	88.059	3.38
Cambie Road	3	4	12			0.66			0			0			128	0.66	38	3.98	272	4.00	4.40		0.00	0.00		0.00	0.66	3.98	1.11	5.52	200	0.35	20.2	0.62	86.3	14.73	91.64	88.262	88.059	3.38	91.93		87.960	87.757	3.97
Serenade Crescent (External)	EXT	Stub2					2.71	134	134			0			0	2.71	134	2.71	134	4.00	2.16		0.00	0.00		0.00	2.71	2.71	0.76	2.92															
Serenade Crescent	Stub2	4	3**			0.28			134			0			0	0.28	10	2.99	143	4.00	2.32		0.00	0.00		0.00	0.28	2.99	0.84	3.16	200	0.35	20.2	0.62	86.4	17.09	92.28	88.653	88.450	3.63	91.93	0.390	88.350	88.147	3.58
Cambie Road	4	8	12			0.64			134			0			128	0.64	38	7.61	453	4.00	7.34		0.00	0.00		0.00	0.64	7.61	2.13	9.47	200	0.35	20.2	0.62	85.1	10.78	91.93	87.960	87.757	3.97	91.97		87.662	87.459	4.31
Dreamcatcher Place (External)	EXT	Stub3					3.65	180	180			0			0	3.65	180	3.65	180	4.00	2.91		0.00	0.00	0.27	0.27	3.92	3.92	1.10	4.01															
Dreamcatcher Place	Stub3	8	3**			0.25			180			0			0	0.25	10	3.90	189	4.00	3.07		0.00	0.00		0.27	0.25	4.17	1.17	4.24	200	0.35	20.2	0.62	84.9	15.98	92.60	88.379	88.176	4.22	91.97	0.420	88.082	87.879	3.89
Carnelian Crescent	17	16	4	11		0.59			0			0			0	0.59	39	0.59	39	4.00	0.64		0.00	0.00		0.00	0.59	0.59	0.17	0.80	200	0.35	20.2	0.62	78.2	19.44	92.48	89.880	89.677	2.60	92.44		89.606	89.403	2.83
Carnelian Crescent	16	15	4	11		0.55			0			0			0	0.55	39	1.14	78	4.00	1.27	1.14	1.14	0.99		0.00	1.69	2.28	0.64	2.90	200	0.35	20.2	0.62	78.2	17.34	92.44	89.606	89.403	2.83	92.23	0.030	89.333	89.129	2.90
Carnelian Crescent	15	14		2		0.20			0			0			0	0.20	5	1.34	83	4.00	1.35		1.14	0.99		0.00	0.20	2.48	0.69	3.03	200	0.35	20.2	0.62	9.8	17.21	92.23	89.303	89.099	2.93	92.28	0.030	89.269	89.065	3.01
Carnelian Crescent	14	13	7	12		0.68			0			0			0	0.68	51	2.02	134	4.00	2.18		1.14	0.99		0.00	0.68	3.16	0.88	4.05	200	0.35	20.2	0.62	82.2	16.19	92.28	89.239	89.035	3.04	92.00		88.951	88.748	3.05
Carnelian Crescent	13	12	14			0.71			0			0			0	0.71	45	2.73	179	4.00	2.90		1.14	0.99		0.00	0.71	3.87	1.08	4.98	200	0.35	20.2	0.62	82.2	15.27	92.00	88.951	88.748	3.05	92.00		88.663	88.460	3.34
Carnelian Crescent	12	8				0.06			0			0			0	0.06	0	2.79	179	4.00	2.90		1.14	0.99		0.00	0.06	3.93	1.10	4.99	200	0.35	20.2	0.62	37.8	15.25	92.00	88.663	88.460	3.34	91.97	0.868	88.531	88.327	3.44
Cambie Road	8	18	10			0.60			313			0			128	0.60	32	14.90	854	3.84	13.29		1.14	0.99		0.27	0.60	16.31	4.57	18.85	250	0.35	36.7	0.72	84.4	17.85	91.97	87.662	87.408	4.31	92.16		87.367	87.113	4.79
Carnelian Crescent	25	24	5			0.35			0			0			0	0.35	16	0.35	16	4.00	0.26		0.00	0.00		0.00	0.35	0.35	0.10	0.36	200	0.65	27.6	0.85	69.0	27.23	92.44	90.083	89.880	2.36	92.60	0.030	89.635	89.432	2.97
Carnelian Crescent	24	23	1			0.09			0			0			0	0.09	3	0.44	19	4.00	0.31		0.00	0.00		0.00	0.09	0.44	0.12	0.43	200	0.35	20.2	0.62	14.5	19.81	92.60	89.605	89.402	3.00	92.60	0.030	89.554	89.351	3.05
Carnelian Crescent	23	22	6			0.40			0			0			0	0.40	19	0.84	38	4.00	0.62		0.00	0.00		0.00	0.40	0.84	0.24	0.86	200	0.35	20.2	0.62	54.5	19.39	92.60	89.524	89.321	3.08	92.27		89.334	89.130	2.94
Carnelian Crescent	22	21	5			0.36			0			0			0	0.36	16	1.20	54	4.00	0.88		0.00	0.00		0.00	0.36	1.20	0.34	1.22	200	0.35	20.2	0.62	52.8	19.03	92.27	89.334	89.130	2.94	92.35	0.030	89.149	88.945	3.20
Carnelian Crescent	21	20	2			0.20			0			0			0	0.20	6	1.40	61	4.00	0.99		0.00	0.00		0.00	0.20	1.40	0.39	1.38	200	0.35	20.2	0.62	13.4	18.87	92.35	89.119	88.915	3.23	92.26	0.030	89.072	88.868	3.19
Carnelian Crescent	20	19	9			0.53			0			0			0	0.53	29	1.93	90	4.00	1.45		0.00	0.00		0.00	0.53	1.93	0.54	1.99	200	0.35	20.2	0.62	62.3	18.25	92.26	89.042	88.838	3.22	92.26		88.823	88.620	3.44
Carnelian Crescent	19	18	6			0.37			0			0			0	0.37	19	2.30	109	4.00	1.76		0.00	0.00		0.00	0.37	2.30	0.64	2.41	200	0.35	20.2	0.62	64.9	17.84	92.26	88.823	88.620	3.44	92.16	1.229	88.596	88.393	3.56
Cambie Road	18	27	7**			0.43			313			0			128	0.43	22	17.63	985	3.80	15.18		1.14	0.99		0.27	0.43	19.04	5.33	21.50	300	0.20	45.1	0.62	84.2	23.61	92.16	87.367	87.062	4.79	92.56		87.199	86.894	5.36
Serenade Crescent (External)	EXT	Stub 4					1.01	50	50			0			0	1.01	50	1.01	50	4.00	0.81		0.00	0.00	0.27	0.27	1.28	1.28	0.36	1.16															
Serenade Crescent	Stub 4	27							50			0			0	0.00	0	1.01	50	4.00	0.81		0.00	0.00		0.27	0.00	1.28	0.36	1.16	200	0.35	20.2	0.62	31.4	19.08	92.41	87.931	87.728	4.48	92.56	0.622	87.821	87.618	4.74
Amulet Grove	30	29	5			0.41			0			0			0	0.41	16	0.41	16	4.00	0.26		0.00	0.00		0.00	0.41	0.41	0.11	0.37	200	0.65	27.6	0.85	61.2	27.21	92.87	90.402	90.199	2.47	93.12	0.030	90.005	89.802	3.12
Amulet Grove	29	28	1			0.11			0			0			0	0.11	3	0.52	19	4.00	0.31		0.00	0.00		0.00	0.11	0.52	0.15	0.46	200	0.35	20.2	0.62	9.8	19.79	93.12	89.975	89.772	3.15	92.72	0.030	89.941	89.737	2.78
Amulet Grove	28	27	8			0.55			0			0			0	0.55	26	1.07	45	4.00	0.73		0.00	0.00		0.00	0.55	1.07	0.30	1.03	200	0.35	20.2	0.62	72.6	19.22	92.98	89.911	89.707	3.07	92.56	2.458	89.657	89.454	2.90
Cambie Road	27	31				0.16			363			0			128	0.16	0	19.87	1,080	3.78	16.53		1.14	0.99		0.54	0.16	21.55	6.03	23.55	300	0.20	45.1	0.62	88.6	21.57	92.56	87.199	86.894	5.36	93.30	0.568	87.021	86.717	6.28
Ralph Hennessy (External)	EXT	Stub 5					48.46	2388	2388	18.46	1178	1178			0	66.92	3,567	66.92	3,567	3.38	48.80	3.43	3.43	2.98	9.42	9.42	79.77	79.77	22.34	74.11															
Ralph Hennessy	Stub 5	31							2388			1178			0	0.00	0	66.92	3,567	3.38	48.80		3.43	2.98		9.42	0.00	79.77	22.34	74.11	450	0.17	122.6	0.75	14.8	48.52	93.28	86.479	86.022	6.80	93.30		86.454	85.997	6.85
Ralph Hennessy	31	32	8			0.48			2751			1178			128	0.48	26	87.27	4,672	3.27	61.93		4.57	3.97		9.96	0.48	101.80	28.50	94.40	450	0.17	122.6	0.75	60.4	28.24	93.30	86.454	85.997	6.85	92.96		86.351	85.894	6.61
Ralph Hennessy	32	33	12			0.68			2751			1178			128	0.68	38	87.95	4,710	3.27	62.37		4.57	3.97		9.96	0.68	102.48	28.69	95.04	450	0.17	122.6	0.75	89.9	27.60	92.96	86.351	85.894	6.61	92.72		86.198	85.741	6.52
Ralph Hennessy	33	37	4			0.25			2751			1178			128	0.25	13	88.20	4,723	3.27	62.52		4.57	3.97		9.96	0.25	102.73	28.76	95.25	450	0.17	122.6	0.75	44.1	27.38	92.72	86.198	85.741	6.52	92.87		86.123	85.666	6.75
Ralph Hennessy	37	36				0.16			2751			1178			128	0.16	0	88.36	4,723	3.27	62.52		4.57	3.97		9.96	0.16	102.89	28.81	95.30	450	0.17	122.6	0.75	62.1	27.34	92.87	86.123	85.666	6.75	92.82		86.018	85.561	6.80
Ralph Hennessy	36	35				0.13			2751			1178			128	0.13	0	88.49	4,723	3.27	62.52		4.57	3.97		9.96	0.13	103.02	28.85	95.34	450	0.17	122.6	0.75	49.5	27.30	92.82	86.018	85.561	6.80	92.86		85.934	85.476	6.93
Ralph Hennessy	Stub	35							2751			1178	1.66	189	189	1.66	189	1.66	189	4.00	3.07		0.00	0.00		0.00	1.66	1.66	0.46	3.53	200	0.32	19.4	0.60	13.1	15.82	92.86	88.042	87.838	4.82	92.86	2.066	88.000	87.796	4.86
Ralph Hennessy	35	34				0.06			2751			1178			317	0.06	0	90.21	4,912	3.25	64.72		4.57	3.97		9.96	0.06	104.74	29.33	98.01	450	0.17	122.6	0.75	22.8	24.63	92.86	85.934	85.476	6.93	92.63		85.895	85.438	6.74
Ralph Hennessy	Stub	34							2751			1178	1.04	119	119	1.04	119	1.04	119	4.00	1.92		0.00	0.00		0.00	1.04	1.04	0.29	2.21	200	0.32	19.4	0.60	13.2	17.14	92.63	88.042	87.839	4.59	92.63	2.105	88.000	87.797	4.63
Ralph Hennessy	34	34A				0.06			2751			1178			435	0.06	0	91.31	5,031	3.24	66.08		4.57	3.97		9.96	0.06	105.84	29.64	99.68	450	0.17	122.6	0.75	22.0	22.95	92.63	85.895	85.438	6.74	92.42		85.858	85.400	6.56
Ralph Hennessy	34A	EX 76				0.21			2751			1178			435	0.21	0	91.52	5,031	3.24	66.08		4.57	3.97		9.96	0.21	106.05	29.69	**99.74**	450	0.20	133.0	0.81	95.2	33.27	92.42	85.858	85.400	6.56	91.74		85.667	85.210	6.07
																																											EX 76	85.210	

