APPENDICES

Appendix A WATER SUPPLY SERVICING

A.1 DOMESTIC WATER DEMAND ESTIMATE

Blackstone South Block 428 - Domestic Water Demand Estimates

- Based on Mattamy Homes Site Plan 2019-03-22

Building ID	# of Units	PPU	Population	Daily Rate of Demand (L/day)	Avg Day Demand [2,3]		Max Day Demand [2,3]		Peak Hour Demand [2,3]	
					(L/min)	(L/s)	(L/min)	(L/s)	(L/min)	(L/s)
Block 1-18	216	2.3	497	350	120.8	2.01	301.9	5.03	664.1	11.07
Total Site :					**120.8**	**2.0**	**301.9**	**5.0**	**664.1**	**11.1**

1 Water demand criteria used to estimate peak demand rates for residential areas are as follows:

maximum day demand rate = 2.5 x average day demand rate

maximum hour demand rate = 2.2 x maximum day demand rate

A.2 FIRE FLOW REQUIRMENTS PER FUS

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401433
Project Name: Blackstone Block 428
Date: 29/8/2019
Fire Flow Calculation #: 1
Description: Stacked Residential - Block 4

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	-	470.0	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less	1	-
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	-	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%	

Step	Task	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	Value Used	Req'd Fire Flow (L/min)
7	Determine Increase for Exposures (Max. 75%)	North	20.1 to 30	20.7	3	61-90	Wood Frame or Non-Combustible	9%	4692
		East	10.1 to 20	27	3	61-90	Wood Frame or Non-Combustible	14%	
		South	10.1 to 20	20.7	3	61-90	Wood Frame or Non-Combustible	14%	
		West	20.1 to 30	27	3	61-90	Wood Frame or Non-Combustible	9%	

Step	Task	Notes	Req'd Fire Flow (L/min)
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min	15000
		Total Required Fire Flow in L/s	250.0
		Required Duration of Fire Flow (hrs)	3.00
		Required Volume of Fire Flow (m^3)	2700

FUS Fire Flow Calculation Sheet

Stantec Project #: 160401433
Project Name: Blackstone Block 428
Date: 29/8/2019
Fire Flow Calculation #: 2
Description: Stacked Residential - Block 9

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	-						470.0	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						1	-
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						-	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	27	3	61-90	Wood Frame or Non-Combustible	14%	4794
		East	3.1 to 10	20.7	3	61-90	Wood Frame or Non-Combustible	19%	
		South	> 45	27	3	61-90	Wood Frame or Non-Combustible	0%	
		West	10.1 to 20	20.7	3	61-90	Wood Frame or Non-Combustible	14%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							15000
		Total Required Fire Flow in L/s							250.0
		Required Duration of Fire Flow (hrs)							3.00
		Required Volume of Fire Flow (m^3)							2700

A.3 BOUNDARY CONDITION

44 Iber Road Boundary Conditions

Information Provided:
Date provided: April 2017

Scenario	Demand	
	L/min	L/s
Average Daily Demand	894.6	14.91
Maximum Daily Demand	2054.4	34.24
Peak Hour	4410	73.5
Fire Flow Demand (Tech Bulletin)	10000	166.66
Fire Flow Demand (Tech Bulletin)	19000	316.66

Location:

Results:

Connection 1 - Cope Drive East

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	161.6	90.8
Peak Hour	156.2	83.1
Max Day plus Fire (10,000 l/min)	154.5	80.7
Max Day plus Fire (19,000 l/min)	145.7	68.2

[1] Ground Elevation = 97.7 m

Connection 2 - Rouncey Road

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	161.5	87.9
Peak Hour	156.2	80.3
Max Day plus Fire (10,000 l/min)	155.0	78.6
Max Day plus Fire (19,000 l/min)	147.2	67.5

[1] Ground Elevation = 99.7 m

Connection 3 - Cope Drive West

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	161.5	85.5
Peak Hour	156.1	77.9
Max Day plus Fire (10,000 l/min)	152.9	73.3
Max Day plus Fire (19,000 l/min)	140.8	56.2

[1] Ground Elevation = 101.3 m

Connection 4 - Haliburton Heights

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	161.5	86.1
Peak Hour	156.2	78.5
Max Day plus Fire (10,000 l/min)	153.7	75.0
Max Day plus Fire (19,000 l/min)	143.2	60.0

[1] Ground Elevation = 100.9 m

Notes:

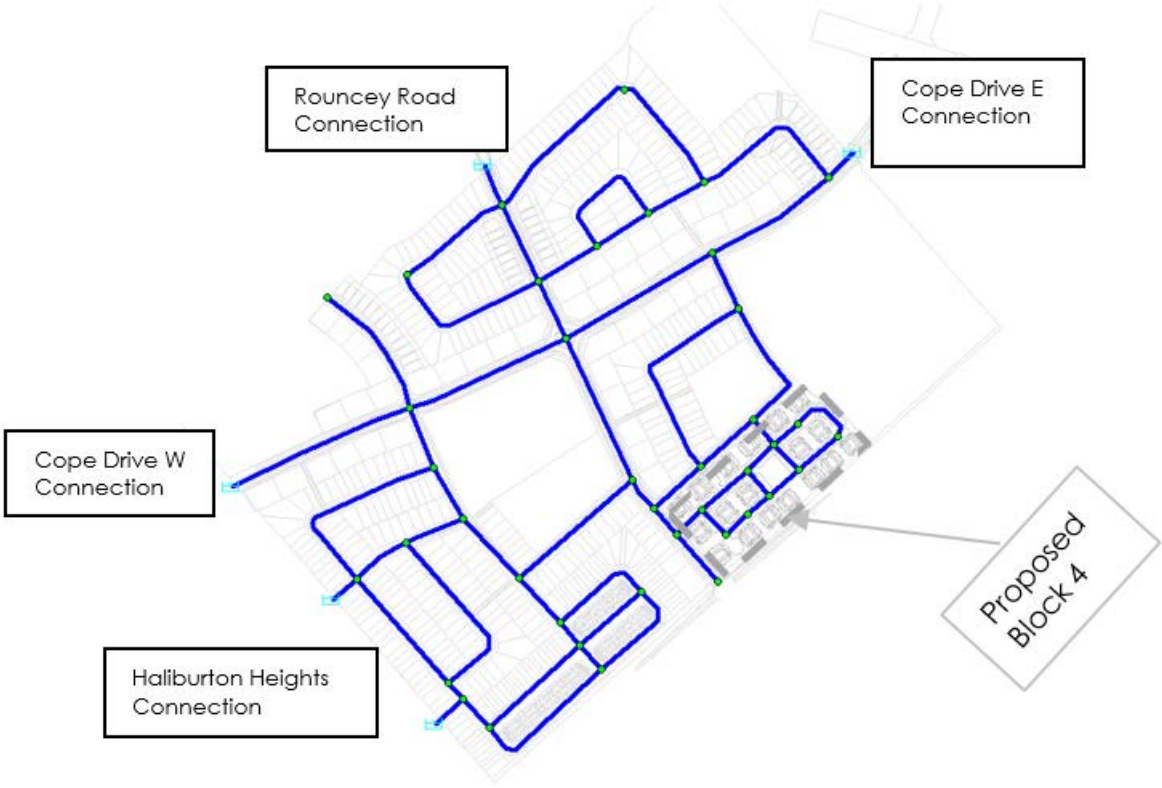
1) As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:

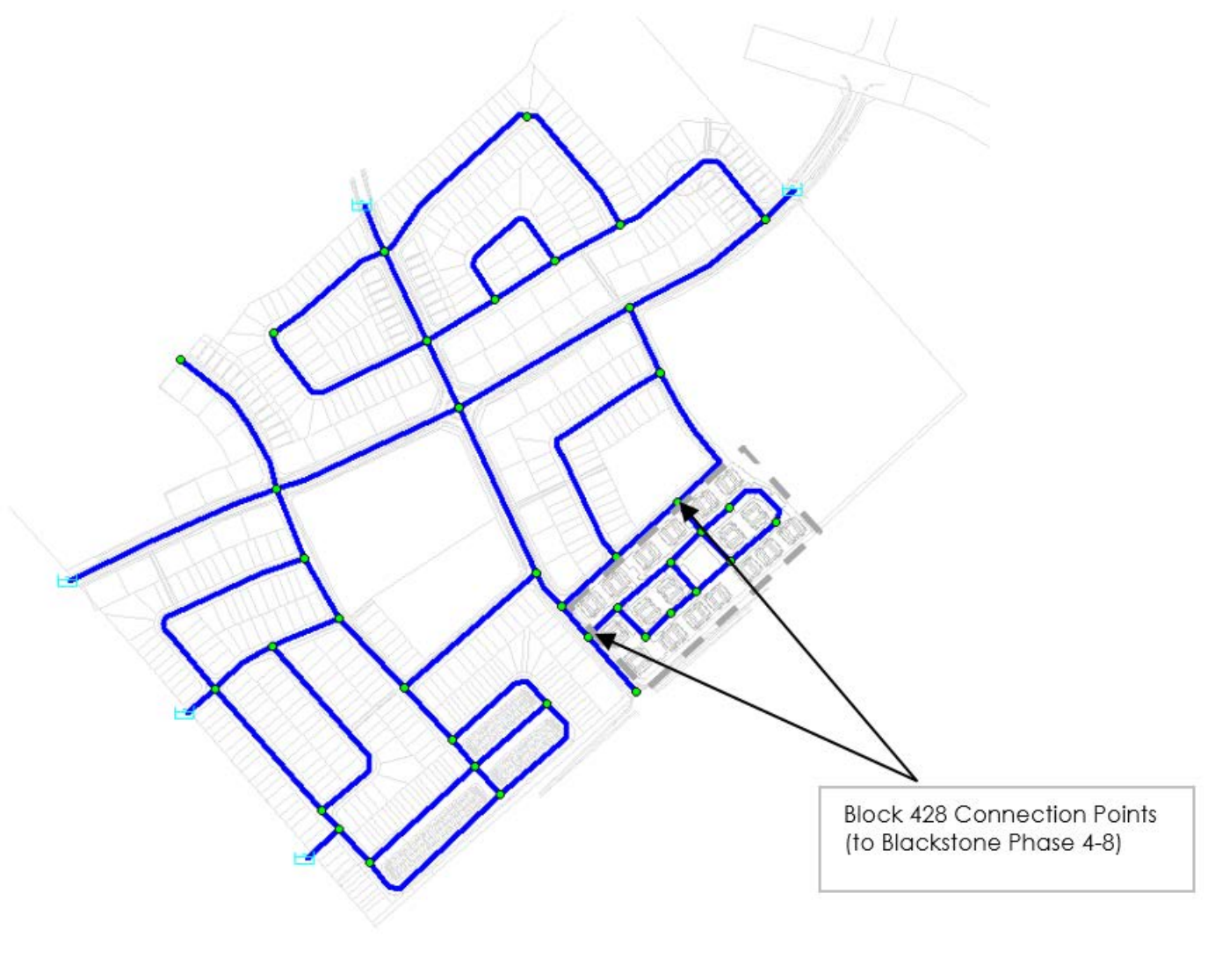
a) If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.
b) Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building,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

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.

A.4 HYDRAULIC ANALYSIS


Rouncey Road Connection
Cope Drive E Connection
Cope Drive W Connection
Haliburton Heights Connection
Proposed Block 4


Block 428 Connection Points
(to Blackstone Phase 4-8)

Hydraulic Model Results - Average Day Analysis

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
58	0.45	101.18	161.51	85.76	591.30
60	0.34	100.52	161.51	86.70	597.78
62	0.22	100.45	161.51	86.80	598.47
64	0.34	100.82	161.51	86.27	594.81
66	0.34	100.69	161.51	86.46	596.12
68	0.34	101.40	161.51	85.45	589.16
72	0.00	100.36	161.51	86.93	599.36
74	0.00	101.38	161.51	85.47	589.30
78	0.00	100.84	161.51	86.24	594.61

Pipe Results

ID	From Node	To Node	Length	Diameter	Roughness	Flow	Velocity
			(m)	(mm)		(L/s)	(m/s)
90	54	58	48.05	204	110	0.05	0.00
94	58	60	82.49	204	110	-0.37	0.01
96	60	72	50.34	204	110	-0.88	0.03
98	72	56	44.7	204	110	-1.98	0.06
100	72	66	47.62	155	100	0.42	0.02
102	66	64	69.65	204	110	-0.12	0.00
104	64	62	91.51	204	110	-0.46	0.01
106	62	72	42.99	204	110	-0.68	0.02
108	58	74	46.61	204	110	-0.03	0.00
112	74	68	41.19	204	110	-0.03	0.00
114	68	78	38.15	204	110	-0.37	0.01
116	78	60	45.08	155	100	-0.16	0.01
118	66	78	53.85	204	110	0.20	0.01

Hydraulic Model Results -Peak Hour Analysis

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
58	2.46	101.18	156.05	78.01	537.86
60	1.84	100.52	156.05	78.94	544.28
62	1.23	100.45	156.05	79.04	544.96
64	1.84	100.82	156.05	78.51	541.31
66	1.84	100.69	156.05	78.70	542.62
68	1.84	101.40	156.05	77.69	535.66
72	0.00	100.36	156.05	79.17	545.86
74	0.00	101.38	156.05	77.72	535.86
78	0.00	100.84	156.05	78.49	541.17

Pipe Results

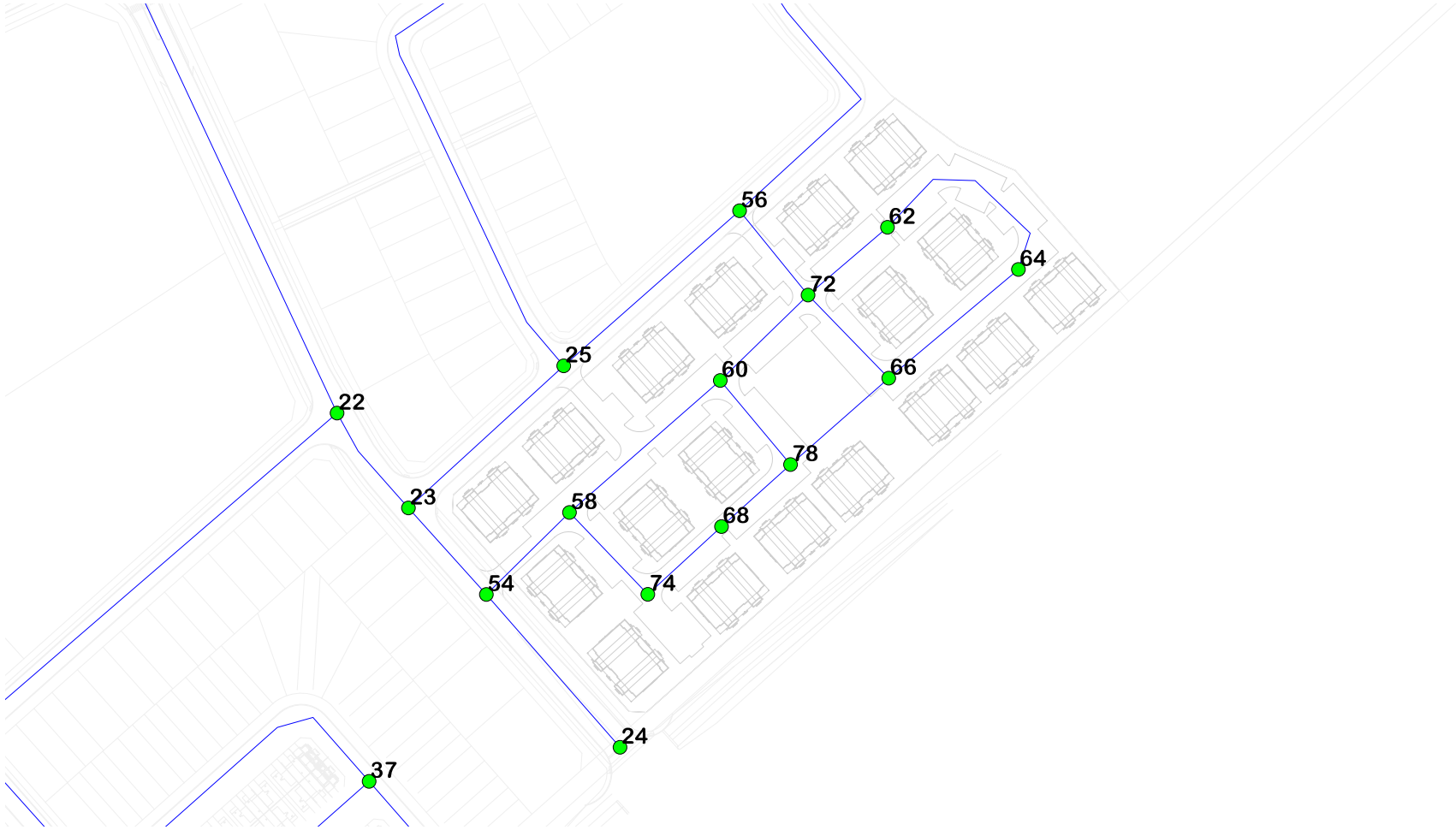
ID	From Node	To Node	Length	Diameter	Roughness	Flow	Velocity
			(m)	(mm)		(L/s)	(m/s)
90	54	58	48.05	204	110	5.15	0.16
94	58	60	82.49	204	110	0.90	0.03
96	60	72	50.34	204	110	-1.90	0.06
98	72	56	44.7	204	110	-5.90	0.18
100	72	66	47.62	155	100	1.39	0.07
102	66	64	69.65	204	110	0.47	0.01
104	64	62	91.51	204	110	-1.37	0.04
106	62	72	42.99	204	110	-2.60	0.08
108	58	74	46.61	204	110	1.79	0.05
112	74	68	41.19	204	110	1.79	0.05
114	68	78	38.15	204	110	-0.05	0.00
116	78	60	45.08	155	100	-0.96	0.05
118	66	78	53.85	204	110	-0.91	0.03

Hydraulic Model Results -Fire Flow Analysis 250 L/s (rest of system at 267 L/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)
58	1.12	66.51	458.57	147.97	250	40.45	278.89	345.9	20	137.90
60	0.84	67.46	465.12	147.98	250	39.04	269.17	333.02	20	137.90
62	0.56	67.57	465.88	147.98	250	33.13	228.42	299.45	20	137.90
64	0.84	67.04	462.23	147.98	250	28.17	194.23	278.61	20	137.90
66	0.84	67.22	463.47	147.98	250	34.42	237.32	306.74	20	137.90
68	0.84	66.21	456.50	147.97	250	32.42	223.53	298.11	20	137.90
72	0.00	67.70	466.78	147.99	250	42.38	292.20	355.39	20	137.90
74	0.00	66.23	456.64	147.97	250	33.67	232.15	303.49	20	137.90
78	0.00	67.01	462.02	147.98	250	35.44	244.35	311.67	20	137.90

JUNCTION ID

Hydraulic Analysis - Blackstone Block 428



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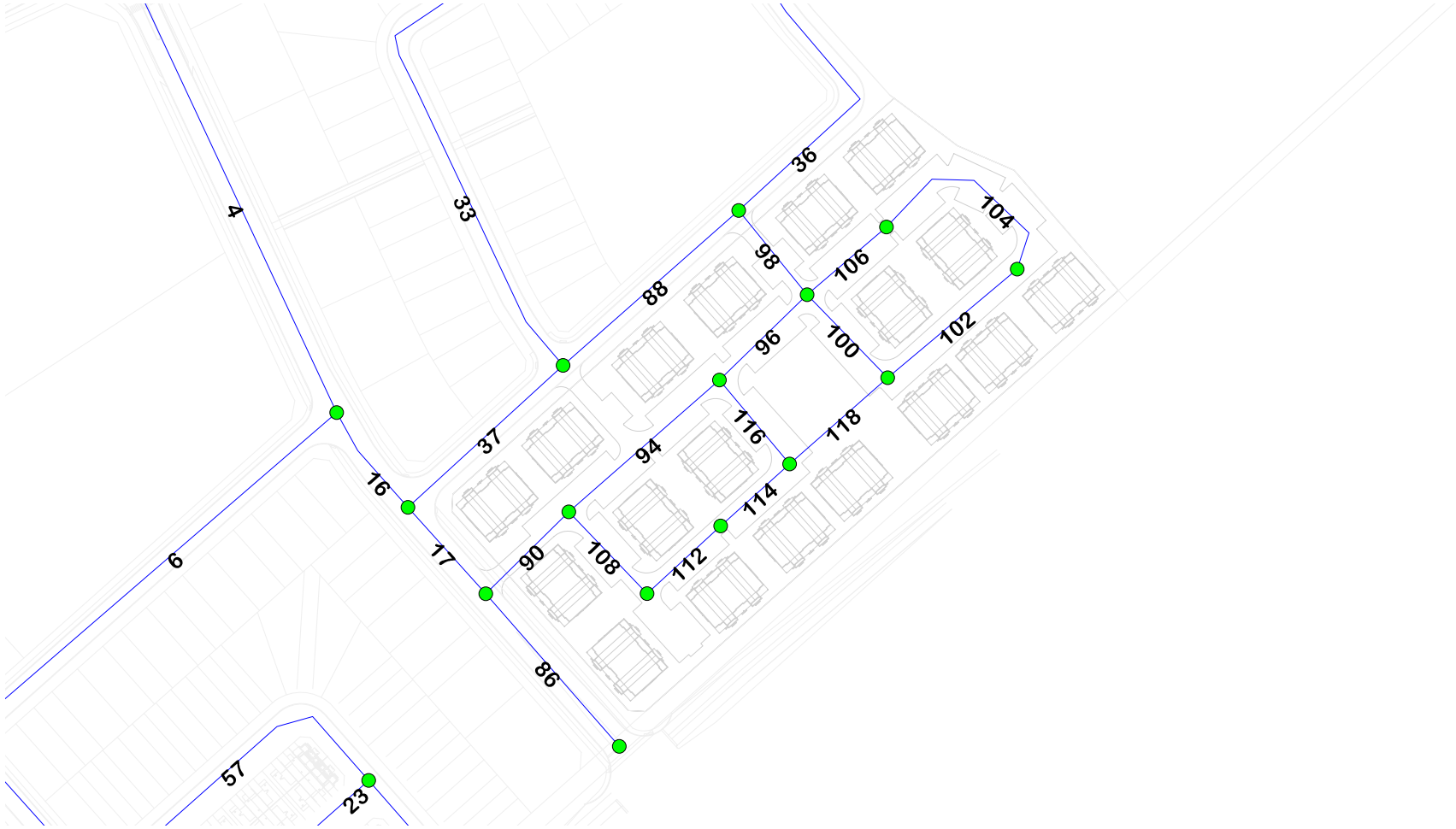
PIPE ID

Hydraulic Analysis - Blackstone Block 428



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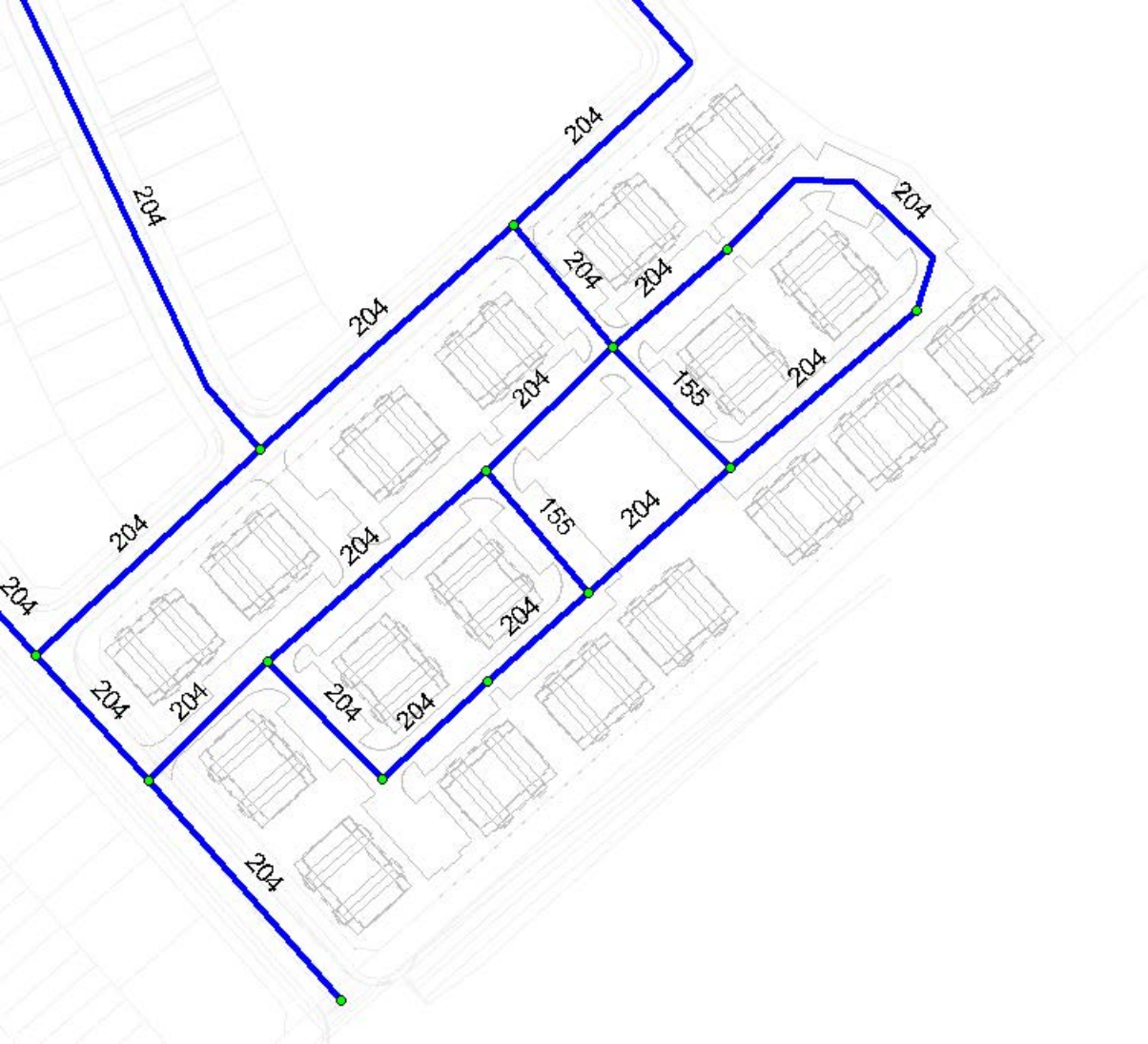
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Appendix B WASTEWATER SUPPLY SERVICING

B.1 SANITARY BACKGROUND EXCERPTS

Stantec

SUBDIVISION:

Blackstone Community Phases 4-8

DATE: 15/4/2019
REVISION: 4
DESIGNED BY: MJS
CHECKED BY: DT

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160401130

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)
R104A	104	103	0.35	0	9	0	24	0.35	24	3.69	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.35	0.35	0.1	0.41	57.7	200	PVC	SDR 35	0.50	23.6	**1.72%**	0.74	0.24
R103A	103	102	0.25	0	6	0	16	0.59	41	3.67	0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.25	0.59	0.2	0.68	42.7	200	PVC	SDR 35	0.50	23.6	**2.86%**	0.74	0.27
R102A	102	101	0.26	0	6	0	16	0.86	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	0.26	0.86	0.3	0.95	42.7	200	PVC	SDR 35	0.50	23.6	**4.03%**	0.74	0.31
R101A	101	100	0.10	0	0	0	0	0.96	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	0.10	0.96	0.3	0.99	42.8	250	PVC	SDR 35	0.50	42.9	**2.30%**	0.86	0.30
R106A	106	100	7.72	110	34	0	466	7.72	466	3.39	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	7.72	7.72	2.5	7.67	20.8	200	PVC	SDR 35	0.40	21.1	**36.25%**	0.67	0.52
I105A	105	100	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	7.40	7.40	0.00	0.00	3.6	7.40	7.40	2.4	6.04	17.6	250	PVC	SDR 35	0.50	42.9	**14.09%**	0.86	0.50
R100A	100	10	0.10	0	0	0	0	8.77	523	3.37	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.40	0.00	0.00	3.6	0.10	16.17	5.3	14.64	37.8	300	PVC	SDR 35	0.20	42.9	**34.10%**	0.61	0.46
	10	4	0.00	0	0	0	0	8.77	523	3.37	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.40	0.00	0.00	3.6	0.00	16.17	5.3	14.64	11.1	300	PVC	SDR 35	0.20	42.9	**34.10%**	0.61	0.46
Fernbank Commercial	4	3	4.24	0	0	0	0	13.01	523	3.37	5.7	3.44	3.44	0.00	0.00	0.00	0.00	0.00	7.40	0.00	0.00	5.3	7.68	23.85	7.9	18.85	62.5	300	PVC	SDR 35	0.20	42.9	**43.90%**	0.61	0.50
EXTR 10	3	2	0.20	0	0	0	0	13.21	523	3.37	5.7	0.00	3.44	0.00	0.00	0.00	0.00	0.00	7.40	0.00	0.00	5.3	0.20	24.05	7.9	18.92	70.7	300	PVC	SDR 35	0.20	42.9	**44.05%**	0.61	0.50
EXTR 11	2	1	0.28	0	0	0	0	13.49	523	3.37	5.7	0.00	3.44	0.00	0.00	0.00	0.00	0.00	7.40	0.00	0.00	5.3	0.28	24.33	8.0	19.01	70.5	300 525	PVC	SDR 35	0.20	42.9	**44.27%**	0.61	0.50
G273A	273	203A	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.35	1.35	0.0	1.35	1.35	0.4	0.45	14.9	200	PVC	SDR 35	0.50	23.6	**1.89%**	0.74	0.24
R207A	207	206	0.37	0	8	0	22	0.37	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	0.37	0.37	0.1	0.38	61.0	200	PVC	SDR 35	0.65	27.0	**1.41%**	0.85	0.26
R206A	206	205	0.41	6	0	0	20	0.78	42	3.66	0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.41	0.78	0.3	0.75	65.0	200	PVC	SDR 35	0.40	21.1	**3.57%**	0.67	0.26
R205A, R205B	205	204	0.46	0	4	0	11	1.24	53	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	0.46	1.24	0.4	1.03	49.4	200	PVC	SDR 35	0.40	21.1	**4.89%**	0.67	0.28
R204A	204	203A	0.52	0	10	0	27	1.76	80	3.62	0.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.52	1.76	0.6	1.51	73.2	200	PVC	SDR 35	0.40	21.2	**7.16%**	0.67	0.32
	203A	203	0.00	0	0	0	0	1.76	80	3.62	0.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.35	0.0	0.00	3.11	1.0	1.96	18.5	200	PVC	SDR 35	0.40	21.2	**9.27%**	0.67	0.35
I275A	275	203	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	2.84	2.84	0.00	0.00	1.4	2.84	2.84	0.9	2.32	15.0	200	PVC	SDR 35	0.50	23.6	**9.81%**	0.74	0.39
R203A	203	202	0.52	0	12	0	32	2.28	112	3.58	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	1.35	1.4	0.52	6.47	2.1	4.82	120.0	200	PVC	SDR 35	0.40	21.1	**22.79%**	0.67	0.45
R900A, External Fernbank	900	212A	8.65	0	10	0	531	8.65	531	3.37	5.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	8.65	8.65	2.9	8.65	29.8	250	PVC	SDR 35	0.27	31.5	**27.46%**	0.63	0.45
	212A	212	0.00	0	0	0	0	8.65	531	3.37	5.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	8.65	2.9	8.65	82.1	250	PVC	SDR 35	0.27	31.5	**27.46%**	0.63	0.45
R212A	212	211	0.89	0	25	0	68	9.54	599	3.35	6.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.89	9.54	3.1	9.64	118.1	250	PVC	SDR 35	0.40	38.3	**25.14%**	0.77	0.53
R211A	211	210	0.50	0	14	0	38	10.05	636	3.33	6.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.50	10.05	3.3	10.19	61.1	250	PVC	SDR 35	0.40	38.3	**26.58%**	0.77	0.55
R272A	272	271	0.43	4	8	0	35	0.43	35	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	0.43	0.43	0.1	0.56	51.9	200	PVC	SDR 35	0.50	23.6	**2.37%**	0.74	0.26
R271A	271	270	0.40	5	5	0	31	0.83	66	3.63	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.40	0.83	0.3	1.05	45.2	200	PVC	SDR 35	0.50	23.6	**4.42%**	0.74	0.32
R270A	270	269	0.38	4	6	0	30	1.21	96	3.60	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.38	1.21	0.4	1.51	45.2	200	PVC	SDR 35	1.00	33.4	**4.52%**	1.05	0.45
R269A	269	210	0.07	0	0	0	0	1.28	96	3.60	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.07	1.28	0.4	1.53	49.4	200	PVC	SDR 35	0.50	23.6	**6.49%**	0.74	0.35
R261A	261	260	0.22	0	6	0	16	0.22	16	3.71	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.22	0.22	0.1	0.27	43.6	200	PVC	SDR 35	0.65	27.0	**1.00%**	0.85	0.23
R260A	260	249	0.39	0	10	0	27	0.62	43	3.66	0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.39	0.62	0.2	0.72	82.0	200	PVC	SDR 35	0.40	21.1	**3.39%**	0.67	0.26
R249A	249	239	0.84	0	28	0	76	1.46	119	3.58	1.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.84	1.46	0.5	1.86	105.3	200	PVC	SDR 35	0.40	21.1	**8.79%**	0.67	0.34
R239A	239	238	0.79	0	22	0	59	2.25	178	3.53	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.79	2.25	0.7	2.78	88.5	200	PVC	SDR 35	0.40	21.1	**13.16%**	0.67	0.38
R238A	238	237	0.71	15	0	0	51	2.97	229	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	0.71	2.97	1.0	3.58	92.3	200	PVC	SDR 35	0.40	21.1	**16.92%**	0.67	0.41
R237A	237	236	0.23	2	0	0	7	3.20	236	3.50	2.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.23	3.20	1.1	3.73	14.8	200	PVC	SDR 35	0.40	21.1	**17.64%**	0.67	0.42
R236A	236	235	0.69	12	0	0	41	3.89	277	3.47	3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.69	3.89	1.3	4.40	92.2	200	PVC	SDR 35	0.40	21.1	**20.80%**	0.67	0.44
R235A	235	234	0.43	8	0	0	27	4.31	304	3.46	3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.43	4.31	1.4	4.83	44.3	200	PVC	SDR 35	0.40	21.1	**22.85%**	0.67	0.45
R234A	234	233	0.27	5	0	0	17	4.58	321	3.45	3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.27	4.58	1.5	5.10	43.0	200	PVC	SDR 35	0.40	21.1	**24.13%**	0.67	0.46
R244A	244	243	0.06	1	0	0	3	0.06	3	3.76	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.06	0.06	0.0	0.06	10.3	200	PVC	SDR 35	1.00	33.4	**0.18%**	1.05	0.17
R243A	243	242	0.19	3	0	0	10	0.25	14	3.72	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.19	0.25	0.1	0.25	36.9	200	PVC	SDR 35	1.00	33.4	**0.74%**	1.05	0.26
R249B	249	248	0.38	6	0	0	20	0.38	20	3.70	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.38	0.38	0.1	0.37	75.1	200	PVC	SDR 35	1.00	33.4	**1.11%**	1.05	0.30
R248A	248	247	0.13	1	0	0	3	0.51	24	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	0.13	0.51	0.2	0.45	9.8	200	PVC	SDR 35	1.00	33.4	**1.36%**	1.05	0.30
R247A	247	246	0.78	15	0	0	51	1.29	75	3.62	0.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.78	1.29	0.4	1.30	88.1	200	PVC	SDR 35	0.40	21.1	**6.17%**	0.67	0.30
R246A	246	245	0.65	12	0	0	41	1.94	116	3.58	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.65	1.94	0.6	1.98	79.6	200	PVC	SDR 35	0.40	21.1	**9.37%**	0.67	0.35
	245	242	0.00	0	0	0	0	1.94	116	3.58	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	1.94	0.6	1.98	7.9	200	PVC	SDR 35	0.40	21.1	**9.37%**	0.67	0.35
R242A	242	250	0.36	5	0	0	17	2.55	146	3.56	1.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.36	2.55	0.8	2.53	83.3	200	PVC	SDR 35	1.00	33.5	**7.54%**	1.05	0.51
R266A	266	263	0.33	0	13	0	35	0.33	35	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	0.33	0.33	0.1	0.53	103.7	200	PVC	SDR 35	0.40	21.1	**2.49%**	0.67	0.24
R265A	265	264	0.22	0	10	0	27	0.22	27	3.69	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.22	0.22	0.1	0.40	70.3	200	PVC	SDR 35	0.65	27.0	**1.47%**	0.85	0.26
R264A	264	263	0.22	0	10	0	27	0.44	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	0.22	0.44	0.1	0.78	83.6	200	PVC	SDR 35	1.00	33.4	**2.35%**	1.05	0.36
	263	258	0.00	0	0	0	0	0.77	89	3.61	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.77	0.3	1.30	44.3	200	PVC	SDR 35	0.40	21.1	**6.13%**	0.67	0.30
R262A	262	258	0.51	0	26	0	70	0.51	70	3.63	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.51	0.51	0.2	0.99	104.2	200	PVC	SDR 35	0.40	21.1	**4.69%**	0.67	0.28
R260B	260	259	0.48	0	20	0	54	0.48	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	0.48	0.48	0.2	0.80	83.3	200	PVC	SDR 35	0.90	31.7	**2.51%**	1.00	0.36
R259A	259	258	0.48	0	20	0	54	0.97	108	3.59	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.48	0.97	0.3	1.57	83.4	200	PVC	SDR 35	0.90	31.7	**4.96%**	1.00	0.43
	258	254	0.00	0	0	0	0	2.24	267	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	2.24	0.7	3.75	45.0	200	PVC	SDR 35	0.40	21.1	**17.75%**	0.67	0.42

