APPENDICES

Appendix A : WATERMAIN HYDRAULIC ANALYSIS

Thiffault, Dustin

From: Alemany, Kevin
Sent: Tuesday, February 27, 2018 9:34 AM
To: Thiffault, Dustin
Cc: Moroz, Peter
Subject: RE: Minto Mahogany

Hi Dustin,

Here are the build out boundary conditions prior to MWL Phase 2:

w Eastman and Potter upgraded to 305 and Manotick Main 305
w NIL & MWL1
w/o MWL2

		HGL (m)		Q (L/s)	
		BC#1 (Potter)	BC#2 (Manotick Main)	BC#1 (Potter)	BC#2 (Manotick Main)
Max P	AVDY = 15.96L/s	146.0	146.0	N/A	N/A
Min P	PKHR = 85.13L/s	139.3	139.2	N/A	N/A
P	MXDY = 38.95L/s+ FF167L/s	109.6	108.7	129.8	76.2
P	MXDY = 38.95L/s+ FF133L/s	119.1	118.5	108.4	63.6

Regards, Kevin

Kevin Alemany
M.A.Sc., P.Eng.
Principal, Water, Regional Discipline Leader

Direct: (613) 724-4091
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Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON K2C 3G4 CA

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From: Thiffault, Dustin
Sent: Thursday, February 22, 2018 10:31 AM
To: Alemany, Kevin <kevin.alemany@stantec.com>
Cc: Moroz, Peter <peter.moroz@stantec.com>
Subject: Minto Mahogany

Hi Kevin,

I believe Peter mentioned to you that Minto was looking to expand on their interim watermain analysis to show a what-if scenario demonstrating full buildout of the subdivision prior to construction of the MWL Phase 2. We are hoping to get yet another boundary condition from your model considering the ultimate buildout demands below:

AVDY = 15.96L/s
PKHR = 85.13L/s
MXDY = 38.95L/s + FF167L/s
MXDY = 38.95L/s + FF133L/s

Thanks for all your help,

Dustin Thiffault
P. Eng.
Project Engineer

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FUS Fire Flow Calculation Sheet

Stantec Project #: 160499000
Project Name: FUS Protocol Test Drive
Date: 10/5/2018
Fire Flow Calculation #: 1
Description: Townhomes

Notes: 900sq. Ft. Townhouse row to max 2 units. 2hr fire separations between each 2 units for larger blocks.

<table>
<tr><th>Step</th><th>Task</th><th colspan="6">Notes</th><th>Value Used</th><th>Req'd Fire Flow (L/min)</th></tr>
<tr><td>1</td><td>Determine Type of Construction</td><td colspan="6">Wood Frame</td><td>1.5</td><td>-</td></tr>
<tr><td rowspan="2">2</td><td>Determine Ground Floor Area of One Unit</td><td colspan="6">-</td><td>83.6</td><td>-</td></tr>
<tr><td>Determine Number of Adjoining Units</td><td colspan="6">Includes adjacent wood frame structures separated by 3m or less</td><td>2</td><td>-</td></tr>
<tr><td>3</td><td>Determine Height in Storeys</td><td colspan="6">Does not include floors >50% below grade or open attic space</td><td>2</td><td>-</td></tr>
<tr><td>4</td><td>Determine Required Fire Flow</td><td colspan="6">($F = 220 \times C \times A^{1/2}$). Round to nearest 1000 L/min</td><td>-</td><td>6000</td></tr>
<tr><td>5</td><td>Determine Occupancy Charge</td><td colspan="6">Limited Combustible</td><td>-15%</td><td>5100</td></tr>
<tr><td rowspan="4">6</td><td rowspan="4">Determine Sprinkler Reduction</td><td colspan="6">None</td><td>0%</td><td rowspan="4">0</td></tr>
<tr><td colspan="6">Non-Standard Water Supply or N/A</td><td>0%</td></tr>
<tr><td colspan="6">Not Fully Supervised or N/A</td><td>0%</td></tr>
<tr><td colspan="6">% Coverage of Sprinkler System</td><td>0%</td></tr>
<tr><td rowspan="5">7</td><td rowspan="5">Determine Increase for Exposures (Max. 75%)</td><td>Direction</td><td>Exposure Distance (m)</td><td>Exposed Length (m)</td><td>Exposed Height (Stories)</td><td>Length-Height Factor (m x stories)</td><td>Construction of Adjacent Wall</td><td>-</td><td>-</td></tr>
<tr><td>North</td><td>0 to 3</td><td>15</td><td>2</td><td>0-30</td><td>Ordinary or Fire Resistive (Blank Wall)</td><td>0%</td><td rowspan="4">1887</td></tr>
<tr><td>East</td><td>10.1 to 20</td><td>6.2</td><td>2</td><td>0-30</td><td>Wood Frame or Non-Combustible</td><td>12%</td></tr>
<tr><td>South</td><td>3.1 to 10</td><td>15</td><td>2</td><td>0-30</td><td>Wood Frame or Non-Combustible</td><td>17%</td></tr>
<tr><td>West</td><td>20.1 to 30</td><td>6.2</td><td>2</td><td>0-30</td><td>Wood Frame or Non-Combustible</td><td>8%</td></tr>
<tr><td rowspan="4">8</td><td rowspan="4">Determine Final Required Fire Flow</td><td colspan="7">Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min</td><td>7000</td></tr>
<tr><td colspan="7">Total Required Fire Flow in L/s</td><td>116.7</td></tr>
<tr><td colspan="7">Required Duration of Fire Flow (hrs)</td><td>2.00</td></tr>
<tr><td colspan="7">Required Volume of Fire Flow (m^3)</td><td>840</td></tr>
</table>

FUS Fire Flow Calculation Sheet

Stantec Project #: 160499000
Project Name: FUS Protocol Test Drive
Date: 10/5/2018
Fire Flow Calculation #: 2
Description: Townhomes

Notes: 900sq. Ft. Townhouse row to max 4 units. 2hr fire separations between each 4 units for larger blocks.

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	-						83.6	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						4	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						2	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	9000
5	Determine Occupancy Charge	Limited Combustible						-15%	7650
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	0 to 3	15	2	0-30	Ordinary or Fire Resistive (Blank Wall)	0%	2831
		East	10.1 to 20	12.4	2	0-30	Wood Frame or Non-Combustible	12%	
		South	3.1 to 10	15	2	0-30	Wood Frame or Non-Combustible	17%	
		West	20.1 to 30	12.4	2	0-30	Wood Frame or Non-Combustible	8%	
8	Determine Final Required Fire Flow	**Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min**							**10000**
		Total Required Fire Flow in L/s							**166.7**
		Required Duration of Fire Flow (hrs)							**2.00**
		Required Volume of Fire Flow (m^3)							**1200**

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FUS Fire Flow Calculation Sheet

Stantec Project #: 160499000
Project Name: FUS Protocol Test Drive
Date: 10/5/2018
Fire Flow Calculation #: 3
Description: Single Family Home

Notes: 900sq. Ft. Townhouse row to max 4 units.