J.L.Richards
ENGINEERS · ARCHITECTS · PLANNERS

RIVERSIDE SOUTH PHASE 8

Part of 980 Earl Armstrong Road

CITY OF OTTAWA

RIVERSIDE SOUTH DEVELOPMENT CORPORATION

JLR No. 21464-08

SANITARY SEWER DESIGN SHEET

Designed by: H.M./J.W.
Checked by: K.F./L.D.

Date : October 2016

Low Density	3.2	pers/unit;	22	unit/ha*	Average Residential Flow =	350	L/cap/day
Medium Density	2.4	pers/unit;	38	unit/ha*	Infiltration =	0.280	L/s/ha
High Density	1.9	pers/unit;	60	unit/ha	Inst./ Commercial =	50000	L/ha/day
* Note as per the RSCISSU, populations for low and medium densities are based on 70% of the total area					Manning's Coeff. N =	0.013	

Denotes Future External Lands (shaded)

OUTLET TO EX SAN MH 51 ON CANYON WALK DRIVE

STREET	M.H. # FR.	M.H. # TO	RESIDENTIAL NUMBER OF UNITS SING.	MULT.	HIGH DENS.	AREA ha	LOW Area	LOW Pop.	LOW Cumm. Pop.	MEDIUM Area	MEDIUM Pop.	MEDIUM Cumm. Pop.	HIGH Area	HIGH Pop.	HIGH Cumm. Pop.	TOTAL AREA ha	TOTAL POPUL. Peop.	CUMULATIVE AREA ha	CUMULATIVE POPUL. peop.	PEAKING FACTOR	RES. FLOW l/s
Future Street	EXT	Stub 6					9.23	455	455	7.59	485	485			0	16.82	939	16.82	939	3.82	14.53
Future Street	Stub 6	39							455			485			0	0.00	0	16.82	939	3.82	14.53
Markdale Terrace	38	39				0.19			0			0			0	0.19	0	0.19	0	4.00	0.00
Dolce Place	54	39		23		0.68			0			0			0	0.68	55	0.68	55	4.00	0.89
Markdale Terrace	39	40				0.14			455			485			0	0.14	0	17.83	995	3.80	15.32
Guardian Grove	51	51A		12		0.41			0			0			0	0.41	29	0.41	29	4.00	0.47
Guardian Grove	51A	40		22		0.66			0			0			0	0.66	53	1.07	82	4.00	1.32
Markdale Terrace	40	41				0.14			455			485			0	0.14	0	19.04	1,076	3.78	16.48
Dolce Place	48	49		12		0.39			0			0			0	0.39	29	0.39	29	4.00	0.47
Dolce Place	49	41		16		0.51			0			0			0	0.51	38	0.90	67	4.00	1.09
Markdale Terrace	41	42				0.13			455			485			0	0.13	0	20.07	1,143	3.76	17.42
Markdale Terrace	42	43				0.03			455			485			0	0.03	0	20.10	1,143	3.76	17.42
Markdale Terrace	43	44		9		0.39			455			485			0	0.39	22	20.49	1,165	3.76	17.73
Markdale Terrace	44	46		1		0.13			455			485			0	0.13	2	20.62	1,167	3.76	17.76
Dolce Place	54	53		16		0.47			0			0			0	0.47	38	0.47	38	4.00	0.62
Dolce Place	53	52		2		0.08			0			0			0	0.08	5	0.55	43	4.00	0.70
Dolce Place	52	50		8		0.29			0			0			0	0.29	19	0.84	62	4.00	1.01
Dolce Place	50	50A		8		0.29			0			0			0	0.29	19	1.13	82	4.00	1.32
Dolce Place	50A	50B				0.03			0			0			0	0.03	0	1.16	82	4.00	1.32
Dolce Place	50B	48				0.05			0			0			0	0.05	0	1.21	82	4.00	1.32
Markdale Terrace	48	46		17		0.63			0			0			0	0.63	41	1.84	122	4.00	1.98
Block 223 Crossing	46	64A							455			485			0	0.00	0	22.46	1,290	3.73	19.47
Block 223 Crossing	64A	64							455			485			0	0.00	0	22.46	1,290	3.73	19.47
Larimar Circle	64	55A		1		0.10			455			485			0	0.10	2	22.56	1,292	3.73	19.50
Larimar Circle	55A	55		2		0.09			455			485			0	0.09	5	22.65	1,297	3.72	19.57
Larimar Circle	55	56		6		0.21			455			485			0	0.21	14	22.86	1,311	3.72	19.77
Larimar Circle	56	57		4		0.26			455			485			0	0.26	10	23.12	1,321	3.72	19.90
Larimar Circle	57	58		12		0.40			455			485			0	0.40	29	23.52	1,350	3.71	20.30
Larimar Circle	58	59		14		0.45			455			485			0	0.45	34	23.97	1,383	3.70	20.76
Larimar Circle	64	65A		2		0.16			0			0			0	0.16	5	0.16	5	4.00	0.08
Larimar Circle	65A	65		20		0.85			0			0			0	0.85	48	1.01	53	4.00	0.86
Larimar Circle	65	66		1		0.04			0			0			0	0.04	2	1.05	55	4.00	0.89
Larimar Circle	66	67		6		0.25			0			0			0	0.25	14	1.30	70	4.00	1.13
Larimar Circle	67	68		3		0.09			0			0			0	0.09	7	1.39	77	4.00	1.24
Larimar Circle	68	59		4		0.17			0			0			0	0.17	10	1.56	86	4.00	1.40
Larimar Circle	59	60		5		0.22			455			485			0	0.22	12	25.75	1,482	3.68	22.11
Larimar Circle	EXT	Stub 7					75.89	3740	3740	14.01	894	894	17.7	1157	1157	107.60	5,791	107.60	5,791	3.19	74.73
Larimar Circle	Stub 7	60							3740			894			1157	0.00	0	107.60	5,791	3.19	74.73
Portico Way	60	69				0.25			4195			1379			1157	0.25	0	133.60	7,273	3.09	91.06
Portico Way	69	70				0.12			4195			1379			1157	0.12	0	133.72	7,273	3.09	91.06
Portico Way	70	EX 51				0.13			4195			1379			1157	0.13	0	133.85	7,273	3.09	91.06