Stantec

SUBDIVISION:

Blackstone Community Phases 4-8

DATE: 15/4/2019
REVISION: 4
DESIGNED BY: MJS
CHECKED BY: DT

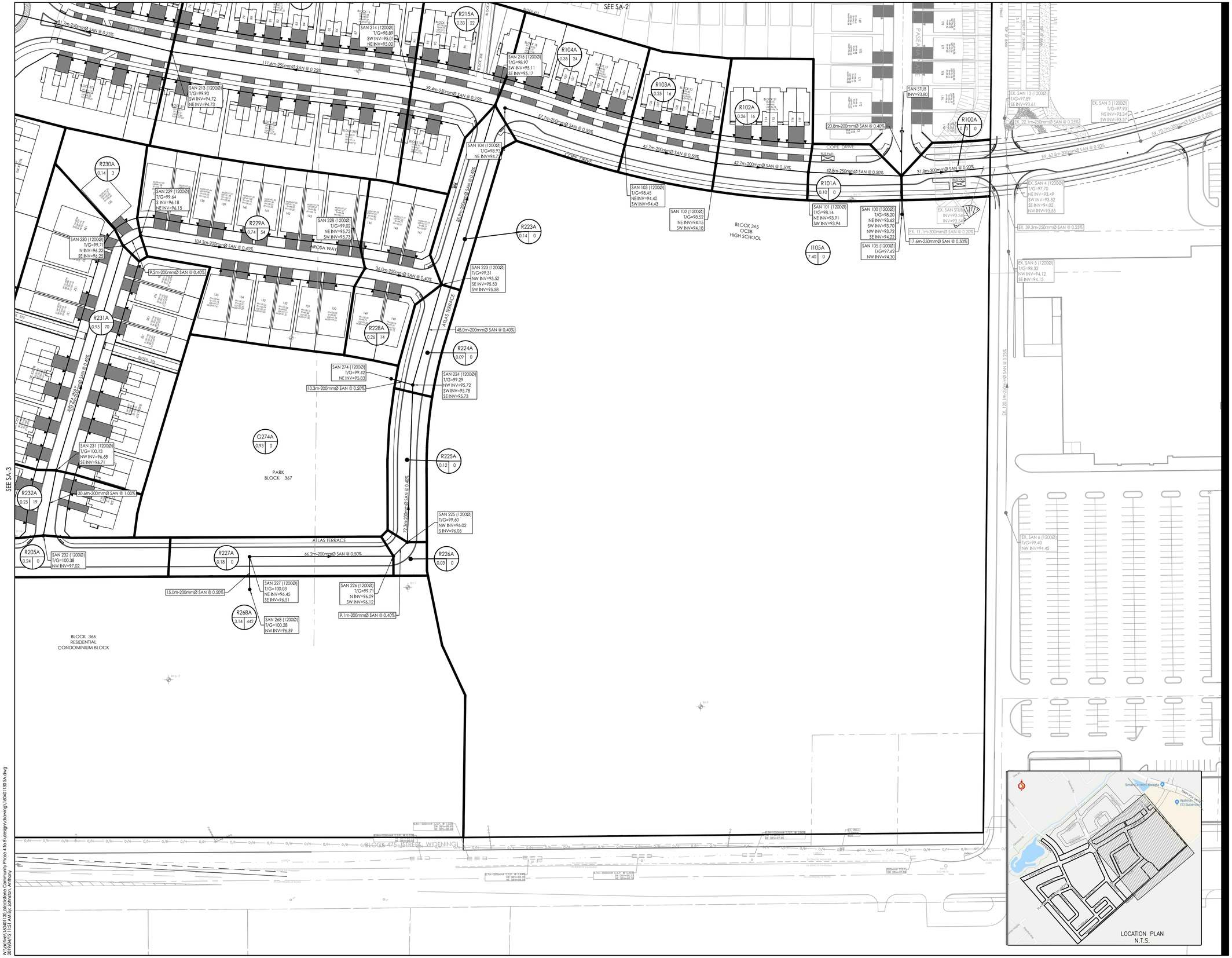
SANITARY SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160401130

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)
R257A	257	256	0.46	0	13	0	35	0.46	35	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	0.46	0.46	0.2	0.57	82.4	200	PVC	SDR 35	0.40	21.1	**2.70%**	0.67	0.24
R256A	256	255	0.16	0	3	0	8	0.62	43	3.66	0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.16	0.62	0.2	0.72	11.8	200	PVC	SDR 35	0.40	21.1	**3.39%**	0.67	0.26
R255A	255	254	0.71	0	27	0	73	1.33	116	3.58	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.71	1.33	0.4	1.79	109.7	200	PVC	SDR 35	0.40	21.1	**8.44%**	0.67	0.34
R254A	254	251	0.44	8	0	0	27	4.01	411	3.41	4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.44	4.01	1.3	5.87	82.0	200	PVC	SDR 35	0.40	21.1	**27.74%**	0.67	0.47
R253A	253	252	0.45	7	0	0	24	0.45	24	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	0.45	0.45	0.1	0.43	81.0	200	PVC	SDR 35	0.65	27.0	**1.61%**	0.85	0.26
R252A	252	251	0.48	8	0	0	27	0.93	51	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	0.48	0.93	0.3	0.91	102.4	200	PVC	SDR 35	0.40	21.1	**4.31%**	0.67	0.27
R251A	251	250	0.85	16	0	0	54	5.80	516	3.37	5.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.85	5.80	1.9	7.55	109.6	200	PVC	SDR 35	0.40	21.1	**35.72%**	0.67	0.51
	250	240	0.00	0	0	0	0	8.35	662	3.33	7.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	8.35	2.8	9.89	14.6	200	PVC	SDR 35	0.40	21.1	**46.78%**	0.67	0.56
R240A	240	233	0.12	0	0	0	0	8.46	662	3.33	7.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.12	8.46	2.8	9.93	68.3	200	PVC	SDR 35	0.40	21.1	**46.97%**	0.67	0.56
R233A	233	210	0.13	0	0	0	0	13.18	983	3.24	10.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.13	13.18	4.3	14.69	86.9	200	PVC	SDR 35	0.40	21.1	**69.44%**	0.67	0.63
	210	209	0.00	0	0	0	0	24.50	1715	3.11	17.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	24.50	8.1	25.37	56.0	300	PVC	SDR 35	0.20	42.9	**59.08%**	0.61	0.55
	209	208	0.00	0	0	0	0	24.50	1715	3.11	17.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	24.50	8.1	25.37	56.0	300	PVC	SDR 35	0.20	42.9	**59.08%**	0.61	0.55
	208	202	0.00	0	0	0	0	24.50	1715	3.11	17.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	24.50	8.1	25.37	120.0	300	PVC	SDR 35	0.20	42.9	**59.08%**	0.61	0.55
R268A	268	227	3.14	0	0	0	442	3.14	442	3.40	4.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	3.14	3.14	1.0	5.91	15.0	200	PVC	SDR 35	0.50	23.6	**24.99%**	0.74	0.51
R227A	227	226	0.18	0	0	0	0	3.32	442	3.40	4.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.18	3.32	1.1	5.97	66.2	200	PVC	SDR 35	0.50	23.6	**25.24%**	0.74	0.51
R226A	226	225	0.03	0	0	0	0	3.35	442	3.40	4.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.03	3.35	1.1	5.98	9.1	200	PVC	SDR 35	0.40	21.1	**28.26%**	0.67	0.48
R225A	225	224	0.12	0	0	0	0	3.47	442	3.40	4.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.12	3.47	1.1	6.02	72.3	200	PVC	SDR 35	0.40	21.1	**28.45%**	0.67	0.48
G274A	274	224	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.93	0.0	0.93	0.93	0.3	0.31	10.3	200	PVC	SDR 35	0.50	23.6	**1.29%**	0.74	0.21
R224A	224	223	0.09	0	0	0	0	3.56	442	3.40	4.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.0	0.09	4.48	1.5	6.35	48.0	200	PVC	SDR 35	0.40	21.1	**30.03%**	0.67	0.49
R232A	232	231	0.25	0	7	0	19	0.25	19	3.71	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.25	0.25	0.1	0.31	30.6	200	PVC	SDR 35	1.00	33.4	**0.93%**	1.05	0.28
R231A	231	230	0.95	8	16	0	70	1.20	89	3.61	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.95	1.20	0.4	1.44	107.8	200	PVC	SDR 35	0.40	21.1	**6.80%**	0.67	0.31
R230A	230	229	0.14	1	0	0	3	1.34	93	3.60	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.14	1.34	0.4	1.52	9.2	200	PVC	SDR 35	0.40	21.1	**7.20%**	0.67	0.32
R229A	229	228	0.74	16	0	0	54	2.07	147	3.56	1.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.74	2.07	0.7	2.38	104.3	200	PVC	SDR 35	0.40	21.1	**11.25%**	0.67	0.36
R228A	228	223	0.26	4	0	0	14	2.33	161	3.54	1.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.26	2.33	0.8	2.62	36.0	200	PVC	SDR 35	0.40	21.1	**12.37%**	0.67	0.37
R223A	223	215	0.14	0	0	0	0	6.03	603	3.34	6.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.0	0.14	6.96	2.3	8.83	85.9	200	PVC	SDR 35	0.40	21.1	**41.75%**	0.67	0.54
R215A	215	214	0.33	0	8	0	22	6.36	624	3.34	6.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.0	0.33	7.29	2.4	9.16	39.4	250	PVC	SDR 35	0.25	30.3	**30.21%**	0.61	0.45
R214A	214	213	1.01	0	31	0	84	7.37	708	3.31	7.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.0	1.01	8.30	2.7	10.34	111.6	250	PVC	SDR 35	0.25	30.3	**34.11%**	0.61	0.46
R213A	213	202	0.66	0	17	0	46	8.03	754	3.30	8.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.93	0.0	0.66	8.96	3.0	11.02	81.7	250	PVC	SDR 35	0.25	30.3	**36.35%**	0.61	0.47
R219A	219	218	0.30	0	7	0	19	0.30	19	3.71	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.30	0.30	0.1	0.33	47.6	200	PVC	SDR 35	0.65	27.0	**1.21%**	0.85	0.24
R218A	218	217	0.28	0	7	0	19	0.58	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	0.28	0.58	0.2	0.64	47.6	200	PVC	SDR 35	0.40	21.1	**3.03%**	0.67	0.25
R217A	217	216	0.70	0	16	0	43	1.28	81	3.61	0.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.70	1.28	0.4	1.37	120.0	200	PVC	SDR 35	0.40	21.1	**6.48%**	0.67	0.31
	216	202	0.00	0	0	0	0	1.28	81	3.61	0.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	1.28	0.4	1.37	5.2	200	PVC	SDR 35	0.40	21.1	**6.48%**	0.67	0.31
R202A	202	201	0.17	0	0	0	0	36.26	2662	2.99	25.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	2.28	0.9	0.17	41.38	13.7	40.36	86.1	375	PVC	SDR 35	0.20	72.6	**55.60%**	0.69	0.61
	201	200	0.00	0	0	0	0	36.26	2662	2.99	25.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	2.28	0.9	0.00	41.38	13.7	40.36	115.0	375	PVC	SDR 35	0.20	72.6	**55.60%**	0.69	0.61
R267A	267	220	1.66	28	0	0	95	1.66	95	3.60	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	1.66	1.66	0.5	1.66	15.5	200	PVC	SDR 35	0.50	23.6	**7.01%**	0.74	0.36
R222A	222	221	1.36	23	0	0	78	1.36	78	3.62	0.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	1.36	1.36	0.4	1.37	15.6	200	PVC	SDR 35	0.50	23.6	**5.78%**	0.74	0.34
R221A	221	220	0.93	16	0	0	54	2.29	133	3.57	1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.93	2.29	0.8	2.29	115.0	200	PVC	SDR 35	1.00	33.4	**6.84%**	1.05	0.49
	220	200	0.00	0	0	0	0	3.95	228	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	3.95	1.3	3.89	2.5	200	PVC	SDR 35	0.50	23.6	**16.44%**	0.74	0.46
	200	303-1	0.00	0	0	0	0	40.20	2890	2.96	27.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	2.28	0.9	0.00	45.32	15.0	43.65	15.3	375	PVC	SDR 35	0.20	72.7	**60.05%**	0.69	0.62
	303-2	303-1	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	0.00	10.9	450	PVC	SDR 35	0.20	134.5	**0.00%**	0.82	0.00
R303-1A	303-1	303	0.11	0	0	0	0	40.32	2890	2.96	27.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	2.28	0.9	0.11	45.44	15.0	43.68	85.5	450	PVC	SDR 35	0.20	134.4	**32.49%**	0.82	0.61
	303	302	0.00	0	0	0	0	40.32	2890	2.96	27.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	2.28	0.9	0.00	45.44	15.0	43.68	80.8	450	PVC	SDR 35	0.20	134.4	**32.49%**	0.82	0.61
																												450							



Stantec

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Legend

- PROPOSED SANITARY SEWER
- R100A / 0.38 / 14 — SANITARY DRAINAGE AREA ID# / POPULATION / SANITARY DRAINAGE AREA ha.
- SANITARY DRAINAGE BOUNDARY
- FUTURE SANITARY SEWER
- R100A / 0.38 / 14 — FUTURE SANITARY DRAINAGE AREA ID# / FUTURE POPULATION / FUTURE SANITARY DRAINAGE AREA ha.
- FUTURE SANITARY DRAINAGE BOUNDARY

Revision		By	Appd.	YY.MM.DD
11	REVISED AS PER NEW DRAFT PLAN	MJS	DT	19.04.11
10	REVISED AS PER CITY COMMENTS	AJ	DT	19.03.04
9	ISSUED FOR GRADING APPROVAL	AJ	DT	19.01.09
8	ISSUED FOR TENDER	AJ	DT	18.12.12
7	REVISED HYDRANT LOCATION @ BLOCK 450	AJ	DT	18.11.23
6	REVISED AS PER UTILITY COORDINATION	MJS	DT	18.11.07
5	REVISED AS PER CITY COMMENTS	AJ	DT	18.11.01
4	ISSUED FOR 3RD SUBMISSION	MJS	DT	18.10.02
3	ISSUED FOR COORDINATION	SG	SG	18.09.17
2	ISSUED FOR 2ND SUBMISSION	MJS	DT	18.08.01
1	ISSUED FOR 1ST SUBMISSION	MJS	DT	18.04.25

File Name: 160401130-SA	MJS	DT	DT	18.01.02
Permit-Seal	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Client/Project

2129786 ONTARIO INC.
MATTAMY (MONARCH) LTD.

BLACKSTONE COMMUNITY
PHASE 4-8

OTTAWA, ON, CANADA

Title

SANITARY DRAINAGE PLAN

Project No.	Scale	Drawing No.	Sheet	Revision
160401130	1:750	SA-4	58 of 66	11

D07-16-17-0014

DWG# 17625

W:\active\160401130_blackstone_community_Phase 4 to 8\design\drawing\160401130-SA.dwg
30-Oct-2018 11:19 AM by: JOHNSON, Anthony

ORIGINAL SHEET - ARCH D

B.2 SANITARY SEWER DESIGN SHEET

Stantec

SUBDIVISION:

BLOCK 428

DATE: 29/8/2019
REVISION: 2
DESIGNED BY: MJS
CHECKED BY: TR

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160401433

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	2.3	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)
R203A	203	202	0.20	0	12	0	28	0.20	28	3.69	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.20	0.20	0.1	0.4	28.3	200	PVC	SDR 35	0.35	19.8	**2.01%**	0.62	0.20
R202A	202	201	0.45	0	36	0	83	0.65	110	3.59	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.45	0.65	0.2	1.5	87.1	200	PVC	SDR 35	0.35	19.8	**7.58%**	0.62	0.31
R201A	201	200	0.17	0	12	0	28	0.82	138	3.56	1.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.17	0.82	0.3	1.9	47.5	200	PVC	SDR 35	0.35	19.8	**9.43%**	0.62	0.32
R204A	204	200	0.35	0	24	0	55	0.35	55	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	0.35	0.35	0.1	0.8	73.5	200	PVC	SDR 35	0.35	19.8	**3.89%**	0.62	0.26
R208A	208	207	0.17	0	12	0	28	0.17	28	3.69	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.17	0.17	0.1	0.4	25.2	200	PVC	SDR 35	0.35	19.8	**1.95%**	0.62	0.20
R207B	207	206	0.28	0	24	0	55	0.44	83	3.61	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.28	0.44	0.1	1.1	47.0	200	PVC	SDR 35	0.35	19.8	**5.64%**	0.62	0.28
R211A	211	206	0.16	0	12	0	28	0.16	28	3.69	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.16	0.16	0.1	0.4	28.8	200	PVC	SDR 35	0.35	19.8	**1.93%**	0.62	0.20
R206A	206	205	0.39	0	24	0	55	0.99	166	3.54	1.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.39	0.99	0.3	2.2	83.2	200	PVC	SDR 35	0.35	19.8	**11.26%**	0.62	0.34
R207A	207	209	0.31	0	24	0	55	0.31	55	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	0.31	0.31	0.1	0.8	83.1	200	PVC	SDR 35	0.45	22.4	**3.36%**	0.71	0.27
R210A	210	209	0.13	0	12	0	28	0.13	28	3.69	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.13	0.13	0.0	0.4	22.3	200	PVC	SDR 35	0.35	19.8	**1.89%**	0.62	0.20
R209A	209	205	0.17	0	12	0	28	0.61	110	3.59	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.17	0.61	0.2	1.5	47.1	200	PVC	SDR 35	0.35	19.8	**7.50%**	0.62	0.30
R205A	205	200	0.29	0	12	0	28	1.89	304	3.46	3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.29	1.89	0.6	4.0	48.5	200	PVC	SDR 35	0.35	19.8	**20.36%**	0.62	0.40
G200A	200	268	0.00	0	0	0	0	3.07	497	3.38	5.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.0	0.07	3.14	1.0	6.5	30.7	200	PVC	SDR 35	0.35	19.8	**32.75%**	0.62	0.47
																												200								

Appendix C STORMWATER MANAGMENT

C.1 STORM SEWER DESIGN SHEET

Stantec

BLOCK 428

DATE: 2019-08-29
REVISION: 2
DESIGNED BY: MJS
CHECKED BY: TR

STORM SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160401433

DESIGN PARAMETERS

$I = a / (t+b)^c$ (As per City of Ottawa Guidelines, 2012)

	1:2 yr	1:5 yr	1:10 yr	1:100 yr
a =	732.951	998.071	1174.184	1735.688
b =	6.199	6.053	6.014	6.014
c =	0.810	0.814	0.816	0.820

MANNING'S n = 0.013 BEDDING CLASS = B
MINIMUM COVER: 2.00 m
TIME OF ENTRY 10 min

LOCATION			DRAINAGE AREA																							PIPE SELECTION											
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)	LENGTH (m)	PIPE WIDTH OR DIAMETEI (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)
L2002A, L2002B	2002	2001	0.311	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.243	0.243	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	51.8	69.2	375	375	CIRCULAR	PVC	-	0.35	97.5	**53.07%**	0.92	0.81	1.43
L2001B, L2001A	2001	2000	0.371	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.215	0.457	0.000	0.000	0.000	0.000	0.000	0.000	11.43	71.71	97.20	113.90	166.46	0.0	0.0	91.1	50.5	450	450	CIRCULAR	CONCRETE	-	0.35	176.0	**51.78%**	1.07	0.93	0.91
																				12.34																			
L2004A	503	2004	0.151	0.00	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.124	0.124	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	26.4	13.3	200	200	CIRCULAR	PVC	-	1.00	33.3	**79.31%**	1.05	1.03	0.21
	2004	2003	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.124	0.000	0.000	0.000	0.000	0.000	0.000	10.21	75.99	103.08	120.83	176.63	0.0	0.0	26.1	7.8	250	250	CIRCULAR	PVC	-	1.00	60.4	**43.28%**	1.22	1.00	0.13
L2003A, L2003B	2003	2000	0.348	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.277	0.401	0.000	0.000	0.000	0.000	0.000	0.000	10.34	75.51	102.41	120.04	175.47	0.0	0.0	84.0	76.5	375	375	CIRCULAR	PVC	-	0.40	104.3	**80.61%**	0.99	0.97	1.31
																				11.65																			
L2007B	515	2007	0.119	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00	0.101	0.101	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	21.6	12.2	200	200	CIRCULAR	PVC	-	1.00	33.3	**64.79%**	1.05	0.97	0.21
L2007A	2007	2006	0.158	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.125	0.226	0.000	0.000	0.000	0.000	0.000	0.000	10.21	76.01	103.09	120.85	176.66	0.0	0.0	47.7	51.0	300	300	CIRCULAR	PVC	-	0.40	60.8	**78.45%**	0.86	0.85	1.00
																				11.21																			
L2006D	517	2006	0.105	0.00	0.00	0.00	0.00	0.82	0.00	0.00	0.00	0.086	0.086	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	18.4	10.5	200	200	CIRCULAR	PVC	-	1.00	33.3	**55.15%**	1.05	0.92	0.19
																				10.19																			
L2006A, L2006B, L2006C	2006	2005	0.367	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.289	0.601	0.000	0.000	0.000	0.000	0.000	0.000	11.21	72.44	98.19	115.07	168.17	0.0	0.0	121.0	86.2	450	450	CIRCULAR	CONCRETE	-	0.35	176.0	**68.75%**	1.07	1.01	1.42
																				12.64																			
L2009B	511	2009	0.162	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.130	0.130	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	27.6	12.7	200	200	CIRCULAR	PVC	-	1.00	33.3	**83.01%**	1.05	1.04	0.20
L2009A	2009	2008	0.147	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.115	0.244	0.000	0.000	0.000	0.000	0.000	0.000	10.20	76.03	103.13	120.89	176.72	0.0	0.0	51.6	45.9	300	300	CIRCULAR	PVC	-	0.45	64.5	**79.98%**	0.92	0.90	0.85
L2008A	2008	2005	0.129	0.00	0.00	0.00	0.00	0.84	0.00	0.00	0.00	0.108	0.353	0.000	0.000	0.000	0.000	0.000	0.000	11.05	72.99	98.95	115.97	169.49	0.0	0.0	71.5	50.1	375	375	CIRCULAR	PVC	-	0.35	97.5	**73.31%**	0.92	0.89	0.94
																				11.99																			
L2005A	2005	2000	0.208	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.167	1.121	0.000	0.000	0.000	0.000	0.000	0.000	12.64	67.97	92.06	107.85	157.58	0.0	0.0	211.6	45.6	525	525	CIRCULAR	CONCRETE	-	0.35	265.4	**79.71%**	1.19	1.17	0.65
																				13.29																			
L2000A	2000	1022	0.072	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.056	2.035	0.000	0.000	0.000	0.000	0.000	0.000	13.29	66.13	89.54	104.89	153.22	0.0	0.0	373.8	27.7	600	600	CIRCULAR	CONCRETE	-	0.50	452.9	**82.53%**	1.55	1.55	0.30
																				13.58									600	600									

C.2 RATIONAL METHOD CALCULATIONS

Stormwater Management Calculations

File No: **160401433**
Project: **Blackstone Block 366**
Date: **29-Aug-19**

SWM Approach:
Post-development to Pre-development flows

Post-Development Site Conditions:

Overall Runoff Coefficient for Site and Sub-Catchment Areas

Runoff Coefficient Table

Catchment Type	Sub-catchment Area ID / Description		Area (ha) "A"		Runoff Coefficient "C"	"A x C"		Overall Runoff Coefficient
Controlled - Tributary	L2006D	Hard	0.09		0.90	0.08		
		Soft	0.01		0.20	0.00		
		Subtotal		0.105			0.09	0.82
Controlled - Tributary	L2009B	Hard	0.14		0.90	0.12		
		Soft	0.02		0.20	0.00		
		Subtotal		0.162			0.13	0.80
Controlled - Tributary	L2009A	Hard	0.12		0.90	0.11		
		Soft	0.03		0.20	0.01		
		Subtotal		0.147			0.11	0.78
Controlled - Tributary	L2008A	Hard	0.12		0.90	0.11		
		Soft	0.01		0.20	0.00		
		Subtotal		0.129			0.11	0.84
Controlled - Tributary	L2007B	Hard	0.11		0.90	0.10		
		Soft	0.01		0.20	0.00		
		Subtotal		0.119			0.10	0.85
Controlled - Tributary	L2007A	Hard	0.13		0.90	0.12		
		Soft	0.02		0.20	0.00		
		Subtotal		0.158			0.13	0.79
Controlled - Tributary	L2006C	Hard	0.13		0.90	0.12		
		Soft	0.02		0.20	0.00		
		Subtotal		0.146			0.12	0.82
Controlled - Tributary	L2006B	Hard	0.03		0.90	0.03		
		Soft	0.01		0.20	0.00		
		Subtotal		0.038			0.03	0.75
Controlled - Tributary	L2006A	Hard	0.15		0.90	0.13		
		Soft	0.03		0.20	0.01		
		Subtotal		0.183			0.14	0.77
Controlled - Tributary	L2005A	Hard	0.18		0.90	0.16		
		Soft	0.03		0.20	0.01		
		Subtotal		0.208			0.17	0.80
Controlled - Tributary	L2004A	Hard	0.13		0.90	0.12		
		Soft	0.02		0.20	0.00		
		Subtotal		0.151			0.12	0.82
Controlled - Tributary	L2003B	Hard	0.14		0.90	0.12		
		Soft	0.03		0.20	0.01		
		Subtotal		0.168			0.13	0.77
Controlled - Tributary	L2003A	Hard	0.16		0.90	0.14		
		Soft	0.02		0.20	0.00		
		Subtotal		0.180			0.15	0.81
Controlled - Tributary	L2002B	Hard	0.14		0.90	0.13		
		Soft	0.03		0.20	0.01		
		Subtotal		0.171			0.13	0.78
Controlled - Tributary	L2002A	Hard	0.12		0.90	0.10		
		Soft	0.02		0.20	0.00		
		Subtotal		0.140			0.11	0.78
Controlled - Tributary	L2001B	Hard	0.05		0.90	0.05		
		Soft	0.15		0.20	0.03		
		Subtotal		0.207			0.08	0.38
Controlled - Tributary	L2001A	Hard	0.15		0.90	0.13		
		Soft	0.02		0.20	0.00		
		Subtotal		0.164			0.14	0.83
Controlled - Tributary	L2000A	Hard	0.06		0.90	0.05		
		Soft	0.01		0.20	0.00		
		Subtotal		0.072			0.06	0.78
Uncontrolled - Tributary	UNC-1	Hard	0.10		0.90	0.09		
		Soft	0.38		0.20	0.08		
		Subtotal		0.489			0.17	0.35
Total				**3.14**			**2.21**	
Overall Runoff Coefficient= C:								**0.70**

Total Roof Areas	**0.000 ha**
Total Tributary Surface Areas (Controlled and Uncontrolled)	**3.141 ha**
Total Tributary Area to Outlet	**3.141 ha**
Total Uncontrolled Areas (Non-Tributary)	**0.000 ha**
Total Site	**3.141 ha**

Stormwater Management Calculations

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

2 yr Intensity $I = a/(t + b)^c$
City of Ottawa

a =	732.951
b =	6.199
c =	0.81

t (min)	I (mm/hr)
10	76.81
20	52.03
30	40.04
40	32.86
50	28.04
60	24.56
70	21.91
80	19.83
90	18.14
100	16.75
110	15.57
120	14.56

2 YEAR Predevelopment Target Release from Portion of Site

Subdrainage Area: Predevelopment Tributary Area to Outlet
Area (ha): 3.14

(From PCSWMM model for Blackstone Subdivision Phases 4-8)

Qtarget (L/s)
504.6

2 YEAR Modified Rational Method for Entire Site

Subdrainage Area: L2006D — Controlled - Tributary
Area (ha): 0.11
C: 0.82

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	18.5	18.5	0.0	**0.0**
20	52.0	12.5	12.5	0.0	**0.0**
30	40.0	9.6	9.6	0.0	**0.0**
40	32.9	7.9	7.9	0.0	**0.0**
50	28.0	6.7	6.7	0.0	**0.0**
60	24.6	5.9	5.9	0.0	**0.0**
70	21.9	5.3	5.3	0.0	**0.0**
80	19.8	4.8	4.8	0.0	**0.0**
90	18.1	4.4	4.4	0.0	**0.0**
100	16.7	4.0	4.0	0.0	**0.0**
110	15.6	3.7	3.7	0.0	**0.0**
120	14.6	3.5	3.5	0.0	**0.0**

Storage: ε Above CB

Orifice Equation: ÷ CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 108.00 mm
Invert Elevation 99.56 m
T/G Elevation 100.94 m
Max Ponding Depth 0.00 m
Downstream W/L 98.25 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.94	0.63	18.5	0.0	13.9	OK

Subdrainage Area: L2009B — Controlled - Tributary
Area (ha): 0.16
C: 0.80

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	27.7	27.7	0.0	**0.0**
20	52.0	18.7	18.7	0.0	**0.0**
30	40.0	14.4	14.4	0.0	**0.0**
40	32.9	11.8	11.8	0.0	**0.0**
50	28.0	10.1	10.1	0.0	**0.0**
60	24.6	8.8	8.8	0.0	**0.0**
70	21.9	7.9	7.9	0.0	**0.0**
80	19.8	7.1	7.1	0.0	**0.0**
90	18.1	6.5	6.5	0.0	**0.0**
100	16.7	6.0	6.0	0.0	**0.0**
110	15.6	5.6	5.6	0.0	**0.0**
120	14.6	5.2	5.2	0.0	**0.0**

Storage: ε Above CB

Orifice Equation: ÷ CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 127.00 mm
Invert Elevation 99.24 m
T/G Elevation 100.62 m
Max Ponding Depth 0.00 m
Downstream W/L 98.03 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.62	0.74	27.7	0.0	23.1	OK

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

100 yr Intensity $I = a/(t + b)^c$
City of Ottawa

a =	1735.688
b =	6.014
c =	0.820

t (min)	I (mm/hr)
10	178.56
20	119.95
30	91.87
40	75.15
50	63.95
60	55.89
70	49.79
80	44.99
90	41.11
100	37.90
110	35.20
120	32.89

100 YEAR Predevelopment Target Release from Portion of Site

Subdrainage Area: Predevelopment Tributary Area to Outlet
Area (ha): 3.14

(From PCSWMM model for Blackstone Subdivision Phases 4-8)

Qtarget (L/s)
565.2

100 YEAR Modified Rational Method for Entire Site

Subdrainage Area: L2006D — Controlled - Tributary
Area (ha): 0.11
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	52.3	29.6	22.7	**13.6**
20	120.0	35.1	29.6	5.5	6.6
30	91.9	26.9	26.9	0.0	0.0
40	75.1	22.0	22.0	0.0	0.0
50	64.0	18.7	18.7	0.0	0.0
60	55.9	16.4	16.4	0.0	0.0
70	49.8	14.6	14.6	0.0	0.0
80	45.0	13.2	13.2	0.0	0.0
90	41.1	12.0	12.0	0.0	0.0
100	37.9	11.1	11.1	0.0	0.0
110	35.2	10.3	10.3	0.0	0.0
120	32.9	9.6	9.6	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 108.00 mm
Invert Elevation 99.56 m — CB Storage 0.50 m3
T/G Elevation 100.94 m — Surface Storage 13.40 m3
Max Ponding Depth 0.25 m
Downstream W/L 98.25 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	101.19	1.63	29.6	13.6	13.9	OK
					0.28	

Subdrainage Area: L2009B — Controlled - Tributary
Area (ha): 0.16
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	80.4	42.0	38.4	**23.1**
20	120.0	54.0	42.0	12.1	14.5
30	91.9	41.4	41.4	0.0	0.0
40	75.1	33.8	33.8	0.0	0.0
50	64.0	28.8	28.8	0.0	0.0
60	55.9	25.2	25.2	0.0	0.0
70	49.8	22.4	22.4	0.0	0.0
80	45.0	20.3	20.3	0.0	0.0
90	41.1	18.5	18.5	0.0	0.0
100	37.9	17.1	17.1	0.0	0.0
110	35.2	15.9	15.9	0.0	0.0
120	32.9	14.8	14.8	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 127.00 mm
Invert Elevation 99.24 m — CB Storage 0.50 m3
T/G Elevation 100.62 m — Surface Storage 22.60 m3
Max Ponding Depth 0.33 m
Downstream W/L 98.03 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.95	1.71	42.0	23.1	23.1	OK
					0.03	

Stormwater Management Calculations

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2009A — Controlled - Tributary
Area (ha): 0.15
C: 0.78