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	-						83.6	-
	Determine Number of Adjoining Units	Includes adjacent wood frame structures separated by 3m or less						4	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						2	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	9000
5	Determine Occupancy Charge	Limited Combustible						-15%	7650
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	3.1 to 10	15	2	0-30	Wood Frame or Non-Combustible	17%	4131
		East	10.1 to 20	12.4	2	0-30	Wood Frame or Non-Combustible	12%	
		South	3.1 to 10	15	2	0-30	Wood Frame or Non-Combustible	17%	
		West	20.1 to 30	12.4	2	0-30	Wood Frame or Non-Combustible	8%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							12000
		Total Required Fire Flow in L/s							200.0
		Required Duration of Fire Flow (hrs)							2.50
		Required Volume of Fire Flow (m^3)							1800

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FUS Fire Flow Calculation Sheet

Stantec Project #: 160499000
Project Name: FUS Protocol Test Drive
Date: 10/5/2018
Fire Flow Calculation #: 4
Description: Single Family Home

Notes: 1500sq.ft. floorplate

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	-						139.4	-
	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						2	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	6000
5	Determine Occupancy Charge	Limited Combustible						-15%	5100
6	Determine Sprinkler Reduction	None						0%	0
		Non-Standard Water Supply or N/A						0%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						0%	
7	Determine Increase for Exposures (Max. 75%)	Direction	Exposure Distance (m)	Exposed Length (m)	Exposed Height (Stories)	Length-Height Factor (m x stories)	Construction of Adjacent Wall	-	-
		North	3.1 to 10	14	2	0-30	Wood Frame or Non-Combustible	17%	2754
		East	10.1 to 20	10	2	0-30	Wood Frame or Non-Combustible	12%	
		South	3.1 to 10	14	2	0-30	Wood Frame or Non-Combustible	17%	
		West	20.1 to 30	10	2	0-30	Wood Frame or Non-Combustible	8%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							8000
		Total Required Fire Flow in L/s							133.3
		Required Duration of Fire Flow (hrs)							2.00
		Required Volume of Fire Flow (m^3)							960

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FUS Fire Flow Calculation Sheet

Stantec Project #: 160499000
Project Name: FUS Protocol Test Drive
Date: 10/5/2018
Fire Flow Calculation #: 5
Description: School

Notes: 4500sq.m. Floorplate

Step	Task	Notes						Value Used	Req'd Fire Flow (L/min)
1	Determine Type of Construction	Ordinary Construction						1	-
2	Determine Ground Floor Area of One Unit	-						4500	-
	Determine Number of Adjoining Units	-						1	-
3	Determine Height in Storeys	Does not include floors >50% below grade or open attic space						1	-
4	Determine Required Fire Flow	(F = 220 x C x $A^{1/2}$). Round to nearest 1000 L/min						-	15000
5	Determine Occupancy Charge	Combustible						0%	15000
6	Determine Sprinkler Reduction	Conforms to NFPA 13						-30%	-6000
		Standard Water Supply						-10%	
		Not Fully Supervised or N/A						0%	
		% Coverage of Sprinkler System						100%	
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	> 45	67.1	1	61-90	Wood Frame or Non-Combustible	0%	0
		East	> 45	67.1	1	61-90	Wood Frame or Non-Combustible	0%	
		South	> 45	67.1	1	61-90	Wood Frame or Non-Combustible	0%	
		West	> 45	67.1	1	61-90	Wood Frame or Non-Combustible	0%	
8	Determine Final Required Fire Flow	Total Required Fire Flow in L/min, Rounded to Nearest 1000L/min							9000
		Total Required Fire Flow in L/s							150.0
		Required Duration of Fire Flow (hrs)							2.00
		Required Volume of Fire Flow (m^3)							1080

Appendix B : SANITARY SEWER CALCULATIONS

SUBDIVISION:

Minto Mahogany Phases 2-4

DATE: 9/5/2018
REVISION: 2
DESIGNED BY: DT
CHECKED BY: PM

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160410140

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)
PHASE 1, EXT	109	110	42.87	299	0	0	1017	42.87	1017	3.24	10.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	42.87	42.87	14.1	24.8	61.5	300	PVC	SDR 35	0.20	42.4	58.51%	0.60	0.54
	110	111	0.00	0	0	0	0	42.87	1017	3.24	10.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	42.87	14.1	24.8	50.3	300	PVC	SDR 35	0.20	42.8	57.95%	0.61	0.54
	111	112	0.00	0	0	0	0	42.87	1017	3.24	10.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	42.87	14.1	24.8	37.3	300	PVC	SDR 35	0.20	42.8	57.98%	0.61	0.54
	112	114	0.00	0	0	0	0	42.87	1017	3.24	10.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	42.87	14.1	24.8	68.2	300	PVC	SDR 35	0.20	43.2	57.44%	0.61	0.55
G11A, G11B, R11A, FUT	11	10	52.90	322	34	0	2220	52.90	2220	3.04	21.9	0.00	0.00	0.00	0.00	0.00	0.00	2.84	2.84	17.34	17.34	0.9	73.07	73.07	24.1	46.9	56.1	450	PVC	SDR 35	0.15	116.4	40.29%	0.71	0.57
R10A	10	9	5.70	64	0	0	218	58.60	2437	3.01	23.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	17.34	0.9	5.70	78.78	26.0	50.7	111.7	450	PVC	SDR 35	0.15	116.4	43.57%	0.71	0.58
R12A	12	9	1.26	14	0	0	48	1.26	48	3.66	0.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	1.26	1.26	0.4	1.0	223.0	200	PVC	SDR 35	0.40	21.1	4.63%	0.67	0.28
	9	8	0.00	0	0	0	0	59.86	2485	3.01	24.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	17.34	0.9	0.00	80.03	26.4	51.6	104.2	450	PVC	SDR 35	0.15	116.4	44.28%	0.71	0.58
	8	7	0.00	0	0	0	0	59.86	2485	3.01	24.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	17.34	0.9	0.00	80.03	26.4	51.6	111.9	450	PVC	SDR 35	0.15	116.4	44.28%	0.71	0.58
	7	6	0.00	0	0	0	0	59.86	2485	3.01	24.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	17.34	0.9	0.00	80.03	26.4	51.6	64.5	450	PVC	SDR 35	0.15	116.4	44.29%	0.71	0.58
R6A	6	5	1.14	19	0	0	65	60.99	2549	3.00	24.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	0.00	17.34	0.9	1.14	81.17	26.8	52.5	175.6	450	PVC	SDR 35	0.15	116.4	45.10%	0.71	0.59
R14A	14	13	4.48	52	0	0	177	4.48	177	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	4.48	4.48	1.5	3.5	273.8	200	PVC	SDR 35	0.40	21.1	16.56%	0.67	0.41
R13A	13	5	5.73	82	0	0	279	10.21	456	3.40	5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	5.73	10.21	3.4	8.4	252.4	200	PVC	SDR 35	0.40	21.1	39.63%	0.67	0.53
R16A	16	15	4.50	15	99	0	318	4.50	318	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	4.50	4.50	1.5	5.0	153.5	200	PVC	SDR 35	0.40	21.1	23.86%	0.67	0.45
R15A	15	5	3.05	19	48	0	194	7.55	513	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	3.05	7.55	2.5	8.1	149.9	200	PVC	SDR 35	0.40	21.1	38.28%	0.67	0.52
G5A, R5A	5	4	3.81	51	0	0	173	82.55	3691	2.89	34.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	2.49	19.83	0.9	6.30	105.22	34.7	70.2	190.9	450	PVC	SDR 35	0.15	116.4	60.32%	0.71	0.64
R4A, I4A	4	3	3.46	48	0	0	163	86.01	3854	2.88	35.9	0.00	0.00	0.00	0.00	0.00	0.00	2.89	5.73	0.00	19.83	1.9	6.35	111.57	36.8	74.6	189.4	450	PVC	SDR 35	0.15	116.4	64.10%	0.71	0.65
R20A	20	3	1.34	16	0	0	54	1.34	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	1.34	1.34	0.4	1.1	172.4	200	PVC	SDR 35	0.40	21.1	5.13%	0.67	0.29
R19A	19	18	5.40	84	0	0	286	5.40	286	3.47	3.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	5.40	5.40	1.8	5.0	319.5	200	PVC	SDR 35	0.40	21.2	23.61%	0.67	0.45
R18A	18	17	3.43	33	28	0	188	8.83	473	3.39	5.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	3.43	8.83	2.9	8.1	146.6	200	PVC	SDR 35	0.40	21.1	38.37%	0.67	0.52
R17A	17	3	5.06	48	30	0	244	13.89	718	3.31	7.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	5.06	13.89	4.6	12.3	154.3	200	PVC	SDR 35	0.40	21.1	58.08%	0.67	0.59
R3A	3	2	0.29	4	0	0	14	101.53	4640	2.82	42.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.73	0.00	19.83	1.9	0.29	127.09	41.9	86.2	77.8	450	PVC	SDR 35	0.15	116.4	74.04%	0.71	0.68
R22A	22	21	5.30	63	0	0	214	5.30	214	3.51	2.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	5.30	5.30	1.7	4.2	366.1	200	PVC	SDR 35	0.40	21.1	19.79%	0.67	0.43
G21A, R21A	21	2	5.67	63	0	0	214	10.97	428	3.41	4.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.60	0.0	6.28	11.58	3.8	8.5	179.2	200	PVC	SDR 35	0.40	21.1	40.43%	0.67	0.54
R2A	2	1	0.48	6	0	0	20	112.97	5089	2.79	46.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.73	0.00	20.43	1.9	0.48	139.14	45.9	93.8	73.6	450	PVC	SDR 35	0.20	134.4	69.77%	0.82	0.77
R1A	1	114	0.94	11	0	0	37	113.91	5126	2.79	46.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.73	0.00	20.43	1.9	0.94	140.08	46.2	94.4	22.1	450	PVC	SDR 35	0.20	134.4	70.22%	0.82	0.78
	114	119	0.00	0	0	0	0	156.78	6143	2.73	54.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.73	0.00	20.43	1.9	0.00	182.95	60.4	116.6	119.6	450	PVC	SDR 35	0.29	162.6	71.67%	0.99	0.95
	119	120	0.00	0	0	0	0	156.78	6143	2.73	54.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.73	0.00	20.43	1.9	0.00	182.95	60.4	116.6	98.9	450	PVC	SDR 35	0.23	144.9	80.42%	0.88	0.87
Manotick Estates	120	102	36.70	97	0	0	330	193.48	6472	2.71	56.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.73	0.00	20.43	1.9	36.70	219.65	72.5	131.2	34.5	450	PVC	SDR 35	0.29	161.8	81.10%	0.99	0.98
																												450							