STREET	M.H. # FR.	M.H. # TO	INSTITUTIONAL / COMMERICAL AREA ha	CUMM. AREA ha	INST./ COMM. FLOW l/s	PARK / ROAD AREA ha	PARK / ROAD CUMM. AREA ha	INFILTRATION AREA ha	INFILTRATION CUMM. AREA ha	PEAK EXTR. l/s	PEAK DES. l/s	SEWER DATA DIA. mm	SLOPE %	CAPAC. l/s	VEL. m/s	LENGTH m	RESIDUAL CAP. l/s	UPSTREAM Center Line	UPSTREAM Obvert	UPSTREAM Invert	UPSTREAM Cover	DOWNSTREAM Center Line	Obvert Drop	DOWNSTREAM Obvert	DOWNSTREAM Invert	DOWNSTREAM Cover
Future Street	EXT	Stub 6		0.00	0.00	3.56	3.56	20.38	20.38	5.71	20.23															
Future Street	Stub 6	39		0.00	0.00		3.56	0.00	20.38	5.71	20.23	250	0.25	31.0	0.61	9.00	10.79	92.59	88.710	88.456	3.88	92.74	0.06	88.687	88.433	4.05
Markdale Terrace	38	39		0.00	0.00		0.00	0.19	0.19	0.05	0.05	200	1.52	42.2	1.30	64.80	42.13	92.80	89.612	89.409	3.19	92.74		88.627	88.424	4.11
Dolce Place	54	39		0.00	0.00		0.00	0.68	0.68	0.19	1.08	200	0.35	20.2	0.62	93.93	19.16	92.49	89.505	89.302	2.98	92.74	0.55	89.176	88.973	3.56
Markdale Terrace	39	40		0.00	0.00		3.56	0.14	21.39	5.99	21.31	250	0.25	31.0	0.61	80.01	9.71	92.74	88.627	88.373	4.11	92.64	0.00	88.427	88.173	4.21
Guardian Grove	51	51A		0.00	0.00		0.00	0.41	0.41	0.11	0.58	200	0.69	28.4	0.88	43.43	27.84	92.32	89.502	89.299	2.82	92.54		89.203	88.999	3.34
Guardian Grove	51A	40		0.00	0.00		0.00	0.66	1.07	0.30	1.62	200	0.69	28.4	0.88	89.16	26.80	92.54	89.203	88.999	3.34	92.64	0.160	88.587	88.384	4.05
Markdale Terrace	40	41		0.00	0.00		3.56	0.14	22.60	6.33	22.80	250	0.25	31.0	0.61	80.05	8.22	92.64	88.427	88.173	4.21	92.54		88.227	87.973	4.31
Dolce Place	48	49		0.00	0.00		0.00	0.39	0.39	0.11	0.58	200	0.64	27.4	0.84	64.69	26.80	92.30	89.535	89.332	2.77	92.45		89.121	88.918	3.33
Dolce Place	49	41		0.00	0.00		0.00	0.51	0.90	0.25	1.34	200	0.64	27.4	0.84	65.57	26.03	92.45	89.121	88.918	3.33	92.54	0.47	88.701	88.498	3.84
Markdale Terrace	41	42		0.00	0.00		3.56	0.13	23.63	6.62	24.04	250	0.25	31.0	0.61	77.23	6.98	92.54	88.227	87.973	4.31	92.40	0.03	88.034	87.780	4.37
Markdale Terrace	42	43		0.00	0.00		3.56	0.03	23.66	6.62	24.05	250	0.25	31.0	0.61	14.33	6.97	92.40	88.004	87.750	4.40	92.39	0.03	87.968	87.714	4.42
Markdale Terrace	43	44		0.00	0.00		3.56	0.39	24.05	6.73	24.46	250	0.25	31.0	0.61	71.65	6.56	92.39	87.938	87.684	4.45	92.06	0.03	87.759	87.505	4.30
Markdale Terrace	44	46		0.00	0.00		3.56	0.13	24.18	6.77	24.53	250	0.25	31.0	0.61	51.21	6.49	92.06	87.729	87.475	4.33	92.25	0.06	87.601	87.347	4.65
Dolce Place	54	53		0.00	0.00		0.00	0.47	0.47	0.13	0.75	200	0.35	20.2	0.62	71.57	19.49	92.49	90.325	90.122	2.16	92.52		90.075	89.871	2.45
Dolce Place	53	52		0.00	0.00		0.00	0.08	0.55	0.15	0.85	200	0.35	20.2	0.62	11.49	19.39	92.52	90.075	89.871	2.45	92.47		90.034	89.831	2.44
Dolce Place	52	50		0.00	0.00		0.00	0.29	0.84	0.24	1.25	200	0.35	20.2	0.62	71.86	19.00	92.47	90.034	89.831	2.44	92.48		89.783	89.580	2.70
Dolce Place	50	50A		0.00	0.00		0.00	0.29	1.13	0.32	1.64	200	0.35	20.2	0.62	71.91	18.60	92.48	89.783	89.580	2.70	92.13		89.531	89.328	2.60
Dolce Place	50A	50B		0.00	0.00		0.00	0.03	1.16	0.32	1.65	200	0.35	20.2	0.62	11.49	18.60	92.13	89.531	89.328	2.60	92.17		89.491	89.288	2.68
Dolce Place	50B	48		0.00	0.00		0.00	0.05	1.21	0.34	1.66	200	0.35	20.2	0.62	31.62	18.58	92.17	89.491	89.288	2.68	92.35	0.03	89.380	89.177	2.97
Markdale Terrace	48	46		0.00	0.00		0.00	0.63	1.84	0.52	2.50	200	0.35	20.2	0.62	83.73	17.74	92.35	89.350	89.147	3.00	92.25	1.52	89.057	88.854	3.19
Block 223 Crossing	46	64A		0.00	0.00		3.56	0.00	26.02	7.29	26.75	250	0.25	31.0	0.61	62.61	4.27	92.24	87.541	87.287	4.70	92.40		87.385	87.131	5.02
Block 223 Crossing	64A	64		0.00	0.00		3.56	0.00	26.02	7.29	26.75	250	0.25	31.0	0.61	46.28	4.27	92.40	87.385	87.131	5.02	92.35		87.269	87.015	5.08
Larimar Circle	64	55A		0.00	0.00		3.56	0.10	26.12	7.31	26.81	300	0.20	45.1	0.62	8.29	18.30	92.35	87.269	86.964	5.08	92.27		87.252	86.948	5.02
Larimar Circle	55A	55		0.00	0.00		3.56	0.09	26.21	7.34	26.91	300	0.20	45.1	0.62	26.08	18.21	92.27	87.252	86.948	5.02	92.21	0.03	87.200	86.895	5.01
Larimar Circle	55	56		0.00	0.00		3.56	0.21	26.42	7.40	27.16	300	0.20	45.1	0.62	37.38	17.95	92.21	87.170	86.865	5.04	92.41	0.03	87.095	86.791	5.31
Larimar Circle	56	57		0.00	0.00		3.56	0.26	26.68	7.47	27.37	300	0.20	45.1	0.62	12.69	17.75	92.41	87.065	86.761	5.34	92.42	0.03	87.040	86.735	5.38
Larimar Circle	57	58		0.00	0.00		3.56	0.40	27.08	7.58	27.88	300	0.20	45.1	0.62	44.64	17.24	92.42	87.010	86.705	5.41	92.30		86.921	86.616	5.38
Larimar Circle	58	59		0.00	0.00		3.56	0.45	27.53	7.71	28.47	300	0.20	45.1	0.62	51.73	16.65	92.30	86.921	86.616	5.38	92.56		86.817	86.513	5.74
Larimar Circle	64	65A		0.00	0.00		0.00	0.16	0.16	0.04	0.12	200	0.65	27.6	0.85	10.45	27.46	92.35	88.430	88.227	3.92	92.31	0.03	88.362	88.159	3.95
Larimar Circle	65A	65		0.00	0.00		0.00	0.85	1.01	0.28	1.14	200	0.35	20.2	0.62	71.28	19.10	92.31	88.332	88.129	3.98	92.41	0.03	88.083	87.880	4.33
Larimar Circle	65	66		0.00	0.00		0.00	0.04	1.05	0.29	1.19	200	0.35	20.2	0.62	7.79	19.05	92.41	88.053	87.850	4.36	92.45	0.03	88.026	87.822	4.42
Larimar Circle	66	67		0.00	0.00		0.00	0.25	1.30	0.36	1.49	200	0.35	20.2	0.62	38.68	18.75	92.45	87.996	87.792	4.45	92.25	0.03	87.860	87.657	4.39
Larimar Circle	67	68		0.00	0.00		0.00	0.09	1.39	0.39	1.63	200	0.35	20.2	0.62	12.46	18.61	92.25	87.830	87.627	4.42	92.21		87.787	87.584	4.42
Larimar Circle	68	59		0.00	0.00		0.00	0.17	1.56	0.44	1.84	200	0.35	20.2	0.62	37.82	18.41	92.21	87.787	87.584	4.42	92.56	0.84	87.654	87.451	4.91
Larimar Circle	59	60		0.00	0.00		3.56	0.22	29.31	8.21	30.32	300	0.20	45.1	0.62	54.03	14.80	92.56	86.817	86.513	5.74	92.62		86.709	86.404	5.91
Larimar Circle	EXT	Stub 7	11.72	11.72	10.17	50.33	50.33	169.65	169.65	47.50	132.40															
Larimar Circle	Stub 7	60		11.72	10.17		50.33	0.00	169.65	47.50	132.40	525	0.19	195.6	0.88	11.50	63.16	92.59	86.791	86.258	5.80	92.62	0.060	86.769	86.236	5.85
Portico Way	60	69		11.72	10.17		53.89	0.25	199.21	55.78	157.01	525	0.19	195.6	0.88	57.27	38.56	92.62	86.709	86.176	5.91	92.51	0.030	86.600	86.067	5.91
Portico Way	69	70		11.72	10.17		53.89	0.12	199.33	55.81	157.04	525	0.19	195.6	0.88	46.83	38.52	92.51	86.570	86.037	5.94	92.73	0.030	86.481	85.948	6.25
Portico Way	70	EX 51		11.72	10.17		53.89	0.13	199.46	55.85	**157.08**	525	0.20	200.6	0.90	61.54	43.57	92.73	86.451	85.918	6.28	92.38		86.328	85.795	6.05
																								EX 51	85.795	