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	24.5	24.5	0.0	**0.0**
20	52.0	16.6	16.6	0.0	**0.0**
30	40.0	12.8	12.8	0.0	**0.0**
40	32.9	10.5	10.5	0.0	**0.0**
50	28.0	8.9	8.9	0.0	**0.0**
60	24.6	7.8	7.8	0.0	**0.0**
70	21.9	7.0	7.0	0.0	**0.0**
80	19.8	6.3	6.3	0.0	**0.0**
90	18.1	5.8	5.8	0.0	**0.0**
100	16.7	5.3	5.3	0.0	**0.0**
110	15.6	5.0	5.0	0.0	**0.0**
120	14.6	4.6	4.6	0.0	**0.0**

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 108.00 mm
Invert Elevation 99.12 m
T/G Elevation 100.50 m
Max Ponding Depth 0.00 m
Downstream W/L 98.16 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.50	1.11	24.5	0.0	24.6	OK

Subdrainage Area: L2008A — Controlled - Tributary
Area (ha): 0.13
C: 0.84

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	23.1	16.7	6.5	**3.9**
20	52.0	15.7	15.7	0.0	0.0
30	40.0	12.1	12.1	0.0	0.0
40	32.9	9.9	9.9	0.0	0.0
50	28.0	8.4	8.4	0.0	0.0
60	24.6	7.4	7.4	0.0	0.0
70	21.9	6.6	6.6	0.0	0.0
80	19.8	6.0	6.0	0.0	0.0
90	18.1	5.5	5.5	0.0	0.0
100	16.7	5.0	5.0	0.0	0.0
110	15.6	4.7	4.7	0.0	0.0
120	14.6	4.4	4.4	0.0	0.0

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 83.00 mm
Invert Elevation 99.12 m
T/G Elevation 100.50 m
Max Ponding Depth 0.10 m
Downstream W/L 98.13 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.60	1.48	16.7	3.9	30.9	OK

Subdrainage Area: L2007B — Controlled - Tributary
Area (ha): 0.12
C: 0.85

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	21.7	10.9	10.8	**6.5**
20	52.0	14.7	10.9	3.8	4.6
30	40.0	11.3	10.9	0.4	0.8
40	32.9	9.3	9.3	0.0	0.0
50	28.0	7.9	7.9	0.0	0.0
60	24.6	6.9	6.9	0.0	0.0
70	21.9	6.2	6.2	0.0	0.0
80	19.8	5.6	5.6	0.0	0.0
90	18.1	5.1	5.1	0.0	0.0
100	16.7	4.7	4.7	0.0	0.0
110	15.6	4.4	4.4	0.0	0.0
120	14.6	4.1	4.1	0.0	0.0

Storage: Above CB

Vortex Size: LMF 100
Invert Elevation 99.67 m
T/G Elevation 101.05 m
Max Ponding Depth 0.10 m
Downstream W/L 98.46 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	101.15	1.48	10.9	6.5	38.8	OK

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2009A — Controlled - Tributary
Area (ha): 0.15
C: 0.98

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	71.1	30.5	40.6	**24.4**
20	120.0	47.8	30.5	17.3	20.7
30	91.9	36.6	30.5	6.1	10.9
40	75.1	29.9	29.9	0.0	0.0
50	64.0	25.5	25.5	0.0	0.0
60	55.9	22.3	22.3	0.0	0.0
70	49.8	19.8	19.8	0.0	0.0
80	45.0	17.9	17.9	0.0	0.0
90	41.1	16.4	16.4	0.0	0.0
100	37.9	15.1	15.1	0.0	0.0
110	35.2	14.0	14.0	0.0	0.0
120	32.9	13.1	13.1	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 108.00 mm
Invert Elevation 99.12 m — CB Storage 0.50 m3
T/G Elevation 100.50 m — Surface Storage 24.10 m3
Max Ponding Depth 0.35 m
Downstream W/L 98.16 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.85	1.73	30.5	24.4	24.6	OK
					0.23	

Subdrainage Area: L2008A — Controlled - Tributary
Area (ha): 0.13
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	64.0	18.0	46.0	27.6
20	120.0	43.0	18.0	25.0	**30.0**
30	91.9	32.9	18.0	14.9	26.8
40	75.1	26.9	18.0	8.9	21.4
50	64.0	22.9	18.0	4.9	14.7
60	55.9	20.0	18.0	2.0	7.3
70	49.8	17.9	17.9	0.0	0.0
80	45.0	16.1	16.1	0.0	0.0
90	41.1	14.7	14.7	0.0	0.0
100	37.9	13.6	13.6	0.0	0.0
110	35.2	12.6	12.6	0.0	0.0
120	32.9	11.8	11.8	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 83.00 mm
Invert Elevation 99.12 m — CB Storage 0.50 m3
T/G Elevation 100.50 m — Surface Storage 30.40 m3
Max Ponding Depth 0.35 m
Downstream W/L 98.13 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.85	1.73	18.0	30.0	30.9	OK
					0.91	

Subdrainage Area: L2007B — Controlled - Tributary
Area (ha): 0.12
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	59.3	11.6	47.7	28.6
20	120.0	39.8	11.6	28.2	33.9
30	91.9	30.5	11.6	18.9	**34.1**
40	75.1	24.9	11.6	13.4	32.1
50	64.0	21.2	11.6	9.7	29.0
60	55.9	18.6	11.6	7.0	25.1
70	49.8	16.5	11.6	5.0	20.8
80	45.0	14.9	11.6	3.4	16.1
90	41.1	13.6	11.6	2.1	11.2
100	37.9	12.6	11.6	1.0	6.1
110	35.2	11.7	11.6	0.1	0.7
120	32.9	10.9	10.9	0.0	0.0

Storage: Surface Storage Above CB

Vortex Size: LMF 100
Invert Elevation 99.67 m — CB Storage 0.50 m3
T/G Elevation 101.05 m — Surface Storage 38.30 m3
Max Ponding Depth 0.30 m
Downstream W/L 98.46 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	101.35	1.68	11.6	34.1	38.8	OK
					4.74	

Stormwater Management Calculations

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2007A — Controlled - Tributary
Area (ha): 0.16
C: 0.79

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	26.7	26.7	0.0	**0.0**
20	52.0	18.1	18.1	0.0	**0.0**
30	40.0	13.9	13.9	0.0	**0.0**
40	32.9	11.4	11.4	0.0	**0.0**
50	28.0	9.8	9.8	0.0	**0.0**
60	24.6	8.5	8.5	0.0	**0.0**
70	21.9	7.6	7.6	0.0	**0.0**
80	19.8	6.9	6.9	0.0	**0.0**
90	18.1	6.3	6.3	0.0	**0.0**
100	16.7	5.8	5.8	0.0	**0.0**
110	15.6	5.4	5.4	0.0	**0.0**
120	14.6	5.1	5.1	0.0	**0.0**

Storage: Above CB

Orifice Equation: = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 108.00 mm
Invert Elevation 99.58 m
T/G Elevation 100.96 m
Max Ponding Depth 0.01 m
Downstream W/L 98.31 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.97	1.33	26.7	0.0	29.5	OK

Subdrainage Area: L2006C — Controlled - Tributary
Area (ha): 0.15
C: 0.82

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	25.6	25.6	0.0	**0.0**
20	52.0	17.4	17.4	0.0	**0.0**
30	40.0	13.4	13.4	0.0	**0.0**
40	32.9	11.0	11.0	0.0	**0.0**
50	28.0	9.4	9.4	0.0	**0.0**
60	24.6	8.2	8.2	0.0	**0.0**
70	21.9	7.3	7.3	0.0	**0.0**
80	19.8	6.6	6.6	0.0	**0.0**
90	18.1	6.1	6.1	0.0	**0.0**
100	16.7	5.6	5.6	0.0	**0.0**
110	15.6	5.2	5.2	0.0	**0.0**
120	14.6	4.9	4.9	0.0	**0.0**

Storage: Above CB

Orifice Equation: = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 127.00 mm
Invert Elevation 99.08 m
T/G Elevation 100.46 m
Max Ponding Depth 0.00 m
Downstream W/L 98.02 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.46	0.64	25.6	0.0	20.2	OK

Subdrainage Area: L2006B — Controlled - Tributary
Area (ha): 0.04
C: 0.75

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	6.1	4.3	1.9	**1.1**
20	52.0	4.2	4.2	0.0	0.0
30	40.0	3.2	3.2	0.0	0.0
40	32.9	2.6	2.6	0.0	0.0
50	28.0	2.2	2.2	0.0	0.0
60	24.6	2.0	2.0	0.0	0.0
70	21.9	1.8	1.8	0.0	0.0
80	19.8	1.6	1.6	0.0	0.0
90	18.1	1.5	1.5	0.0	0.0
100	16.7	1.3	1.3	0.0	0.0
110	15.6	1.2	1.2	0.0	0.0
120	14.6	1.2	1.2	0.0	0.0

Storage: Above CB

Vortex Size: LMF 65
Invert Elevation 98.97 m
T/G Elevation 100.35 m
Max Ponding Depth 0.02 m
Downstream W/L 98.02 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.37	1.40	4.3	1.1	19.3	OK

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2007A — Controlled - Tributary
Area (ha): 0.16
C: 0.99

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	77.6	30.4	47.3	**28.4**
20	120.0	52.2	30.4	21.8	26.2
30	91.9	39.9	30.4	9.6	17.3
40	75.1	32.7	30.4	2.3	5.6
50	64.0	27.8	27.8	0.0	0.0
60	55.9	24.3	24.3	0.0	0.0
70	49.8	21.7	21.7	0.0	0.0
80	45.0	19.6	19.6	0.0	0.0
90	41.1	17.9	17.9	0.0	0.0
100	37.9	16.5	16.5	0.0	0.0
110	35.2	15.3	15.3	0.0	0.0
120	32.9	14.3	14.3	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 108.00 mm
Invert Elevation 99.58 m — CB Storage 0.50 m3
T/G Elevation 100.96 m — Surface Storage 29.00 m3
Max Ponding Depth 0.33 m
Downstream W/L 98.31 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	101.29	1.71	30.4	28.4	29.5	OK
					1.12	

Subdrainage Area: L2006C — Controlled - Tributary
Area (ha): 0.15
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	72.7	41.4	31.3	**18.8**
20	120.0	48.8	41.4	7.5	9.0
30	91.9	37.4	37.4	0.0	0.0
40	75.1	30.6	30.6	0.0	0.0
50	64.0	26.0	26.0	0.0	0.0
60	55.9	22.7	22.7	0.0	0.0
70	49.8	20.3	20.3	0.0	0.0
80	45.0	18.3	18.3	0.0	0.0
90	41.1	16.7	16.7	0.0	0.0
100	37.9	15.4	15.4	0.0	0.0
110	35.2	14.3	14.3	0.0	0.0
120	32.9	13.4	13.4	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 127.00 mm
Invert Elevation 99.08 m — CB Storage 0.50 m3
T/G Elevation 100.46 m — Surface Storage 19.70 m3
Max Ponding Depth 0.28 m
Downstream W/L 98.02 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.74	1.66	41.4	18.8	20.2	OK
					1.40	

Subdrainage Area: L2006B — Controlled - Tributary
Area (ha): 0.04
C: 0.94

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	17.9	4.7	13.2	7.9
20	120.0	12.0	4.7	7.3	**8.8**
30	91.9	9.2	4.7	4.5	8.1
40	75.1	7.5	4.7	2.8	6.8
50	64.0	6.4	4.7	1.7	5.1
60	55.9	5.6	4.7	0.9	3.3
70	49.8	5.0	4.7	0.3	1.2
80	45.0	4.5	4.5	0.0	0.0
90	41.1	4.1	4.1	0.0	0.0
100	37.9	3.8	3.8	0.0	0.0
110	35.2	3.5	3.5	0.0	0.0
120	32.9	3.3	3.3	0.0	0.0

Storage: Surface Storage Above CB

Vortex Size: LMF 65
Invert Elevation 98.97 m — CB Storage 0.50 m3
T/G Elevation 100.35 m — Surface Storage 18.80 m3
Max Ponding Depth 0.30 m
Downstream W/L 98.02 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.65	1.68	4.7	8.8	19.3	OK
					10.52	

Stormwater Management Calculations

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2006A — Controlled - Tributary
Area (ha): 0.18
C: 0.77

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	30.2	30.2	0.0	**0.0**
20	52.0	20.4	20.4	0.0	0.0
30	40.0	15.7	15.7	0.0	0.0
40	32.9	12.9	12.9	0.0	0.0
50	28.0	11.0	11.0	0.0	0.0
60	24.6	9.6	9.6	0.0	0.0
70	21.9	8.6	8.6	0.0	0.0
80	19.8	7.8	7.8	0.0	0.0
90	18.1	7.1	7.1	0.0	0.0
100	16.7	6.6	6.6	0.0	0.0
110	15.6	6.1	6.1	0.0	0.0
120	14.6	5.7	5.7	0.0	0.0

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 127.00 mm
Invert Elevation 98.79 m
T/G Elevation 100.17 m
Max Ponding Depth 0.00 m
Downstream W/L 98.02 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.17	0.88	30.2	0.0	29.8	OK

Subdrainage Area: L2005A — Controlled - Tributary
Area (ha): 0.21
C: 0.80

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	35.6	21.8	13.7	**8.2**
20	52.0	24.1	21.8	2.3	2.7
30	40.0	18.6	18.6	0.0	0.0
40	32.9	15.2	15.2	0.0	0.0
50	28.0	13.0	13.0	0.0	0.0
60	24.6	11.4	11.4	0.0	0.0
70	21.9	10.2	10.2	0.0	0.0
80	19.8	9.2	9.2	0.0	0.0
90	18.1	8.4	8.4	0.0	0.0
100	16.7	7.8	7.8	0.0	0.0
110	15.6	7.2	7.2	0.0	0.0
120	14.6	6.7	6.7	0.0	0.0

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 95.00 mm
Invert Elevation 98.75 m
T/G Elevation 100.13 m
Max Ponding Depth 0.10 m
Downstream W/L 97.83 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.23	1.48	21.8	8.2	57.0	OK

Subdrainage Area: L2004A — Controlled - Tributary
Area (ha): 0.15
C: 0.82

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	26.5	16.6	9.9	**6.0**
20	52.0	18.0	16.6	1.4	1.7
30	40.0	13.8	13.8	0.0	0.0
40	32.9	11.3	11.3	0.0	0.0
50	28.0	9.7	9.7	0.0	0.0
60	24.6	8.5	8.5	0.0	0.0
70	21.9	7.6	7.6	0.0	0.0
80	19.8	6.8	6.8	0.0	0.0
90	18.1	6.3	6.3	0.0	0.0
100	16.7	5.8	5.8	0.0	0.0
110	15.6	5.4	5.4	0.0	0.0
120	14.6	5.0	5.0	0.0	0.0

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 83.00 mm
Invert Elevation 98.82 m
T/G Elevation 100.20 m
Max Ponding Depth 0.08 m
Downstream W/L 98.18 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.28	1.46	16.6	6.0	45.8	OK

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2006A — Controlled - Tributary
Area (ha): 0.18
C: 0.96

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	87.6	42.2	45.4	**27.2**
20	120.0	58.9	42.2	16.6	20.0
30	91.9	45.1	42.2	2.9	5.2
40	75.1	36.9	36.9	0.0	0.0
50	64.0	31.4	31.4	0.0	0.0
60	55.9	27.4	27.4	0.0	0.0
70	49.8	24.4	24.4	0.0	0.0
80	45.0	22.1	22.1	0.0	0.0
90	41.1	20.2	20.2	0.0	0.0
100	37.9	18.6	18.6	0.0	0.0
110	35.2	17.3	17.3	0.0	0.0
120	32.9	16.1	16.1	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 127.00 mm
Invert Elevation 98.79 m — CB Storage 0.50 m3
T/G Elevation 100.17 m — Surface Storage 29.30 m3
Max Ponding Depth 0.35 m
Downstream W/L 98.02 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.52	1.73	42.2	27.2	29.8	OK
					2.55	

Subdrainage Area: L2005A — Controlled - Tributary
Area (ha): 0.21
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	103.4	23.4	80.0	48.0
20	120.0	69.5	23.4	46.1	**55.3**
30	91.9	53.2	23.4	29.8	53.7
40	75.1	43.5	23.4	20.1	48.3
50	64.0	37.1	23.4	13.6	40.9
60	55.9	32.4	23.4	9.0	32.3
70	49.8	28.8	23.4	5.4	22.8
80	45.0	26.1	23.4	2.6	12.7
90	41.1	23.8	23.4	0.4	2.2
100	37.9	22.0	22.0	0.0	0.0
110	35.2	20.4	20.4	0.0	0.0
120	32.9	19.1	19.1	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 95.00 mm
Invert Elevation 98.75 m — CB Storage 0.50 m3
T/G Elevation 100.13 m — Surface Storage 56.50 m3
Max Ponding Depth 0.32 m
Downstream W/L 97.83 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.45	1.70	23.4	55.3	57.0	OK
					1.70	

Subdrainage Area: L2004A — Controlled - Tributary
Area (ha): 0.15
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	75.2	17.8	57.4	34.4
20	120.0	50.5	17.8	32.7	**39.3**
30	91.9	38.7	17.8	20.9	37.6
40	75.1	31.6	17.8	13.9	33.3
50	64.0	26.9	17.8	9.1	27.4
60	55.9	23.5	17.8	5.8	20.7
70	49.8	21.0	17.8	3.2	13.4
80	45.0	18.9	17.8	1.2	5.6
90	41.1	17.3	17.3	0.0	0.0
100	37.9	16.0	16.0	0.0	0.0
110	35.2	14.8	14.8	0.0	0.0
120	32.9	13.8	13.8	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 83.00 mm
Invert Elevation 98.82 m — CB Storage 0.50 m3
T/G Elevation 100.20 m — Surface Storage 45.30 m3
Max Ponding Depth 0.30 m
Downstream W/L 98.18 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.50	1.68	17.8	39.3	45.8	OK
					6.54	

Stormwater Management Calculations

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2003B — Controlled - Tributary
Area (ha): 0.17
C: 0.77

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	27.6	21.6	6.1	**3.6**
20	52.0	18.7	18.7	0.0	0.0
30	40.0	14.4	14.4	0.0	0.0
40	32.9	11.8	11.8	0.0	0.0
50	28.0	10.1	10.1	0.0	0.0
60	24.6	8.8	8.8	0.0	0.0
70	21.9	7.9	7.9	0.0	0.0
80	19.8	7.1	7.1	0.0	0.0
90	18.1	6.5	6.5	0.0	0.0
100	16.7	6.0	6.0	0.0	0.0
110	15.6	5.6	5.6	0.0	0.0
120	14.6	5.2	5.2	0.0	0.0

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 95.00 mm
Invert Elevation 98.77 m
T/G Elevation 100.15 m
Max Ponding Depth 0.06 m
Downstream W/L 97.75 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.21	1.44	21.6	3.6	36.8	OK

Subdrainage Area: L2003A — Controlled - Tributary
Area (ha): 0.18
C: 0.81

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	31.1	21.6	9.5	**5.7**
20	52.0	21.1	21.1	0.0	0.0
30	40.0	16.2	16.2	0.0	0.0
40	32.9	13.3	13.3	0.0	0.0
50	28.0	11.4	11.4	0.0	0.0
60	24.6	10.0	10.0	0.0	0.0
70	21.9	8.9	8.9	0.0	0.0
80	19.8	8.0	8.0	0.0	0.0
90	18.1	7.4	7.4	0.0	0.0
100	16.7	6.8	6.8	0.0	0.0
110	15.6	6.3	6.3	0.0	0.0
120	14.6	5.9	5.9	0.0	0.0

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 95.00 mm
Invert Elevation 98.63 m
T/G Elevation 100.01 m
Max Ponding Depth 0.07 m
Downstream W/L 97.75 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.08	1.45	21.6	5.7	44.2	OK

Subdrainage Area: L2002B — Controlled - Tributary
Area (ha): 0.17
C: 0.78

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	28.5	28.5	0.0	**0.0**
20	52.0	19.3	19.3	0.0	**0.0**
30	40.0	14.9	14.9	0.0	**0.0**
40	32.9	12.2	12.2	0.0	**0.0**
50	28.0	10.4	10.4	0.0	**0.0**
60	24.6	9.1	9.1	0.0	**0.0**
70	21.9	8.1	8.1	0.0	**0.0**
80	19.8	7.4	7.4	0.0	**0.0**
90	18.1	6.7	6.7	0.0	**0.0**
100	16.7	6.2	6.2	0.0	**0.0**
110	15.6	5.8	5.8	0.0	**0.0**
120	14.6	5.4	5.4	0.0	**0.0**

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 127.00 mm
Invert Elevation 98.96 m
T/G Elevation 100.34 m
Max Ponding Depth 0.00 m
Downstream W/L 98.00 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.34	0.79	28.5	0.0	26.2	OK

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2003B — Controlled - Tributary
Area (ha): 0.17
C: 0.96

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	80.3	23.3	57.0	34.2
20	120.0	53.9	23.3	30.6	**36.8**
30	91.9	41.3	23.3	18.0	32.4
40	75.1	33.8	23.3	10.5	25.2
50	64.0	28.7	23.3	5.5	16.4
60	55.9	25.1	23.3	1.8	6.7
70	49.8	22.4	22.4	0.0	0.0
80	45.0	20.2	20.2	0.0	0.0
90	41.1	18.5	18.5	0.0	0.0
100	37.9	17.0	17.0	0.0	0.0
110	35.2	15.8	15.8	0.0	0.0
120	32.9	14.8	14.8	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 95.00 mm
Invert Elevation 98.77 m — CB Storage 0.50 m3
T/G Elevation 100.15 m — Surface Storage 36.30 m3
Max Ponding Depth 0.30 m
Downstream W/L 97.75 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.45	1.68	23.3	36.8	36.8	OK
					0.02	

Subdrainage Area: L2003A — Controlled - Tributary
Area (ha): 0.18
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	89.4	23.6	65.7	39.4
20	120.0	60.0	23.6	36.4	**43.7**
30	91.9	46.0	23.6	22.3	40.2
40	75.1	37.6	23.6	14.0	33.6
50	64.0	32.0	23.6	8.4	25.1
60	55.9	28.0	23.6	4.3	15.7
70	49.8	24.9	23.6	1.3	5.4
80	45.0	22.5	22.5	0.0	0.0
90	41.1	20.6	20.6	0.0	0.0
100	37.9	19.0	19.0	0.0	0.0
110	35.2	17.6	17.6	0.0	0.0
120	32.9	16.5	16.5	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 95.00 mm
Invert Elevation 98.63 m — CB Storage 0.50 m3
T/G Elevation 100.01 m — Surface Storage 43.70 m3
Max Ponding Depth 0.35 m
Downstream W/L 97.75 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.36	1.73	23.6	43.7	44.2	OK
					0.51	

Subdrainage Area: L2002B — Controlled - Tributary
Area (ha): 0.17
C: 0.98

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	83.0	42.2	40.7	**24.4**
20	120.0	55.7	42.2	13.5	16.2
30	91.9	42.7	42.2	0.5	0.8
40	75.1	34.9	34.9	0.0	0.0
50	64.0	29.7	29.7	0.0	0.0
60	55.9	26.0	26.0	0.0	0.0
70	49.8	23.1	23.1	0.0	0.0
80	45.0	20.9	20.9	0.0	0.0
90	41.1	19.1	19.1	0.0	0.0
100	37.9	17.6	17.6	0.0	0.0
110	35.2	16.4	16.4	0.0	0.0
120	32.9	15.3	15.3	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 127.00 mm
Invert Elevation 98.96 m — CB Storage 0.50 m3
T/G Elevation 100.34 m — Surface Storage 25.70 m3
Max Ponding Depth 0.35 m
Downstream W/L 98.00 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.69	1.73	42.2	24.4	26.2	OK
					1.75	

Stormwater Management Calculations

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2002A — Controlled - Tributary
Area (ha): 0.14
C: 0.78

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	23.3	23.3	0.0	**0.0**
20	52.0	15.8	15.8	0.0	**0.0**
30	40.0	12.2	12.2	0.0	**0.0**
40	32.9	10.0	10.0	0.0	**0.0**
50	28.0	8.5	8.5	0.0	**0.0**
60	24.6	7.5	7.5	0.0	**0.0**
70	21.9	6.7	6.7	0.0	**0.0**
80	19.8	6.0	6.0	0.0	**0.0**
90	18.1	5.5	5.5	0.0	**0.0**
100	16.7	5.1	5.1	0.0	**0.0**
110	15.6	4.7	4.7	0.0	**0.0**
120	14.6	4.4	4.4	0.0	**0.0**

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 102.00 mm
Invert Elevation 98.98 m
T/G Elevation 100.36 m
Max Ponding Depth 0.00 m
Downstream W/L 98.00 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.36	1.27	23.3	0.0	25.4	OK

Subdrainage Area: L2001B — Controlled - Tributary
Area (ha): 0.21
C: 0.38

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	16.8	4.4	12.4	7.4
20	52.0	11.4	4.4	7.0	**8.4**
30	40.0	8.8	4.4	4.4	7.8
40	32.9	7.2	4.4	2.8	6.7
50	28.0	6.1	4.4	1.7	5.2
60	24.6	5.4	4.4	1.0	3.5
70	21.9	4.8	4.4	0.4	1.7
80	19.8	4.3	4.3	0.0	0.0
90	18.1	4.0	4.0	0.0	0.0
100	16.7	3.7	3.7	0.0	0.0
110	15.6	3.4	3.4	0.0	0.0
120	14.6	3.2	3.2	0.0	0.0

Storage: Above CB

Vortex Size: LMF 65
Invert Elevation 98.86 m
T/G Elevation 100.24 m
Max Ponding Depth 0.10 m
Downstream W/L 97.83 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.34	1.48	4.4	8.4	53.3	OK

Subdrainage Area: L2001A — Controlled - Tributary
Area (ha): 0.16
C: 0.83

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	29.1	22.2	6.8	**4.1**
20	52.0	19.7	19.7	0.0	0.0
30	40.0	15.2	15.2	0.0	0.0
40	32.9	12.4	12.4	0.0	0.0
50	28.0	10.6	10.6	0.0	0.0
60	24.6	9.3	9.3	0.0	0.0
70	21.9	8.3	8.3	0.0	0.0
80	19.8	7.5	7.5	0.0	0.0
90	18.1	6.9	6.9	0.0	0.0
100	16.7	6.3	6.3	0.0	0.0
110	15.6	5.9	5.9	0.0	0.0
120	14.6	5.5	5.5	0.0	0.0

Storage: Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 95.00 mm
Invert Elevation 98.84 m
T/G Elevation 100.22 m
Max Ponding Depth 0.15 m
Downstream W/L 97.83 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.37	1.53	22.2	4.1	37.7	OK

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2002A — Controlled - Tributary
Area (ha): 0.14
C: 0.98

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	67.8	27.1	40.7	**24.4**
20	120.0	45.5	27.1	18.4	22.1
30	91.9	34.9	27.1	7.8	14.0
40	75.1	28.5	27.1	1.4	3.5
50	64.0	24.3	24.3	0.0	0.0
60	55.9	21.2	21.2	0.0	0.0
70	49.8	18.9	18.9	0.0	0.0
80	45.0	17.1	17.1	0.0	0.0
90	41.1	15.6	15.6	0.0	0.0
100	37.9	14.4	14.4	0.0	0.0
110	35.2	13.4	13.4	0.0	0.0
120	32.9	12.5	12.5	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 102.00 mm
Invert Elevation 98.98 m — CB Storage 0.50 m3
T/G Elevation 100.36 m — Surface Storage 24.90 m3
Max Ponding Depth 0.33 m
Downstream W/L 98.00 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.69	1.71	27.1	24.4	25.4	OK
					0.99	

Subdrainage Area: L2001B — Controlled - Tributary
Area (ha): 0.21
C: 0.48

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	48.8	4.7	44.1	26.5
20	120.0	32.8	4.7	28.1	33.7
30	91.9	25.1	4.7	20.4	36.7
40	75.1	20.5	4.7	15.8	38.0
50	64.0	17.5	4.7	12.8	**38.3**
60	55.9	15.3	4.7	10.6	38.1
70	49.8	13.6	4.7	8.9	37.4
80	45.0	12.3	4.7	7.6	36.5
90	41.1	11.2	4.7	6.5	35.3
100	37.9	10.4	4.7	5.7	34.0
110	35.2	9.6	4.7	4.9	32.5
120	32.9	9.0	4.7	4.3	30.9

Storage: Surface Storage Above CB

Vortex Size: LMF 65
Invert Elevation 98.86 m — CB Storage 0.50 m3
T/G Elevation 100.24 m — Surface Storage 52.80 m3
Max Ponding Depth 0.31 m
Downstream W/L 97.83 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.55	1.69	4.7	38.3	53.3	OK
					14.96	

Subdrainage Area: L2001A — Controlled - Tributary
Area (ha): 0.16
C: 1.00

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	81.4	23.3	58.1	34.9
20	120.0	54.7	23.3	31.4	**37.7**
30	91.9	41.9	23.3	18.6	33.5
40	75.1	34.3	23.3	11.0	26.4
50	64.0	29.2	23.3	5.9	17.6
60	55.9	25.5	23.3	2.2	7.9
70	49.8	22.7	22.7	0.0	0.0
80	45.0	20.5	20.5	0.0	0.0
90	41.1	18.7	18.7	0.0	0.0
100	37.9	17.3	17.3	0.0	0.0
110	35.2	16.0	16.0	0.0	0.0
120	32.9	15.0	15.0	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 95.00 mm
Invert Elevation 98.84 m — CB Storage 0.50 m3
T/G Elevation 100.22 m — Surface Storage 37.20 m3
Max Ponding Depth 0.30 m
Downstream W/L 97.83 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.52	1.68	23.3	37.7	37.7	OK
					0.00	

Stormwater Management Calculations

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2000A — Controlled - Tributary
Area (ha): 0.07
C: 0.78

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	12.0	12.0	0.0	**0.0**
20	52.0	8.1	8.1	0.0	**0.0**
30	40.0	6.3	6.3	0.0	**0.0**
40	32.9	5.1	5.1	0.0	**0.0**
50	28.0	4.4	4.4	0.0	**0.0**
60	24.6	3.8	3.8	0.0	**0.0**
70	21.9	3.4	3.4	0.0	**0.0**
80	19.8	3.1	3.1	0.0	**0.0**
90	18.1	2.8	2.8	0.0	**0.0**
100	16.7	2.6	2.6	0.0	**0.0**
110	15.6	2.4	2.4	0.0	**0.0**
120	14.6	2.3	2.3	0.0	**0.0**

Storage: e Above CB

Orifice Equation: = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 83.00 mm
Invert Elevation 98.62 m
T/G Elevation 100.00 m
Max Ponding Depth 0.00 m
Downstream W/L 97.69 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
5-year Water Level	100.00	0.77	12.0	0.0	12.8	OK

Subdrainage Area: UNC-1 — Uncontrolled - Tributary
Area (ha): 0.49
C: 0.35

tc (min)	I (5 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	76.8	36.5	36.5		
20	52.0	24.8	24.8		
30	40.0	19.1	19.1		
40	32.9	15.6	15.6		
50	28.0	13.3	13.3		
60	24.6	11.7	11.7		
70	21.9	10.4	10.4		
80	19.8	9.4	9.4		
90	18.1	8.6	8.6		
100	16.7	8.0	8.0		
110	15.6	7.4	7.4		
120	14.6	6.9	6.9		

SUMMARY TO OUTLET

Tributary Area	2.7	ha
Total 2yr Flow to Sewer	357.0	L/s
Non-Tributary Area	0.5	ha
Total 2yr Flow Uncontrolled	36.5	L/s
Total Area	3.1	ha
Total 2yr Flow	393.5	L/s
Target	504.6	L/s

Project #160401433, Blackstone Block 366
Modified Rational Method Calculatons for Storage

Subdrainage Area: L2000A — Controlled - Tributary
Area (ha): 0.07
C: 0.98

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	34.8	17.2	17.6	**10.6**
20	120.0	23.4	17.2	6.2	7.4
30	91.9	17.9	17.2	0.7	1.3
40	75.1	14.7	14.7	0.0	0.0
50	64.0	12.5	12.5	0.0	0.0
60	55.9	10.9	10.9	0.0	0.0
70	49.8	9.7	9.7	0.0	0.0
80	45.0	8.8	8.8	0.0	0.0
90	41.1	8.0	8.0	0.0	0.0
100	37.9	7.4	7.4	0.0	0.0
110	35.2	6.9	6.9	0.0	0.0
120	32.9	6.4	6.4	0.0	0.0

Storage: Surface Storage Above CB

Orifice Equation: Q = CdA(2gh)^0.5 — Where C = 0.57
Orifice Diameter: 83.00 mm
Invert Elevation 98.62 m — CB Storage 0.50 m3
T/G Elevation 100.00 m — Surface Storage 12.30 m3
Max Ponding Depth 0.20 m
Downstream W/L 97.69 m

	Stage	Head (m)	Discharge (L/s)	Vreq (cu. m)	Vavail (cu. m)	Volume Check
100-year Water Level	100.20	1.58	17.2	10.6	12.8	OK
					2.23	

Subdrainage Area: UNC-1 — Uncontrolled - Tributary
Area (ha): 0.49
C: 0.44

tc (min)	I (100 yr) (mm/hr)	Qactual (L/s)	Qrelease (L/s)	Qstored (L/s)	Vstored (m^3)
10	178.6	106.2	106.2		
20	120.0	71.3	71.3		
30	91.9	54.6	54.6		
40	75.1	44.7	44.7		
50	64.0	38.0	38.0		
60	55.9	33.2	33.2		
70	49.8	29.6	29.6		
80	45.0	26.8	26.8		
90	41.1	24.5	24.5		
100	37.9	22.5	22.5		
110	35.2	20.9	20.9		
120	32.9	19.6	19.6		

SUMMARY TO OUTLET

Tributary Area	2.7	ha
Total 100yr Flow to Sewer	452.9	L/s
Non-Tributary Area	0.5	ha
Total 100yr Flow Uncontrolled	106.2	L/s
Total Area	3.1	ha
Total 100yr Flow	559.1	L/s
Target	565.2	L/s

C.3 STORMWATER BACKGROUND EXCERPTS

L2047A-O2	L2047A-S	2047	99.08	CIRCULAR	0.108
LM97A-O1	LM97A-S	M97	99.27	CIRCULAR	0.200
PND_OUTLET	POND	PD_OUTFALL	95.00	RECT_CLOSED	0.200
W3	POND	PD_OUTFALL	95.20	RECT_CLOSED	0.450

Table 13: Outlet & Storage Parameters – Future Development Areas, Schools, Park Blocks

Name	2yr Discharge (L/s)	5yr Discharge (L/s)	100yr Discharge (L/s)	100yr+20% Discharge (L/s)	100yr Storage Volume (m3)
C1023A-O	*	1412.8	1582.3	1604.9	417
C2049A-O	*	585.4	655.7	665.0	176
F1021A-O	*	*	*	*	0
F2006A-O	*	*	*	*	0
L1000A-O	1013.3	1064.2	1134.9	1151.1	873
L1022A-O	504.6	531.7	565.2	573.2	483
L1053B-O	177.1	186.6	198.4	201.2	212
L1054A-O	138.2	145.6	154.8	157.0	172

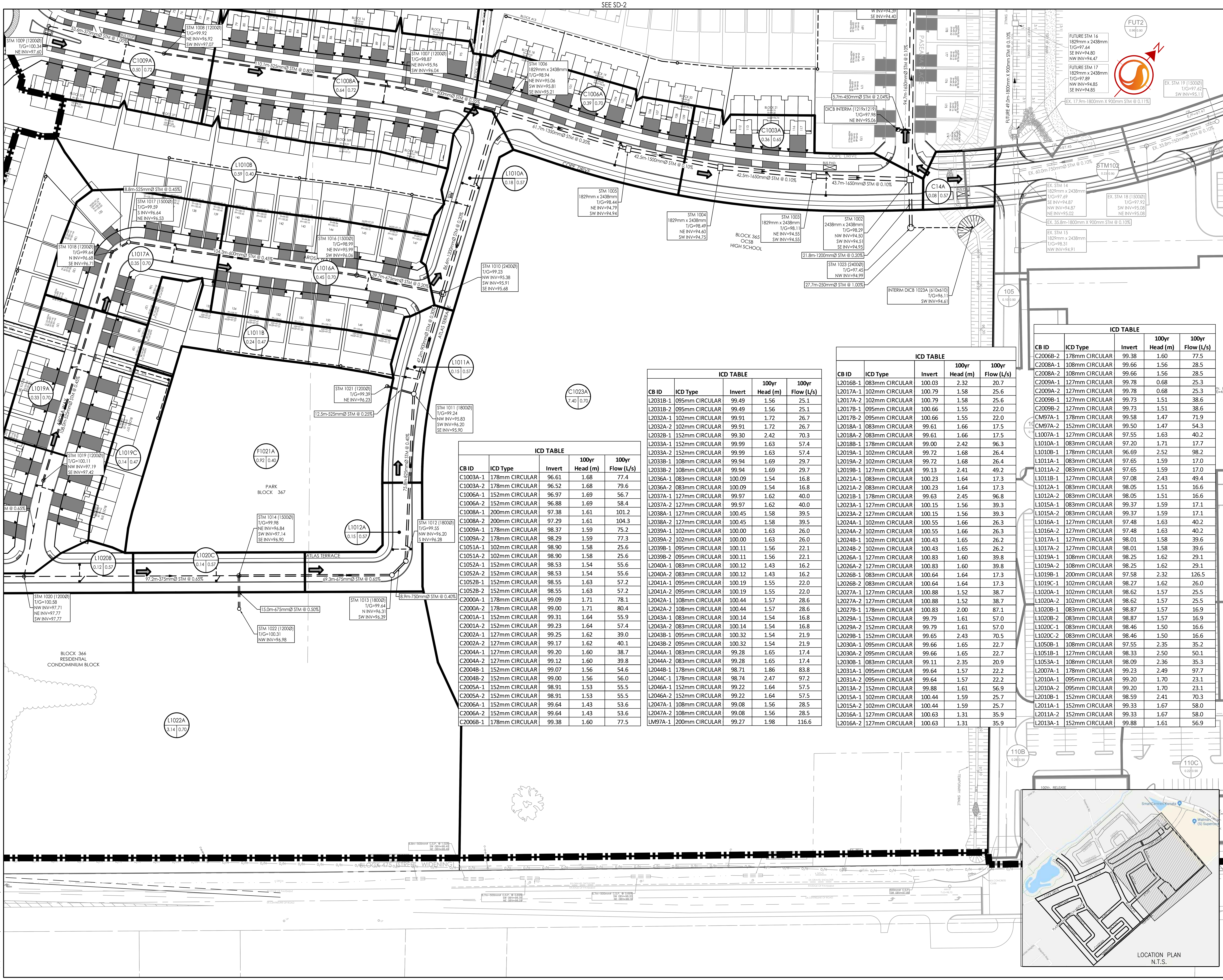
*Denotes unrestricted release rate.