Appendix C : STORMWATER MANAGEMENT CALCULATIONS

C.1 Background Reports Excerpts

C.2 Conceptual Storm Sewer Design Sheet

C.3 Wilson Cowan Municipal Drain Monitoring Program Data

C.4 Wilson Cowan Municipal Drain Existing Condition Model - Calibrated

C.5 Pond 2 - PCSWMM Model Input (Mahogany Creek)

C.6 Pond 3 - PCSWMM Model Input (WCMD)

C.7 Conceptual Profile Pond 2

C.8 Conceptual Profile Pond 3

C.9 Conceptual SWM Pond Calculations

C.1 BACKGROUND REPORTS EXCERPTS

Minto Developments Inc.

MAHOGANY COMMUNITY
STORMWATER MANAGEMENT SERVICING REPORT

14167-5.2.3
DRAFT

JULY 2007

IBI
GROUP

2.0 DESIGN CONSTRAINTS AND REGULATORY REQUIREMENTS

The regulatory requirements are related to water quantity and water quality and erosion control and are discussed for each watercourse independently in the following sections. There are, however, some regulatory requirements that apply to the entire study area. Each of the four watercourses is tributary to the Rideau River and as a result, water quality control for the proposed stormwater management facilities must meet the effluent target pertaining to E.coli bacteria established by the Ontario Ministry of the Environment[6]. According to the Assessment of Discharge Criteria for Stormwater Management Facilities on the Rideau River[5], the stormwater quality control objectives for the Rideau River in the vicinity of the Village of Manotick, as determined by the Provincial Water Quality Objectives (PWQO), limit stormwater facility discharge during the recreational season (May 15–September 15) to a maximum allowable bacterial concentration of 100 counts of E.coli per dL. It should be noted that 'it is permitted to exceed this target criterion an average of four times per recreational season, the typical frequency for a 25 mm rainfall event in the Ottawa region. All new or rehabilitated stormwater facilities are required to meet this stormwater quality objective.'

According to the MDP[1], water quantity-runoff control is a desirable objective to mitigate the impact of the development on groundwater recharge. It is proposed that increases in the total runoff volume from the Mahogany Community be mitigated with BMP's. Utilizing infiltration techniques, infiltrative BMP's are proposed in the residential areas to encourage groundwater recharge rates on the site.

2.1 Unnamed Drain

The Unnamed Drain is tributary to the Rideau River and is therefore part of the Rideau River watershed. The drain is located on the east side of the study area, and outlets to Mahogany Harbour in the Rideau River, approximately 200 m downstream of the study area's northern limit. The proposed stormwater management system for the Mahogany Community includes two end-of-pipe stormwater management facilities that discharge to the Unnamed Drain.

Water Quality Control

Water quality and erosion control are required on the Unnamed Drain. With respect to suspended solids, the proposed stormwater management facilities should be designed as standard off-line facilities treating water to an Enhanced Level of Protection (80% suspended solids removal as per the MOE Stormwater Management Planning and Design Manual, March 2003). The facilities must also meet the Provincial Water Quality Objectives for bacteria concentrations.

Water Quantity Control

It was determined from studies conducted for the lower Rideau River that stormwater management facilities tributary to the Rideau River do not require water quantity-peak flow control. Since the Unnamed Drain is located in the lower reaches of the Rideau River watershed, water quantity control to pre-development levels would result in an increase of peak flows and velocities downstream during flood events. A review of the hydraulic regime confirmed that relatively fast runoff from the development, retained in a stormwater management facility, would be delayed and the urban peak flows would coincide with the peak flows in the river, causing adverse impacts downstream. It should be noted that the conclusions from these studies are drawn only upon the application of theoretical hydrologic principles and not on actual calculations.

2.2 Wilson Cowan Drain

The Wilson Cowan Drain extends from the southern limit to the northern limit of the study area. The drain and its tributary form part of the Mud Creek subwatershed. The tributary flows east of the drain and begins south of the southern study area limit and flows into the drain at the northern limit. The proposed stormwater management system for the Mahogany Community includes one end-of-pipe stormwater management facility that discharges to the Wilson Cowan Drain.