** Unit count includes future units

EXISTING INFRASTRUCTURE INFORMATION

Spratt Road:
Ex. INV@ SAN MH 2 = 86.322 (525 mm inlet)
Ex. Pipe Data from Stub to SAN MH 2 = 107.8m 525mm dia. pipe @ 0.12%

Information taken from Riverside South Phase 9, Plan & Profile Spratt Road DWG No. 01, prepared by JLR dated October 18, 2012

Shoreline Drive:
Ex. INV@ SAN MH 76 = 85.21 (450 mm inlet)
Ex. Pipe Data from Stub to SAN MH 76 = 57m 450mm dia. pipe @ 0.2%

Canyon Walk Drive:
Ex. INV@ SAN MH 51 = 85.795 (525 mm inlet)
Ex. Pipe Data from Stub to SAN MH 51 = 52.5m 525mm dia. pipe @ 0.2%

Information taken from Earl Armstrong Widening - Road Reconstruction Part A - DWG Nos. 14361-17 and 14361-23 prepared by AECOM, dated September 2009.

Appendix D GEOTECHNICAL INVESTIGATION

July 2015

REPORT ON

Geotechnical Investigation Proposed Residential Development Riverside South Development (Phase 8) Ottawa, Ontario

Submitted to:
Riverside South Development Corporation
2193 Arch Street
Ottawa, Ontario
K1G 2H5

REPORT

Report Number: 1418804

Distribution:

11 copies - Riverside South Development Corporation
1 copy - Golder Associates Ltd.

Golder Associates

Table of Contents

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation carried out for a proposed residential development to be located within the Riverside South Community (Phase 8) in Ottawa, Ontario.

The purpose of this geotechnical investigation was to supplement the existing subsurface information and determine the general soil and groundwater conditions across the site by means of 16 boreholes. Based on an interpretation of the factual information obtained, along with existing data available for the site, engineering guidelines are provided on the geotechnical design aspects of the project, including construction considerations which could affect design decisions.

The reader is referred to the "Important Information and Limitations of This Report" which follows the text but forms an integral part of this document.

2.0 DESCRIPTION OF PROJECT AND SITE

Plans are being prepared to develop a proposed residential subdivision within the Riverside South Community (Phase 8) in Ottawa, Ontario (see Site Plan, Figure 1).

The site is located south of Earl Armstrong Road, between Spratt Road and Canyon Walk Drive. The subject site is irregular in shape and measures approximately 1,250 by 420 metres in size.

It is understood that the development will consist of a conventional subdivision with a mix of single family homes and townhouses, as well as access roads and services within the subdivision.

The site topography is relatively flat with a gentle downward slope from east to west (i.e., towards the river). The majority of the site is currently undeveloped, consisting of former agricultural land or forested areas.

Golder Associates previously completed two geotechnical investigations within or in close proximity to the site. The results of those investigations are provided in the following reports:

1) Report to Totten Sims Hubicki Associates by Golder Associates Ltd. titled "Geotechnical Considerations for Earl Armstrong Road Widening, Former River Road to Limebank Road, Ottawa, Ontario", dated January 2008 (Project No. 06-1120-290).

2) Report to the Riverside South Development Corporation by Golder Associates Ltd. titled "Preliminary Geotechnical Investigation, Proposed Residential Development, Riverside South Community Development, Phases 6 to 9" dated September 2009 (Project No. 09-1121-0120).

Based on a review of these previous geotechnical investigations and the published geological mapping, the subsurface conditions at the site likely consist of surficial deposits of layered silty clay, clayey silt, sandy silt and silty sand overlying silty clay and glacial till, which in turn are underlain by bedrock. Based on published geological maps, the bedrock surface is expected to be at depths ranging from about 5 to 25 metres (sloping downward from south to north across the site) and to consist of March formation sandstone.

3.0 PROCEDURE

The field work for this investigation was carried out between January 5 and 15, 2015. At that time, 16 boreholes (numbered 14-1 to 14-16, inclusive) were put down at the approximate locations shown on the Site Plan, Figure 1.

The boreholes were advanced using a track-mounted continuous flight hollow-stem auger drill rig, supplied and operated by Marathon Drilling Ltd. of Ottawa, Ontario. The boreholes were generally advanced to depths of about 5.9 to 9.8 metres below the existing ground surface. Below about 7.6 and 6.1 metres depth, boreholes 14-5 and 14-14 were advanced without sampling, using a dynamic cone penetration test (DCPT), to depths of about 9.8 and 10.4 metres, respectively, below the existing ground surface.

Standard Penetration Tests (SPT) were carried out in the boreholes at regular intervals of depth and samples of the soils encountered were recovered using split spoon sampling equipment. In situ vane testing was carried out where possible in the cohesive deposits to determine the undrained shear strength of these soils. In addition, seven relatively undisturbed 73 millimetre diameter thin walled Shelby tube samples of the silty clay were obtained from selected boreholes using a fixed piston sampler.

Standpipe piezometers were sealed into boreholes 14-1, 14-4, 14-8, 14-11, 14-14, and 14-16 to allow subsequent measurement of the groundwater level across the site. The groundwater levels in these standpipe piezometers were measured on January 27, 2015.

The field work was supervised by an experienced technician from our staff who located the boreholes, directed the drilling operations and in situ testing, logged the boreholes, and took custody of the soil samples retrieved.

Upon completion of the drilling operations, samples of the soils encountered in the boreholes were transported to our laboratory for further examination by the project engineer and for laboratory testing. The laboratory testing included natural water content determinations, Atterberg limit tests and oedometer consolidation testing.

Soil samples from boreholes 14-3 and 14-14 were submitted to EXOVA Environmental Ontario Ltd. for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The borehole locations were selected, picketed, and surveyed in the field by Golder Associates Ltd. The borehole locations and elevations were surveyed using a Trimble R8 Global Positioning System (GPS) unit. The elevations are referenced to Geodetic datum.

4.0 SUBSURFACE CONDITIONS

4.1 General

Information on the subsurface conditions is provided as follows:

- Record of Borehole Sheets for the current investigation are provided in Appendix A, which also show the results of the laboratory testing.
- Record of Borehole Sheets from relevant boreholes from the previous investigations by Golder Associates are provided in Appendix B.
- The results of the basic chemical analysis carried out on soil samples from boreholes 14-3 and 14-14 are provided in Appendix C.

The subsurface conditions on the site generally consist of topsoil, underlain by layered silty clay, clayey silt and silty sand, overlying compressible silty clay, followed by glacial till.

The following sections present a more detailed overview of the subsurface conditions on this site, with a focus on the boreholes advanced for the current investigation.

4.2 Topsoil and Fill

Topsoil exists at ground surface at all of the borehole locations, with the exception of borehole 14-2 where the topsoil had been stripped. The topsoil varies in thickness from about 220 to 300 millimetres.

A layer of topsoil fill and soil was encountered at borehole 14-9 with a total thickness of about 0.6 metres. The soil fill consists of silty clay with organic matter and cobbles.

4.3 Weathered Silty Clay to Clay

The topsoil and fill are typically underlain by a deposit of silty clay to clay which has been weathered to a grey brown colour. The weathered deposit extends to depths of about 0.6 to 3.1 metres below the existing ground surface.

Standard penetration tests carried out within this material gave SPT N values of about 2 to 10 blows per 0.3 metres of penetration. The results of two in situ vane tests carried out in the weathered silty clay to clay measured undrained shear strength values of about 92 and greater than 96 kilopascals. The results of the in situ testing indicate a stiff to very stiff consistency.

The results of one Atterberg limit test carried out on a sample of the weathered deposit gave a plasticity index value of about 43 percent and a liquid limit value of about 74 percent, indicating a soil of high plasticity.

The measured natural water contents of two samples of the weathered silty clay were about 32 and 43 percent.