5.3.4 Model Results

The following section summarizes the key hydrologic and hydraulic model results. For detailed model results or inputs please refer to the example input file in **Appendix C.2** and the electronic model files on the enclosed CD.

5.3.4.1 Hydrologic Results

The following table demonstrates the peak outflow from each modeled connection point to downstream infrastructure (southern inlet to Pond 6, pond 8 outlet to the Monahan Drain) during the design storm (3hr Chicago 2-100yr, 100yr SCS) events. Peak outflows from the upstream Fernbank Crossing subdivision have been included in the peak discharge values to Pond 6, whereas peak outflows from Pond 8 incorporate design flows from the adjacent commercial developments on Terry Fox Drive.



ICD TABLE				
CB ID	ICD Type	Invert	100yr Head (m)	100yr Flow (L/s)
C1003A-1	178mm CIRCULAR	96.61	1.68	77.4
C1003A-2	178mm CIRCULAR	96.52	1.68	79.6
C1006A-1	152mm CIRCULAR	96.97	1.69	56.7
C1006A-2	152mm CIRCULAR	96.88	1.69	58.4
C1008A-1	200mm CIRCULAR	97.38	1.61	101.2
C1008A-2	200mm CIRCULAR	97.29	1.61	104.3
C1009A-1	178mm CIRCULAR	98.37	1.59	75.2
C1009A-2	178mm CIRCULAR	98.29	1.59	77.3
C1051A-1	102mm CIRCULAR	98.90	1.58	25.6
C1051A-2	102mm CIRCULAR	98.90	1.58	25.6
C1052A-1	152mm CIRCULAR	98.53	1.54	55.6
C1052A-2	152mm CIRCULAR	98.53	1.54	55.6
C1052B-1	152mm CIRCULAR	98.55	1.63	57.2
C1052B-2	152mm CIRCULAR	98.55	1.63	57.2
C2000A-1	178mm CIRCULAR	99.09	1.71	78.1
C2000A-2	178mm CIRCULAR	99.00	1.71	80.4
C2001A-1	152mm CIRCULAR	99.31	1.64	55.9
C2001A-2	152mm CIRCULAR	99.23	1.64	57.4
C2002A-1	127mm CIRCULAR	99.25	1.62	39.0
C2002A-2	127mm CIRCULAR	99.17	1.62	40.1
C2004A-1	127mm CIRCULAR	99.20	1.60	38.7
C2004A-2	127mm CIRCULAR	99.12	1.60	39.8
C2004B-1	152mm CIRCULAR	99.07	1.56	54.6
C2004B-2	152mm CIRCULAR	99.00	1.56	56.0
C2005A-1	152mm CIRCULAR	98.91	1.53	55.5
C2005A-2	152mm CIRCULAR	98.91	1.53	55.5
C2006A-1	152mm CIRCULAR	99.64	1.43	53.6
C2006A-2	152mm CIRCULAR	99.64	1.43	53.6
C2006B-1	178mm CIRCULAR	99.38	1.60	77.5

ICD TABLE				
CB ID	ICD Type	Invert	100yr Head (m)	100yr Flow (L/s)
L2031B-1	095mm CIRCULAR	99.49	1.56	25.1
L2031B-2	095mm CIRCULAR	99.49	1.56	25.1
L2032A-1	102mm CIRCULAR	99.91	1.72	26.7
L2032A-2	102mm CIRCULAR	99.91	1.72	26.7
L2032B-1	152mm CIRCULAR	99.30	2.42	70.3
L2033A-1	152mm CIRCULAR	99.99	1.63	57.4
L2033A-2	152mm CIRCULAR	99.99	1.63	57.4
L2033B-1	108mm CIRCULAR	99.94	1.69	29.7
L2033B-2	108mm CIRCULAR	99.94	1.69	29.7
L2036A-1	083mm CIRCULAR	100.09	1.54	16.8
L2036A-2	083mm CIRCULAR	100.09	1.54	16.8
L2037A-1	127mm CIRCULAR	99.97	1.62	40.0
L2037A-2	127mm CIRCULAR	99.97	1.62	40.0
L2038A-1	127mm CIRCULAR	100.45	1.58	39.5
L2038A-2	127mm CIRCULAR	100.45	1.58	39.5
L2039A-1	102mm CIRCULAR	100.00	1.63	26.0
L2039A-2	102mm CIRCULAR	100.00	1.63	26.0
L2039B-1	095mm CIRCULAR	100.11	1.56	22.1
L2039B-2	095mm CIRCULAR	100.11	1.56	22.1
L2040A-1	083mm CIRCULAR	100.12	1.43	16.2
L2040A-2	083mm CIRCULAR	100.12	1.43	16.2
L2041A-1	095mm CIRCULAR	100.19	1.55	22.0
L2041A-2	095mm CIRCULAR	100.19	1.55	22.0
L2042A-1	108mm CIRCULAR	100.44	1.57	28.6
L2042A-2	108mm CIRCULAR	100.44	1.57	28.6
L2043A-1	083mm CIRCULAR	100.14	1.54	16.8
L2043A-2	083mm CIRCULAR	100.14	1.54	16.8
L2043B-1	095mm CIRCULAR	100.32	1.54	21.9
L2043B-2	095mm CIRCULAR	100.32	1.54	21.9
L2044A-1	083mm CIRCULAR	99.28	1.65	17.4
L2044A-2	083mm CIRCULAR	99.28	1.65	17.4
L2044B-1	178mm CIRCULAR	98.71	1.86	83.8
L2044C-1	178mm CIRCULAR	98.74	2.47	97.2
L2046A-1	152mm CIRCULAR	99.22	1.64	57.5
L2046A-2	152mm CIRCULAR	99.22	1.64	57.5
L2047A-1	108mm CIRCULAR	99.08	1.56	28.5
L2047A-2	108mm CIRCULAR	99.08	1.56	28.5
LM97A-1	200mm CIRCULAR	99.27	1.98	116.6

ICD TABLE				
CB ID	ICD Type	Invert	100yr Head (m)	100yr Flow (L/s)
L2016B-1	083mm CIRCULAR	100.03	2.32	20.7
L2017A-1	102mm CIRCULAR	100.79	1.58	25.6
L2017A-2	102mm CIRCULAR	100.79	1.58	25.6
L2017B-1	095mm CIRCULAR	100.66	1.55	22.0
L2017B-2	095mm CIRCULAR	100.66	1.55	22.0
L2018A-1	083mm CIRCULAR	99.61	1.66	17.5
L2018A-2	083mm CIRCULAR	99.61	1.66	17.5
L2018B-1	178mm CIRCULAR	99.00	2.42	96.3
L2019A-1	102mm CIRCULAR	99.72	1.68	26.4
L2019A-2	102mm CIRCULAR	99.72	1.68	26.4
L2019B-1	127mm CIRCULAR	99.13	2.41	49.2
L2021A-1	083mm CIRCULAR	100.23	1.64	17.3
L2021A-2	083mm CIRCULAR	100.23	1.64	17.3
L2021B-1	178mm CIRCULAR	99.63	2.45	96.8
L2023A-1	127mm CIRCULAR	100.15	1.56	39.3
L2023A-2	127mm CIRCULAR	100.15	1.56	39.3
L2024A-1	102mm CIRCULAR	100.55	1.66	26.3
L2024A-2	102mm CIRCULAR	100.55	1.66	26.3
L2024B-1	102mm CIRCULAR	100.43	1.65	26.2
L2024B-2	102mm CIRCULAR	100.43	1.65	26.2
L2026A-1	127mm CIRCULAR	100.83	1.60	39.8
L2026A-2	127mm CIRCULAR	100.83	1.60	39.8
L2026B-1	083mm CIRCULAR	100.64	1.64	17.3
L2026B-2	083mm CIRCULAR	100.64	1.64	17.3
L2027A-1	127mm CIRCULAR	100.88	1.52	38.7
L2027A-2	127mm CIRCULAR	100.88	1.52	38.7
L2027B-1	178mm CIRCULAR	100.83	2.00	87.1
L2029A-1	152mm CIRCULAR	99.79	1.61	57.0
L2029A-2	152mm CIRCULAR	99.79	1.61	57.0
L2029B-1	152mm CIRCULAR	99.65	2.43	70.5
L2030A-1	095mm CIRCULAR	99.66	1.65	22.7
L2030A-2	095mm CIRCULAR	99.66	1.65	22.7
L2030B-1	083mm CIRCULAR	99.11	2.35	20.9
L2031A-1	095mm CIRCULAR	99.64	1.57	22.2
L2031A-2	095mm CIRCULAR	99.64	1.57	22.2
L2013A-2	152mm CIRCULAR	99.88	1.61	56.9
L2015A-1	102mm CIRCULAR	100.44	1.59	25.7
L2015A-2	102mm CIRCULAR	100.44	1.59	25.7
L2016A-1	127mm CIRCULAR	100.63	1.31	35.9
L2016A-2	127mm CIRCULAR	100.63	1.31	35.9

ICD TABLE				
CB ID	ICD Type	Invert	100yr Head (m)	100yr Flow (L/s)
C2006B-2	178mm CIRCULAR	99.38	1.60	77.5
C2008A-1	108mm CIRCULAR	99.66	1.56	28.5
C2008A-2	108mm CIRCULAR	99.66	1.56	28.5
C2009A-1	127mm CIRCULAR	99.78	0.68	25.3
C2009A-2	127mm CIRCULAR	99.78	0.68	25.3
C2009B-1	127mm CIRCULAR	99.73	1.51	38.6
C2009B-2	127mm CIRCULAR	99.73	1.51	38.6
CM97A-1	178mm CIRCULAR	99.58	1.47	71.9
CM97A-2	152mm CIRCULAR	99.50	1.47	54.3
L1007A-1	127mm CIRCULAR	97.55	1.63	40.2
L1010A-1	083mm CIRCULAR	97.20	1.71	17.7
L1010B-1	178mm CIRCULAR	96.69	2.52	98.2
L1011A-1	083mm CIRCULAR	97.65	1.59	17.0
L1011A-2	083mm CIRCULAR	97.65	1.59	17.0
L1011B-1	127mm CIRCULAR	97.08	2.43	49.4
L1012A-1	083mm CIRCULAR	98.05	1.51	16.6
L1012A-2	083mm CIRCULAR	98.05	1.51	16.6
L1015A-1	083mm CIRCULAR	99.37	1.59	17.1
L1015A-2	083mm CIRCULAR	99.37	1.59	17.1
L1016A-1	127mm CIRCULAR	97.48	1.63	40.2
L1016A-2	127mm CIRCULAR	97.48	1.63	40.2
L1017A-1	127mm CIRCULAR	98.01	1.58	39.6
L1017A-2	127mm CIRCULAR	98.01	1.58	39.6
L1019A-1	108mm CIRCULAR	98.25	1.62	29.1
L1019A-2	108mm CIRCULAR	98.25	1.62	29.1
L1019B-1	200mm CIRCULAR	97.58	2.32	126.5
L1019C-1	102mm CIRCULAR	98.27	1.62	26.0
L1020A-1	102mm CIRCULAR	98.62	1.57	25.5
L1020A-2	102mm CIRCULAR	98.62	1.57	25.5
L1020B-1	083mm CIRCULAR	98.87	1.57	16.9
L1020B-2	083mm CIRCULAR	98.87	1.57	16.9
L1020C-1	083mm CIRCULAR	98.46	1.50	16.6
L1020C-2	083mm CIRCULAR	98.46	1.50	16.6
L1050B-1	108mm CIRCULAR	97.55	2.35	35.2
L1051B-1	127mm CIRCULAR	98.33	2.50	50.1
L1053A-1	108mm CIRCULAR	98.09	2.36	35.3
L2007A-1	178mm CIRCULAR	99.23	2.49	97.7
L2010A-1	095mm CIRCULAR	99.20	1.70	23.1
L2010A-2	095mm CIRCULAR	99.20	1.70	23.1
L2010B-1	152mm CIRCULAR	98.59	2.41	70.3
L2011A-1	152mm CIRCULAR	99.33	1.67	58.0
L2011A-2	152mm CIRCULAR	99.33	1.67	58.0
L2013A-1	152mm CIRCULAR	99.88	1.61	56.9

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Legend

- AREA ID
- RUNOFF COEFFICIENT
- STORM DRAINAGE AREA ha.
- STORM DRAINAGE BOUNDARY
- EXISTING/FUTURE STORM DRAINAGE BOUNDARY
- FUTURE MINOR DRAINAGE AREA
- TYPICAL SERVICE LATERAL LOCATION
- MAXIMUM PONDING LIMITS
- DIRECTION OF OVERLAND FLOW
- PROPOSED STORM SEWER
- PROPOSED CATCHBASIN MANHOLE
- PROPOSED CATCHBASIN
- PROPOSED DOUBLE CATCH BASIN
- PROPOSED SUB DRAIN CATCH BASIN AS PER CITY OF OTTAWA STANDARD DETAIL DRAWINGS L10 AND L11.
- PROPOSED PERFORATED SUBDRAIN
- EXISTING STORM SEWER
- EXISTING CATCHBASIN MANHOLE
- EXISTING CATCHBASIN
- EXISTING SUBDRAIN CATCHBASIN
- FUTURE STORM SEWER
- FUTURE CATCHBASIN MANHOLE
- FUTURE CATCHBASIN
- FUTURE SUBDRAIN CATCHBASIN
- Ⓐ Ⓑ Ⓒ Ⓓ Ⓕ IPEX ICD TYPE AS NOTED OR EQUIVALENT
- Ⓗ HYDROVEX ICD OR EQUIVALENT (SEE ICD TABLE SD-1/SD-2)
- Ⓞ CIRCULAR ORIFICE (SEE SEE ICD TABLE SD-1/SD-2)
- Ⓒ CATCHBASINS TO BE INTERCONNECTED
- MINOR SYSTEM DRAINAGE DIVIDE

		By	Appd.	YY.MM.DD
11	REVISED AS PER NEW DRAFT PLAN	MJS	DT	19.04.11
10	REVISED AS PER CITY COMMENTS	AJ	DT	19.03.04
9	ISSUED FOR GRADING APPROVAL	AJ	DT	19.01.09
8	ISSUED FOR TENDER	AJ	DT	18.12.12
7	REVISED HYDRANT LOCATION @ BLOCK 450	AJ	DT	18.11.23
6	REVISED AS PER UTILITY COORDINATION	MJS	DT	18.11.07
5	REVISED AS PER CITY COMMENTS	AJ	DT	18.11.01
4	ISSUED FOR 3RD SUBMISSION	MJS	DT	18.10.02
3	ISSUED FOR COORDINATION	SG	SG	18.09.17
2	ISSUED FOR 2ND SUBMISSION	MJS	DT	18.08.01
1	ISSUED FOR 1ST SUBMISSION	MJS	DT	18.04.25

Revision

File Name: 160401130-SD	MJS	DT	DT	18.01.02
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

2129786 ONTARIO INC.
MATTAMY (MONARCH) LTD.

BLACKSTONE COMMUNITY
PHASE 4-8

OTTAWA, ON, CANADA

Title

STORM DRAINAGE PLAN

Project No. 160401130

Scale 1:750 (0 7.5 22.5 37.5m)

Drawing No. SD-4

Sheet 54 of 66

Revision 11

D07-16-17-0014

DWG# 17625

Stantec

Blackstone Phases 4-8	
DATE:	2019-08-29
REVISION:	4
DESIGNED BY:	DT
CHECKED BY:	SG

STORM SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160401130

DESIGN PARAMETERS

$I = a / (t+b)^c$ (As per City of Ottawa Guidelines, 2012)

	1:2 yr	1:5 yr	1:10 yr	1:100 yr			
a =	732.951	998.071	1174.184	1735.688	MANNING'S n =	0.013	BEDDING CLASS = B
b =	6.199	6.053	6.014	6.014	MINIMUM COVER:	2.00 m	
c =	0.810	0.814	0.816	0.820	TIME OF ENTRY	10 min	

LOCATION			DRAINAGE AREA																											PIPE SELECTION											
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-YEAR} (mm/h)	I_{5-YEAR} (mm/h)	$I_{10-YEAR}$ (mm/h)	$I_{100-YEAR}$ (mm/h)	$Q_{CONTROL}$ (L/s)	ACCUM. $Q_{CONTROL}$ (L/s)	Q_{ACT} (CIA/360) (L/s)	LENGTH (m)	PIPE WIDTH OR DIAMETEI (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)
Fernbank Crossing P1-4	301	M97	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	6451.8	6451.8	6451.8	78.3	1950	1950	CIRCULAR	CONCRETE	-	0.30	8131.0	**79.35%**	2.64	2.60	0.50
LM97A, CM97A	M97	M98	0.67	0.41	0.00	0.00	0.00	0.45	0.70	0.00	0.00	0.303	0.303	0.284	0.284	0.000	0.000	0.000	0.000	10.50	74.93	101.61	119.10	174.09	0.0	6451.8	6594.9	78.0	2100	2100	CIRCULAR	CONCRETE	-	0.20	8089.5	**81.52%**	2.26	2.24	0.58
																				11.08																					
F2006A	2048	2005A	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.00	0.40	0.000	0.000	0.000	0.000	0.000	0.000	0.541	0.541	10.00	76.81	104.19	122.14	178.56	0.0	0.0	268.3	12.9	525	525	CIRCULAR	CONCRETE	-	0.50	317.2	**84.57%**	1.42	1.42	0.15
																				10.15																					
C2009A, C2009B	2009	2008	0.00	0.34	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.000	0.238	0.238	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	68.8	64.5	450	450	CIRCULAR	CONCRETE	-	0.20	133.0	**51.75%**	0.81	0.70	1.54
C2008A	2008	2007	0.00	0.21	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.000	0.150	0.388	0.000	0.000	0.000	0.000	11.54	71.37	96.72	113.34	165.63	0.0	0.0	104.3	64.5	600	600	CIRCULAR	CONCRETE	-	0.20	286.5	**36.41%**	0.98	0.76	1.41
L2007A	2007	2006	0.56	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.219	0.219	0.000	0.388	0.000	0.000	0.000	0.000	12.95	67.08	90.84	106.42	155.47	0.0	0.0	138.8	49.4	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**30.85%**	0.99	0.73	1.13
C2006A, C2006B	2006	2005A	0.00	0.55	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.219	0.385	0.774	0.000	0.000	0.000	0.000	14.07	64.04	86.67	101.52	148.27	0.0	0.0	225.2	70.3	900	900	CIRCULAR	CONCRETE	-	0.10	597.2	**37.71%**	0.91	0.72	1.64
																				15.71																					
	2005A	2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.219	0.000	0.774	0.000	0.000	0.000	0.541	15.71	60.14	81.33	95.23	139.05	0.0	0.0	420.3	22.9	900	900	CIRCULAR	CONCRETE	-	0.10	597.2	**70.37%**	0.91	0.86	0.44
																				16.15																					
C2049A	2049	2005	0.00	2.84	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.000	1.989	1.989	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	575.7	13.0	825	825	CIRCULAR	CONCRETE	-	0.25	748.8	**76.89%**	1.36	1.32	0.16
																				10.16																					
C2005A	2005	2004	0.00	0.38	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.219	0.265	3.028	0.000	0.000	0.000	0.541	16.15	59.17	80.01	93.68	136.77	0.0	0.0	914.4	120.0	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**71.09%**	1.10	1.05	1.91
C2004A, C2004B	2004	2003	0.00	0.63	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.219	0.444	3.471	0.000	0.000	0.000	0.541	18.07	55.37	74.80	87.56	127.80	0.0	0.0	947.0	119.0	1350	1350	CIRCULAR	CONCRETE	-	0.10	1760.8	**53.78%**	1.19	1.04	1.91
	2003	2002	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.219	0.000	3.471	0.000	0.000	0.000	0.541	19.98	52.07	70.30	82.27	120.04	0.0	0.0	889.9	55.9	1350	1350	CIRCULAR	CONCRETE	-	0.10	1760.8	**50.54%**	1.19	1.02	0.92
C2002A	2002	2001	0.00	0.30	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.219	0.209	3.680	0.000	0.000	0.000	0.541	20.89	50.64	68.35	79.98	116.68	0.0	0.0	904.8	56.7	1350	1350	CIRCULAR	CONCRETE	-	0.10	1760.8	**51.39%**	1.19	1.03	0.92
																				21.81																					
L2047A	2047	2046	0.31	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.219	0.219	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	46.7	73.3	450	450	CIRCULAR	CONCRETE	-	0.20	133.0	**35.13%**	0.81	0.62	1.96
L2046A	2046	2045	0.49	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.347	0.566	0.000	0.000	0.000	0.000	0.000	0.000	11.96	70.01	94.86	111.15	162.42	0.0	0.0	110.1	44.9	525	525	CIRCULAR	CONCRETE	-	0.15	173.8	**63.34%**	0.78	0.71	1.05
	2045	2044	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.566	0.000	0.000	0.000	0.000	0.000	0.000	13.01	66.89	90.58	106.12	155.02	0.0	0.0	105.2	44.6	525	525	CIRCULAR	CONCRETE	-	0.15	173.8	**60.52%**	0.78	0.71	1.05
L2044B, L2044C, L2044A	2044	2001	1.20	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.587	1.153	0.000	0.000	0.000	0.000	0.000	0.000	14.07	64.06	86.70	101.55	148.32	0.0	0.0	205.1	44.5	675	675	CIRCULAR	CONCRETE	-	0.15	339.6	**60.40%**	0.92	0.84	0.89
																				14.95																					
L2027B, L2027A	2027	2026	0.79	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.465	0.465	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	99.2	128.6	450	450	CIRCULAR	CONCRETE	-	0.25	148.7	**66.69%**	0.91	0.85	2.53
L2026A	2026	2017	0.34	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.236	0.701	0.000	0.000	0.000	0.000	0.000	0.000	12.53	68.30	92.50	108.38	158.34	0.0	0.0	132.9	105.3	525	525	CIRCULAR	CONCRETE	-	0.20	200.6	**66.25%**	0.90	0.83	2.10
L2017B, L2017A	2017	2015	0.50	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.350	1.051	0.000	0.000	0.000	0.000	0.000	0.000	14.63	62.66	84.77	99.28	144.99	0.0	0.0	182.9	89.5	600	600	CIRCULAR	CONCRETE	-	0.20	286.5	**63.83%**	0.98	0.91	1.65
																				16.28																					
L2016A, L2016B	2016	2015	0.18	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.088	0.088	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	18.9	38.3	300	300	CIRCULAR	PVC	-	0.65	77.5	**24.33%**	1.10	0.76	0.84
																				10.84																					
L2015A	2015	2014	0.27	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.192	1.332	0.000	0.000	0.000	0.000	0.000	0.000	16.28	58.91	79.65	93.26	136.15	0.0	0.0	217.9	91.3	675	675	CIRCULAR	CONCRETE	-	0.40	554.6	**39.29%**	1.50	1.19	1.27
	2014	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.332	0.000	0.000	0.000	0.000	0.000	0.000	17.55	56.34	76.13	89.12	130.08	0.0	0.0	208.4	15.8	675	675	CIRCULAR	CONCRETE	-	0.40	554.6	**37.57%**	1.50	1.18	0.22
L2013A	2013	2012	0.51	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.357	1.689	0.000	0.000	0.000	0.000	0.000	0.000	17.77	55.91	75.55	88.44	129.08	0.0	0.0	262.3	95.7	675	675	CIRCULAR	CONCRETE	-	0.40	554.6	**47.30%**	1.50	1.26	1.27
	2012	2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.689	0.000	0.000	0.000	0.000	0.000	0.000	19.04	53.63	72.43	84.77	123.70	0.0	0.0	251.6	41.4	675	675	CIRCULAR	CONCRETE	-	0.40	554.6	**45.37%**	1.50	1.25	0.55
L2011A	2011	2010	0.55	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.382	2.071	0.000	0.000	0.000	0.000	0.000	0.000	19.59	52.69	71.15	83.27	121.51	0.0	0.0	303.1	42.1	825	825	CIRCULAR	CONCRETE	-	0.15	580.0	**52.26%**	1.05	0.91	0.77
																				20.37																					
L2042A	2042	2041	0.32	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.235	0.235	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	50.2	70.8	300	300	CIRCULAR	PVC	-	0.65	77.5	**64.78%**	1.10	1.02	1.16
L2041A	2041	2040	0.20	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.150	0.386	0.000	0.000	0.000	0.000	0.000	0.000	11.16	72.61	98.43	115.36	168.59	0.0	0.0	77.8	83.1	375	375	CIRCULAR	PVC	-	0.65	132.9	**58.51%**	1.26	1.13	1.23
																				12.39																					
L2043B, L2043A	2043	2040	0.34	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.251	0.251	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	53.6	107.2	300	300	CIRCULAR	PVC	-	0.65	77.5	**69.08%**	1.10	1.04	1.72
																				11.72																					
L2040A	2040	2036	0.08	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.045	0.682	0.000	0.000	0.000	0.000	0.000	0.000	12.39	68.70	93.06	109.03	159.30	0.0	0.0	130.2	48.3	525	525	CIRCULAR	CONCRETE	-	0.15	173.8	**74.90%**	0.78	0.75	1.07
																				13.46																					
L2039B, L2039A	2039	2036	0.49	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.366	0.366	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	78.0	105.7	375	375	CIRCULAR	PVC	-	0.40	104.3	**74.80%**	0.99	0.96	1.84
																				11.84																					
L2038A	2038	2037	0.35	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.257	0.257	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	54.9	69.9	300	300	CIRCULAR	PVC	-	0.65	77.5	**70.85%**	1.10	1.05	1.11
L2037A	2037	2036	0.36	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.265	0.522	0.000	0.000	0.000	0.000	0.000	0.000	11.11	72.78	98.66	115.62	168.98	0.0	0.0	105.6	83.4	450	450	CIRCULAR	PVC	-	0.75	257.6	**41.01%**	1.57	1.26	1.10
																				12.21																					
L2036A	2036	2032	0.07	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.038	1.608	0.000	0.000	0.000	0.000	0.000	0.000	13.46	65.66	88.89	104.12	152.09	0.0	0.0	293.3	44.0	825	825	CIRCULAR	CONCRETE	-	0.10	473.6	**61.93%**	0.86	0.79	0.93
																				14.39																					
	2035	2034	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	85.0	300	300	CIRCULAR	PVC	-	0.40	60.8	**0.00%**	0.86	0.00	0.00
	2034	2033	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	11.7	300	300	CIRCULAR	PVC	-	0.40	60.8	**0.00%**	0.86	0.00	0.00
L2033A, L2033B	2033	2032	0.73	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.539	0.539	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	115.0	113.4	450	450	CIRCULAR	CONCRETE	-	0.25	148.7	**77.30%**	0.91	0.88	2.14
																				12.14																					
L2032A, L2032B	2032	2029	0.73	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.371	2.518	0.000	0.000	0.000	0.000	0.000	0.000	14.39	63.24	85.57	100.22	146.37	0.0	0.0	442.3	82.0	900	900	CIRCULAR	CONCRETE	-	0.15	731.4	**60.47%**	1.11	1.01	1.35
																				15.74																					
L2031A, L2031B	2031	2030	0.43	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.300	0.300	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	64.0	82.0	450	450	CIRCULAR	CONCRETE	-	0.20	133.0	**48.10%**	0.81	0.69	1.99
L2030B, L2030A	2030	2029	0.35	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.214	0.514	0.000	0.000	0.000	0.000	0.000	0.000	11.99	69.92	94.74	111.00	162.20	0.0	0.0	99.7	102.4	825	825	CIRCULAR	CONCRETE	-	0.10	473.6	**21.06%**	0.86	0.57	3.02
																				15.01																					
L2029A, L2029B	2029	2028	1.30	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.674	3.705	0.000	0.000	0.000	0.000	0.000	0.000	15.74	60.06	81.23	95.11	138.87	0.0	0.0	618.2	111.7	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**48.07%**	1.10	0.93	1.99
																				17.74																					
L2021A, L2021B	2021	2020	0.81	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.419	0.419	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	89.3	9.7	375	375	CIRCULAR	PVC	-	0.65	132.9	**67.23%**	1.26	1.18	0.14
	2020	2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.419	0.000	0.000	0.000	0.000	0.000	0.000	10.14	76.29	103.48	121.30	177.32	0.0	0.0	88.7	35.9	450	450	CIRCULAR	CONCRETE	-	0.20	133.0	**66.71%**	0.81	0.76	0.79
																				10.92																					
L2026B	2026	2025	0.16	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.110	0.110	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	23.5	75.3	300	300	CIRCULAR	PVC	-	0.50	68.0	**34.62%**	0.97	0.74	1.69
	2025	2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.110	0.000	0.000	0.000	0.000	0.000	0.000	11.69	70.87	96.04	112.54	164.46	0.0	0.0	21.7	9.6	300	300	CIRCULAR	PVC	-	0.50	68.0	**31.95%**	0.97	0.72	0.22
L2024A, L2024B	2024	2023	0.57	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.400	0.510	0.000	0.000	0.000	0.000	0.000	0.000	11.91	70.17	95.08	111.41	162.80	0.0	0.0	99.4	89.0	600	600	CIRCULAR	CONCRETE	-	0.20	286.5	**34.71%**	0.98	0.75	1.97
L2023A	2023	2022	0.35	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.245	0.755	0.000	0.000	0.000	0.000	0.000	0.000	13.88	64.55	87.37	102.34	149.48	0.0	0.0	135.5	76.1	675	675	CIRCULAR	CONCRETE	-	0.15	339.6	**39.88%**	0.92	0.73	1.73
	2022	2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.755	0.000	0.000	0.000	0.000	0.000	0.000	15.61	60.36	81.63	95.59	139.58	0.0	0.0	126.7	12.2	675	675	CIRCULAR	CONCRETE	-	0.15	339.6	**37.30%**	0.92	0.71	0.29
																				15.90																					
L2019A, L2019B	2019	2028	0.64	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.360	1.534	0.000	0.000	0.000	0.000	0.000	0.000	15.90	59.73	80.77	94.57	138.08	0.0	0.0	254.6	81.3	825	825	CIRCULAR	CONCRETE	-	0.10	473.6	**53.76%**	0.86	0.75	1.81
																				17.71																					
	2028	2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	5.240	0.000	0.000	0.000	0.000	0.000	0.000	17.74	55.98	75.64	88.54	129.24	0.0	0.0	814.7	11.0	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**63.34%**	1.10	1.01	0.18
L2018A, L2018B	2018	2010	0.71	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.346	5.585	0.000	0.000	0.000	0.000	0.000	0.000	17.92	55.64	75.17	88.00	128.43	0.0	0.0	863.2	71.4	1350	1350	CIRCULAR	CONCRETE	-	0.10	1760.8	**49.02%**	1.19	1.01	1.18
																				19.10																					
L2010A, L2010B	2010	2001	0.48	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.234	7.890	0.000	0.000	0.000	0.000	0.000	0.000	20.37	51.45	69.45	81.27	118.58	0.0	0.0	1127.6	88.2	1350	1350	CIRCULAR	CONCRETE	-	0.10	1760.8	**64.04%**	1.19	1.10	1.34

Stantec

Blackstone Phases 4-8

DATE: 2019-08-29
REVISION: 4
DESIGNED BY: DT
CHECKED BY: SG

STORM SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160401130

DESIGN PARAMETERS

$I = a / (t+b)^c$ (As per City of Ottawa Guidelines, 2012)