Water Quality Control

Water quality and erosion control are required on the Wilson Cowan Drain. The SDA[3] recommends that the proposed stormwater management facility be designed as a standard off-line facility treating water to an Enhanced Level of Protection (80% suspended solids removal as per the MOE Stormwater Management Planning and Design Manual, March 2003). The facilities must also meet the Provincial Water Quality Objectives for bacteria concentrations.

Water Quantity Control

Subject to model calibration, water quantity control measures will be included in the design of the proposed stormwater management facility. Post-development peak flows from the facility will meet pre-development levels.

2.3 Mud Creek

Mud Creek flows along the western limit of the study area and is part of the Rideau River watershed. The proposed stormwater management system for the Mahogany Community includes one end-of-pipe stormwater management facility that discharges to Mud Creek.

Water Quality Control

Water quality and erosion control are required on Mud Creek. The SDA[3] recommends that the proposed stormwater management facility be designed as a standard off-line facility treating water to an Enhanced Level of Protection (80% suspended solids removal as per the MOE Stormwater Management Planning and Design Manual, March 2003). The facilities must also meet the Provincial Water Quality Objectives for bacteria concentrations.

Water Quantity Control

The SDA[3] concluded that water quantity control measures are not recommended for the Mud Creek subwatershed. "It has been observed from previous studies that in such cases, quantity controls providing post to predevelopment flow attenuation for individual catchments may not be beneficial for the watershed as a whole. Such controls cause a delay in the peak of the hydrographs from these lower regions, so that they may

3.0 EXISTING CONDITIONS

The study area land use is predominantly agricultural. According to the Natural Resource Assessment[4], the study area is approximately 5% old field meadow/scrubland, 20% treed, and 75% agricultural with no buildings or structures. There are four watercourses within the study area: Mud Creek; Wilson Cowan Drain and its tributary, which are tributaries to Mud Creek; and the Unnamed Drain, tributary to the Rideau River. The Unnamed Drain does not share any links with Mud Creek and Wilson Cowan Drain.

The existing conditions flow regime was examined to help in the assessment of the development on the natural drainage system. Existing conditions watershed delineation was based on topography (Figure 2). Surface runoff from the lands drains to the Rideau River, via the Wilson Cowan Drain and the Unnamed Drain, primarily via natural swales and man made ditches.

Hydrologic analysis of the existing conditions was conducted using the hydraulic/hydrologic model XPSWMM. Runoff simulations were conducted using the 25 mm 4 hour Chicago, 2, 5 and 100 year 24 hour SCS Type II storm event. The hydrologic parameters and results of the analysis are presented in the tables below and detailed XPSWMM output is included in Appendix D. Flow point locations are included in Figure 2.

Table 1. Existing Conditions Hydrologic Parameters

Watercourse	Drainage Area ID	Drainage Area (ha)	Time to Peak (h)
Unnamed Drain	1	73.8	0.71
	2	214.0	2.70
Wilson Cowan Drain Tributary	3	23.0	0.67
	4	4.0	0.41
	5	7.9	0.30
	6	1.8	0.16
	7	9.2	0.58
Wilson Cowan Drain	8	34.8	0.85
	9	245.0	2.69

Table 2. Existing Conditions Flowrates

Watercourse (Flow Point)	Flow (cms)			
	25 mm	2 year	5 year	100 year
Unnamed Drain (A)	0.72	1.76	2.69	6.03
Wilson Cowan Drain* (B)	0.82	1.88	2.90	6.37

* at confluence with Wilson Cowan Drain Tributary

For consistency with other studies, the peak flows generated in XPSWMM were compared with a SWMHYMO simulation. The rural land use routine in SWMHYMO utilizes a combination of the Nash Unit Hydrograph Method and the SCS Rainfall Abstraction Method. Equivalent results were achieved by selecting the SCS Hydrology routine in XPSWMM. In this method, the shape of the former Nash Unit Hydrographs is emulated by the SCS Unit Hydrographs with a shape factor of 388. Results of the comparison are presented in Appendix A.

The 100 year water surface elevations for the four watercourses were evaluated in the ECR[2]. As part of the stormwater management servicing, the Wilson Cowan Drain and its tributary were re-evaluated using HEC-2. Surveyed cross-section data and flow data from the XPSWMM hydrologic analysis were used in the analysis. The 100 year water surface elevations for all four watercourses are presented in Figure 3. The results of the HEC-2 analysis for the Wilson Cowan Drain and its tributary are summarized in the below table and results for Mud Creek and the Unnamed Drain were developed for the ECR[2].

Table 3. Wilson Cowan Drain – HEC-2 100 year Water Surface Elevations

Wilson Cowan Drain Tributary		Wilson Cowan Drain	
Cross-section	**100 year WSE (m)**	**Cross-section**	**100 year WSE (m)**
1000	87.41	2000	87.41
1153	88.05	2099	87.49
1269	88.33	2204	87.58
1373	88.50	2312	87.79
1473	88.90	2406	87.94
1534	89.04	2526	88.09
1586	89.05	2585	88.18
1706	89.05	2645	88.24
1809	89.09	2741	88.37
		2846	88.49
		2953	88.60

Meander belt widths were established for each of the four watercourses. "Meander belt width is defined as the lateral containment of a channel within its valley. The meander belt width is a tool for managing risk from river erosion and for protecting the long term integrity of the watercourse as it provides a measure of the area in which river processes occur and are likely to occur in the future."[3]

Meander belt widths for the four watercourses were developed using two techniques: empirical morphological relationships and a planform analysis using 1:2000 scale topographic mapping and aerial photographs. Information about channel form was taken from the geomorphological investigation completed for the City of Ottawa ("Mud Creek Subwatershed Existing Conditions – Final Draft," Parish Geomorphic, April 2004[7]).

The established meander belt widths for the four watercourses are presented in Figure 4.

Table 4. Unnamed Drain Urban Drainage – Pond 1 Hydrologic Parameters

Drainage Area ID	Receiving MH	Drainage Area (ha)	Weighted IMP Ratio (%)	
			Total	Directly Connected
A1	1070	3.9	51	23
A2	1020	2.3	51	23
A3	1050	0.7	51	23
A4	1031	4.8	54	27
A5	1010	3.6	52	25
A6	1030	3.9	52	25
Total Area (ha) = 19.2			Weighted Imperviousness (%) = 52	

Table 5. Unnamed Drain Urban Drainage – Pond 2 Hydrologic Parameters

Drainage Area ID	Receiving MH	Drainage Area (ha)	Weighted IMP Ratio (%)	
			Total	Directly Connected
B1	2090	6.5	51	23
B2	2060	6.1	51	23
B3	2070	4.9	52	25
B4	2080	4.5	42	22
B5	2042	1.9	51	23
B6	2026	1.8	51	23
B7	2030	17.6	51	26
B8	2025	4.0	52	25
B9	2010	5.3	51	23
B10	2020	1.9	51	23
Total Area (ha) = 54.5			Weighted Imperviousness (%) = 50	

Table 6. Unnamed Drain Rural Drainage – Hydrologic Parameters

Drainage Area ID	Drainage Area (ha)	Tp (h)
2	214.0	2.70
10	7.5	0.15
Total Area (ha) = 221.5		

Table 7. Wilson Cowan Drain Urban Drainage – Pond 3 Hydrologic Parameters

Drainage Area ID	Receiving MH	Drainage Area (ha)	Weighted IMP Ratio (%)	
			Total	Directly Connected
C1	3060	4.8	51	23
C2	3050	4.1	54	43
C3	3040	7.5	51	23
C4	3010	6.3	51	23
Total Area (ha) = 22.7			Weighted Imperviousness (%) = 52	