About 0.4 metres of intermixed clayey silt, silty clay, and silty sand were encountered above the weathered deposit at borehole 14-3. Similarly, about 0.7 metres of clayey silt and silty clay overlie the weathered deposit at borehole 14-15.

A discontinuous layer of sand was encountered below the weathered deposit at borehole 14-15. The sand has a thickness of about 0.3 metres and extends down to a depth of about 2.2 metres below the existing ground surface.

4.4 Layered Silty Sand and Clayey Silt

A deposit of layered silty sand and clayey silt was encountered below the topsoil and/or weathered deposit in all of the boreholes with the exception of 14-8 and 14-15. The layered silty sand and clayey silt has a thickness that ranges from about 0.5 to 2.1 metres and extends down to depths of about 1.4 to 4.0 metres below the ground surface. This deposit generally contains silty clay layers. In boreholes 14-7, 14-9, 14-12, and 14-13 this deposit grades to a clayey silt and silty clay with silty sand layers.

Standard penetration tests carried out within this deposit gave SPT N values of about 1 to 7 blows per 0.3 metres of penetration, indicating a very loose to loose state of packing.

The results of one Atterberg limit test carried out on a sample of the clayey silt and silty clay from borehole 14-12 gave a plasticity index value of about 23 percent and a liquid limit value of 39 percent, indicating a soil of intermediate plasticity.

The measured natural water contents of four samples of this deposit ranged from about 28 to 41 percent.

4.5 Unweathered Silty Clay to Clay

The layered silty sand and clayey silt are underlain by a deposit of silty clay to clay (hereafter referred to as silty clay). The silty clay deposit is unweathered and typically grey in colour. The unweathered deposit extends to, or was proven/inferred to, depths ranging from 4.4 to 9.1 metres below the ground surface. The silty clay was fully penetrated in boreholes 14-1, 14-5, 14-8, 14-12, and 14-13, which are located generally within the central-south part of the site. The deposit is apparently thicker beneath the east, west, and north parts of the site.

The results of in situ vane testing in the deposit measured undrained shear strength values generally ranging from about 29 to greater than 96 kilopascals, indicating a firm to very stiff consistency, with the shear strength generally increasing with depth. Within the shallower/weaker portions of the deposit the undrained shear strength is more typically in the range of 30 to 50 kilopascals (i.e., firm).

The results of two Atterberg limit tests carried out on samples of the unweathered silty gave plasticity index values of about 20 and 36 percent and liquid limit values of about 34 and 57 percent, indicating a soil of intermediate to high plasticity.

Natural water contents ranging from about 33 to 69 percent were measured in the unweathered silty clay.

Oedometer consolidation testing was carried out on two Shelby tube samples of the unweathered clay. The results of the testing are provided on Figures 2 and 3 and are summarized in the table below.

Borehole/ Sample No.	Sample Depth/ Elevation (m)	σ_{v0}' (kPa)	σ_p' (kPa)	C_c	C_r	e_0	OCR
14-3 / 6	5.1 / 86.2	50	125	0.70	0.014	1.31	2.5
14-9 / 6	5.0 / 86.2	50	130	0.45	0.010	1.06	2.6

Notes:
σ_p' - Apparent preconsolidation pressure
σ_{v0}' - Computed existing vertical effective stress
C_c - Compression index
e_0 - Initial void ratio
OCR - Overconsolidation ratio
C_r - Recompression index

4.6 Clayey Silt to Silty Clay

A thin layer of clayey silt and/or silty clay was encountered below the silty clay in boreholes 14-10, 14-12, and 14-14. The clayey silt and silty clay was encountered at depths between about 4.4 to 6.1 metres below the existing ground surface and was proven/inferred to depths ranging from about 4.9 to 7.0 metres.

The measured natural water content of one sample of the clayey silt was about 39 percent.

4.7 Glacial Till

A deposit of glacial till was encountered beneath the silty clay at boreholes 14-1, 14-5, 14-8, 14-10, 14-12, 14-13, and 14-14. The glacial till consists of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of silty sand or sandy silt. The glacial till was encountered at depths ranging from about 4.9 to 9.1 metres below the existing ground surface and proven to extend to depths ranging from about 6.1 to 10.4 metres below the existing ground surface. The till surface was found to be shallowest beneath the central-south portions of the site.

Standard penetration tests carried out within the glacial till gave SPT N values typically ranging from about 14 to 52 blows per 0.3 metres of penetration, indicating a generally compact to very dense state of packing.

The measured natural water content of one sample of the glacial till was about 10 percent.

4.8 Groundwater

The groundwater levels sealed in boreholes 14-1, 14-4, 14-8, 14-11, 14-14, and 14-16 were measured on January 27, 2015. The observed groundwater levels are summarized in the table below:

Borehole Number	Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)
14-1	91.18	1.17	90.01
14-4	91.91	0.94	90.39
14-8	92.21	1.91	90.30
14-11	91.55	1.32	90.23
14-14	92.03	0.82	91.21
14-16	91.99	1.22	90.77

Groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

5.0 DISCUSSION

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of this project based on our interpretation of the borehole information as well as the project requirements, and is subject to the limitations in the "Important Information and Limitations of This Report" which follows the text of this report.

5.2 Site Grading

Based on the subsurface conditions encountered and the soil strengths determined within the boreholes, the site has been divided into two assessment areas, Area A and Area B, as shown on the Site Plan, Figure 1. The subsurface conditions in Areas A and B generally consist of topsoil underlain by weathered silty clay, layered clayey silt and silty sand, overlying a deposit of unweathered and compressible sensitive silty clay, followed by glacial till.

The "softer" unweathered silty clay deposits in Areas A and B have limited capacity to accept additional load from the weight of grade raise fill and from the foundations of houses without undergoing consolidation settlements. Therefore, for these areas, to leave sufficient remaining capacity for the silty clay to support house foundations, with reasonable footing sizes, the thicknesses of grade raise fill will need to be limited.

The following table provides the maximum grade raises which are permitted for each of the assessment areas indicated on Figure 1. These grade raise limitations have been assessed based on leaving sufficient remaining capacity in the silty clay deposit such that strip footings up to 0.6 metres in size can be designed using an allowable bearing pressure of at least 75 kilopascals, consistent with design in accordance with Part 9 of the Ontario Building Code.

Assessment Zone	Maximum Permissible Grade Raise (metres)
A	2.1
B	1.9

It should also be noted that these maximum permissible grade raises were calculated assuming that any fill required for site grading (above original grade) and the backfill within the garages would have a unit weight of no more than 19.5 kilonewtons per cubic metre. Silty clay, clayey silt and silty sand (such as present on this site), as well as crushed clear stone and uniform fine sand (for the garage backfill) may be suitable for this purpose. Sand and gravel, glacial till, and crushed stone typically have a higher unit weight and, if these materials are to be used, the maximum permissible grade raises would be reduced and would need to be re-evaluated.

If the grading restrictions given above cannot be accommodated, then further recommendations from Golder Associates could be provided, if and when they are required.

As a general guideline regarding the site grading, the preparation for filling of the site should include stripping the topsoil for predictable performance of structures and services. The topsoil is not suitable as engineered fill and should be stockpiled separately for re-use in landscaping applications only. In areas with no proposed structures, services, or roadways, the topsoil may be left in place provided some settlement of the ground surface following filling can be tolerated.

5.3 Foundations

It is considered that the proposed residences may be supported on spread footings founded on or within the weathered silty clay or layered clayey silt and silty sand.

As discussed in the preceding section, the silty clay has a limited capacity to accept the combined load from site grading fill and foundation loads. The allowable bearing pressures for spread footing foundations are therefore based on limiting the stress increases on the unweathered firm, compressible, grey silty clay at depth to an acceptable level so that foundation settlements do not become excessive.

Four important parameters in calculating the stress increase on the unweathered silty clay are:

- The thickness of soil below the underside of the footings and above the firm silty clay;
- The size (dimensions) of the footings;
- The amount of surcharge in the vicinity of the foundations due to landscape fill, underslab fill, floor loads, etc., as described in Section 5.2; and,
- The effects of groundwater lowering caused by this or other construction.

Provided that the grade raises are restricted to those indicated in Section 5.2, strip footing foundations up to 0.6 metres in width and pad footings up to 2.0 metres square can be designed using a maximum allowable bearing pressure of 75 kilopascals. As such, the house footings may be sized in accordance with Part 9 of the Ontario Building Code (OBC).

The post construction total and differential settlements of footings sized using the above maximum allowable bearing pressure should be less than about 25 and 15 millimetres, respectively, provided that the subgrade at or below founding level is not disturbed during construction.

The tolerance of the house foundations to accept those settlements could be increased by providing nominal levels of reinforcing steel in the top and bottom of the foundation walls.

Further, the provided maximum allowable bearing pressure for footing foundations supported by the silty clay corresponds to settlement resulting from consolidation of this deposit. Consolidation of the silty clay is a process which takes months or longer and, as such, results from sustained loading. Therefore, the foundation loads to be used in conjunction with the above allowable bearing pressure should be the full dead load plus sustained live load.