	1:2 yr	1:5 yr	1:10 yr	1:100 yr				
a =	732.951	998.071	1174.184	1735.688	MANNING'S n =	0.013	BEDDING CLASS =	B
b =	6.199	6.053	6.014	6.014	MINIMUM COVER:	2.00 m		
c =	0.810	0.814	0.816	0.820	TIME OF ENTRY	10 min		

LOCATION			DRAINAGE AREA																											PIPE SELECTION										
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-YEAR} (mm/h)	I_{5-YEAR} (mm/h)	$I_{10-YEAR}$ (mm/h)	$I_{100-YEAR}$ (mm/h)	$Q_{CONTROL}$ (L/s)	ACCUM. $Q_{CONTROL}$ (L/s)	Q_{ACT} (CIA/360) (L/s)	LENGTH (m)	PIPE WIDTH OR DIAMETEI (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)
																				21.71																				
C2001A	2001	2000	0.00	0.41	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.000	9.262	0.294	3.974	0.000	0.000	0.000	0.541	21.81	49.29	66.51	77.82	113.51	0.0	0.0	2172.9	55.7	1800	1800	CIRCULAR	CONCRETE	-	0.10	3792.1	**57.30%**	1.44	1.29	0.72
C2000A	2000	M98	0.00	0.56	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.000	9.262	0.396	4.371	0.000	0.000	0.000	0.541	22.53	48.29	65.15	76.21	111.16	0.0	0.0	2200.2	79.7	1800	1800	CIRCULAR	CONCRETE	-	0.10	3792.1	**58.02%**	1.44	1.29	1.03
																				23.56																				
	M98	M99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	9.565	0.000	4.654	0.000	0.000	0.000	0.541	23.56	46.93	63.30	74.04	107.98	0.0	6451.8	8679.2	26.9	2400	2400	CIRCULAR	CONCRETE	-	0.15	8420.8	**103.07%**	2.05	2.17	0.21
																				23.77									2400	2400									
L1054A	1054	1052	1.07	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	0.631	0.631	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	134.7	13.5	525	525	CIRCULAR	CONCRETE	-	0.20	200.6	**67.13%**	0.90	0.84	0.27
C1052A, C1052B	1052	1050	0.00	0.87	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.631	0.609	0.609	0.000	0.000	0.000	0.000	10.27	75.79	102.80	120.50	176.15	0.0	0.0	306.8	111.4	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**68.20%**	0.99	0.92	2.01
																				12.28																				
L1053B, L1053A	1053	1050	1.48	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.852	0.852	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	181.8	42.6	600	600	CIRCULAR	CONCRETE	-	0.15	248.1	**73.26%**	0.85	0.82	0.87
																				10.87																				
L1051B, C1051A	1051	1050	0.49	0.18	0.00	0.00	0.00	0.47	0.71	0.00	0.00	0.230	0.230	0.127	0.127	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	85.8	58.5	375	375	CIRCULAR	PVC	-	0.65	132.9	**64.60%**	1.26	1.16	0.84
																				10.84																				
L1050B	1050	1049	0.17	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.080	1.794	0.000	0.736	0.000	0.000	0.000	0.000	12.28	69.04	93.52	109.58	160.10	0.0	0.0	535.1	70.0	900	900	CIRCULAR	CONCRETE	-	0.15	731.4	**73.16%**	1.11	1.07	1.09
																				13.37									900	900									
C1009A	1009	1008	0.00	0.50	0.00	0.00	0.00	0.00	0.72	0.00	0.00	0.000	0.000	0.361	0.361	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	104.5	53.6	375	375	CIRCULAR	PVC	-	1.00	164.8	**63.38%**	1.56	1.43	0.62
C1008A	1008	1007	0.00	0.64	0.00	0.00	0.00	0.00	0.72	0.00	0.00	0.000	0.000	0.462	0.823	0.000	0.000	0.000	0.000	10.62	74.49	101.01	118.39	173.05	0.0	0.0	231.0	110.1	525	525	CIRCULAR	CONCRETE	-	0.80	401.3	**57.56%**	1.80	1.61	1.14
L1007A	1007	1006	0.34	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.158	0.158	0.000	0.823	0.000	0.000	0.000	0.000	11.77	70.63	95.70	112.14	163.87	0.0	0.0	249.9	43.1	600	600	CIRCULAR	CONCRETE	-	0.35	379.0	**65.94%**	1.30	1.21	0.60
																				12.36																				
L1015A	1015	1020	0.11	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.065	0.065	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	13.9	52.8	300	300	CIRCULAR	PVC	-	0.65	77.5	**17.91%**	1.10	0.69	1.27
L1020C, L1020B	1020	1014	0.26	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.148	0.214	0.000	0.000	0.000	0.000	0.000	0.000	11.27	72.24	97.91	114.74	167.69	0.0	0.0	42.8	97.2	375	375	CIRCULAR	PVC	-	0.65	132.9	**32.24%**	1.26	0.94	1.71
																				12.99																				
L1022A	1022	1014	3.14	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	2.197	2.197	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	468.8	15.0	675	675	CIRCULAR	CONCRETE	-	0.50	620.1	**75.60%**	1.68	1.62	0.15
																				10.15																				
	1014	1013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	2.411	0.000	0.000	0.000	0.000	0.000	0.000	12.99	66.96	90.67	106.22	155.18	0.0	0.0	448.4	69.3	675	675	CIRCULAR	CONCRETE	-	0.65	707.0	**63.43%**	1.91	1.75	0.66
	1013	1012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	2.411	0.000	0.000	0.000	0.000	0.000	0.000	13.65	65.15	88.20	103.31	150.90	0.0	0.0	436.3	8.9	750	750	CIRCULAR	CONCRETE	-	0.40	734.5	**59.40%**	1.61	1.45	0.10
L1012A	1012	1011	0.15	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.087	2.498	0.000	0.000	0.000	0.000	0.000	0.000	13.75	64.88	87.82	102.87	150.26	0.0	0.0	450.2	75.8	825	825	CIRCULAR	CONCRETE	-	0.40	947.1	**47.53%**	1.72	1.44	0.88
																				14.63																				
F1021A	1021	1011	0.00	0.00	0.00	0.92	0.00	0.00	0.00	0.00	0.40	0.000	0.000	0.000	0.000	0.000	0.000	0.370	0.370	10.00	76.81	104.19	122.14	178.56	0.0	0.0	183.4	12.5	525	525	CIRCULAR	CONCRETE	-	0.25	224.3	**81.77%**	1.00	0.99	0.21
																				10.21																				
L1011B, L1011A	1011	1010	0.39	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.200	2.697	0.000	0.000	0.000	0.000	0.000	0.370	14.63	62.66	84.78	99.29	145.00	0.0	0.0	618.5	47.2	900	900	CIRCULAR	CONCRETE	-	0.30	1034.4	**59.79%**	1.58	1.42	0.55
																				15.18																				
L1020A	1020	1019	0.27	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.189	0.189	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	40.4	44.2	300	300	CIRCULAR	PVC	-	0.65	77.5	**52.13%**	1.10	0.95	0.78
L1019B, L1019C, L1019A	1019	1018	1.11	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	0.532	0.721	0.000	0.000	0.000	0.000	0.000	0.000	10.78	73.95	100.27	117.52	171.76	0.0	0.0	148.1	108.0	525	525	CIRCULAR	CONCRETE	-	0.45	301.0	**49.21%**	1.35	1.14	1.58
	1018	1017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.721	0.000	0.000	0.000	0.000	0.000	0.000	12.35	68.81	93.21	109.21	159.57	0.0	0.0	137.8	8.8	525	525	CIRCULAR	CONCRETE	-	0.45	301.0	**45.79%**	1.35	1.12	0.13
L1017A	1017	1016	0.35	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.245	0.966	0.000	0.000	0.000	0.000	0.000	0.000	12.48	68.42	92.67	108.58	158.64	0.0	0.0	183.6	104.3	600	600	CIRCULAR	CONCRETE	-	0.45	429.7	**42.73%**	1.47	1.20	1.45
L1016A	1016	1010	0.45	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.00	0.315	1.281	0.000	0.000	0.000	0.000	0.000	0.000	13.94	64.40	87.16	102.09	149.11	0.0	0.0	229.1	39.7	675	675	CIRCULAR	CONCRETE	-	0.20	392.2	**58.41%**	1.06	0.95	0.70
																				14.63																				
L1010A, L1010B	1010	1006	0.77	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.337	4.315	0.000	0.000	0.000	0.000	0.000	0.370	15.18	61.34	82.97	97.17	141.89	0.0	0.0	881.0	86.6	1200	1200	CIRCULAR	CONCRETE	-	0.20	1819.0	**48.43%**	1.56	1.32	1.09
																				16.28																				
C1006A	1006	1005	0.00	0.39	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	4.473	0.271	1.094	0.000	0.000	0.000	0.370	16.28	58.91	79.65	93.26	136.15	0.0	0.0	1113.9	61.7	1350	1350	CIRCULAR	CONCRETE	-	0.20	2490.2	**44.73%**	1.69	1.40	0.74
	1005	1004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.473	0.000	1.094	0.000	0.000	0.000	0.370	17.01	57.39	77.58	90.82	132.57	0.0	0.0	1085.1	42.5	1500	1500	CIRCULAR	CONCRETE	-	0.10	2332.0	**46.53%**	1.28	1.07	0.66
	1004	1003	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.473	0.000	1.094	0.000	0.000	0.000	0.370	17.67	56.11	75.81	88.75	129.54	0.0	0.0	1060.6	42.5	1650	1650	CIRCULAR	CONCRETE	-	0.10	3006.9	**35.27%**	1.36	1.05	0.68
C1003A	1003	1002	0.00	0.36	0.00	0.00	0.00	0.00	0.65	0.00	0.00	0.000	4.473	0.231	1.325	0.000	0.000	0.000	0.370	18.35	54.85	74.10	86.73	126.58	0.0	0.0	1084.3	43.7	1650	1650	CIRCULAR	CONCRETE	-	0.10	3006.9	**36.06%**	1.36	1.06	0.69
																				19.03																				
C1023A	1023	1002	0.00	7.40	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.000	5.179	5.179	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	1499.0	21.8	1200	1200	CIRCULAR	CONCRETE	-	0.20	1819.0	**82.41%**	1.56	1.55	0.23
																				10.23																				
	1002	1001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.473	0.000	6.505	0.000	0.000	0.000	0.370	19.03	53.64	72.44	84.79	123.73	0.0	0.0	2102.5	94.7	1650	1650	CIRCULAR	CONCRETE	-	0.10	3006.9	**69.92%**	1.36	1.29	1.22
	1001	1000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.473	0.000	6.505	0.000	0.000	0.000	0.370	20.26	51.62	69.70	81.56	118.99	0.0	0.0	2022.9	6.3	1650	1650	CIRCULAR	CONCRETE	-	0.10	3006.9	**67.28%**	1.36	1.28	0.08
																				20.34																				
L1000A	1000	P3	8.33	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	4.912	11.179	0.000	7.240	0.000	0.000	0.000	0.370	20.34	51.50	69.52	81.35	118.69	0.0	0.0	3119.1	43.9	1800	1800	CIRCULAR	CONCRETE	-	0.10	3792.1	**82.25%**	1.44	1.43	0.51
	P3	P2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	11.179	0.000	7.240	0.000	0.000	0.000	0.370	20.85	50.70	68.44	80.09	116.83	0.0	0.0	3071.0	14.0	1800	1800	CIRCULAR	CONCRETE	-	0.10	3792.1	**80.98%**	1.44	1.43	0.16
	P2	P1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	11.179	0.000	7.240	0.000	0.000	0.000	0.370	21.01	50.46	68.11	79.69	116.26	0.0	0.0	3056.0	6.5	1800	1800	CIRCULAR	CONCRETE	-	0.10	3792.1	**80.59%**	1.44	1.42	0.08
																				21.09																				
	P1	HW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	11.179	0.000	7.287	0.000	0.000	0.000	0.370	21.09	50.34	67.95	79.51	115.99	0.0	0.0	3057.8	8.4	2100	2100	CIRCULAR	CONCRETE	-	1.00	18088.7	**16.90%**	5.06	3.12	0.05
																				21.13									2100	2100									

Volume III: TEMPEST™ INLET CONTROL DEVICES

Municipal Technical Manual Series

SECOND EDITION

LMF (Low to Medium Flow) ICD

HF (High Flow) ICD

MHF (Medium to High Flow) ICD

IPEX

IPEX Tempest™ Inlet Control Devices

Municipal Technical Manual Series

Vol. I, 2nd Edition

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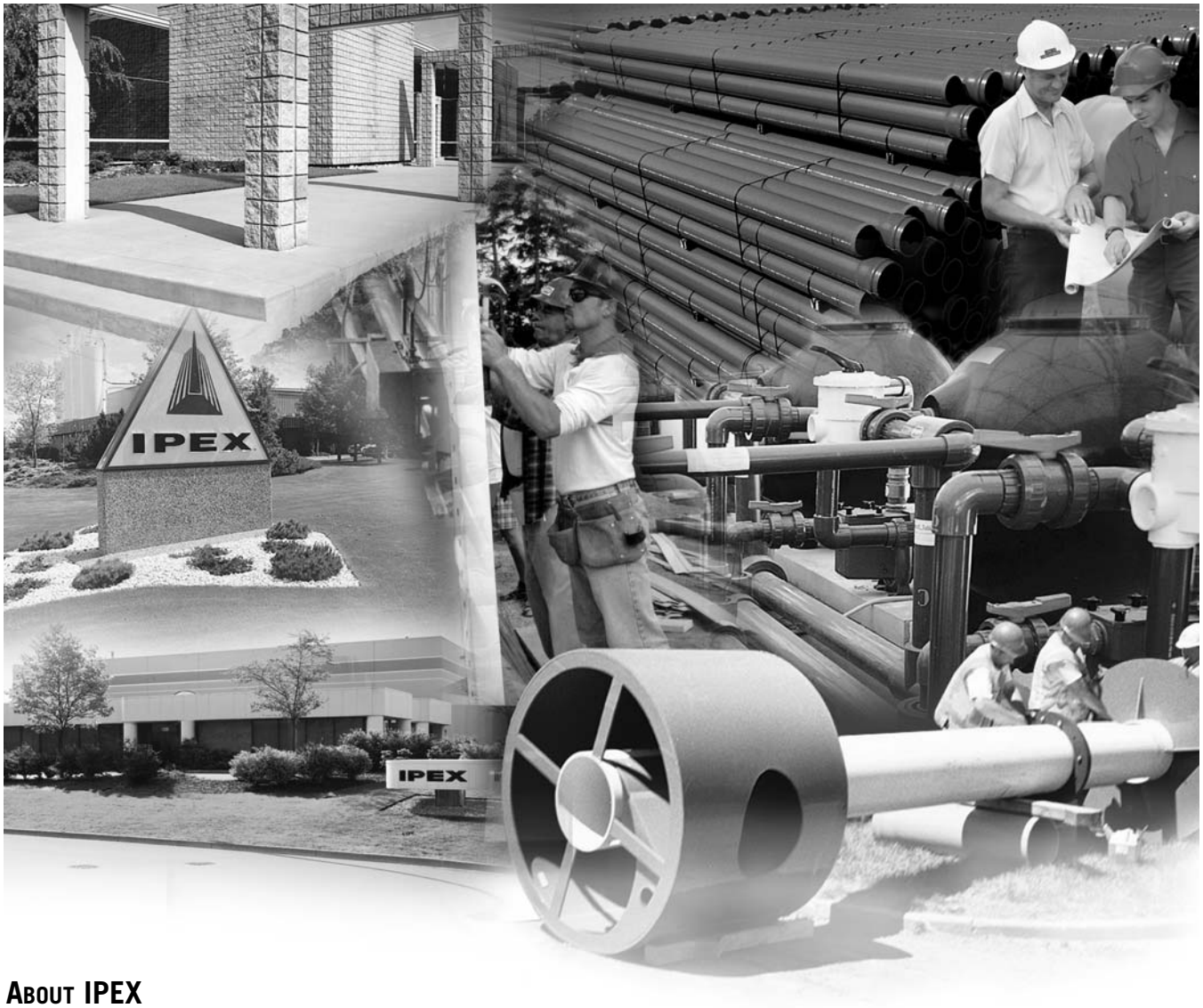

About IPEX

At IPEX, we have been manufacturing non-metallic pipe and fittings since 1951. We formulate our own compounds and maintain strict quality control during production. Our products are made available for customers thanks to a network of regional stocking locations throughout North America. We offer a wide variety of systems including complete lines of piping, fittings, valves and custom-fabricated items.

More importantly, we are committed to meeting our customers' needs. As a leader in the plastic piping industry, IPEX continually develops new products, modernizes manufacturing facilities and acquires innovative process technology. In addition, our staff take pride in their work, making available to customers their extensive thermoplastic knowledge and field experience. IPEX personnel are committed to improving the safety, reliability and performance of thermoplastic materials. We are involved in several standards committees and are members of and/or comply with the organizations listed on this page.

For specific details about any IPEX product, contact our customer service department.

CONTENTS

TEMPEST INLET CONTROL DEVICES Technical Manual

About IPEX

Section One: **Product Information: TEMPEST Low, Medium Flow (LMF) ICD**

Purpose 4
Product Description 4
Product Function 4
Product Construction 4
Product Applications 4
Chart 1: LMF 14 Preset Flow Curves 5
Chart 2: LMF Flow Vs. ICD Alternatives 5

Product Installation

Instructions to assemble a TEMPEST LMF ICD into a square catch basin: 6
Instructions to assemble a TEMPEST LMF ICD into a round catch basin: 6

Product Technical Specification

General 7
Materials 7
Dimensioning 7
Installation 7

Section Two: **Product Information: TEMPEST High Flow (HF) & Medium, High Flow (MHF) ICD**

Product Description 8
Product Function 8
Product Construction 8
Product Applications 8
Chart 3: HF & MHF Preset Flow Curves 9

Product Installation

Instructions to assemble a TEMPEST HF or MHF ICD into a square catch basin: 10
Instructions to assemble a TEMPEST HF or MHF ICD into a round catch basin: 10
Instructions to assemble a TEMPEST HF Sump into a square or round catch basin: . . . 11

Product Technical Specification

General 11
Materials 11
Dimensioning 11
Installation 11

NOTE: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

PRODUCT INFORMATION: TEMPEST LOW, MEDIUM FLOW (LMF) ICD

Purpose

To control the amount of storm water runoff entering a sewer system by allowing a specified flow volume out of a catch basin or manhole at a specified head. This approach conserves pipe capacity so that catch basins downstream do not become uncontrollably surcharged, which can lead to basement floods, flash floods and combined sewer overflows.

Product Description

Our LMF ICD is designed to accommodate catch basins or manholes with sewer outlet pipes 6" in diameter and larger. Any storm sewer larger than 12" may require custom modification. However, IPEX can custom build a TEMPEST device to accommodate virtually any storm sewer size.

Available in 14 preset flow curves, the LMF ICD has the ability to provide flow rates: 2lps – 17lps (31gpm – 270gpm)

Product Function

The LMF ICD vortex flow action allows the LMF ICD to provide a narrower flow curve using a larger orifice than a conventional orifice plate ICD, making it less likely to clog. When comparing flows at the same head level, the LMF ICD has the ability to restrict more flow than a conventional ICD during a rain event, preserving greater sewer capacity.

Product Construction

Constructed from durable PVC, the LMF ICD is light weight 8.9 Kg (19.7 lbs).

Product Applications

Will accommodate both square and round applications:

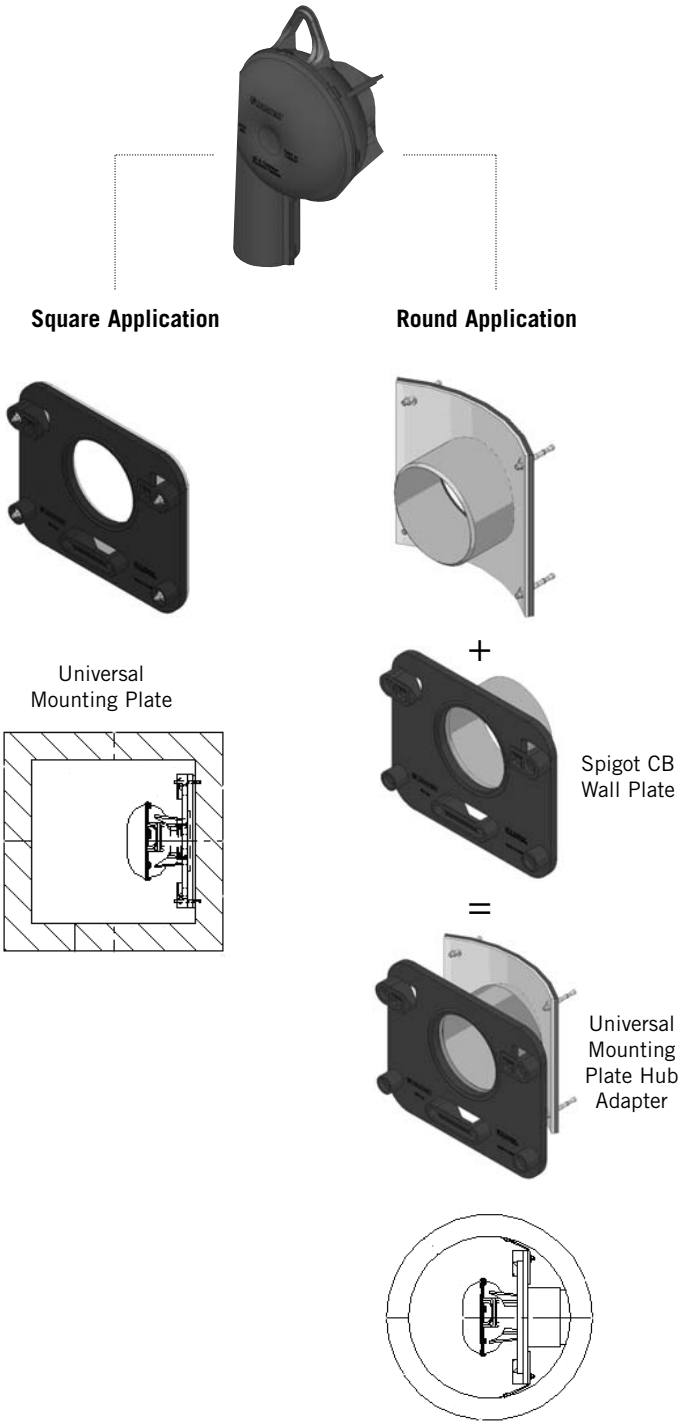

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Chart 1: LMF 14 Preset Flow Curves

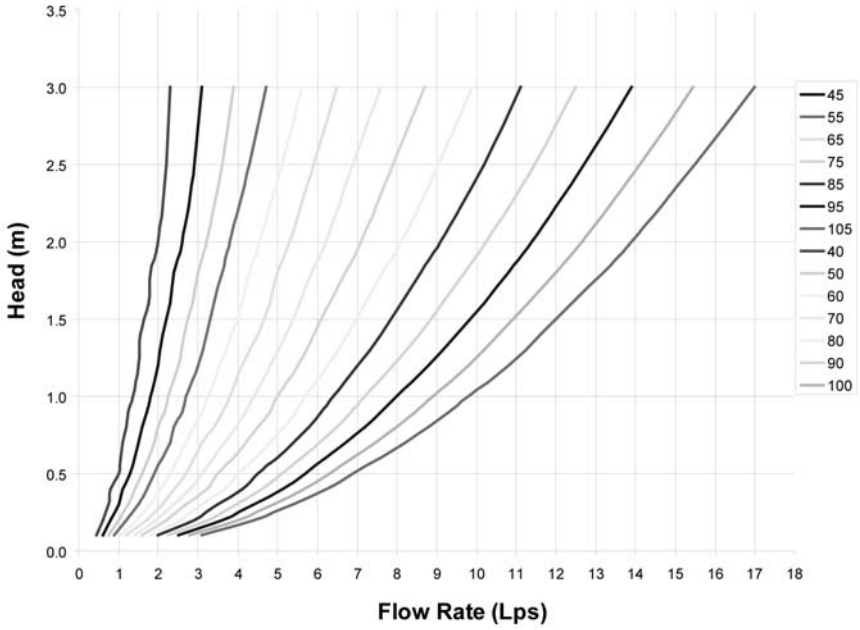
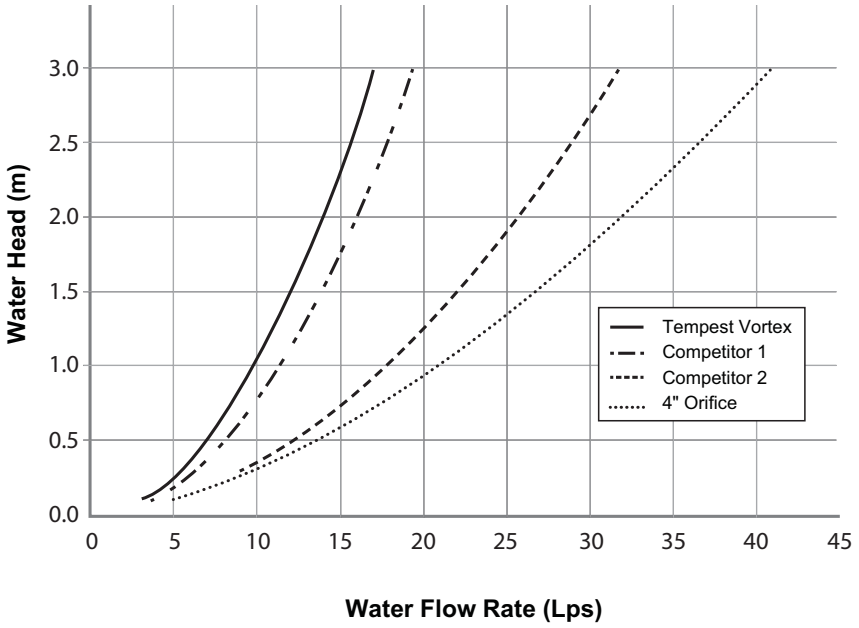


Chart 2: LMF Flow vs. ICD Alternatives



NOTE: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

PRODUCT INSTALLATION

Instructions to assemble a TEMPEST LMF ICD into a Square Catch Basin:

STEPS:

1. Materials and tooling verification:
   - Tooling: impact drill, 3/8" concrete bit, torque wrench for 9/16" nut, hand hammer, level, and marker.
   - Material: (4) concrete anchor 3/8 x 3-1/2, (4) washers, (4) nuts, universal mounting plate, ICD device.
2. Use the mounting wall plate to locate and mark the hole (4) pattern on the catch basin wall. You should use a level to ensure that the plate is at the horizontal.
3. Use an impact drill with a 3/8" concrete bit to make the four holes at a minimum of 1-1/2" depth up to 2-1/2". Clean the concrete dust from the holes.
4. Install the anchors (4) in the holes by using a hammer. Thread the nuts on the top of the anchors to protect the threads when you hit the anchors with the hammer. Remove the nuts from the ends of the anchors.
5. Install the universal mounting plate on the anchors and screw the 4 nuts in place with a maximum torque of 40 N.m (30 lbf-ft). There should be no gap between the wall mounting plate and the catch basin wall.
6. From the ground above using a reach bar, lower the ICD device by hooking the end of the reach bar to the handle of the ICD device. Align the triangular plate portion into the mounting wall plate. Push down the device to be sure it has centered in to the universal mounting plate and has created a seal.

WARNING

- Verify that the outlet pipe doesn't protrude into the catch basin. If it does, cut down the pipe flush to the catch basin wall.
- Call your IPEX representative for more information or if you have any questions about our products.

Instructions to assemble a TEMPEST LMF ICD into a Round Catch Basin:

STEPS:

1. Materials and tooling verification.
   - Tooling: impact drill, 3/8" concrete bit, torque wrench for 9/16" nut, hand hammer, level and marker.
   - Material: (4) concrete anchor 3/8 x 3-1/2, (4) washers and (4) nuts, spigot CB wall plate, universal mounting plate hub adapter, ICD device.
2. Use the spigot catch basin wall plate to locate and mark the hole (4) pattern on the catch basin wall. You should use a level to ensure that the plate is at the horizontal.
3. Use an impact drill with a 3/8" concrete bit to make the four holes at a depth between 1-1/2" to 2-1/2". Clean the concrete dust from the holes.
4. Install the anchors (4) in the holes by using a hammer. Thread the nuts on the top of the anchors to protect the threads when you hit the anchors with the hammer. Remove the nuts from the ends of the anchors.
5. Install the CB spigot wall plate on the anchors and screw the 4 nuts in place with a maximum torque of 40 N.m (30 lbf-ft). There should be no gap between the spigot wall plate and the catch basin wall.
6. Apply solvent cement on the hub of the universal mounting plate, hub adapter and the spigot of the CB wall plate, then slide the hub over the spigot. Make sure the universal mounting plate is at the horizontal and its hub is completely inserted onto the spigot. Normally, the corners of the universal mounting plate hub adapter should touch the catch basin wall.
7. From ground above using a reach bar, lower the ICD device by hooking the end of the reach bar to the handle of the ICD device. Align the triangular plate portion into the mounting wall plate. Push down the device to be sure it has centered in to the mounting plate and has created a seal.

WARNING

- Verify that the outlet pipe doesn't protrude into the catch basin. If it does, cut back the pipe flush to the catch basin wall.
- The solvent cement which is used in this installation is to be approved for PVC.
- The solvent cement should not be used below 0°C (32°F) or in a high humidity environment. Refer to the IPEX solvent cement guide to confirm the required curing time or visit the IPEX Online Solvent Cement Training Course available at www.ipexinc.com.
- Call your IPEX representative for more information or if you have any questions about our products.

PRODUCT TECHNICAL SPECIFICATION

General

Inlet control devices (ICD's) are designed to provide flow control at a specified rate for a given water head level and also provide odour and floatable control. All ICD's will be IPEX Tempest or approved equal.

All devices shall be removable from a universal mounting plate. An operator from street level using only a T-bar with a hook will be able to retrieve the device while leaving the universal mounting plate secured to the catch basin wall face. The removal of the TEMPEST devices listed above must not require any unbolting or special manipulation or any special tools.

High Flow (HF) Sump devices will consist of a removable threaded cap which can be accessible from street level with out entry into the catchbasin (CB). The removal of the threaded cap shall not require any special tools other than the operator's hand.

ICD's shall have no moving parts.

Materials

ICD's are to be manufactured from Polyvinyl Chloride (PVC) or Polyurethane material, designed to be durable enough to withstand multiple freeze-thaw cycles and exposure to harsh elements.

The inner ring seal will be manufactured using a Buna or Nitrile material with hardness between Duro 50 and Duro 70.

The wall seal is to be comprised of a 3/8" thick Neoprene Closed Cell Sponge gasket which is attached to the back of the wall plate.

All hardware will be made from 304 stainless steel.

Dimensioning

The Low Medium Flow (LMF), High Flow (HF) and the High Flow (HF) Sump shall allow for a minimum outlet pipe diameter of 200mm with a 600mm deep Catch Basin sump.

Installation

Contractor shall be responsible for securing, supporting and connecting the ICD's to the existing influent pipe and catchbasin/manhole structure as specified and designed by the Engineer.

NOTE: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

PRODUCT INFORMATION: TEMPEST HF & MHF ICD

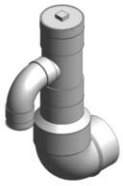
Product Description

Our HF, HF Sump and MHF ICD's are designed to accommodate catch basins or manholes with sewer outlet pipes 6" in diameter or larger. Any storm sewer larger than 12" may require custom modification. However, IPEX can custom build a TEMPEST device to accommodate virtually any storm sewer size.

Available in 5 preset flow curves, these ICDs have the ability to provide constant flow rates: 9lps (143 gpm) and greater

Product Function

TEMPEST HF (High Flow): designed to manage moderate to higher flows 15 L/s (240 gpm) or greater and prevent the propagation of odour and floatables. With this device, the cross-sectional area of the device is larger than the orifice diameter and has been designed to limit head losses. The HF ICD can also be ordered without flow control when only odour and floatable control is required.



TEMPEST HF (High Flow) Sump: The height of a sewer outlet pipe in a catch basin is not always conveniently located. At times it may be located very close to the catch basin floor, not providing enough sump for one of the other TEMPEST ICDs with universal back plate to be installed. In these applications, the HF Sump is offered. The HF Sump offers the same features and benefits as the HF ICD; however, is designed to raise the outlet in a square or round catch basin structure. When installed, the HF sump is fixed in place and not easily removed. Any required service to the device is performed through a clean-out located in the top of the device which can be often accessed from ground level.

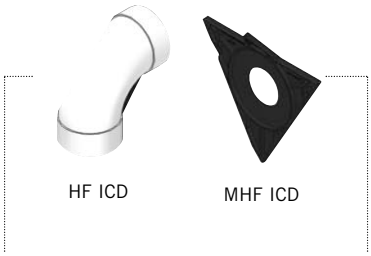
TEMPEST MHF (Medium to High Flow):
The MHF plate or plug is designed to control flow rates 9 L/s (143 gpm) or greater. It is not designed to prevent the propagation of odour and floatables.

Product Construction

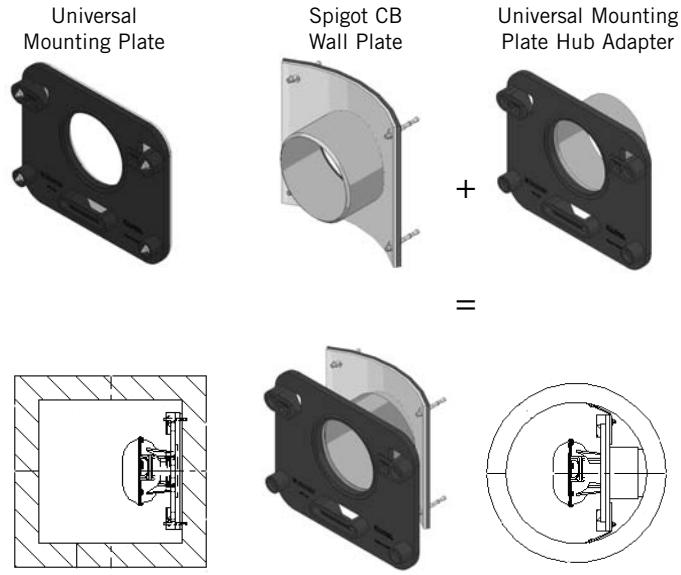
The HF, HF Sump and MHF ICDs are built to be light weight at a maximum weight of 6.8 Kg (14.6 lbs).