Table 8. Wilson Cowan Drain Rural Drainage – Hydrologic Parameters

Drainage Area ID	Drainage Area (ha)	Tp (h)
7	9.2	0.58
6	1.8	0.16
11	16.2	0.60
12	3.2	0.60
9	245.0	2.69
13	3.3	0.15
14	8.3	0.15
15	2.4	0.15
Total Area (ha) = 289.4		

Table 9. Mud Creek Urban Drainage – Pond 4 Hydrologic Parameters

Drainage Area ID	Receiving MH	Drainage Area (ha)	Weighted IMP Ratio (%)	
			Total	Directly Connected
D1	4043	3.8	43	20
D2	4090	4.7	35	18
D3	4042	5.7	47	22
D4	4043	0.8	51	23
D5	4060	1.8	51	23
D6	4060	5.9	53	29
D7	4030	7.9	45	24
D8	4090	1.9	51	23
D9	4070	12.3	51	23
D10	4010	4.0	54	40
Total Area (ha) = 48.8			Weighted Imperviousness (%) = 48	

5.1.4 Overall Performance of the Stormwater Management System

The overall performance of the stormwater management system is summarized in the below tables.

Table 14. Unnamed Drain – Post-Development Flowrates

Location	Flow (cms) *(Existing Conditions)*			
	25 mm	2 year	5 year	100 year
Pond 1 Outflow	0.06	0.07	0.07	0.07
Pond 2 Outflow	0.31	0.37	0.41	0.45
Flow Point A	0.86 (0.72)	1.79 (1.76)	3.38 (2.69)	7.24 (6.03)

Table 15. Wilson Cowan Drain – Post-Development Flowrates

Location	Flow (cms) *(Existing Conditions)*			
	25 mm	2 year	5 year	100 year
Pond 3 Outflow	0.33	0.55	0.71	0.74
Flow Point B	0.80 (0.82)	1.80 (1.88)	2.75 (2.90)	6.09 (6.37)

Table 16. Mud Creek – Post-Development Flowrates

Location	Flow (cms)			
	25 mm	2 year	5 year	100 year
Pond 4 Outflow	0.79	1.29	1.70	2.01

With respect to pollutant loading, the overall impact of stormwater management facilities on Rideau River water quality was investigated by Baird and Associates in "Assessment of Discharge Criteria for Stormwater Management Facilities on the Rideau River[5]," January 2000. The report examined acceptable target discharge criteria for bacterial concentration from proposed stormwater management facilities with respect to mixing zones and bacteria die-off reaching the Rideau River. According to this study, facilities achieving treatment of 200 counts of E.coli/dL are acceptable. Consideration was given to the design of a passive stormwater management facility providing quality treatment as opposed to active disinfection.

Due to the above, it should be noted that the permanent storage was oversized, to ensure future flexibility in design. The permanent storage can be adjusted during detailed design. In addition, the extended storage was oversized to provide downstream erosion protection (refer to Section 5.4). During detailed design, water quality storage can be adjusted using either the XPSWMM or QUALHYMO model.

5.4 Erosion Control Analysis

Natural channel systems exist in a state of dynamic equilibrium where erosion and sedimentation processes work in tandem to maintain overall channel stability. Over the long term, watercourses can undergo changes in position and shape as a consequence of hydraulic forces acting on the bed and banks and related biological forces (i.e. roots, tree falls) interacting with the hydraulic forces. Channel adjustments may be slow or rapid and can result from human activity in watersheds. It is important to be able to predict the potential changes, resulting from a planned activity, to a watercourse regime.

One of the most obvious results of human influence on watercourses is accelerated rates of erosion or deposition. Disruption of the natural flow and/or sediment regimes of a system is most often the catalyst for excessive erosion or deposition as the system tries to adjust to the new conditions. Rate and type of erosion or deposition is dependent on the interrelationship between erosive and resistive forces of flow and sediment. Consideration of potential deposition is an integral part of the erosion process because excess deposition can change flow patterns which can increase shear stresses in previously stable portions of the watercourse.

Stormwater management facilities are examples of outsides perturbances which could potentially have impacts on the amount of erosion or deposition occurring within the system. The purpose of the erosion analysis for each of the four watercourses was to investigate potential changes in instream erosion potential as a result of the urbanization and to evaluate the performance of the proposed stormwater management facilities.

Although many factors influence the rate of sediment transport in a channel the basic control can be summarized by the relationship between the erosive (velocity) and the resistive (gravity and cohesion) forces of the system. The general controlling principle, however, is that when the drag force (erosive force) exerted on sediment, at a bed or back, is less than some critical value (related to resistive forces), the material remains motionless. When, however, the shear stress (which is the same as drag force) over the bed or bank attains or exceeds the critical shear stress value for the bed or bank material, particle motion begins. Critical shear stress (t_c) is intrinsic to sediment type and critical velocity in the stream.

The resistance of sediment to erosion is dependent on the nature of the sediment. For non-cohesive sediment (granular material such as sand) the ability to resist movement is dependent on the weight, size and shape and packing of the material. For cohesive material (e.g. clay) the resistance to erosion is governed more by bonding strengths (via electrostatic or van der Waal's forces) between individual soil particles. The strength of these bonds depends on soil characteristics such as: ionic charge, presence of electrolytes, mineralogy, temperature, pH, and porewater chemistry.

The banks of the four watercourses are comprised of silty clay soils. The bank material can be potentially more easily eroded than that of the bed. Resistive ability of the channel material to erosion can be used to assess potential future erodibility of the system as a result of changes in flow regime. The critical velocity was evaluated in "Mud Creek Subwatershed Existing Conditions – Final Draft," Parish Geomorphic, April 2004, in which it was concluded that the critical velocity reaches 0.7 m/s.

Erosion control analysis was conducted with the dynamic model XPSWMM with the 25 mm 4 hour Chicago storm event under existing and post-development conditions. The flow generated by this storm even is commonly considered to correspond to bankfull conditions. This approach is consistent with the MOE manual suggesting the use of this short-duration storm, regardless of land use, to evaluate erosion and water quality. The precipitation intensities were based on those set forth by the City of Ottawa Sewer Design Guidelines, November 2004. The results are presented below and the comparison hydrographs are presented in Appendix C.

Table 21. Unnamed Drain (Flow Point A) – Erosion Control Analysis

Location	Velocity (m/s)
Existing Conditions	0.54
Post-Development	0.54

Table 22. Wilson Cowan Drain (Flow Point B) – Erosion Control Analysis

Location	Velocity (m/s)
Existing Conditions	0.52
Post-Development	0.51

In order to achieve existing conditions velocities, the extended storage for Ponds 1, 2 and 3 was significantly oversized (refer to Section 5.3). The evaluation of Mud Creek's critical velocity is out of the scope of this project. Therefore, the outlet conditions were approximated based on the rationale of the other three ponds by oversizing the extended storage.

In conclusion, during the detailed design stage, the extended storage release flow rates and the size of the proposed facilities can be adjusted using a continuous shear stress modeling methodology.