Any existing ditches that may underlie future houses (such as the ditch located on the east side of Area B), will need to be filled. The following guidelines are provided in regards to filling of the ditches beneath future houses:

- The ditch should be made dry and cleaned of all organic or disturbed soil prior to filling.
- Filling to the underside of footing elevation should be carried out using crushed clear stone having a unit weight not exceeding about 17.5 kilonewtons per cubic metre (i.e., similar to the native soil). The use of clear stone is recommended so as to avoid possible settlements associated with the use of heavier material.
- The engineered fill should be placed to occupy the full house footprint and the full zone of influence/support for the foundations. That zone is considered to extend down and out from the outside edge of the perimeter foundations at a slope of 1H:1V (horizontal:vertical).

- The engineered fill should be placed in maximum 300 millimetre thick lifts and be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.
- To avoid settlements resulting from loss of soil into the voids in the clear stone, it should be fully encapsulated in a geotextile. The geotextile should be placed on the bottom and sides of the ditch, as well as over the top of the clear stone.
- A Class II non-woven geotextile should be used, with a Filtration Opening Size (FOS) not exceeding 150 microns, in accordance with Ontario Provincial Standard Specifications (OPSS) 1860.
- Footings founded on or within properly placed engineered fill (as described above) can also be designed using a maximum allowable bearing pressure of 75 kilopascals.

5.4 Frost Protection

All exterior perimeter foundation elements or foundation elements in unheated areas should be provided with a minimum of 1.5 metres of earth cover for frost protection purposes. Isolated and/or unheated exterior footings adjacent to surfaces which are cleared of snow cover during winter months should be provided with a minimum of 1.8 metres of earth cover.

5.5 Seismic Design

The seismic design provisions of the 2012 Ontario Building Code (OBC) depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or bedrock below founding level. The OBC also permits the Site Class to be specified based solely on the stratigraphy and in situ testing data, rather than from direct measurement of the shear wave velocity. Based on this methodology, and based on the available information it is considered that a Site Class of E would be applicable to the design of structures in both Areas A and B. It should be noted that the seismic Site Class is not directly applicable to structures designed in accordance with Part 9 of the OBC (i.e., conventional housing); however this assessment is provided to address City of Ottawa requirements that relate to housing on Site Class E sites. It should also be noted that a more favourable Site Class value could potentially be assigned for houses in Areas A and B. Based on previous shear wave velocity testing in the Phase 9 site to the west of Phase 8, it is considered reasonably likely that a Site Class of at least D might feasibly be assigned to much of the site on the basis of such testing (particularly where the glacial till is shallower).

5.6 Basement Excavations

Excavations for basements will be through the topsoil, weathered silty clay and layered clayey silt and silty sand. No unusual problems are anticipated with excavating the overburden soils using conventional hydraulic excavating equipment.

Side slopes in the overburden materials should be stable in the short term at 1 horizontal to 1 vertical in accordance with the *Occupational Health and Safety Act* (OHSA) of Ontario for Type 3 soils.

Some groundwater inflow into the excavations could be expected. However, for the planned basement excavation depths, it should be possible to handle the groundwater inflow by pumping from well filtered sumps in the excavations.

Based on the *present* groundwater levels, excavations deeper than about 0.8 metres may, in some areas, extend below the groundwater level. Where the subgrade is found to be wet and sensitive to disturbance, consideration should be given to placing a mud slab of lean concrete over the subgrade (following inspection and approval by geotechnical personnel) or a 150 millimetre thick layer of OPSS Granular A underlain by a non-woven geotextile, to protect the subgrade from construction traffic.

5.7 Basement and Garage Floor Slabs

In preparation for the construction of the basement floor slabs, all loose, wet and disturbed materials should be removed from beneath the floor slabs. Provision should be made for at least 200 millimetres of 19 millimetres crushed clear stone to form the base of the basement floor slabs.

To prevent hydrostatic pressure build up beneath the basement floor slabs, it is suggested that the granular base material be positively drained. This could be achieved by providing a hydraulic link between the underslab fill material and the exterior drainage system.

The backfill material inside the garage should have a unit weight no greater than 19.5 kilonewtons per cubic metre (i.e., uniform fine sand or clear crushed stone). The garage backfill should be placed in maximum 300 millimetre thick lifts and be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment. The granular base for the garage floor slab should consist of at least 150 millimetres of OPSS Granular A compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

5.8 Basement Wall and Foundation Wall Backfill

The soils at this site are frost susceptible and should not be used as backfill directly against exterior, unheated, or well insulated foundation elements. To avoid problems with frost adhesion and heaving, a bond break such as Platon system sheeting should be placed against the foundation walls.

Drainage of the wall backfill should be provided by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in geotextile, which leads by gravity drainage to an adjacent storm sewer or sump pit. Conventional damp proofing of the basement walls is appropriate with the above design approach.

Should the foundations be designed in accordance with Part 4 of the Ontario Building Code, further guidelines on the foundation wall design will be required.

5.9 Site Servicing

Excavations for the installation of site services will be made through the topsoil, layered clays, silts, and sand, as well as potentially the glacial till. No unusual problems are anticipated with excavating the overburden using conventional hydraulic excavating equipment. However, it should be expected that boulders will be encountered within the glacial till (for deeper trenches). Boulders larger than 0.3 metres in size should be removed from the excavation side slopes.

In accordance with the OHSA of Ontario, the overburden soils would generally be classified as Type 3 soils and side slopes in the overburden in the short term may be sloped at 1 horizontal to 1 vertical. Alternatively, excavations within the overburden could also be carried out within a fully braced steel trench box, which would minimize the width of the excavation.

Some groundwater inflow into the excavations could be expected. However, it should generally be possible to handle the groundwater inflow by pumping from well filtered sumps in the excavations provided suitably sized pumps are used.

The actual rate of groundwater inflow to the trench will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, and the time of year at which the excavation is made. There also may be instances where significant volumes of precipitation and/or groundwater collects in an open excavation, and must be pumped out. A Permit to Take Water (PTTW) should be obtained from the provincial Ministry of the Environment and Climate Change (MOECC) for this work.

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for sewer and water pipes. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. The bedding material should, in all cases, extend to the spring line of the pipe and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density. The use of crushed clear stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials or sandy soils on the trench walls could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the drier weathered silty clay, clayey silt, silty sand, and glacial till as trench backfill.

However, the high moisture content of the deeper clayey deposits (i.e., silty clay and clayey silt) makes these soils difficult to handle and compact. If these materials are excavated during installation of the site services, they should be wasted or should only be used as backfill in the lower portion of the trenches to limit the amount of long term settlement of the roadway surface. If the unweathered silty clay or clayey silt are used in trenches under roadways, long term settlement of the pavement surface should be expected. Some significant padding of the roadways may be required prior to final paving. In that case, it would also be prudent to delay final paving for as long as practical.

Where the trench will be covered with hard surfaced areas, the type of native material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility.

Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

Impervious dykes or cut-offs should be constructed at 100 metre intervals in the service trenches to reduce groundwater lowering at the site due to the "french drain" effect of the granular bedding and surround for the service pipes. It is important that these barriers extend from trench wall to trench wall and that they fully penetrate the granular materials to the trench bottom. The dykes should be at least 1.5 metres wide and could be constructed using relatively dry (i.e., compactable) grey brown silty clay from the weathered zone.

5.10 Pavement Design

In preparation for pavement construction, all topsoil, fill (if containing organic matter); disturbed or otherwise deleterious materials should be removed from the roadway areas.

Pavement areas requiring grade raising to proposed subgrade level should be filled using acceptable OPSS Select Subgrade Material (SSM) or Earth Borrow. The SSM or Earth Borrow should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

The surface of the pavement subgrade should be crowned to promote drainage of the roadway granular structure. Perforated pipe sub-drains should be provided at subgrade level extending from the catch basins for a distance of at least 3 metres longitudinally, parallel to the curb in two directions.

The pavement structure for local roads without bus or truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	375

The pavement structure for collector roadways which will include bus and truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	450

The granular base and subbase materials should be uniformly compacted as per OPSS 501, Method A. The asphaltic concrete should be compacted in accordance with the procedures outlined in OPSS 310

The composition of the asphaltic concrete pavement should be as follows:

- Superpave 12.5 mm Surface Course 40 mm
- Superpave 19 mm Base Course 50 mm

The asphaltic cement should consist of PG 58-34 and the design of the mixes should be based on a Traffic Category B for local roads and Category D for collector roads.

In regards to the above pavement structure for local roads, it should be noted that the 50 millimetres of asphaltic concrete base course would provide sufficient structural support and would therefore be adequate for the initial periods of roadway service. However, the 90 millimetres of asphaltic concrete is specified for the local roadways based on the typical construction sequence which would require a surface course placement following substantial completion of the house construction.

In addition, if a similar paving sequence is proposed for collector roads, with an additional course being required upon substantial completion of site development, then a thicker overall asphaltic concrete layer would be required (to allow for three lifts), since two initial lifts will likely be required to support the construction traffic. Alternatively, a thicker base course could be provided during construction phase and a 40 millimetre surface course provided at the substantial completion. Further guidelines for both options can be provided, if required.

The above pavement designs are based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where the trench backfill and grade raise fill have been adequately compacted to the required density and the subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase and/or to place a woven geotextile beneath the granular materials.