Product Applications

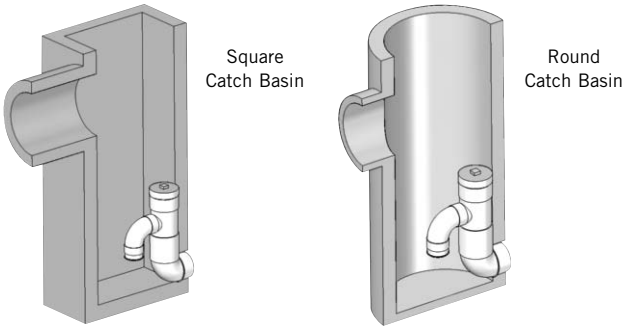
The HF and MHF ICD's are available to accommodate both square and round applications:



Square Application **Round Application**

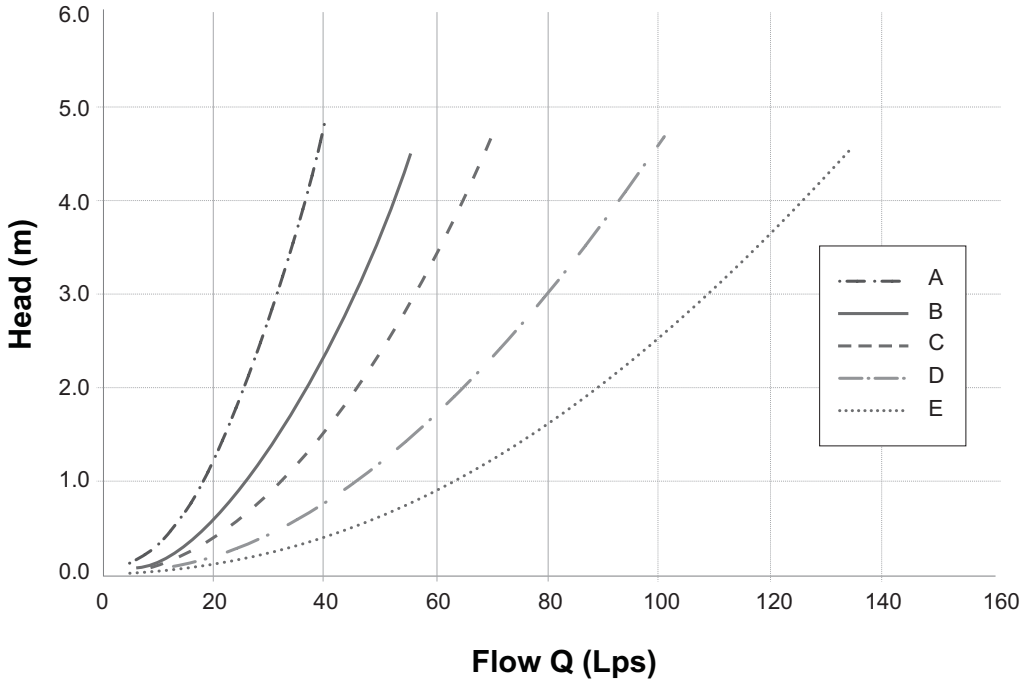


The HF Sump is available to accommodate low to no sump applications in both square and round catch basins:



NOTE: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

Chart 3: HF & MHF Preset Flow Curves



NOTE: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

PRODUCT INSTALLATION

Instructions to assemble a TEMPEST HF or MHF ICD into a Square Catch Basin:

1. Materials and tooling verification:
   - Tooling: impact drill, 3/8" concrete bit, torque wrench for 9/16" nut, hand hammer, level, and marker.
   - Material: (4) concrete anchor 3/8 x 3-1/2, (4) washers, (4) nuts, universal mounting plate, ICD device
2. Use the mounting wall plate to locate and mark the hole (4) pattern on the catch basin wall. You should use a level to ensure that the plate is at the horizontal.
3. Use an impact drill with a 3/8" concrete bit to make the four holes at a minimum of 1-1/2" depth up to 2-1/2". Clean the concrete dust from the holes.
4. Install the anchors (4) in the holes by using a hammer. Thread the nuts on the top of the anchors to protect the threads when you hit the anchors with the hammer. Remove the nuts from the ends of the anchors.
5. Install the universal wall mounting plate on the anchors and screw the 4 nuts in place with a maximum torque of 40 N.m (30 lbf-ft). There should be no gap between the wall mounting plate and the catch basin wall.
6. From the ground above using a reach bar, lower the device by hooking the end of the reach bar to the handle of the ICD device. Align the triangular plate portion into the mounting wall plate. Push down the device to be sure it has centered in to the universal wall mounting plate and has created a seal.

WARNING

- Verify that the outlet pipe doesn't protrude into the catch basin. If it does, cut down the pipe flush to the catch basin wall.
- Call your IPEX representative for more information or if you have any questions about our products.

Instructions to assemble a TEMPEST HF or MHF ICD into a Round Catch Basin:

STEPS:

1. Materials and tooling verification.
   - Tooling: impact drill, 3/8" concrete bit, torque wrench for 9/16" nut, hand hammer, level and marker.
   - Material: (4) concrete anchor 3/8 x 3-1/2, (4) washers and (4) nuts, spigot CB wall plate, universal mounting plate hub adapter, ICD device.
2. Use the round catch basin spigot adaptor to locate and mark the hole (4) pattern on the catch basin wall. You should use a level to ensure that the plate is at the horizontal.
3. Use an impact drill with a 3/8" concrete bit to make the four holes at a depth between 1-1/2" to 2-1/2". Clean the concrete dust from the holes.
4. Install the anchors (4) in the holes by using a hammer. Thread the nuts on the top of the anchors to protect the threads when you hit the anchors with the hammer. Remove the nuts from the ends of the anchors.
5. Install the spigot CB wall plate on the anchors and screw the 4 nuts in place with a maximum torque of 40 N.m (30 lbf-ft). There should be no gap between the spigot CB wall plate and the catch basin wall.
6. Put solvent cement on the hub of the universal mounting plate, hub adapter and the spigot of the CB wall plate, then slide the hub over the spigot. Make sure the universal mounting plate is at the horizontal and its hub is completely inserted onto the spigot. Normally, the corners of the hub adapter should touch the catch basin wall.
7. From ground above using a reach bar, lower the device by hooking the end of the reach bar to the handle of the ICD device. Align the triangular plate portion into the mounting wall plate. Push down the device to be sure it has centered in to the wall mounting plate and has created a seal.

WARNING

- Verify that the outlet pipe doesn't protrude into the catch basin. If it does, cut down the pipe flush to the catch basin wall.
- The solvent cement which is used in this installation is to be approved for PVC.
- The solvent cement should not be used below 0°C (32°F) or in a high humidity environment. Refer to the IPEX solvent cement guide to confirm the required curing time or visit the IPEX Online Solvent Cement Training Course available at www.ipexinc.com.
- Call your IPEX representative for more information or if you have any questions about our products.

NOTE: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

Instructions to assemble a TEMPEST HF Sump into a Square or Round Catch Basin:

STEPS:

1. Materials and tooling verification:
   - Tooling: impact drill, 3/8" concrete bit, torque wrench for 9/16" nut, hand hammer, level, mastic tape and metal strapping
   - Material: (2) concrete anchor 3/8 x 3-1/2, (2) washers, (2) nuts, HF Sump pieces (2).
2. Apply solvent cement to the spigot end of the top half of the sump. Apply solvent cement to the hub of the bottom half of the sump. Insert the spigot of the top half of the sump into the hub of the bottom half of the sump.
3. Install the 8" spigot of the device into the outlet pipe. Use the mastic tape to seal the device spigot into the outlet pipe. You should use a level to be sure that the fitting is standing at the vertical.
4. Use an impact drill with a 3/8" concrete bit to make a series of 2 holes along each side of the body throat. The depth of the hole should be between 1-1/2" to 2-1/2". Clean the concrete dust from the 2 holes.
5. Install the anchors (2) in the holes by using a hammer. Put the nuts on the top of the anchors to protect the threads when you hit the anchors. Remove the nuts from the ends of the anchors.
6. Cut the metal strapping to length and connect each end of the strapping to the anchors. Screw the nuts in place with a maximum torque of 40 N.m (30 lbf-ft). The device should be completely flush with the catch basin wall.

WARNING

- Verify that the outlet pipe doesn't protrude into the catch basin. If it does, cut down the pipe flush to the catch basin wall.
- The solvent cement which is used in this installation is to be approved for PVC.
- The solvent cement should not be used below 0°C (32°F) or in a high humidity environment. Refer to the IPEX solvent cement guide to confirm the required curing time or visit the IPEX Online Solvent Cement Training Course available at www.ipexinc.com.
- Call your IPEX representative for more information or if you have any questions about our products.

PRODUCT TECHNICAL SPECIFICATION

General

Inlet control devices (ICD's) are designed to provide flow control at a specified rate for a given water head level and also provide odour and floatable control where specified. All ICD's will be IPEX Tempest or approved equal.

All devices shall be removable from a universal mounting plate. An operator from street level using only a T-bar with a hook shall be able to retrieve the device while leaving the universal mounting plate secured to the catch basin wall face. The removal of the TEMPEST devices listed above shall not require any unbolting or special manipulation or any special tools.

High Flow (HF) Sump devices shall consist of a removable threaded cap which can be accessible from street level with out entry into the catchbasin (CB). The removal of the threaded cap shall not require any special tools other than the operator's hand.

ICD's shall have no moving parts.

Materials

ICD's are to be manufactured from Polyvinyl Chloride (PVC) or Polyurethane material, designed to be durable enough to withstand multiple freeze-thaw cycles and exposure to harsh elements.

The inner ring seal will be manufactured using a Buna or Nitrile material with hardness between Duro 50 and Duro 70.

The wall seal is to be comprised of a 3/8" thick Neoprene Closed Cell Sponge gasket which is attached to the back of the wall plate.

All hardware will be made from 304 stainless steel.

Dimensioning

The Low Medium Flow (LMF), High Flow (HF) and the High Flow (HF) Sump shall allow for a minimum outlet pipe diameter of 200mm with a 600mm deep Catch Basin sump.

Installation

Contractor shall be responsible for securing, supporting and connecting the ICD's to the existing influent pipe and catchbasin/manhole structure as specified and designed by the Engineer.

NOTE: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

NOTE: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters

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A policy of ongoing product improvement is maintained. This may result in modifications of features and/or specifications without notice.

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Appendix D GEOTECHNICAL INVESTIGATION

Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

patersongroup

Geotechnical Investigation

Proposed Residential Development
Blackstone - Phase 5 - Condominium Block
Fernbank Road - Ottawa

Prepared For

Mattamy Homes

February 19, 2019

Report: PG4053-2

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Table of Contents

PAGE

1.0 Introduction 1

2.0 Proposed Development 1

3.0 Method of Investigation
3.1 Field Investigation 2
3.2 Field Survey 3
3.3 Laboratory Testing 4
3.4 Analytical Testing 4

4.0 Observations
4.1 Surface Conditions 5
4.2 Subsurface Profile 5
4.3 Groundwater 6

5.0 Discussion
5.1 Geotechnical Assessment 8
5.2 Site Grading and Preparation 8
5.3 Foundation Design 10
5.4 Design for Earthquakes 13
5.5 Basement Slab 13
5.6 Pavement Structure 14

6.0 Design and Construction Precautions
6.1 Foundation Drainage and Backfill 16
6.2 Protection of Footings Against Frost Action 16
6.3 Excavation Side Slopes 16
6.4 Pipe Bedding and Backfill 18
6.5 Groundwater Control 19
6.6 Winter Construction 20
6.7 Corrosion Potential and Sulphate 21
6.8 Landscaping Considerations 21

7.0 Recommendations 23

8.0 Statement of Limitations 24

Appendices

Appendix 1 Soil Profile and Test Data Sheets
Symbols and Terms
Consolidation Testing Results
Atterberg Limits' Testing Results
Analytical Testing Results

Appendix 2 Figure 1 - Key Plan
Drawing PG4053-4 - Test Hole Location Plan

1.0 Introduction

Paterson Group (Paterson) was commissioned by Mattamy Homes to conduct a supplemental geotechnical investigation for the condominium block within Phase 5 of the Blackstone Community residential development, which is located north of Fernbank Road, in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objectives of the investigation were to:

- determine the subsurface soil and groundwater conditions by means of boreholes, and existing soils information.
- provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. The report contains our findings and includes geotechnical recommendations pertaining to the design and construction of the proposed development as understood at the time of this report.

Investigating the presence or potential presence of contamination on the proposed development was not part of the scope of work. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

It is understood that the current phase of the proposed development consists of low rise residential condominium housing blocks. Local roadways, residential driveways, municipal services and park areas are further anticipated for the proposed development.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current investigation was carried out on November 20 and 21, 2018. During that time, five (5) boreholes were drilled to a maximum depth of 6.6 m below the existing ground surface. The borehole locations were distributed in a manner to provide general coverage of the subject site taking into consideration existing borehole coverage, site features and underground utilities. The locations of the boreholes are shown on Drawing PG4053-4 - Test Hole Location Plan included in Appendix 2.

Several previous field programs were also carried out within the subject site by Paterson on November 2010 and March 2017. A total of 3 boreholes were completed as part of our previous investigations for PG4053-1 (March 2017) and PG2233-1 (November 2010). The relevant test hole logs from the previous investigations are presented in Appendix 1.

The boreholes were completed using a track-mounted auger drill rig operated by a two person crew. The test pits were completed using a rubber tire backhoe. All fieldwork was conducted under the full-time supervision of personnel from our geotechnical division under the direction of a senior engineer. The testing procedure consisted of augering to the required depths and at the selected locations sampling the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler, using 73 mm diameter thin walled (TW) Shelby tubes in conjunction with a piston sampler, or from the auger flights. All soil samples were visually inspected and initially classified on site. The split-spoon samples were placed in sealed plastic bags and the Shelby tubes were sealed at both ends on site. All samples were transported to our laboratory for examination and classification. The depths at which the split-spoon, Shelby tube and auger samples were recovered from the test holes are shown as SS, TW and AU, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Undrained shear strength testing was conducted in cohesive soils using a field vane apparatus.

Overburden thickness was evaluated during the course of the site investigation by dynamic cone penetration testing (DCPT). DCPT was completed at one borehole location of the current investigation and several of the borehole locations during previous investigations. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

The subsurface conditions observed at the boreholes and test pits were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1.

Groundwater

Flexible standpipes were installed in all boreholes to monitor the groundwater levels subsequent to the completion of the sampling program. Groundwater infiltration levels were noted at the time of excavation at the test pit locations.

Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of the report. They will then be discarded unless we are otherwise directed.

3.2 Field Survey

The test holes were located in the field by Annis O’Sullivan Vollebekk. It is understood that the elevations are referenced to a geodetic datum. The ground surface elevation and location of the test holes are presented on Drawing PG4053-4 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the investigation were examined in our laboratory to review field notes and soil samples.

A series of Shelby tube samples were submitted for unidimensional consolidation during previous investigations and Atterberg limit testing was completed from both current and previous investigations.

The results of the consolidation and Atterberg testing are presented on the Consolidation Test sheets and Atterberg Limits' Results presented in Appendix 1 and are further discussed in Sections 4 and 5.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

Currently, the subject site consists of agricultural fields with a residential building along Fernbank Road. The ground surface across the subject site is relatively flat and gradually slopes towards existing ditches located between agricultural crops and along Fernbank Road. The topsoil located within the western agricultural lot had been previously stripped prior to our investigation. The site is bordered to the north, east and west by former agricultural fields and to the south by Fernbank Road.

4.2 Subsurface Profile

Generally, the soil conditions encountered at the test hole locations consists of a cultivated topsoil/organic layer followed by a silty sand fill, overlying a sensitive silty clay deposit. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

Based on available geological mapping, the bedrock in this area mostly consists of interbedded limestone and dolomite of the Gull River formation with an overburden drift thickness of 10 to 50 m depth.

Laboratory Testing

Atterberg limits testing, as well as associated moisture content testing, was completed on the recovered silty clay samples at selected locations throughout the subject site. The results of the Atterberg limits tests are presented in Table 1 and on the Atterberg Limits Results sheet in Appendix 1. The tested silty clay samples classify as inorganic clay of low plasticity (CL) in accordance with the Unified Soil Classification System.

Table 1 - Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	w (%)	Classification
BH 1-18	2.50	41.4	18.0	23.4	18.0	CL
BH 2-18	1.82	39.8	18.0	21.8	18.0	CL
BH 3-18	2.59	31.9	15.5	16.3	15.5	CL
BH 4-18	1.51	38.2	16.2	22.0	16.2	CL
BH 5-18	1.86	42.2	18.6	23.6	18.6	CL

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plasticity Index; w: water content;
CH: Inorganic Clay of High Plasticity CL: Inorganic Clay of Low Plasticity

The results of the shrinkage limit test indicate a shrinkage limit of 19% and a shrinkage ratio of 1.77. Grain size distribution (sieve and hydrometer analysis) was also completed on two (2) selected soil samples. The results of the grain size analysis are summarized in Table 2 and presented on the Grain Size Distribution Results sheets in Appendix 1.

Table 2 - Summary of Grain Size Distribution Analysis

Test Hole	Sample	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH 1	SS4	0	1.1	57.9	41.0
BH 3	SS3	0	2.3	78.2	19.5

4.3 Groundwater

The groundwater levels in the boreholes from the current and previous geotechnical investigations are presented in Table 1. It is important to note that groundwater readings at piezometers can be influenced by surface water perched within the borehole backfill material. Long-term groundwater level can also be estimated based on the observed color and consistency of the recovered soil samples. Based on these observations, the long-term groundwater level can be expected between 2 to 3 m depth. Groundwater levels are subject to seasonal fluctuations and therefore could vary during time of construction.

Table 3 - Summary of Groundwater Level Readings - (Geotechnical Investigation PG2233)

Test Hole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 1	98.86	5.11	93.75	November 18, 2010

Note: Assumed geodetic elevations at the test hole locations were provided by Annis O'Sullivan Vollebekk Ltd.

Table 4 - Summary of Groundwater Level Readings - (Geotechnical Investigation PG4053-1)

Test Hole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 6-17	99.57	0.84	94.92	March 21, 2018

Note: Geodetic elevations at the test hole locations were provided by Annis O'Sullivan Vollebekk Ltd.

Table 5 - Summary of Groundwater Level Readings - (Current Geotechnical Investigation PG4053-2)

Test Hole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 1-18	99.98	0.75	99.23	December 3, 2018
BH 2-18	99.50	0.23	99.27	December 3, 2018
BH 3-18	99.15	2.29	96.86	December 3, 2018
BH 4-18	99.51	0.22	99.29	December 3, 2018
BH 5-18	99.76	0.35	99.41	December 3, 2018

Note: Geodetic elevations at the test hole locations were provided by Annis O'Sullivan Vollebekk Ltd.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the current phase of the proposed residential development. Due to the presence of the sensitive silty clay layer, the proposed development will be subjected to grade raise restrictions.

Permissible grade raise recommendations are discussed in Subsection 5.3. If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction total and differential settlements.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures.

Fill Placement

Fill used for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. Granular material should be tested and approved prior to delivery to the site. The fill should be placed in lifts of 300 mm thick or less and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of the Standard Proctor Maximum Dry Density (SPMDD).

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in lifts with a maximum thickness of 300 mm and compacted by the tracks of the spreading equipment to minimize voids. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls, unless used in conjunction with a geocomposite drainage membrane, such as Miradrain G100N or Delta Drain 6000.

Ditch Area

The existing drainage ditches will be backfilled as part of the proposed development. The drainage ditches, regardless of whether a roadway or building is constructed above, is recommended to be backfilled by the following methodology;

- ❑ Remove the topsoil material.
- ❑ Provide benching in existing slope at a minimum of 2H:1V profile.
- ❑ Backfill in maximum 300 mm thick loose lifts and compact to 95% of the SPMDD to 1.0 m below finished grade for roadways. All material placed within 1.0 m of finished grade and below the design underside of footing elevation should be compacted to 98% of the SPMDD.
- ❑ The backfill materials should consist of site approved material or engineered fill.
- ❑ The backfilling procedure should be reviewed on-site by Paterson personnel.

Park Blocks

For grading within the proposed park blocks, site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. In landscaped areas, these materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. A site specific review should be completed to provide recommendations for any settlement sensitive structures, such as splash pads or shade structures.

5.3 Foundation Design

Based on the results of the geotechnical investigation, lightly loaded structures, such as the residential buildings anticipated, could be founded on shallow footings bearing on an undisturbed compact sandy silt or firm to stiff clayey silt/silty clay bearing surface.

Bearing Resistance Values

Footings for the proposed buildings can be designed using the bearing resistance values presented in Table 6.

Table 6 - Bearing Resistance Values

Bearing Surface	Bearing Resistance Value at SLS (kPa)	Factored Bearing Resistance Value at ULS (kPa)
Compact sandy silt	60	125
Firm Clayey Silt/Silty Clay	60	125
Stiff Silty Clay/Clayey Silt	100	150

The bearing resistance values are provided on the condition that the footings will be placed on undisturbed soil bearing surfaces. An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to the in-situ bearing medium soils above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

Settlement/Grade Raise

Consideration must be given to potential settlements which could occur due to the presence of the silty clay deposit and the combined loads from the proposed footings, any groundwater lowering effects, and grade raise fill. The foundation loads to be considered for the settlement case are the continuously applied loads which consist of the unfactored dead loads and the portion of the unfactored live load that is considered to be continuously applied. For dwellings, a minimum value of 50% of the live load is recommended by Paterson.

Generally, the potential long term settlement is evaluated based on the compressibility characteristics of the silty clay. These characteristics are estimated in the laboratory by conducting unidimensional consolidation tests on undisturbed soil samples collected using Shelby tubes in conjunction with a piston sampler. Three (3) site specific consolidation tests were conducted within the subject portion of the proposed development. The results of the consolidation tests from the previous and current investigations are presented in Table 7 and 8, respectively, and in Appendix 1.

The value for p'_c is the preconsolidation pressure and p'_o is the effective overburden pressure of the test sample. The difference between these values is the available preconsolidation. The increase in stress on the soil due to the cumulative effects of the fill surcharge, the footing pressures, the slab loadings and the lowering of the groundwater should not exceed the available preconsolidation if unacceptable settlements are to be avoided.

The values for C_{cr} and C_c are the recompression and compression indices, respectively. These soil parameters are a measure of the compressibility due to stress increases below and above the preconsolidation pressures. The higher values for the C_c, as compared to the C_{cr}, illustrate the increased settlement potential above, as compared to below, the preconsolidation pressure.

Table 7 - Summary of Consolidation Test Results (Paterson Investigation PG2233)

Borehole No.	Sample	Depth (m)	p'_c (kPa)	p'_o (kPa)	C_{cr}	C_c	Q (*)
BH 1	TW 2	3.45	78	40	0.012	0.471	A

* - Q - Quality assessment of sample - G: Good A: Acceptable P: Likely disturbed

Table 8 - Summary of Consolidation Test Results (Paterson Investigation PG4053-2)

Borehole No.	Sample	Depth (m)	p'_c (kPa)	p'_o (kPa)	C_{cr}	C_c	Q (*)
BH 2	TW 4	4.19	142	42	0.014	1.974	P
BH 3	TW 6	4.95	133	39	0.014	0.723	P
BH 5	TW 6	5.85	136	27	0.016	0.829	P

* - Q - Quality assessment of sample - G: Good A: Acceptable P: Likely disturbed

The values of p'_c, p'_o, C_{cr} and C_c are determined using standard engineering testing procedures and are estimates only. Natural variations within the soil deposit will affect the results. The p'_o parameter is directly influenced by the groundwater level. Groundwater levels were measured during the site investigation. Groundwater levels vary seasonally which has an impact on the available preconsolidation. Lowering the groundwater level increases the p'_o and therefore reduces the available preconsolidation. Unacceptable settlements could be induced by a significant lowering of the groundwater level. The p'_o values for the consolidation tests during the investigation are based on the long term groundwater level being at 0.5 m below the existing groundwater table. The groundwater level is based on the colour and undrained shear strength profile of the silty clay.

The total and differential settlements will be dependent on characteristics of the proposed buildings. For design purposes, the total and differential settlements are estimated to be 25 and 20 mm, respectively. A post-development groundwater lowering of 0.5 m was assumed.

The potential post construction total and differential settlements are dependent on the position of the long term groundwater level when building are situated over deposits of compressible silty clay. Efforts can be made to reduce the impacts of the proposed development on the long term groundwater level by placing clay dykes in the service trenches, reducing the sizes of paved areas, leaving green spaces to allow for groundwater recharge or limiting planting of trees to areas away from the buildings. However, it is not economically possible to control the groundwater level.

To reduce potential long term liabilities, consideration should be given to accounting for a larger groundwater lowering and to provide means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the dwellings, etc). Buildings on silty clay deposits increases the likelihood of movements and therefore of cracking. The use of steel reinforcement in foundations placed at key structural locations will tend to reduce foundation cracking compared to unreinforced foundations.

Based on our findings, permissible grade raise restriction of **2.0 m** above the original ground surface is recommended for the current phase of the proposed residential development.

5.4 Design for Earthquakes

Shear wave velocity testing was completed for the subject site during a previous investigation to accurately determine the applicable seismic site classification for the proposed buildings from Table 4.1.8.4.A of the Ontario Building Code 2012. The shear wave velocity testing was completed by Paterson personnel. Based on our seismic testing results and our field investigations, the recommended seismic site classification for the proposed development is a **Site Class E**. The soils are not susceptible to liquefaction.

5.5 Basement Slab

With the removal of all topsoil and deleterious fill, such as those containing organic materials, within the footprint of the proposed buildings, the native soil surface will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction.

Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-floor fill consists of 19 mm clear crushed stone. All backfill material

within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

5.6 Pavement Structure

For design purposes, the pavement structure presented in the following tables could be used for the design of car parking areas and access lanes/local residential streets. These guidelines should be reviewed once the details of the development are known.

Table 9 - Recommended Pavement Structure - Car Parking Areas

Thickness (mm)	Material Description
50	**Wear Course** - HL 3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 10 - Recommended Pavement Structure - Local Residential Roadways

Thickness (mm)	Material Description
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil	

Table 11 - Recommended Pavement Structure - Roadways with Bus Traffic	
Thickness mm	**Material Description**
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete
50	**Upper Binder Course** - Superpave 19.0 Asphaltic Concrete
50	**Lower Binder Course** - Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
600	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either in situ soil or OPSS Granular B Type II material placed over in situ soil	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or II material. Weak subgrade conditions may be experienced over service trench fill materials. This may require the use of a geotextile, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable vibratory equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing load carrying capacity.

Due to the low permeability of the subgrade materials consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter foundation drainage system is recommended for the proposed structures. The system should consist of a 150 mm diameter, geotextile-wrapped, perforated, corrugated, plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structures. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for placement as backfill against the foundation walls unless used in conjunction with a composite drainage system, such as Delta Drain 6000 or Miradrain G100N. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be placed for this purpose.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are recommended to be protected against the deleterious effects of frost action. A minimum of 1.5 m of soil cover alone, or a combination of soil cover and foundation insulation should be provided.

Exterior unheated footings, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

6.3 Excavation Side Slopes

The excavation for the current phase of the proposed development will be mostly through sandy silt and/or clayey silt/silty clay. Above the groundwater level, for excavations to depths of approximately 3 m, the excavation side slopes should be stable in the short term at 1H:1V. Flatter slopes could be required for deeper excavations or for excavation below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring should be used. The subsoil at this site is considered to be mainly a Type 2 or 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

The slope cross-sections recommended above are for temporary slopes. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

A trench box is recommended to be installed at all times to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by "cut and cover" methods and excavations should not remain exposed for extended periods of time.

Excavation Base Stability

The base of supported excavations can fail by three (3) general modes:

- ❑ Shear failure within the ground caused by inadequate resistance to loads imposed by grade difference inside and outside of the excavation,
- ❑ Piping from water seepage through granular soils, and
- ❑ Heave of layered soils due to water pressures confined by intervening low permeability soils.

Shear failure of excavation bases is typically rare in granular soils if adequate lateral support is provided. Inadequate dewatering can cause instability in excavations made through granular or layered soils. The potential for base heave in cohesive soils should be determined for stability of flexible retaining systems.

The factor of safety with respect to base heave, FS_b, is:

$$FS_b = N_b s_u / \sigma_z$$

where:

N_b - stability factor dependent upon the geometry of the excavation and given in Figure 1 on the following page.
s_u - undrained shear strength of the soil below the base level
σ_z - total overburden and surcharge pressures at the bottom of the excavation

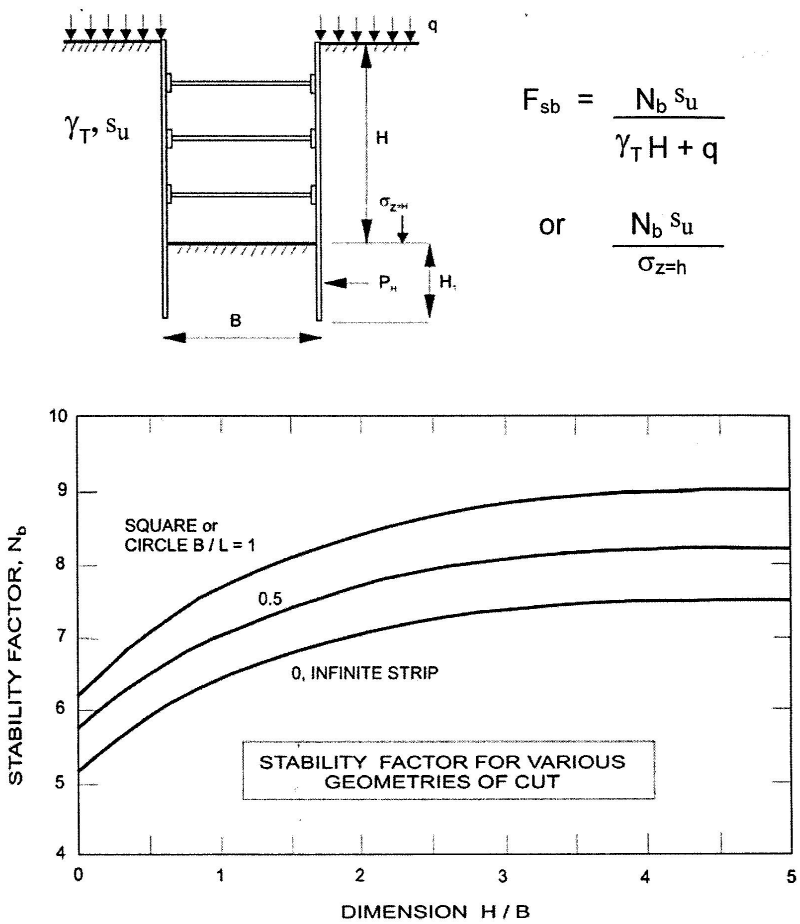

Figure 1 - Stability Factor for Various Geometries of Cut

In the case of soft to firm clays, a factor of safety of 2 is recommended for base stability.

6.4 Pipe Bedding and Backfill

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. Where the bedding is located within the firm grey silty clay, the thickness of the bedding material could be increased to a minimum of 300 mm. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD. The bedding material should extend at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD.

Generally, it should be possible to re-use the moist (not wet) brown silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay materials will be difficult to re-use, as the high water contents make compacting impractical without an extensive drying period.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. The seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches. Periodic inspection of the clay seal placement work should be completed by Paterson personnel during servicing installation work.

6.5 Groundwater Control

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Due to the relatively impervious nature of the silty clay/clayey silt materials, it is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. A perched groundwater condition may be encountered within the sandy silt deposit which may produce significant temporary groundwater infiltration levels. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations.

A temporary Ministry of Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes, being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

6.6 Winter Construction

The subsurface conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters, tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

The trench excavations should be constructed in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. These results are indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The results of the chloride content, pH and resistivity indicate the presence of a non-aggressive to slightly aggressive environment for exposed ferrous metals at this site.

6.8 Landscaping Considerations

Tree Planting Restrictions

Paterson completed a soils review of the site to determine applicable tree planting setbacks, in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines) for trees planted within a public right-of-way (ROW). Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. Sieve analysis testing was also completed on selected soil samples. The above-noted test results were completed on samples taken at depths between the anticipated underside of footing elevation and a 3.5 m depth below finished grade. The results of our testing are presented in Tables 1 and 2 in Subsection 4.2 and in Appendix 1.

Based on our Atterberg limits test results, the modified plasticity index does not exceed 40% in the area of the current development. The following tree planting setbacks are recommended for the low to medium sensitivity silty clay deposit throughout the area. Large trees (mature height over 14 m) can be planted within these areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). Tree planting setback limits may be reduced to **4.5 m** for small (mature height up to 7.5 m) and medium size trees (mature tree height 7.5 to 14 m), provided that the conditions noted below are met.

- ❑ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the grading plan.

- ❑ A small tree must be provided with a minimum of 25 m^3 of available soils volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

- The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

- The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).

- Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree), as noted on the subdivision Grading Plan.

Swimming Pools

The in-situ soils are considered to be acceptable for swimming pools. Above ground swimming pools must be placed at least 4 m away from the residence foundation and neighboring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer`s requirements.

Installation of Decks or Additions

If consideration is given to construction of a deck or addition, a geotechnical consultant should be retained by the homeowner to review the site conditions. Additional grading around proposed deck or addition should not exceed permissible grade raises. Otherwise, standard construction practices are considered acceptable.

7.0 Recommendations

It is recommended that the following be completed once the master plan and site development are determined:

- ❑ Review detailed grading plan(s) from a geotechnical perspective.
- ❑ Observation of all bearing surfaces prior to the placement of concrete.
- ❑ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ❑ Observation of all subgrades prior to placing backfilling materials.
- ❑ Field density tests to ensure that the specified level of compaction has been achieved.
- ❑ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with Paterson's recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with Paterson's present understanding of the project. Paterson requests permission to review the grading plan once available. Paterson's recommendations should be reviewed when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and all test hole logs are furnished as a matter of general information only. Test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests to be notified immediately in order to permit reassessment of the recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Mattamy Homes or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Drew Petahtegoose, EIT

LICENSED PROFESSIONAL ENGINEER
Feb. 19, 2019
D. J. GILBERT
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PROVINCE OF ONTARIO

David J. Gilbert, P.Eng.

Report Distribution:

- ❑ Mattamy Homes (4 copies)
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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

CONSOLIDATION TEST RESULTS

ATTERBERG LIMITS' TESTING RESULTS

GRAIN SIZE ANALYSIS TESTING RESULTS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Residential Development - Blackstone Phase 5
Ottawa, Ontario

DATUM Ground surface elevations at borehole locations provided by Annis, O'Sullivan, Vollebekk Limited.