The shape and the depths of the permanent pool should be selected to create transitional shallow water surfaces adjacent to the sediment forebay to disperse the main flow trajectory during treatment. These shallow water surfaces will play an important role in the ecology of the pond. The biological systems that occur naturally in shallow waters provide a breeding ground for micro-organisms and provide habitat for littoral vegetation such as cattails, bulrushes and other species. The soft, gently sloped edges of the pond will create an appealing transition to the adjacent area.

The main portion of the wet pond could resemble a manicured and landscaped urban lake with a continuous open water surface.

Water will be released from the stormwater management pond into a chamber, in which the permanent water level is controlled by the invert of the outlet pipe. The outlet structure will be provided with a sluice gate at the bottom to drain the pond during maintenance. Once in the chamber, water will rise to the permanent water level and the flow will be conveyed via an adequate flow control device to the receiving watercourse. At this conceptual level of detail, to evaluate the functionality of the facility vertical alignment, the outlet structure was simulated with the help of an equivalent pipe and weir. In other words, the specific configuration of the outlet structure must be designed during the detailed design stage.

Anticipated cross-sections are presented in Figures 8-11 and stage-storage for each facility is summarized in the below tables.

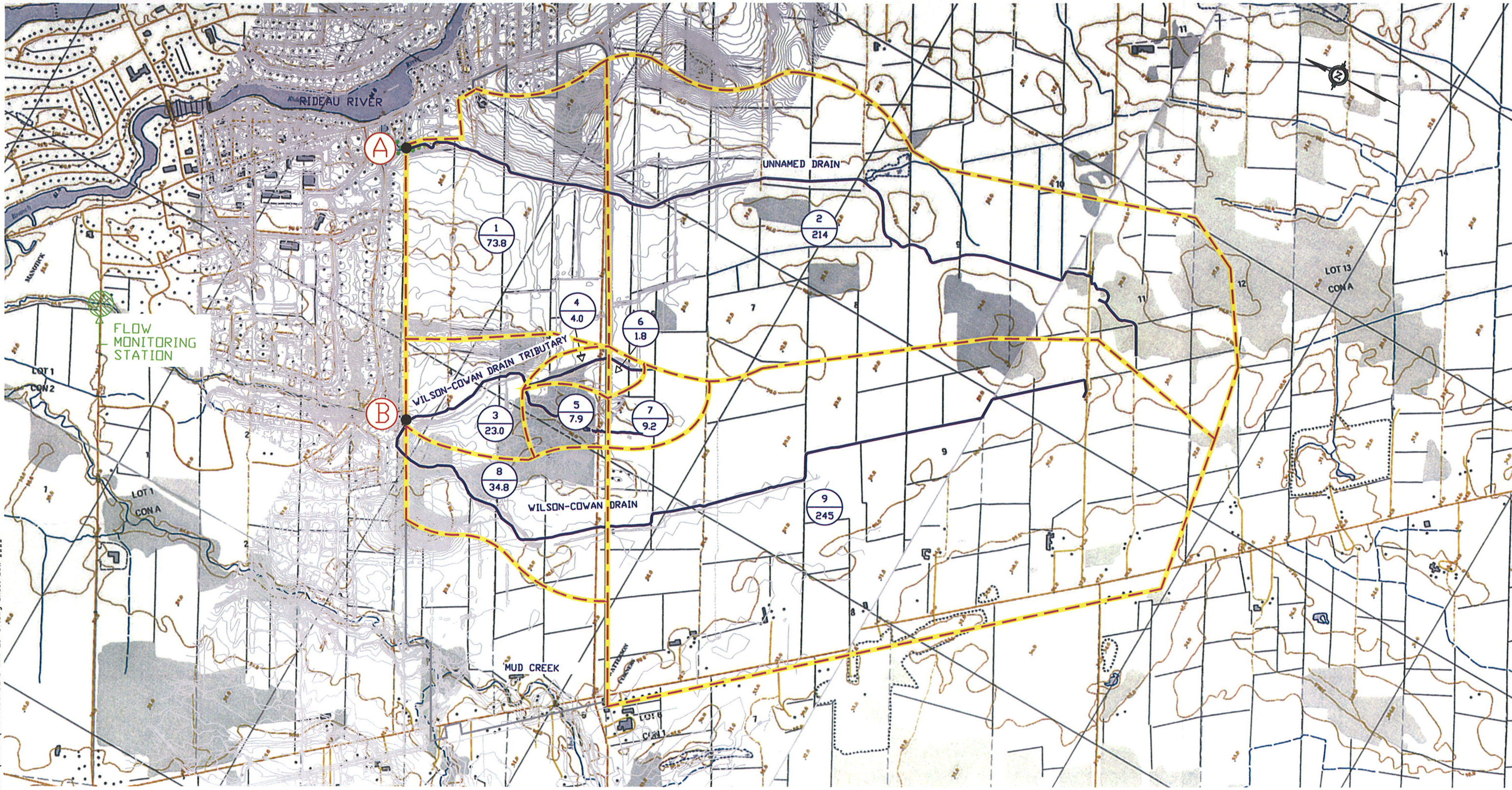
Table 24. Stage-Storage

	Permanent		25 mm		100 year	
	Water Level (m)	Storage (m^3)	Water Level (m)	Storage (m^3)	Water Level (m)	Storage (m^3)
Pond 1	86.85	3050	87.60	1475	87.90	695
Pond 2	85.50	8000	86.20	3813	86.67	2731
Pond 3	86.46	3850	86.90	1206	87.34	1755
Pond 4	85.83	6950	86.40	2480	86.89	2623

6.2 Hydraulic Grade Line Analysis

In order to determine the feasibility of the stormwater management facility in relation to the development, the hydraulic grade line (HGL) was analyzed using a dynamic model. Initial analysis indicated that the trunk system can be designed with no surcharge due to sufficient overall site gradient.

The dynamic HGL analysis for Mahogany Community was modeled using the hydraulic layer of XPSWMM and the 25 mm 4 hour Chicago and the 2, 5 and 100 year SCS Type II storms. The hydrographs created in the runoff



LEGEND

AREA ID

AREA (ha)

FLOW POINT

J:\14167\5.9 Drawings\59civil\current\MAPINGBORDERS MAY 29-07.dwg Sheet Set: ####