Based on previous experience with the construction of roadways on other phases of the Riverside South Community, there is considered to be a high likelihood for portions of the roadways to require both a geotextile and additional granular subbase, unless the pavement construction is carried out during optimal weather conditions. A significant contingency in the construction budget should be carried for such measures.

5.11 Pools, Decks and Additions

The following guidelines are provided to address some typical requirements of the City of Ottawa.

5.11.1 Above Ground and In Ground Pools

No special geotechnical considerations are necessary for the installation of in-ground pools, provided that the pool (including piping) does not extend deeper than the house footing level. A geotechnical assessment will be required if the pool extends deeper than the house foundations.

Due to the additional loads that would be imposed by the construction of *above-ground pools*, these should be located no closer than 2 metres from the outside wall of the house. In addition, the installation of an above-ground pool should not be permitted to alter the existing grades within 2 metres of the house. Provided these restrictions are adhered to, no further geotechnical assessment should be required for above-ground pools.

5.11.2 Decks

It is considered that, in general, no particular geotechnical evaluation/assessment will be necessary for future decks, added by the homeowners, except where:

- The deck will be attached to the house; and/or,
- The deck will be heavily loaded and require spread footing or drilled pier foundations (i.e., where the deck will be designed in accordance with Part 9 of the OBC and require a building permit).

5.11.3 Additions

Any proposed addition to a house (regardless of size) will require a geotechnical assessment. The geotechnical assessment must consider the proposed grading, foundation types and sizes, depths of foundations, and design bearing pressures. Written approval from a geotechnical engineer should be required by the City of Ottawa prior to the building permit being issued.

5.12 Corrosion and Cement Type

Samples of soil from boreholes 14-3 and 14-14 were submitted to EXOVA Environmental Ontario for basic chemical analysis related to potential corrosion of buried steel elements and potential sulphate attack on buried concrete elements. The results of this testing are provided in Appendix C. The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a moderate to elevated potential for corrosion of exposed ferrous metal, which should be considered in the design of substructures.

5.13 Trees

The clay soils on this site are potentially sensitive to water depletion by trees of high water demand during periods of dry weather. When trees draw water from clay soil, the clay undergoes shrinkage which can result in settlement of adjacent structures. Some restrictions could therefore need to be imposed on the planting of trees of higher water demand in close proximity to the foundations of houses or other structures founded at shallow depth. The required set-backs can be evaluated once further details are available on the site grading design.

6.0 ADDITIONAL CONSIDERATIONS

The soils at this site are sensitive to disturbance from ponded water, construction traffic and frost.

All footing and subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that soil having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared. The placing and compaction of any engineered fill as well as sewer bedding and backfill should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction point of view.

At the time of the writing of this report, only limited details for the proposed subdivision were available. Golder Associates should be retained to review the guidelines provided in this report once additional details are known.

It should also be noted that no oedometer consolidation tests were carried out on the Shelby tube samples retrieved for this investigation; if the permissible grade raises specified in Section 5.2 cannot be accommodated, consolidation testing could be considered to further refine the grading recommendations.

For any higher/heavier structures (e.g., schools, commercial buildings etc.) proposed for the site that will be designed in accordance with Part 4 of the OBC, further investigation will be required to support the site plan and building permit applications and additional geotechnical guidelines will need to be provided for detailed design.

The groundwater level monitoring devices (i.e., standpipe piezometers or wells) installed at the site will require decommissioning at the time of construction in accordance with Ontario Regulation 128/03. However, it is expected that most of the wells will either be destroyed during construction or can be more economically abandoned as part of the construction contract. If that is not the case or is not considered feasible, abandonment of the monitoring wells can be carried out separately.

7.0 CLOSURE

We trust this report satisfies your current requirements. If you have any questions regarding this report, please contact the undersigned.

GOLDER ASSOCIATES LTD.

LICENSED PROFESSIONAL ENGINEER
S. A. TRICKEY
100104579
PROVINCE OF ONTARIO

Susan Trickey, P.Eng.	Mike Cunningham, P.Eng.
Geotechnical Engineer	Principal, Geotechnical Engineer

WAM/SAT/MIC/sg/ob
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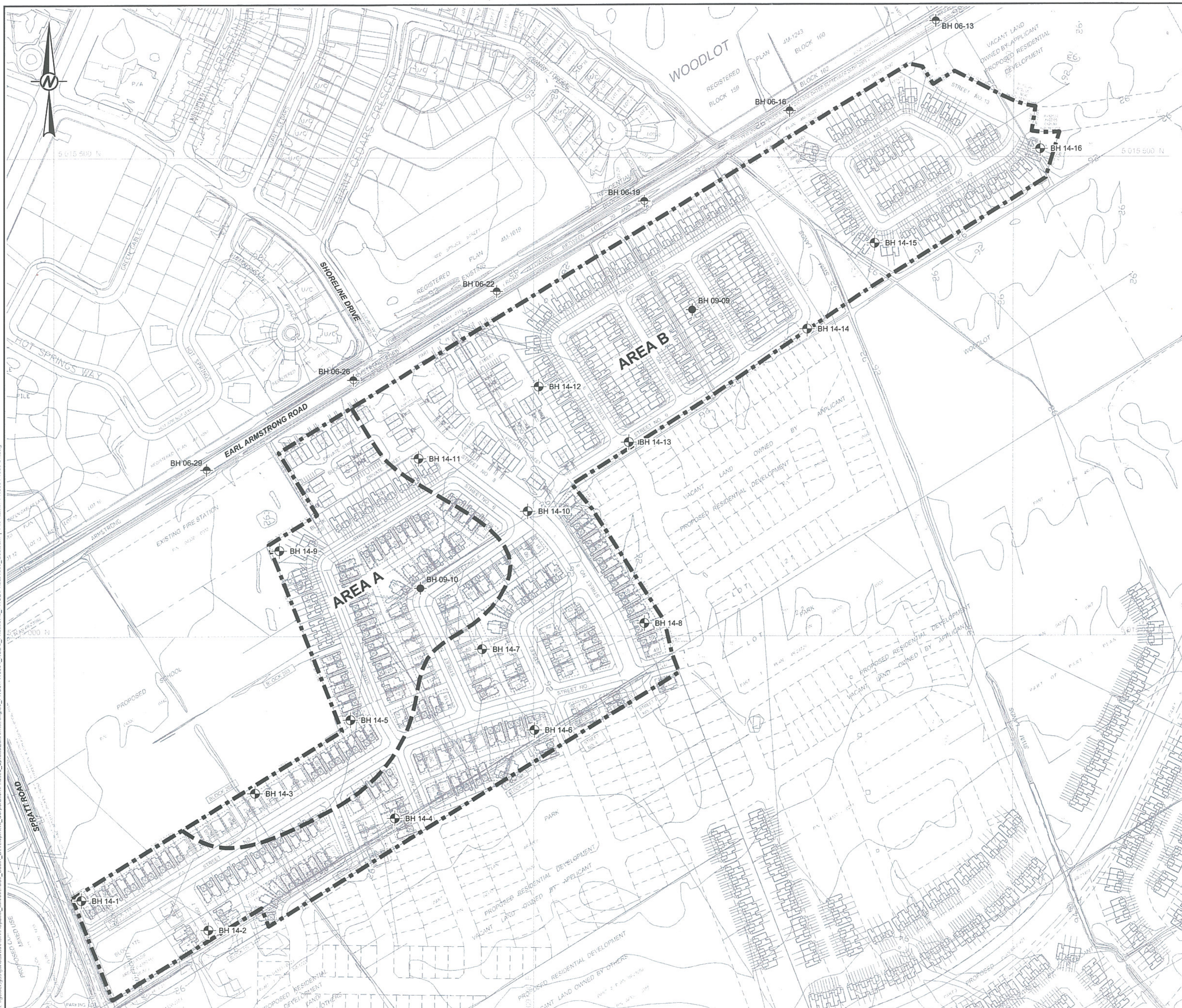
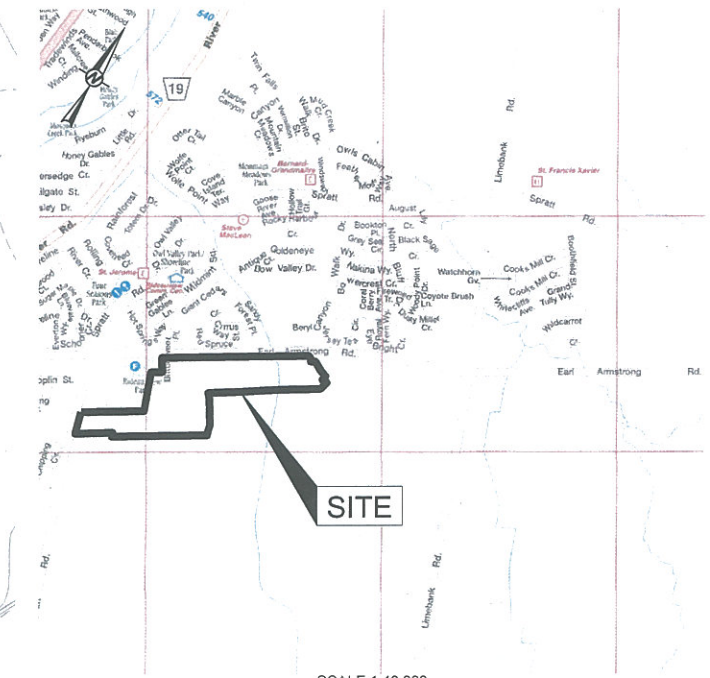