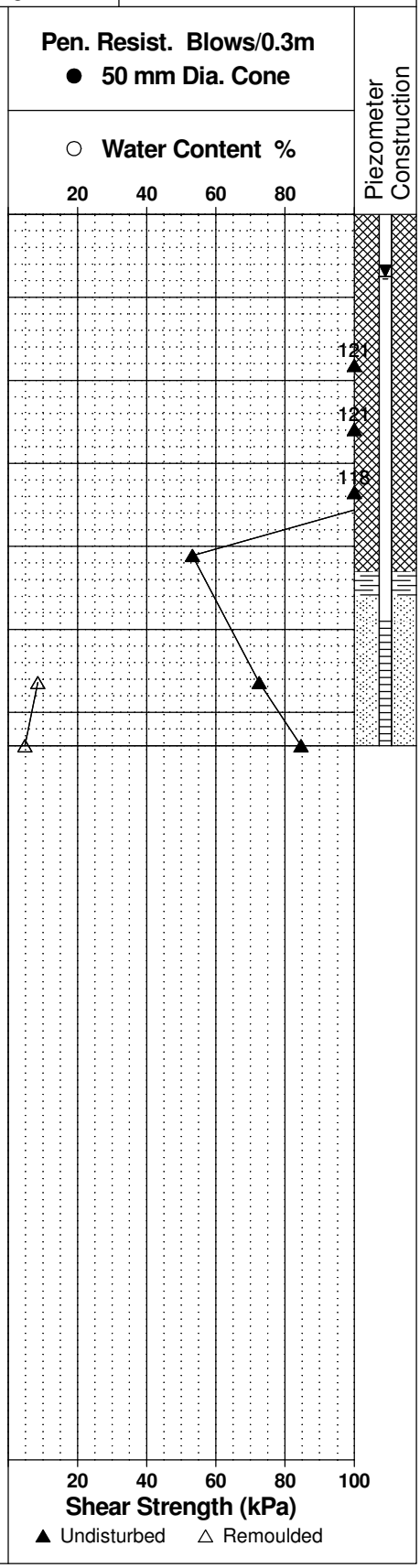
REMARKS

BORINGS BY CME 55 Power Auger **DATE** November 21, 2018

FILE NO. PG4053

HOLE NO. BH 1-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.98
		AU	1				
Very stiff, brown **CLAYEY SILT**		SS	2	79	3	1	98.98
1.83		SS	3		P	2	97.98
Very stiff to stiff, brown **SILTY CLAY**		SS	4	96	P		
		SS	5	96	P	3	96.98
- grey by 3.7m depth		SS	6		P	4	95.98
		TW	7	100		5	94.98
6.40						6	93.98
End of Borehole							
(GWL @ 0.75m - Dec. 3, 2018)							



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Ottawa, Ontario

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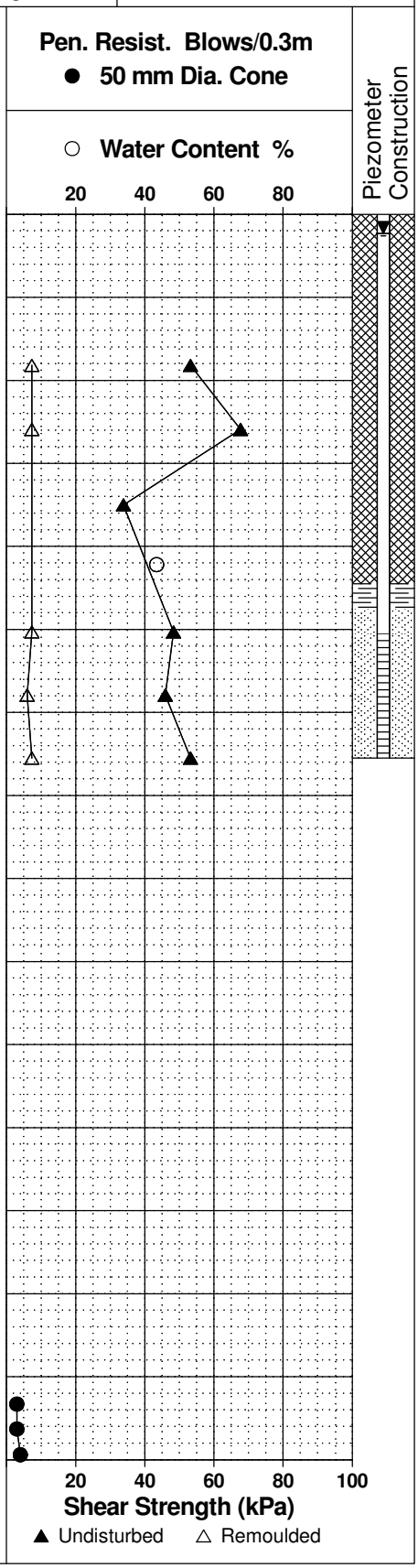
REMARKS

BORINGS BY CME 55 Power Auger **DATE** November 20, 2018

FILE NO. PG4053

HOLE NO. BH 2-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.50
TOPSOIL 0.25							
Very loose, brown **SANDY SILT,** some clay 0.60							
Brown **CLAYEY SILT,** trace sand 1.52		SS	1	50	3	1	98.50
		SS	2	83	P	2	97.50
Stiff to firm, brown **SILTY CLAY**		G	3			3	96.50
- grey by 2.7m depth		TW	4			4	95.50
						5	94.50
						6	93.50
6.55							
Dynamic Cone Penetration Test (DCPT) commenced at 6.55m depth. Cone pushed to 14.0m depth.						7	92.50
						8	91.50
						9	90.50
						10	89.50
						11	88.50
						12	87.50
						13	86.50
						14	85.50
						15	84.50



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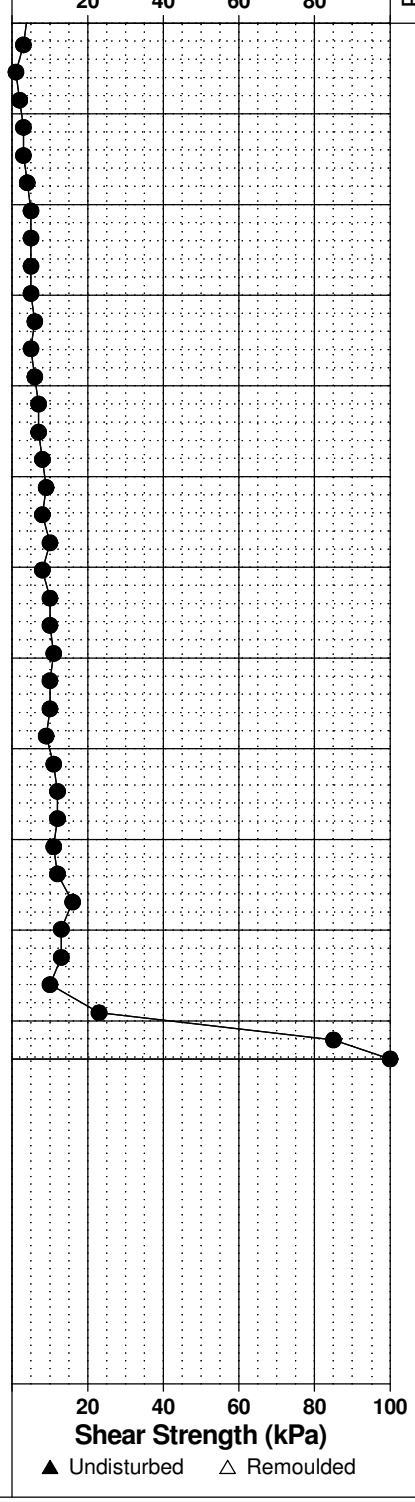
REMARKS

BORINGS BY CME 55 Power Auger **DATE** November 20, 2018

FILE NO. PG4053

HOLE NO. BH 2-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE									
						15	84.50		
						16	83.50		
						17	82.50		
						18	81.50		
						19	80.50		
						20	79.50		
						21	78.50		
						22	77.50		
						23	76.50		
						24	75.50		
						25	74.50		
						26	73.50		
26.42									
End of Borehole									
Practical DCPT refusal at 26.42m depth									
(GWL @ 0.23m - Dec. 3, 2018)									



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Residential Development - Blackstone Phase 5
Ottawa, Ontario

DATUM Ground surface elevations at borehole locations provided by Annis, O'Sullivan, Vollebekk Limited.

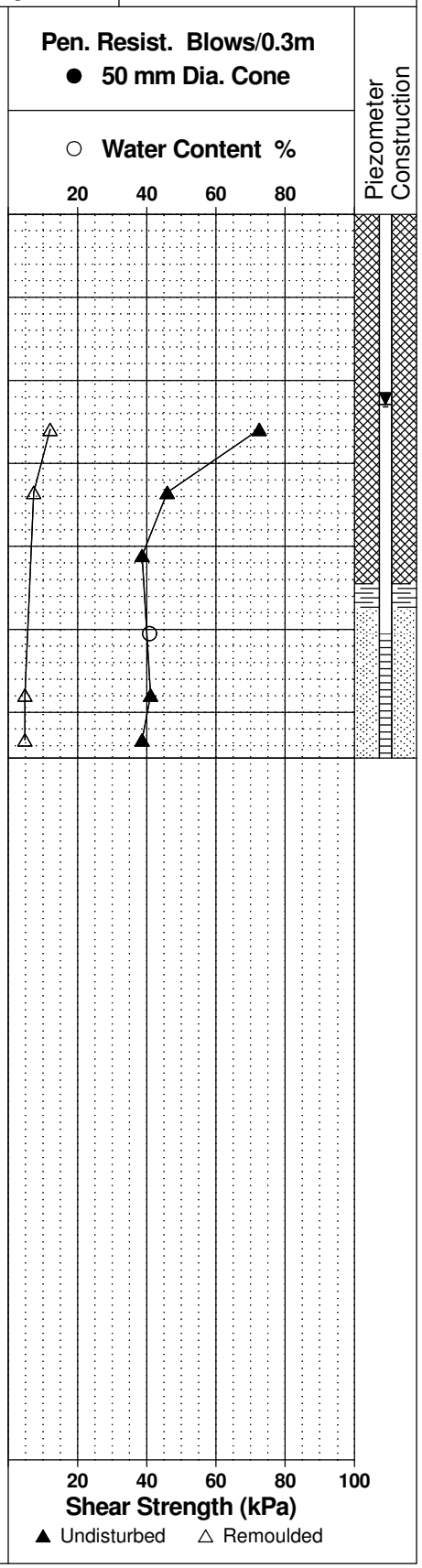
REMARKS

BORINGS BY CME 55 Power Auger **DATE** November 20, 2018

FILE NO. PG4053

HOLE NO. BH 3-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.15
TOPSOIL 0.15							
FILL: Brown silty sand, some clay, trace organics 1.52		SS	1	58	6	1	98.15
		SS	2	67	3	2	97.15
Stiff, brown **CLAYEY SILT,** trace sand		SS	3	83	P	3	96.15
3.50		SS	4	100	P		
		G	5			4	95.15
Firm, grey **SILTY CLAY**		TW	6			5	94.15
		G	7			6	93.15
6.55							
End of Borehole							
(GWL @ 2.29m - Dec. 3, 2018)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Residential Development - Blackstone Phase 5
Ottawa, Ontario

DATUM Ground surface elevations at borehole locations provided by Annis, O'Sullivan, Vollebekk Limited.

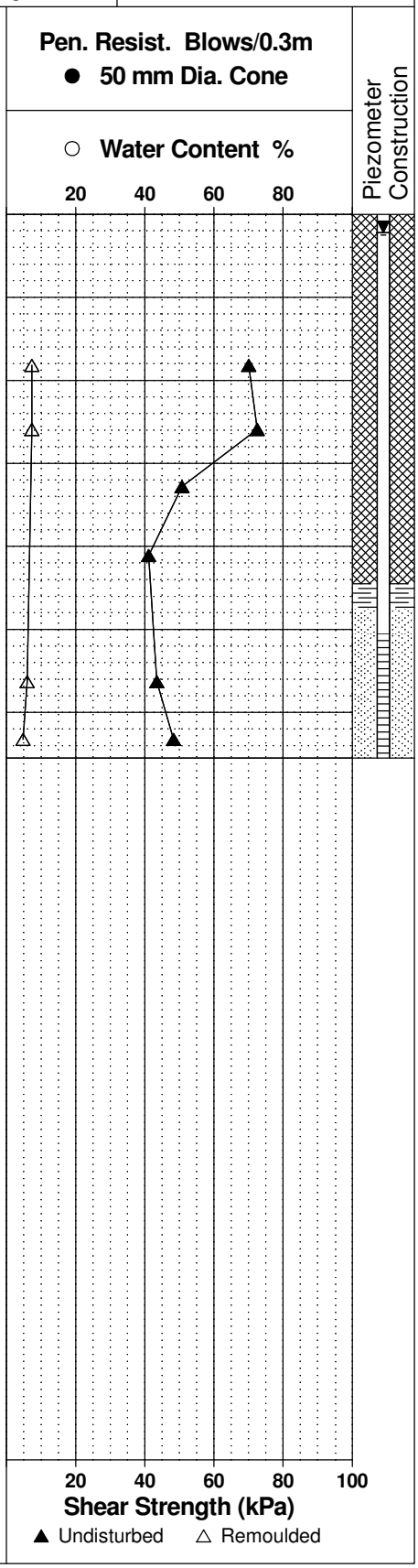
REMARKS

BORINGS BY CME 55 Power Auger **DATE** November 20, 2018

FILE NO. PG4053

HOLE NO. BH 4-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.51
TOPSOIL 0.20							
Stiff, brown **CLAYEY SILT,** trace sand		SS	1	8	2	1	98.51
		SS	2	100	P	2	97.51
2.74		SS	3		P		
Stiff to firm, brown **SILTY CLAY**		G	4			3	96.51
- grey by 3.7m depth		SS	5	100		4	95.51
		TW	6			5	94.51
		SS	7	100	P	6	93.51
6.55		G	G				
End of Borehole							
(GWL @ 0.22m - Dec. 3, 2018)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Residential Development - Blackstone Phase 5
Ottawa, Ontario

DATUM Ground surface elevations at borehole locations provided by Annis, O'Sullivan, Vollebekk Limited.

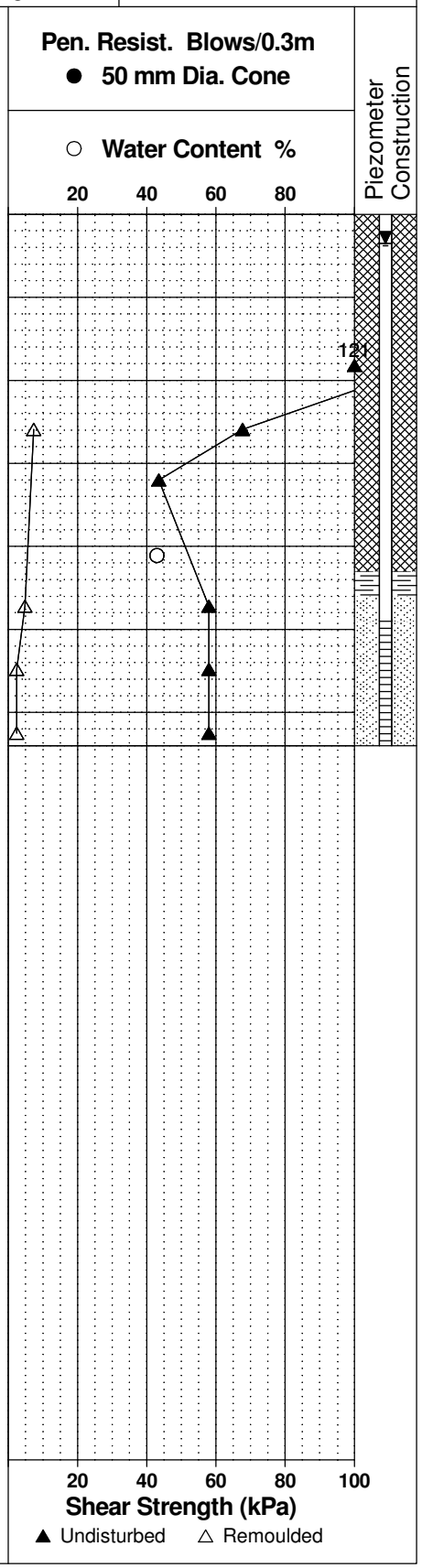
REMARKS

BORINGS BY CME 55 Power Auger **DATE** November 21, 2018

FILE NO. PG4053

HOLE NO. BH 5-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.76
FILL: Brown silty clay with sand and gravel		SS	1	25	4		
		SS	2	96	3	1	98.76
1.52							
Very stiff to stiff, brown **SILTY CLAY**		SS	3	96	P	2	97.76
		SS	4	96	P		
- firm to stiff and grey by 2.8m depth		G	5			3	96.76
		TW	6	98		4	95.76
						5	94.76
						6	93.76
6.40							
End of Borehole							
(GWL @ 0.35m - Dec. 3, 2018)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Residential Development - Blackstone Phases 4 to 8
Ottawa, Ontario

DATUM Ground surface elevations at borehole locations provided by Annis, O'Sullivan, Vollebekk Limited.

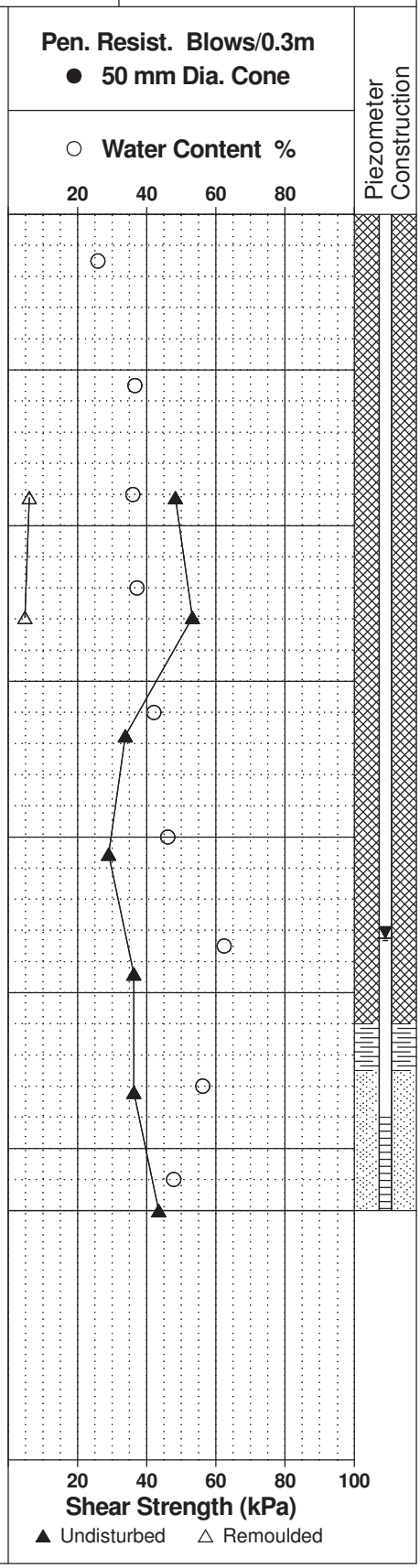
REMARKS

BORINGS BY CME 55 Power Auger **DATE** March 13, 2017

FILE NO. PG4053

HOLE NO. BH 6-17

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL 0.25		AU	1			0	99.57
		SS	2	25	1	1	98.57
		SS	3	50	P	2	97.57
Stiff, brown **SILTY CLAY,** some sand							
- firm and grey by 3.0m depth						3	96.57
						4	95.57
						5	94.57
						6	93.57
6.40 End of Borehole							
(GWL @ 4.65m-March 21, 2017)							



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
West Park Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Ltd.

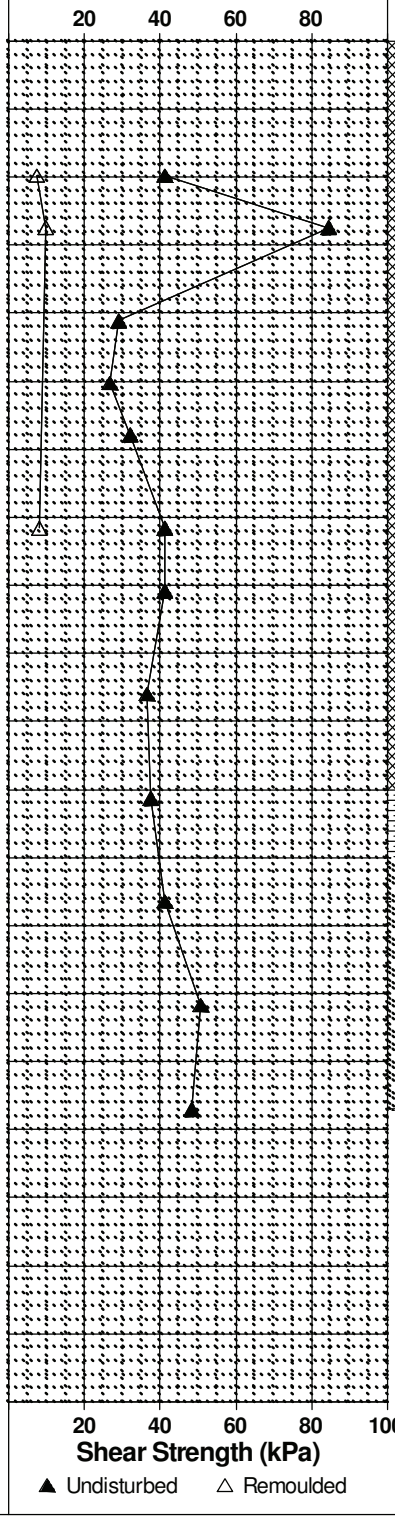
FILE NO. PG2233

REMARKS

HOLE NO. BH 1

BORINGS BY CME 75 Power Auger **DATE** 5 November 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.86
TOPSOIL 0.36							
Very loose, brown **SILTY SAND** 1.45		SS	1	92	2	1	97.86
Stiff to firm, brown interlayered **SILTY CLAY** and **CLAYEY SILT**						2	96.86
		TW	2	100		3	95.86
- grey by 2.2m depth						4	94.86
						5	93.86
						6	92.86
		TW	3	100		7	91.86
						8	90.86
						9	89.86
						10	88.86
						11	87.86
						12	86.86
						13	85.86
						14	84.86
(GWL @ 5.11m-Nov. 11/10)						15	83.86
15.70							
Dynamic Cone Penetration Test commenced @ 15.70m depth. Cone push to 28.35m and hit refusal at 28.50m depth						16	82.86
						17	81.86
						18	80.86
						19	79.86
						20	78.86



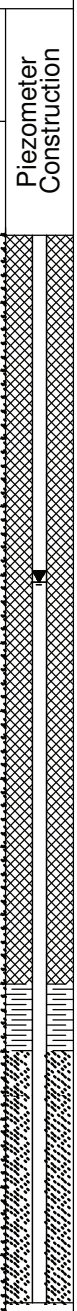


TABLE 1 (continued)

RECORD OF TEST PITS

Test Pit Number	Depth (metres)	Soil Description	
TP 94-3	0.00 - 0.10	Dark brown silty sand (TOPSOIL)	
	0.10 - 1.70	Brown SILTY SAND	
	1.70 - 2.00	Grey SILTY SAND, trace clay	
	2.00 - 2.20	Grey layered CLAYEY SILT and SANDY SILT	Cu @ 2.65m = 24 kPa Cu @ 3.3m = 31 kPa
	2.20 - 3.30	Grey layered SILTY CLAY and SANDY SILT	
		Notes: Groundwater inflow at 0.6 metres	
TP 94-4	0.00 - 0.20	Dark brown silty sand (TOPSOIL)	
	0.20 - 1.70	Brown fine to medium SAND, some silt	
	1.70 - 2.70	Grey brown SILTY CLAY, trace sand (WEATHERED CRUST)	Cu @ 2.1m = 29 kPa Cu @ 2.4m = 33 kPa Cu @ 2.7m = 32 kPa
	2.70 - 3.20	Grey SILTY CLAY, trace sand	Cu @ 2.9m = 25 kPa Cu @ 3.2m = 30 kPa
	3.20	End of test pit	
		Notes: Groundwater inflow at 1.7 metres	
TP 94-5	0.00 - 0.20	Dark brown sandy silt (TOPSOIL)	
	0.20 - 1.70	Grey brown SILTY fine SAND, trace clay	
	1.70 - 3.50	Grey brown SILTY CLAY, trace sand (WEATHERED CRUST)	Cu @ 1.9m = 43 kPa Cu @ 2.2m = 49 kPa Cu @ 2.4m = 49 kPa
	3.50	End of test pit	Cu @ 2.7m = 44 kPa Cu @ 3.1m = 47 kPa
		Notes: Groundwater inflow at 1.7 metres	Cu @ 3.5m = 42 kPa

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the relative strength of cohesionless soils is the compactness condition, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm. An SPT N value of "P" denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity:	$S_t < 2$
Medium Sensitivity:	$2 < S_t < 4$
Sensitive:	$4 < S_t < 8$
Extra Sensitive:	$8 < S_t < 16$
Quick Clay:	$S_t > 16$

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube, generally recovered using a piston sampler
G	-	"Grab" sample from test pit or surface materials
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC%	-	Natural water content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic Limit, % (water content above which soil behaves plastically)
PI	-	Plasticity Index, % (difference between LL and PL)
Dxx	-	Grain size at which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

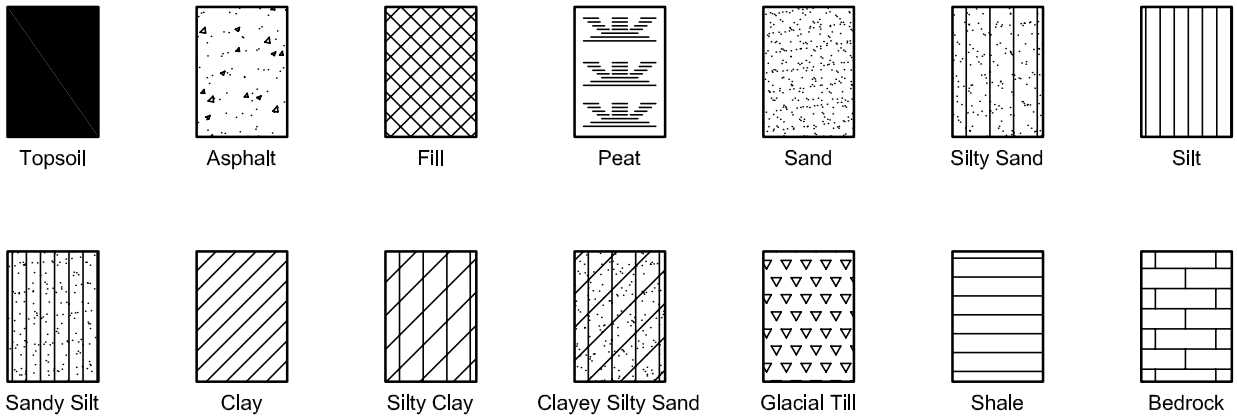
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

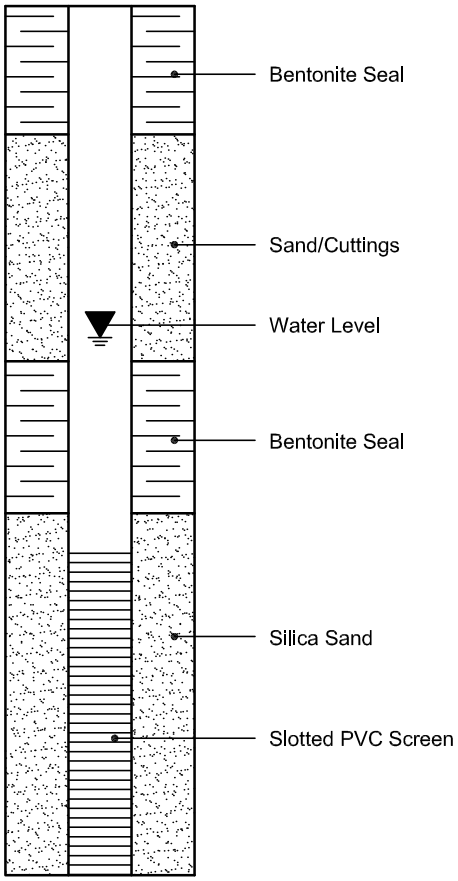
SYMBOLS AND TERMS (continued)

STRATA PLOT

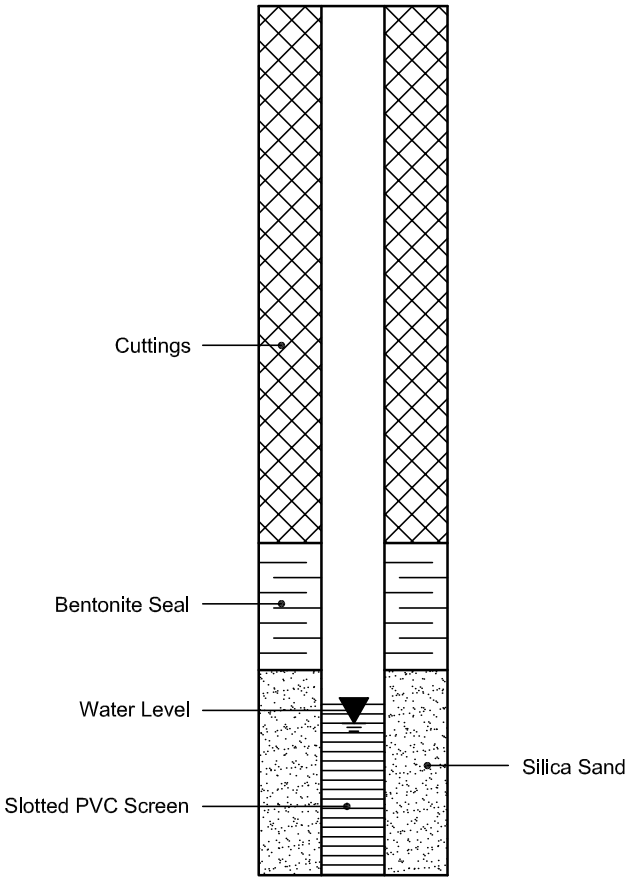


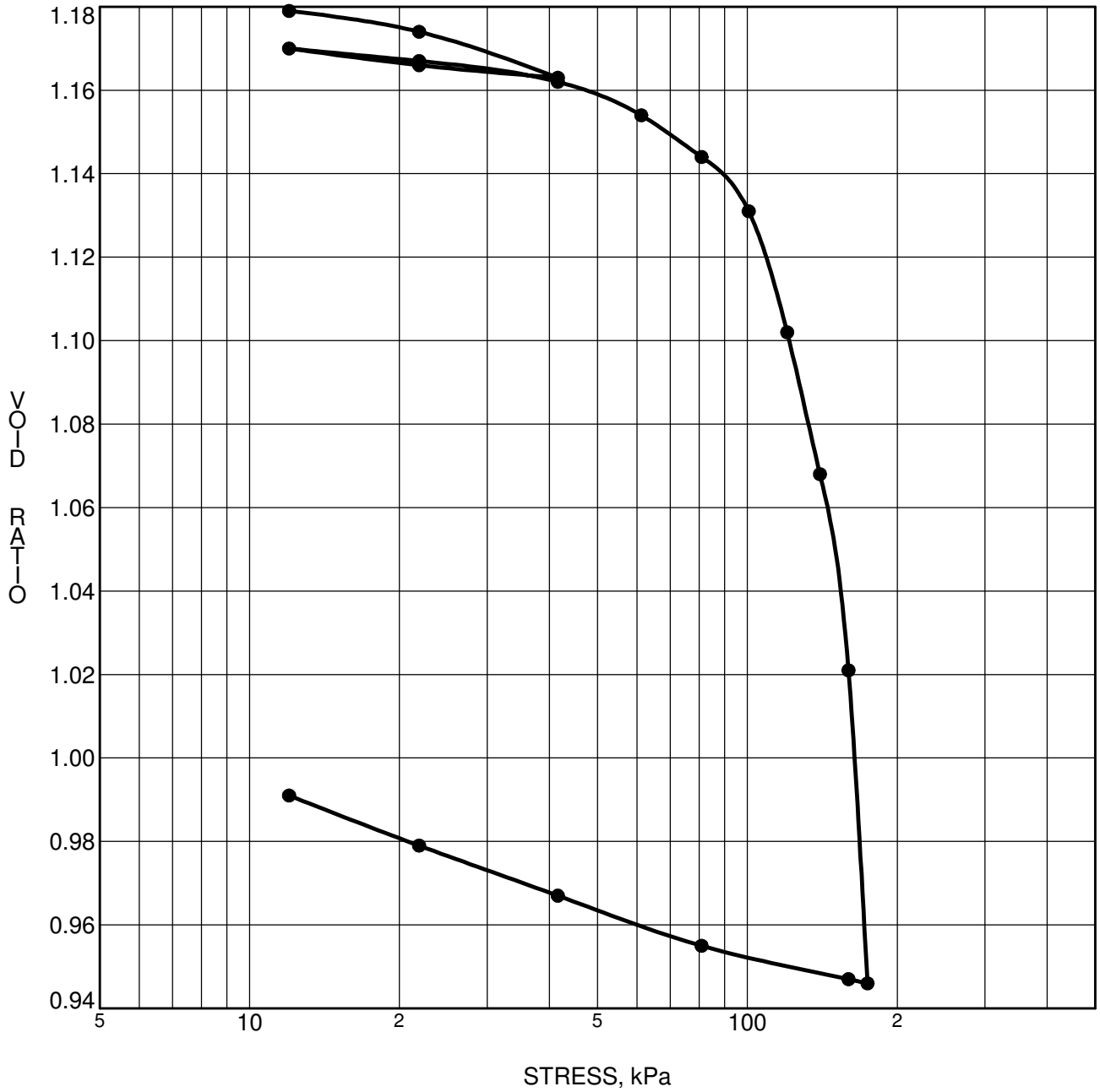
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 2-18**	p'o	**41.63** kPa	Ccr	**0.014**
Sample No.	**TW 4**	p'c	**141.9** kPa	Cc	**1.974**
Sample Depth	**4.22** m	OC Ratio	**3.4**	Wo	**43.4** %
Sample Elev.	**95.28** m	Void Ratio	**1.194**	Unit Wt.	**17.6** kN/m ^{3}

CLIENT	**Mattamy Homes**	FILE NO.	**PG4053**
PROJECT	**Geotechnical Investigation - Residential Development - Blackstone Phases 4 to 8**	DATE	**29/11/2018**