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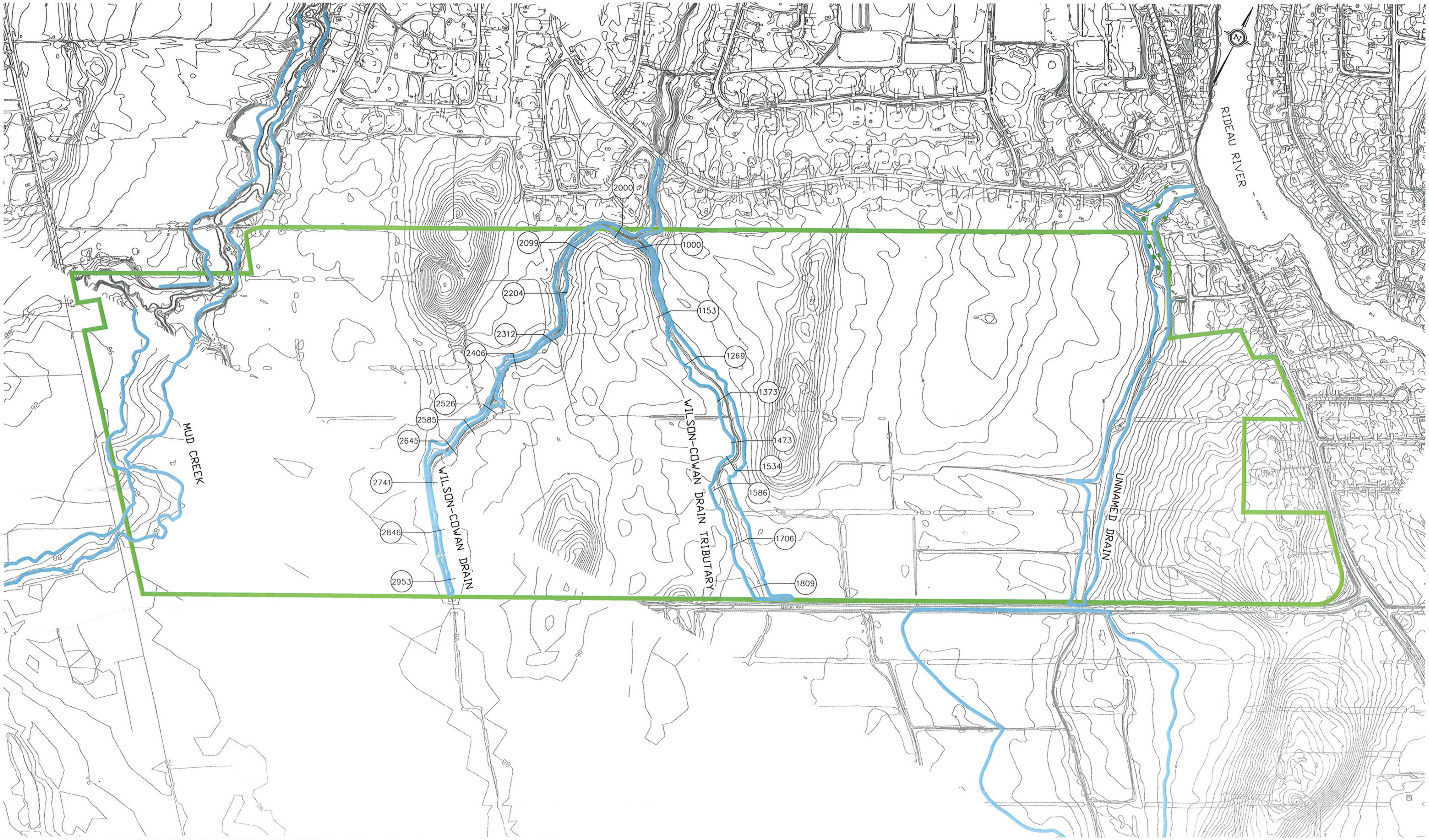

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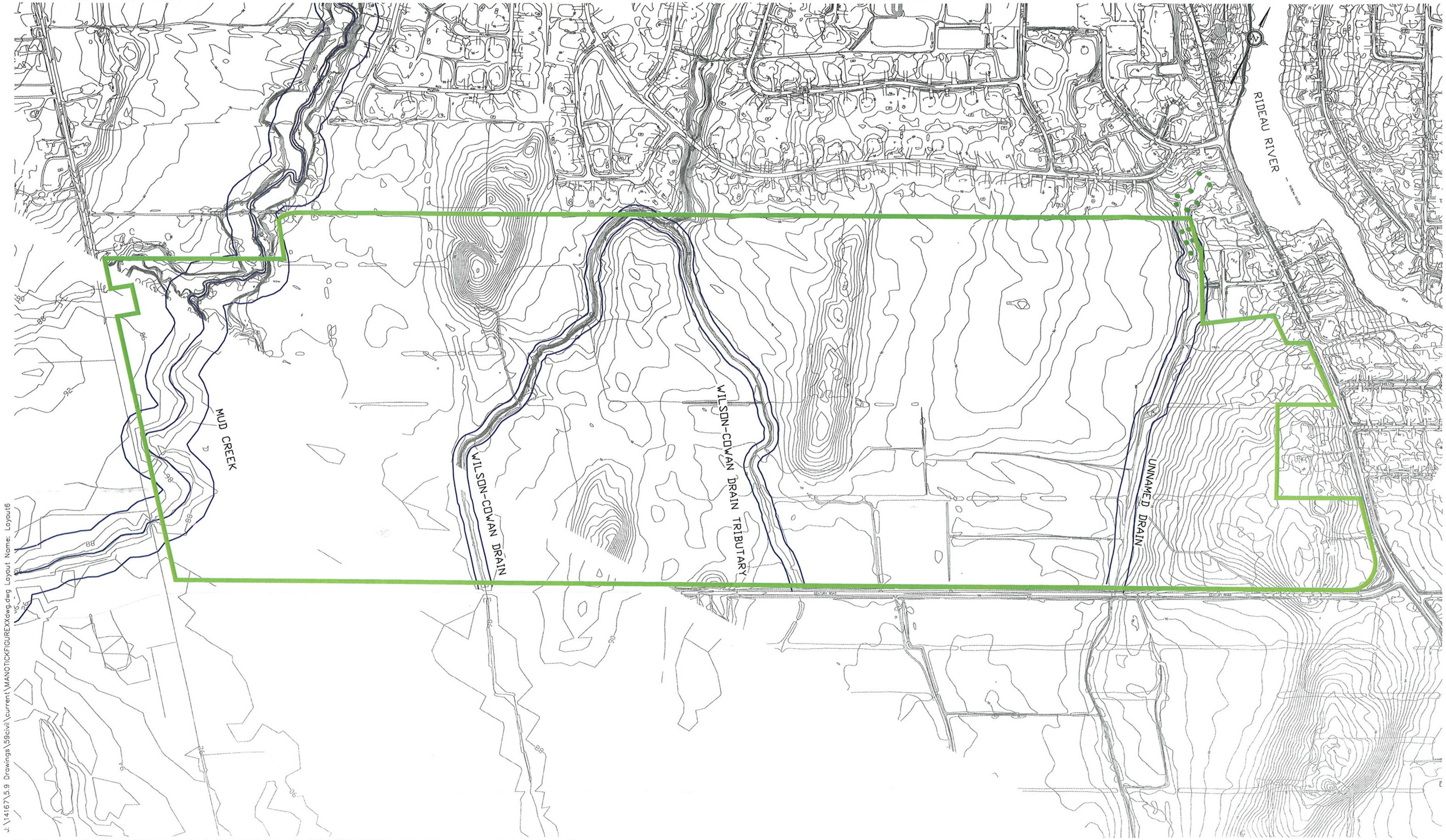