KEY MAP



SCALE 1:40,000

LEGEND

- APPROXIMATE BOREHOLE LOCATION IN PLAN, PRESENT INVESTIGATION
- APPROXIMATE BOREHOLE LOCATION IN PLAN, PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD. REPORT N o. 09-1121-0120
- APPROXIMATE BOREHOLE LOCATION IN PLAN, PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD. REPORT N o. 06-1120-290
- APPROXIMATE LIMIT OF PHASE 8 DEVELOPMENT
- ASSESSMENT AREA

NOTES

1. THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. LETTER REPORT No. 1418804

REFERENCE

1. BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY ANNIS, O'SULLIVAN VOLLEBEKK LTD. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

0 100 200

1:4,000 METRES

CLIENT

RIVERSIDE SOUTH DEVELOPMENT CORPORATION

PROJECT

GEOTECHNICAL INVESTIGATION
RIVERSIDE SOUTH DEVELOPMENT (PHASE 8)
PROPOSED RESIDENTIAL DEVELOPMENT - OTTAWA, ONTARIO

TITLE

SITE PLAN

CONSULTANT

Golder Associates

YYYY-MM-DD	2015-02-26
PREPARED	JM
DESIGN	----
REVIEW	SAT
APPROVED	MIC

PROJECT No.	PHASE	Rev.	FIGURE
1418804	1000	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

PROJECT: 1418804

RECORD OF BOREHOLE: 14-12

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: January 13, 2015

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE: DESCRIPTION | STRATA PLOT | ELEV. DEPTH (m) | SAMPLES: NUMBER | TYPE | BLOWS/0.30m | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl (20 40 60 80) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Depth (m)	Boring Method	Description	Elev. / Depth (m)	Number	Type	Blows/0.30m
		GROUND SURFACE	91.90			
0	Power Auger, 200 mm Diam. (Hollow Stem)	TOPSOIL	0.00			
		(CI/CH) SILTY CLAY to CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL	91.65 / 0.25	1	GRAB	-
1		(SM-ML) SILTY SAND and CLAYEY SILT; grey brown; non-cohesive, moist, loose	91.29 / 0.61	2	SS	5
2		(ML-CI) CLAYEY SILT and SILTY CLAY; grey brown, contains silty sand layers; cohesive, w>PL, firm	90.47 / 1.43	3	SS	1
		(CI/CH) SILTY CLAY to CLAY; grey brown; cohesive, w>PL, stiff	89.46 / 2.44	4	SS	2
3		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm to stiff	88.85 / 3.05	5	SS	1
4		(ML) CLAYEY SILT; grey; cohesive, w>PL, very stiff	87.48 / 4.42			
5		(ML) sandy SILT, some gravel; grey, contains cobbles/boulders (GLACIAL TILL); non-cohesive, wet, compact	87.02 / 4.88	6	SS	6
6				7	SS	14
		End of Borehole	85.80 / 6.10			

WL in open borehole at 1.22 m depth below ground surface upon completion of drilling

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: PAH

CHECKED: WAM

GOLDER

TECHNICAL MEMORANDUM

Project No. 06-1120-063-5000

DATE July 11, 2018

TO Phil Castro
Richcraft

FROM Susan Trickey

EMAIL strickey@golder.com

PROPOSED RESIDENTIAL HOUSES
BLOCK 221
RIVERSIDE SOUTH DEVELOPMENT- PHASE 8
OTTAWA, ONTARIO

This memo confirms that the geotechnical recommendations provided in Golder Associates' report to the Riverside South Development Corporation titled "*Geotechnical Investigation, Proposed Residential Development, Riverside South Development (Phase 8), Ottawa, Ontario*" dated July 2015 (Report Number 1418804) are applicable to the design and construction of the proposed houses to be located in Block 221 of the development (see attached drawing for the location of Block 221).

We trust that this memo contains sufficient information for your present requirements. If you have any questions concerning this memo, please contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

LICENSED PROFESSIONAL ENGINEER
July 11/18
S. A. TRICKEY
100104570
PROVINCE OF ONTARIO

Susan Trickey
Geotechnical Engineer

Bill Cavers, P.Eng.
Associate, Senior Geotechnical Engineer

SAT/WC/mvrd
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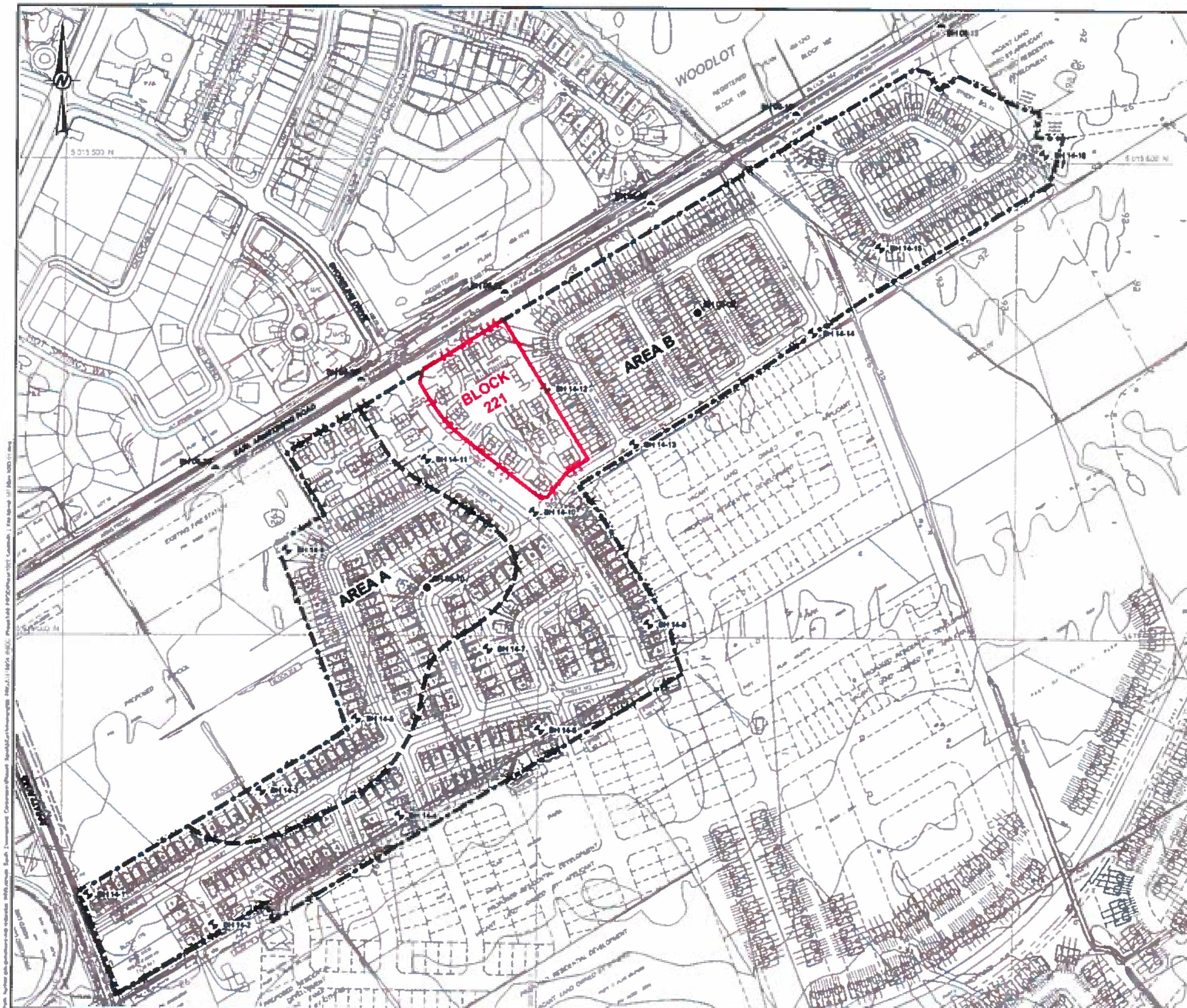
Attachment: Figure1 – Site Plan



LEGEND

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- ASSESSMENT AREA

NOTES

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REFERENCE

1. BASE PLAN SUPPLIED IN ELECTRONIC FORMAT BY ANNIS, O'SULLIVAN VOLLEBEKK LTD. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

0 100 200
1:4,000 METRES

CLIENT
RIVERSIDE SOUTH DEVELOPMENT CORPORATION

PROJECT
GEOTECHNICAL INVESTIGATION
RIVERSIDE SOUTH DEVELOPMENT (PHASE 8)
PROPOSED RESIDENTIAL DEVELOPMENT - OTTAWA, ONTARIO

TITLE
SITE PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2018-07-11
PREPARED	JM/JEM
DESIGN	—
REVIEW	SAT
APPROVED	WC

PROJECT No.	PHASE	Rev.	FIGURE
1418804	1000	0	1

Appendix E DRAWINGS