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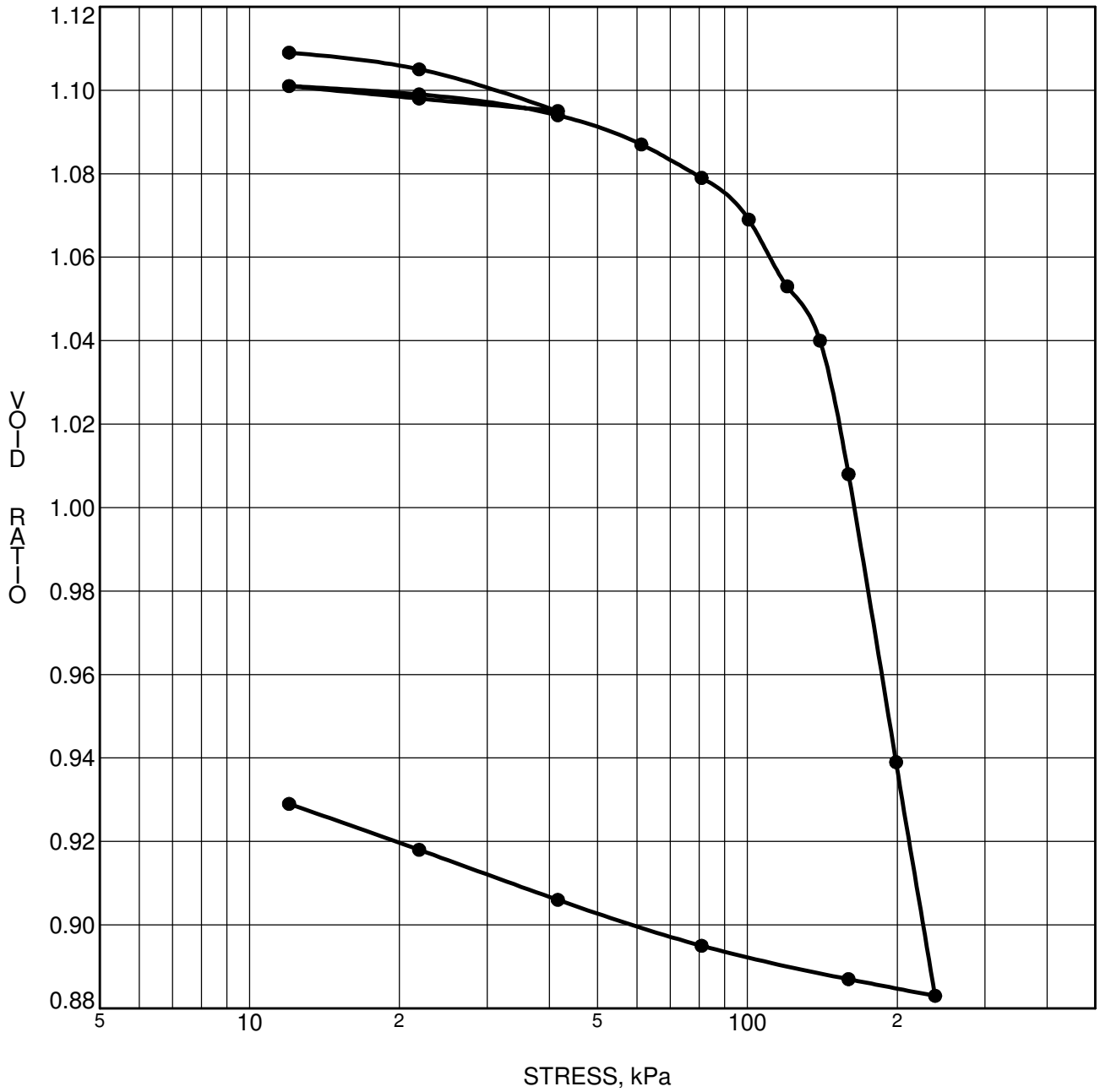
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 3-18**	p'o	**38.55** kPa	Ccr	**0.014**
Sample No.	**TW 6**	p'c	**133.04** kPa	Cc	**0.723**
Sample Depth	**5.05** m	OC Ratio	**3.5**	Wo	**40.8** %
Sample Elev.	**94.10** m	Void Ratio	**1.122**	Unit Wt.	**17.9** kN/m ^{3}

CLIENT	**Mattamy Homes**	FILE NO.	**PG4053**
PROJECT	**Geotechnical Investigation - Residential Development - Blackstone Phases 4 to 8**	DATE	**30/11/2018**

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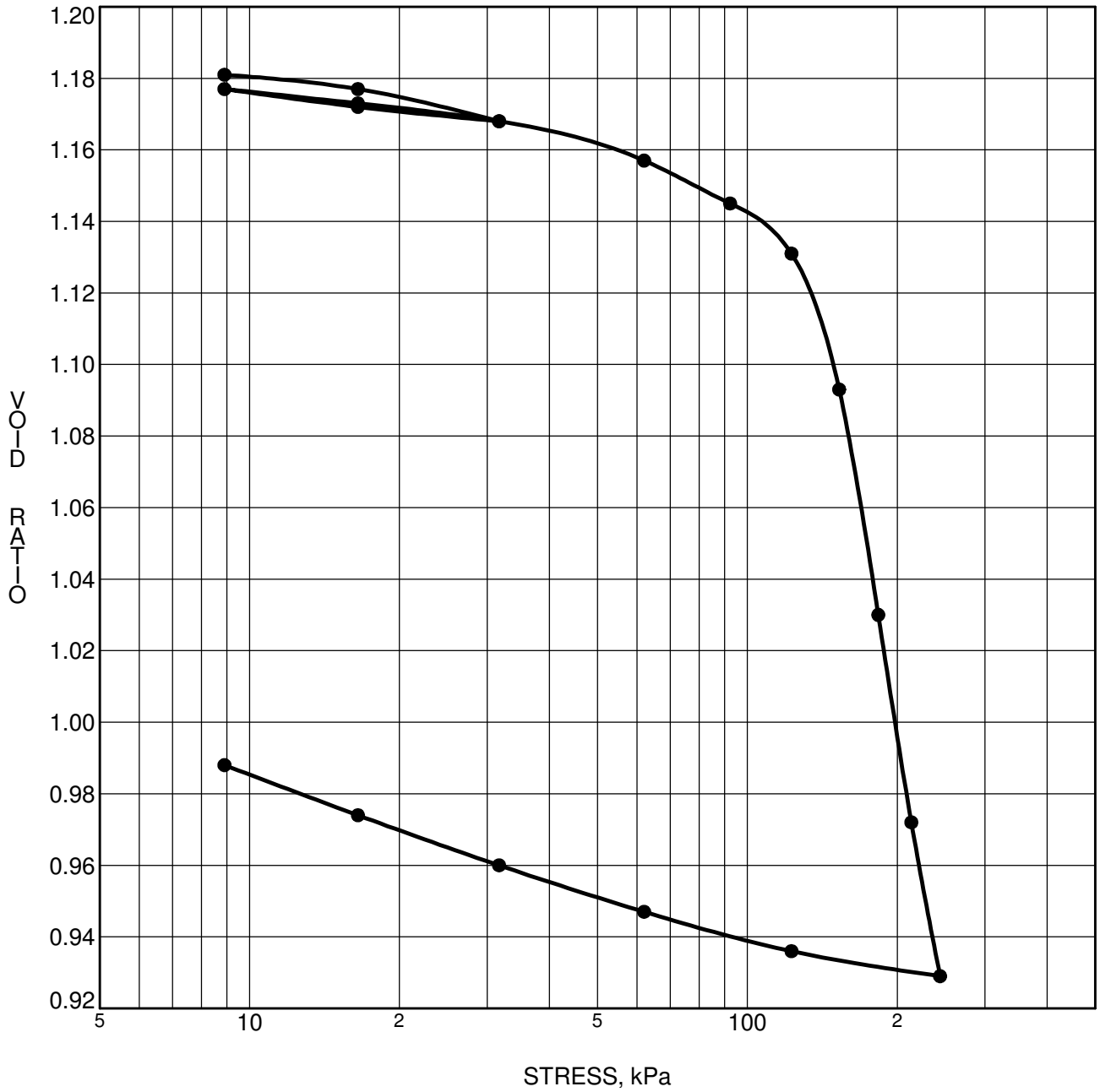
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 5-18**	p'o	**27.22** kPa	Ccr	**0.016**
Sample No.	**TW 6**	p'c	**136.14** kPa	Cc	**0.829**
Sample Depth	**4.11** m	OC Ratio	**5.0**	Wo	**43.0** %
Sample Elev.	**95.65** m	Void Ratio	**1.181**	Unit Wt.	**17.7** kN/m ^{3}

CLIENT	**Mattamy Homes**	FILE NO.	**PG4053**
PROJECT	**Geotechnical Investigation - Residential Development - Blackstone Phases 4 to 8**	DATE	**30/11/2018**

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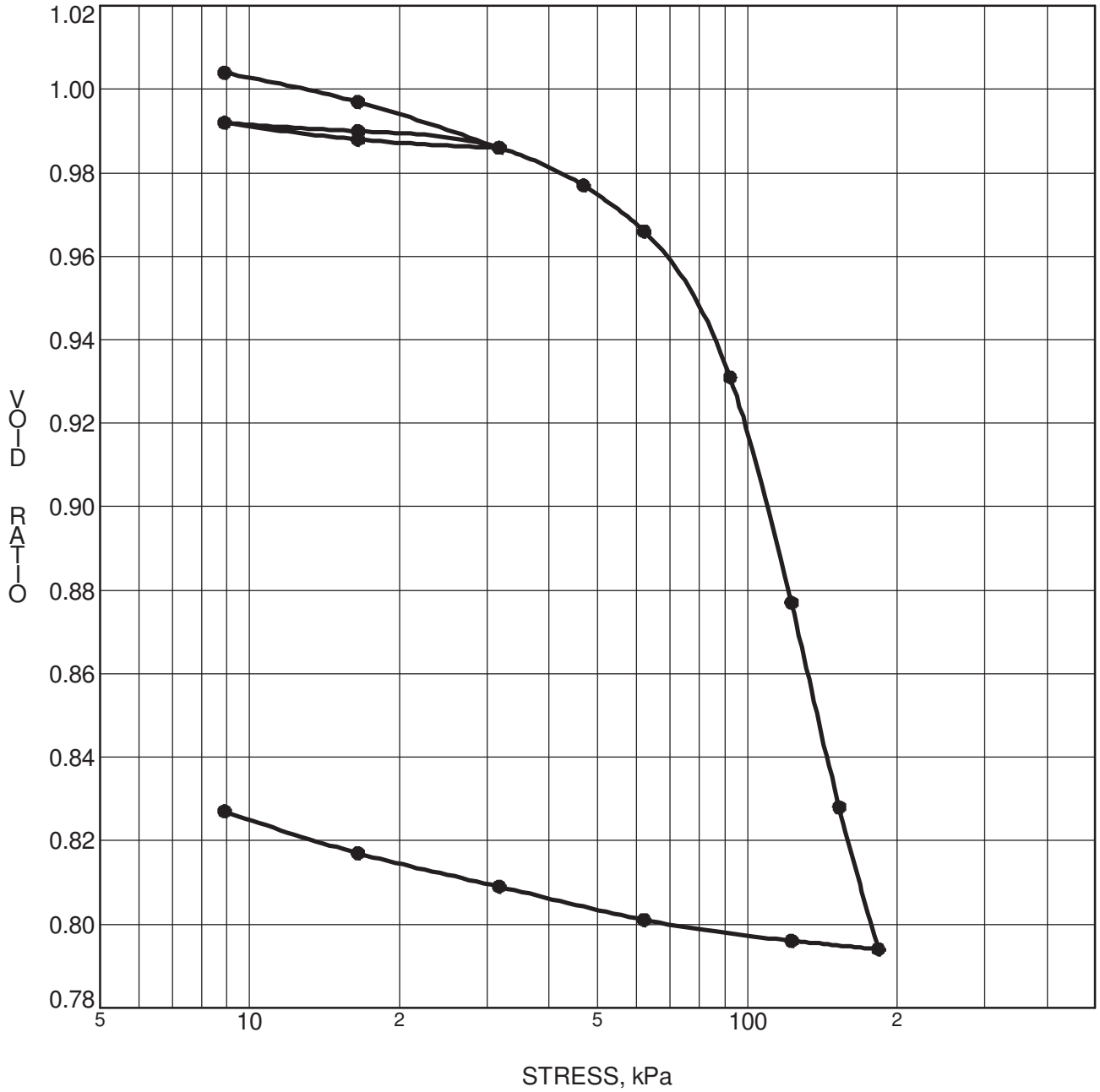
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 1**	p'_o	**40** kPa	Ccr	**0.012**
Sample No.	**TW 2**	p'_c	**78** kPa	Cc	**0.471**
Sample Depth	**3.45** m	OC Ratio	**2.0**	Wo	**36.7** %
Sample Elev.	**95.41** m	Void Ratio	**1.01**	Unit Wt.	**18.6** kN/m ^{3}

CLIENT	**Monarch Group**	FILE NO.	**PG2233**
PROJECT	**Supplemental Geotechnical Investigation - West Park Residential Development**	DATE	**11/20/2010**

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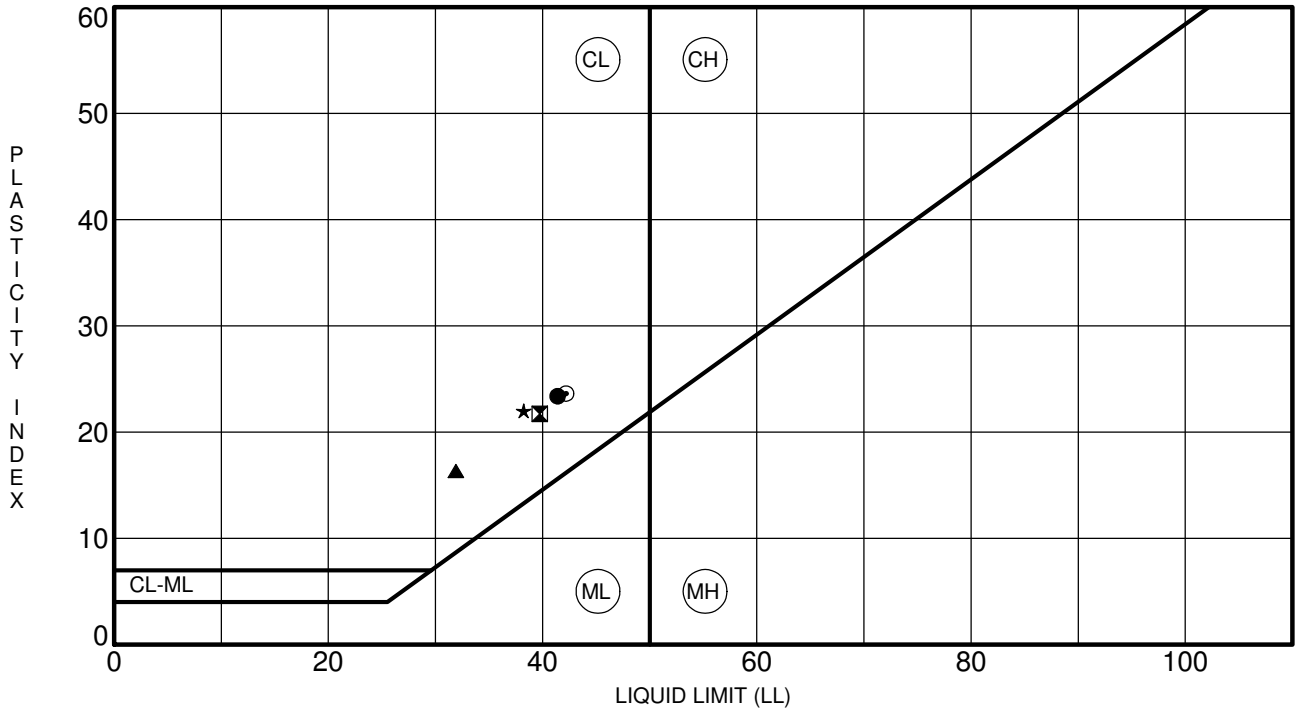
28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



Specimen Identification			LL	PL	PI	Fines	Classification
●	**BH 1-18**	**SS 4**	**41**	**18**	**23**		**CL - Inorganic clays of low plasticity**
⧗	**BH 2-18**	**SS 2**	**40**	**18**	**22**		**CL - Inorganic clays of low plasticity**
▲	**BH 3-18**	**SS 3**	**32**	**16**	**16**		**CL - Inorganic clays of low plasticity**
★	**BH 4-18**	**SS 2**	**38**	**16**	**22**		**CL - Inorganic clays of low plasticity**
⊙	**BH 5-18**	**SS 3**	**42**	**19**	**24**		**CL - Inorganic clays of low plasticity**

CLIENT	**Mattamy Homes**	FILE NO.	**PG4053**
PROJECT	**Geotechnical Investigation - Residential Development - Blackstone Phases 4 to 8**	DATE	**21 Nov 18**

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ATTERBERG LIMITS' RESULTS

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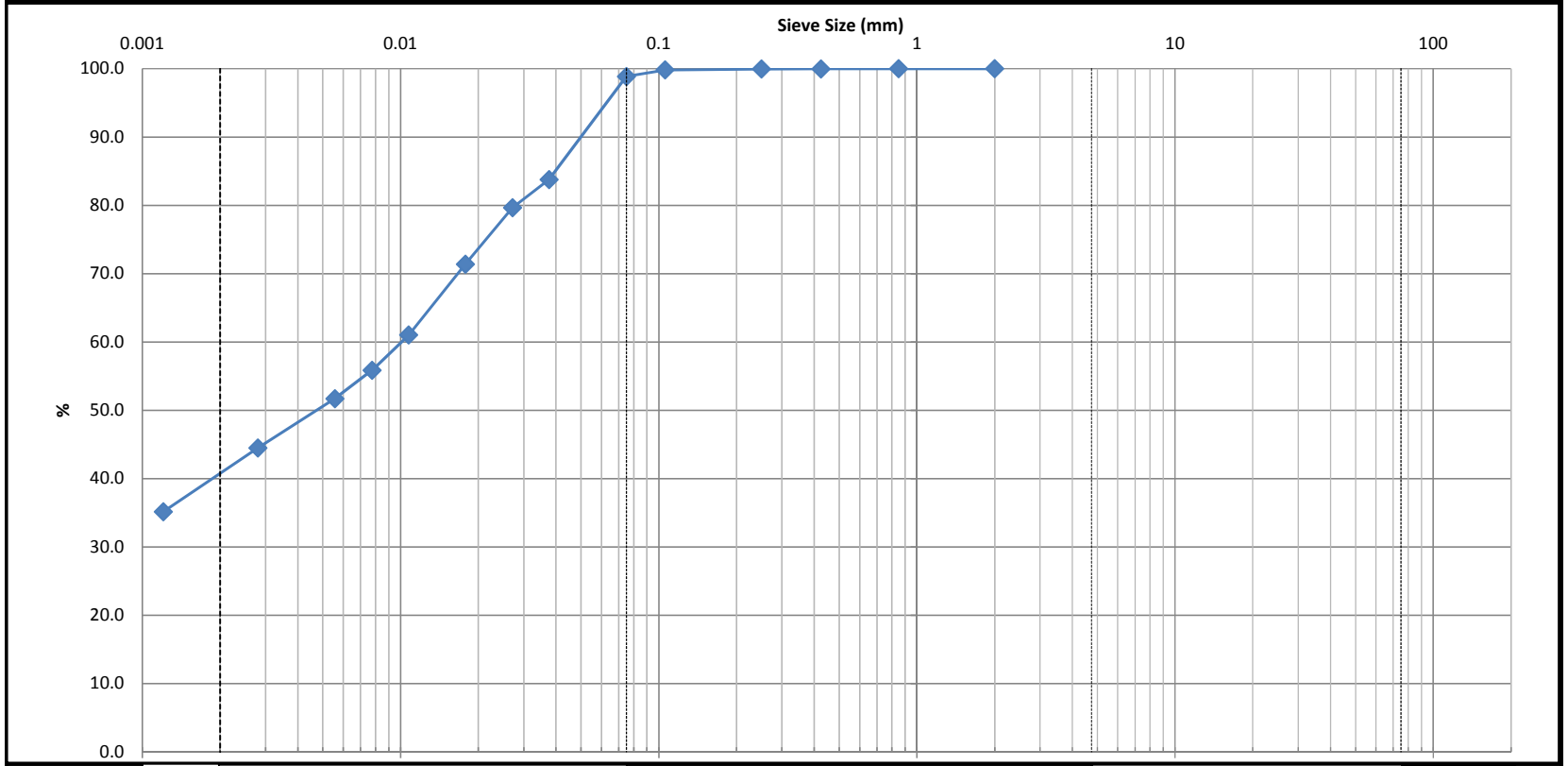
CLIENT:	Mattamy Homes	DEPTH:	7'6" - 9'6"	FILE NO:	PG4053
CONTRACT NO.:		BH OR TP No.:	BH1 - SS4	LAB NO:	06565
PROJECT:	Blackstone Ridge - Fernbank PH. 4-8			DATE RECEIVED:	10-Dec-18
				DATE TESTED:	12-Dec-18
DATE SAMPLED:	20-Nov-18			DATE REPORTED:	17-Dec-18
SAMPLED BY:	J. Sullivan			TESTED BY:	D. Bertrand



	Clay	Silt	Sand			Gravel		Cobble
			Fine	Medium	Coarse	Fine	Coarse	

Identification	Soil Classification					MC(%)	LL	PL	PI	Cc	Cu
						28.1					
	D100	D60	D30	D10	Gravel (%)	Sand (%)		Silt (%)		Clay (%)	
					0.0	1.1		57.9		41.0	

Comments	

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HYDROMETER
LS-702 ASTM-422

CLIENT:	Mattamy Homes	DEPTH:	7'6" - 9'6"	FILE NO.:	PG4053
PROJECT:	Blackstone Ridge - Fernbank PH. 4-8	BH OR TP No.:	BH1 - SS4	DATE SAMPLED:	20-Nov-18
LAB No. :	06565	TESTED BY:	D. Bertrand	DATE RECEIVED:	10-Dec-18
SAMPLED BY:	J. Sullivan	DATE REPT'D:	17-Dec-18	DATE TESTED:	12-Dec-18

SAMPLE INFORMATION

SAMPLE MASS	110.2	50.00	
SPECIFIC GRAVITY (Gs)	2.700	REMARKS	
HYGROSCOPIC MOISTURE	Tare No.		
TARE Wt.	50.00	ACTUAL Wt.	
AIR DRY (Wa)	150.00	100.00	
OVEN DRY (Wo)	145.60	95.60	
F=(Wo/Wa)	0.956		
INITIAL Wt. (Ma)	50.00		
Wt. CORRECTED	47.80		
Wt. AFTER WASH BACK SIEVE	0.66		
SOLUTION CONCENTRATION	40 g / L		

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)		WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
63.0				
53.0				
37.5				
26.5				
19.0				
16.0				
13.2				
9.5				
4.75				
2.0		**0.0**	0.0	100.0
Pan		**110.2**		
0.850		**0.01**	0.0	100.0
0.425		**0.02**	0.0	100.0
0.250		**0.03**	0.1	99.9
0.106		**0.09**	0.2	99.8
0.075		**0.57**	1.1	98.9
Pan		**0.66**		
SIEVE CHECK	0.0	MAX = 0.3%		

HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (°C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	9:04	46.5	6.0	23.0	0.0376	83.8	83.8
2	9:05	44.5	6.0	23.0	0.0271	79.6	79.6
5	9:08	40.5	6.0	23.0	0.0178	71.4	71.4
15	9:18	35.5	6.0	23.0	0.0107	61.0	61.0
30	9:33	33.0	6.0	23.0	0.0078	55.9	55.9
60	10:03	31.0	6.0	23.0	0.0056	51.7	51.7
250	13:13	27.5	6.0	23.0	0.0028	44.5	44.5
1440	9:03	23.0	6.0	23.0	0.0012	35.2	35.2

COMMENTS

Moisture Content = 28.1%

REVIEWED BY:	**Curtis Beadow**	**APPROVED BY:**	**Joe Forsyth, P. Eng.**

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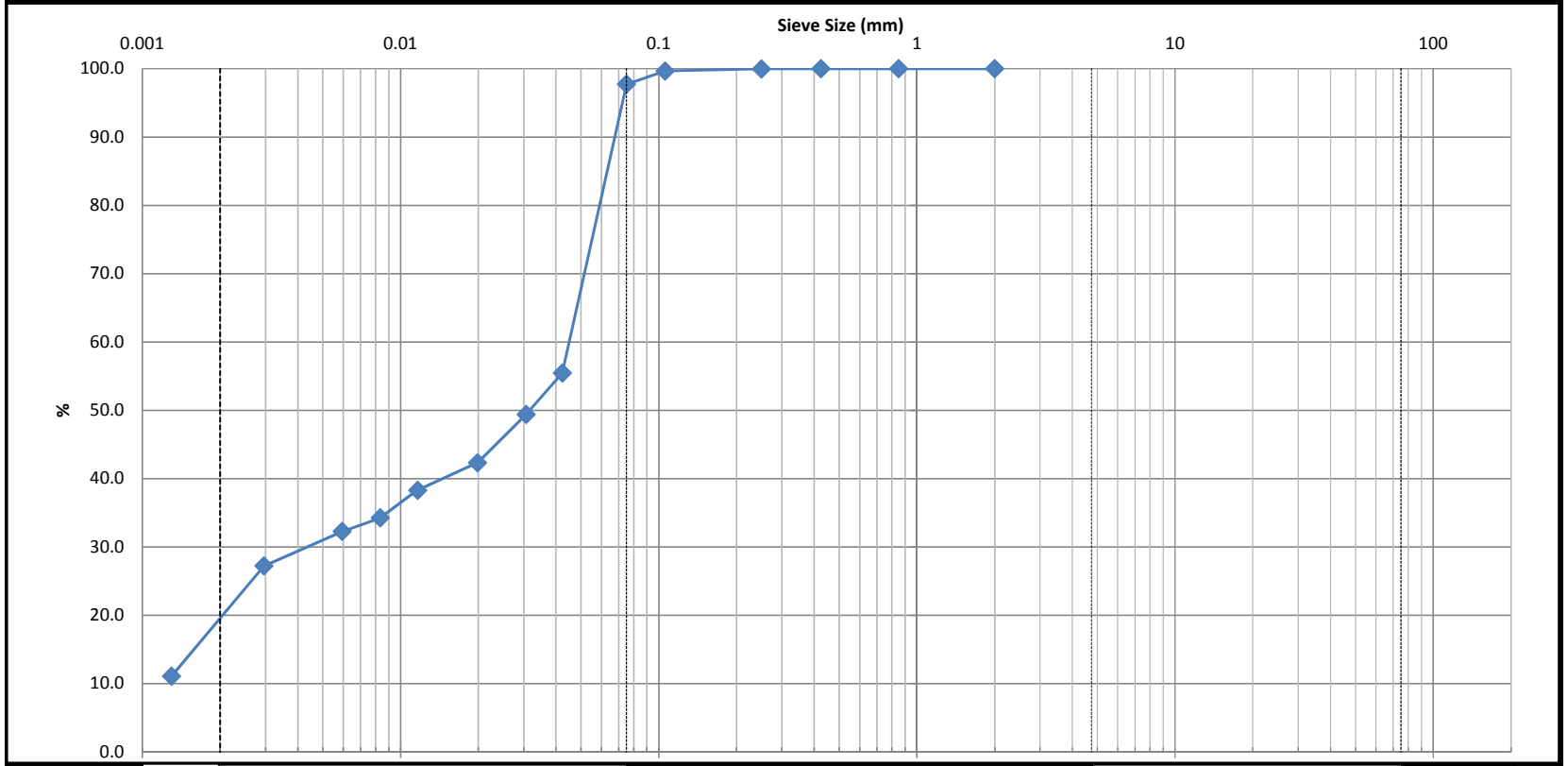
CLIENT:	Mattamy Homes	DEPTH:	7'6" - 9'6"	FILE NO:	PG4053
CONTRACT NO.:		BH OR TP No.:	BH3 - SS3	LAB NO:	06566
PROJECT:	Blackstone Ridge - Fernbank PH. 4-8			DATE RECEIVED:	10-Dec-18
				DATE TESTED:	12-Dec-18
DATE SAMPLED:	20-Nov-18			DATE REPORTED:	17-Dec-18
SAMPLED BY:	J. Sullivan			TESTED BY:	D. Bertrand



	Clay	Silt	Sand			Gravel		Cobble
			Fine	Medium	Coarse	Fine	Coarse	

Identification	Soil Classification					MC(%)	LL	PL	PI	Cc	Cu
						22.6					
	D100	D60	D30	D10	Gravel (%)	Sand (%)		Silt (%)		Clay (%)	
					0.0	2.3		78.2		19.5	

Comments	

patersongroup
consulting engineers

HYDROMETER
LS-702 ASTM-422

CLIENT:	Mattamy Homes	DEPTH:	7'6" - 9'6"	FILE NO.:	PG4053
PROJECT:	Blackstone Ridge - Fernbank PH. 4-8	BH OR TP No.:	BH3 - SS3	DATE SAMPLED:	20-Nov-18
LAB No. :	06566	TESTED BY:	D. Bertrand	DATE RECEIVED:	10-Dec-18
SAMPLED BY:	J. Sullivan	DATE REPT'D:	17-Dec-18	DATE TESTED:	12-Dec-18

SAMPLE INFORMATION

SAMPLE MASS	117.2	50.00	
SPECIFIC GRAVITY (Gs)	2.700	REMARKS	
HYGROSCOPIC MOISTURE	Tare No.		
TARE Wt.	50.00	ACTUAL Wt.	
AIR DRY (Wa)	150.00	100.00	
OVEN DRY (Wo)	148.10	98.10	
F=(Wo/Wa)	0.981		
INITIAL Wt. (Ma)	50.00		
Wt. CORRECTED	49.05		
Wt. AFTER WASH BACK SIEVE	1.61		
SOLUTION CONCENTRATION	40 g / L		

GRAIN SIZE ANALYSIS

SIEVE DIAMETER (mm)	WEIGHT RETAINED (g)	PERCENT RETAINED	PERCENT PASSING
63.0			
53.0			
37.5			
26.5			
19.0			
16.0			
13.2			
9.5			
4.75			
2.0	**0.0**	0.0	100.0
Pan	**117.2**		
0.850	**0.00**	0.0	100.0
0.425	**0.00**	0.0	100.0
0.250	**0.02**	0.0	100.0
0.106	**0.17**	0.3	99.7
0.075	**1.14**	2.3	97.7
Pan	**1.61**		
SIEVE CHECK 0.0	MAX = 0.3%		

HYDROMETER DATA

ELAPSED	TIME (24 hours)	Hs	Hc	Temp. (°C)	DIAMETER	(P)	TOTAL PERCENT PASSING
1	9:16	33.5	6.0	23.0	0.0423	55.4	55.4
2	9:17	30.5	6.0	23.0	0.0306	49.4	49.4
5	9:20	27.0	6.0	23.0	0.0199	42.3	42.3
15	9:30	25.0	6.0	23.0	0.0116	38.3	38.3
30	9:45	23.0	6.0	23.0	0.0084	34.3	34.3
60	10:15	22.0	6.0	23.0	0.0059	32.3	32.3
250	13:25	19.5	6.0	23.0	0.0030	27.2	27.2
1440	9:15	11.5	6.0	23.0	0.0013	11.1	11.1

COMMENTS

Moisture Content = 22.6%

REVIEWED BY:	**Curtis Beadow**	**APPROVED BY:**	**Joe Forsyth, P. Eng.**

Certificate of Analysis

Report Date: 11-Dec-2018

Client: Paterson Group Consulting Engineers

Order Date: 5-Dec-2018

Client PO: 25617

Project Description: PG4053

	Client ID:	BH#2 SS3	-	-	-
	Sample Date:	11/21/2018 09:00	-	-	-
	Sample ID:	1849403-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	74.0	-	-	-
General Inorganics					
pH	0.05 pH Units	7.74	-	-	-
Resistivity	0.10 Ohm.m	49.9	-	-	-
Anions					
Chloride	5 ug/g dry	27	-	-	-
Sulphate	5 ug/g dry	29	-	-	-

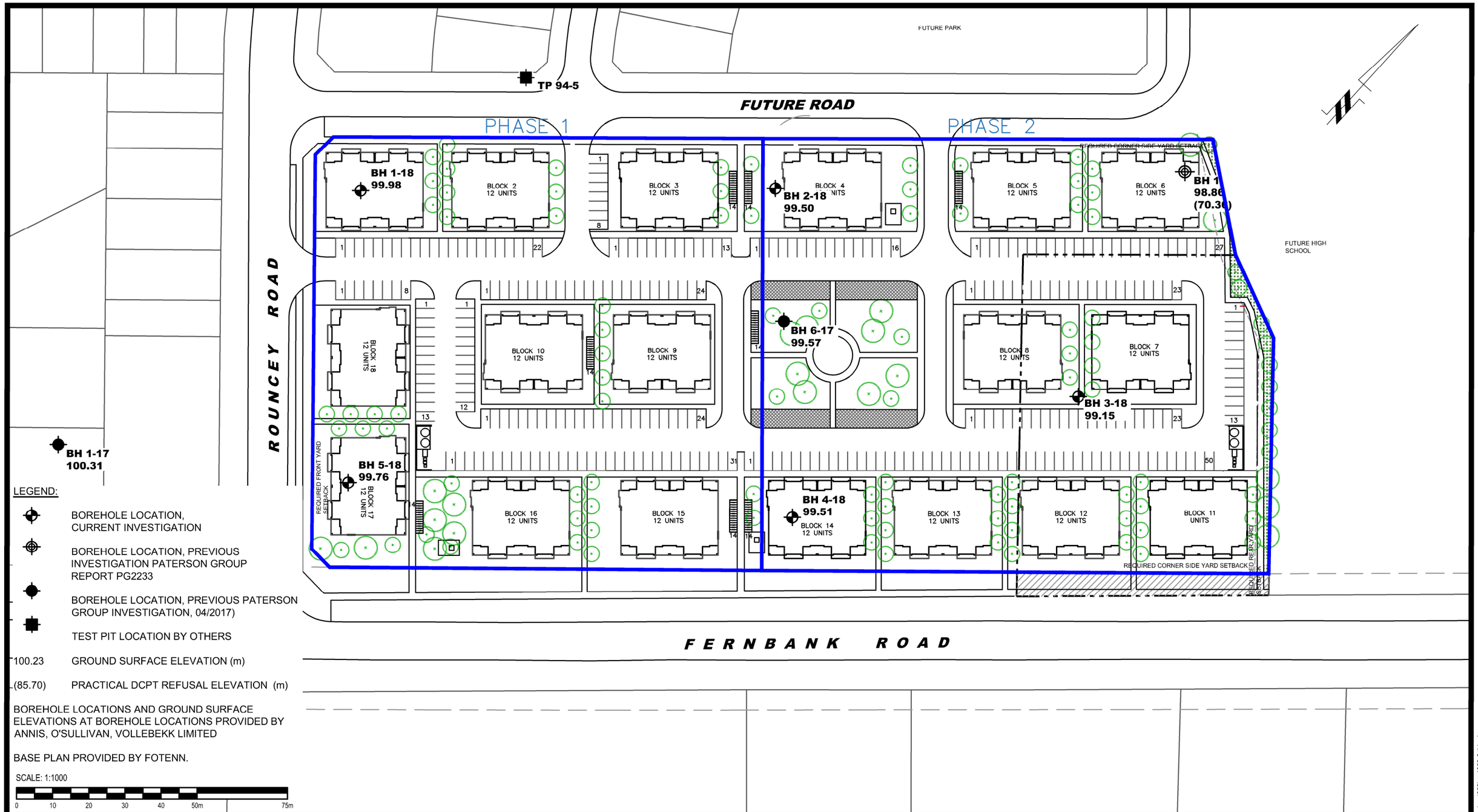
APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG4053-4 - TEST HOLE LOCATION PLAN

FIGURE 1

KEY PLAN



LEGEND:

- BOREHOLE LOCATION, CURRENT INVESTIGATION
- BOREHOLE LOCATION, PREVIOUS INVESTIGATION PATERSON GROUP REPORT PG2233
- BOREHOLE LOCATION, PREVIOUS PATERSON GROUP INVESTIGATION, 04/2017)
- TEST PIT LOCATION BY OTHERS
- 100.23 GROUND SURFACE ELEVATION (m)
- (85.70) PRACTICAL DCPT REFUSAL ELEVATION (m)

BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LIMITED

BASE PLAN PROVIDED BY FOTENN.

SCALE: 1:1000

0 10 20 30 40 50m 75m

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consulting engineers

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Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL

MATTAMY HOMES

GEOTECHNICAL INVESTIGATION

RESIDENTIAL DEVELOPMENT - BLACKSTONE PHASES 4 TO 8 - 5505 TO 5441 FERNBANK ROAD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1000	Date: 12/2018
Drawn by: RCG	Report No.: PG4053
Checked by: SB	Dwg. No.: PG4053-4
Approved by: DJG	Revision No.: 0

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Appendix E DRAWINGS