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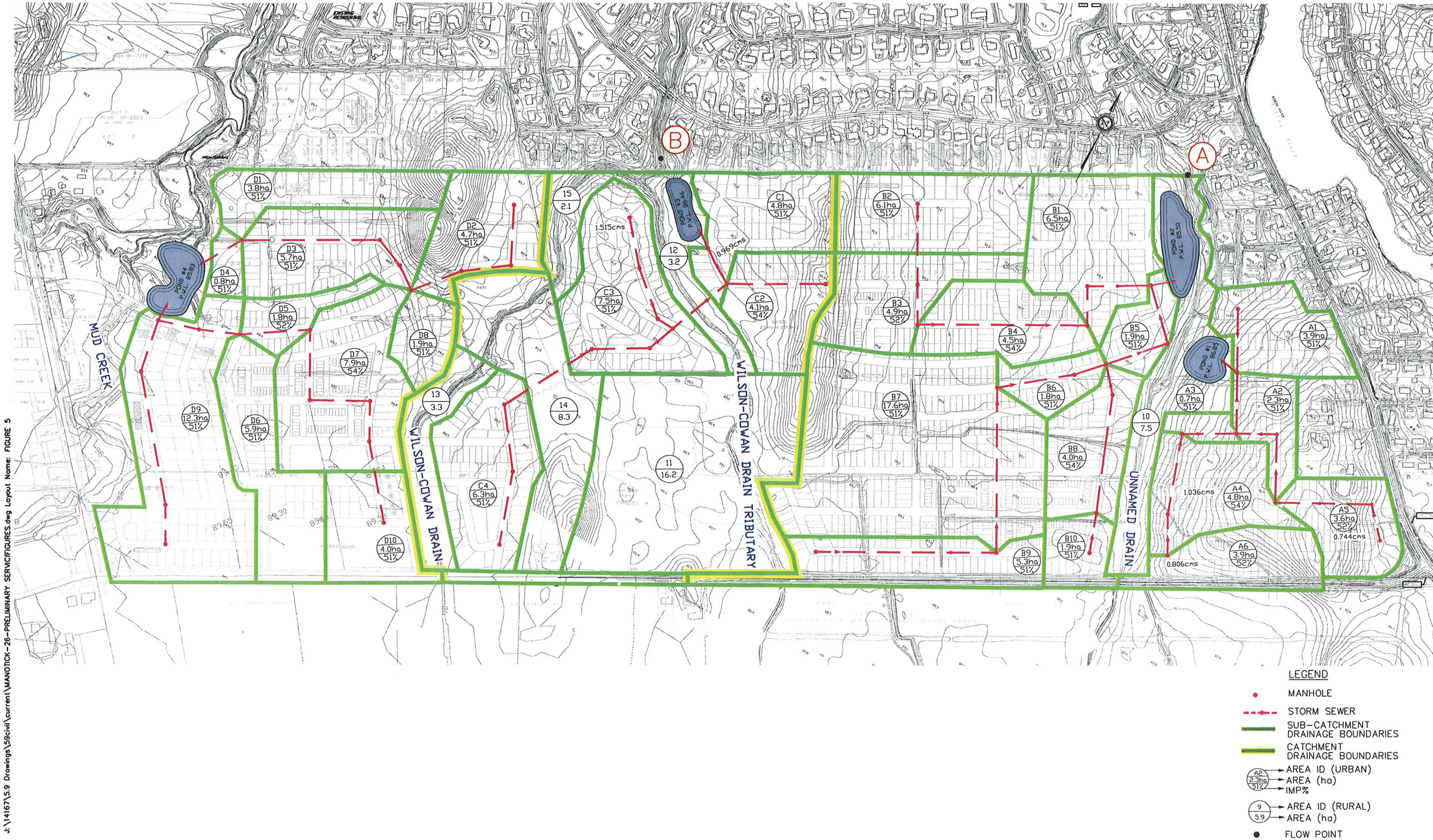
IBI GROUP	Scale	Project Title	Drawing Title	Sheet No.
	1:7500	MAHOGANY COMMUNITY	MEANDER BELT WIDTHS	FIGURE 4



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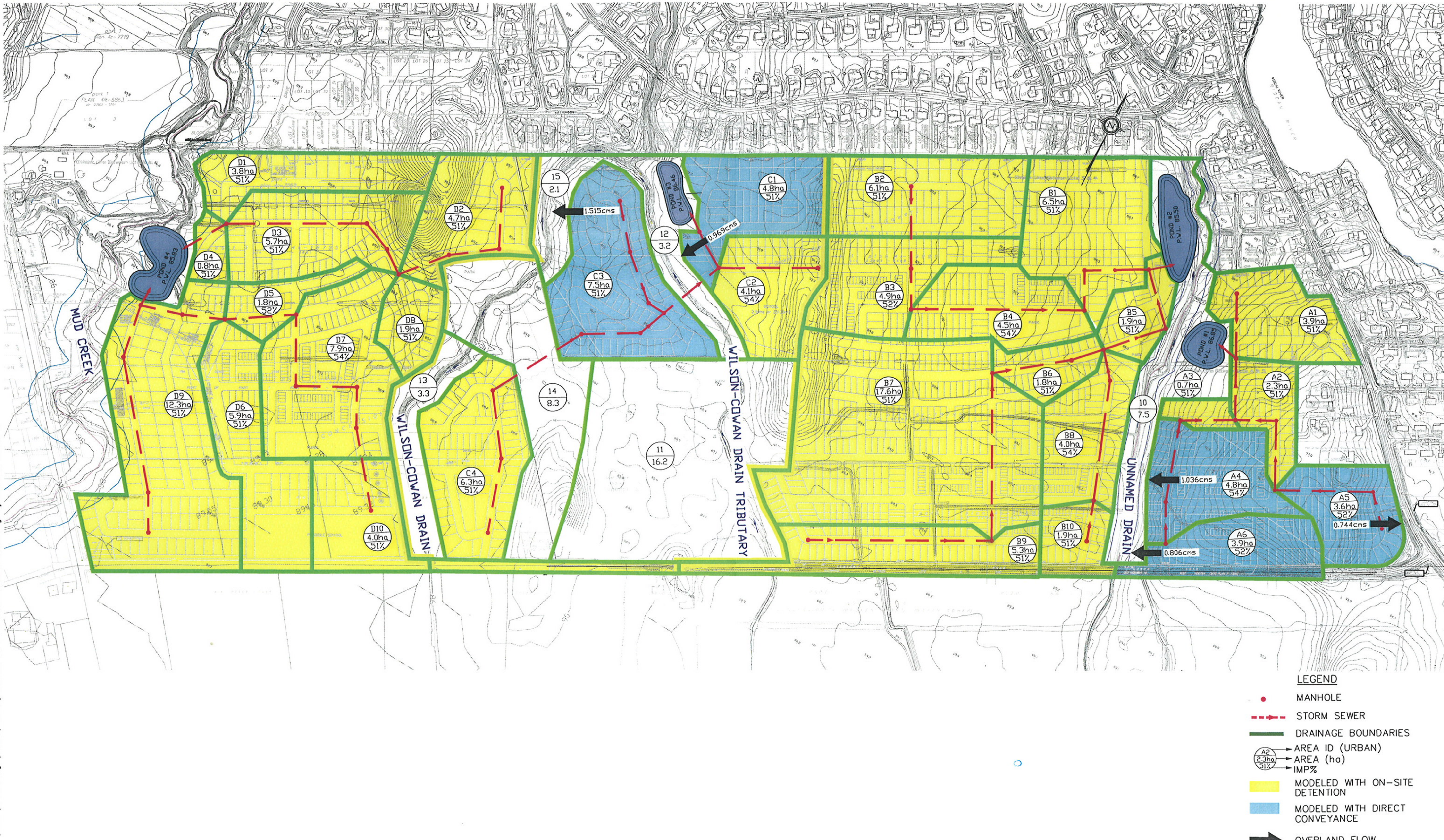
Sheet No.
FIGURE 5



J:\14167\5.9 Drawings\59civil\current\MANOTICK-26-PRELIMINARY SERVICFIGURES.dwg Layout Name: FIGURE 6

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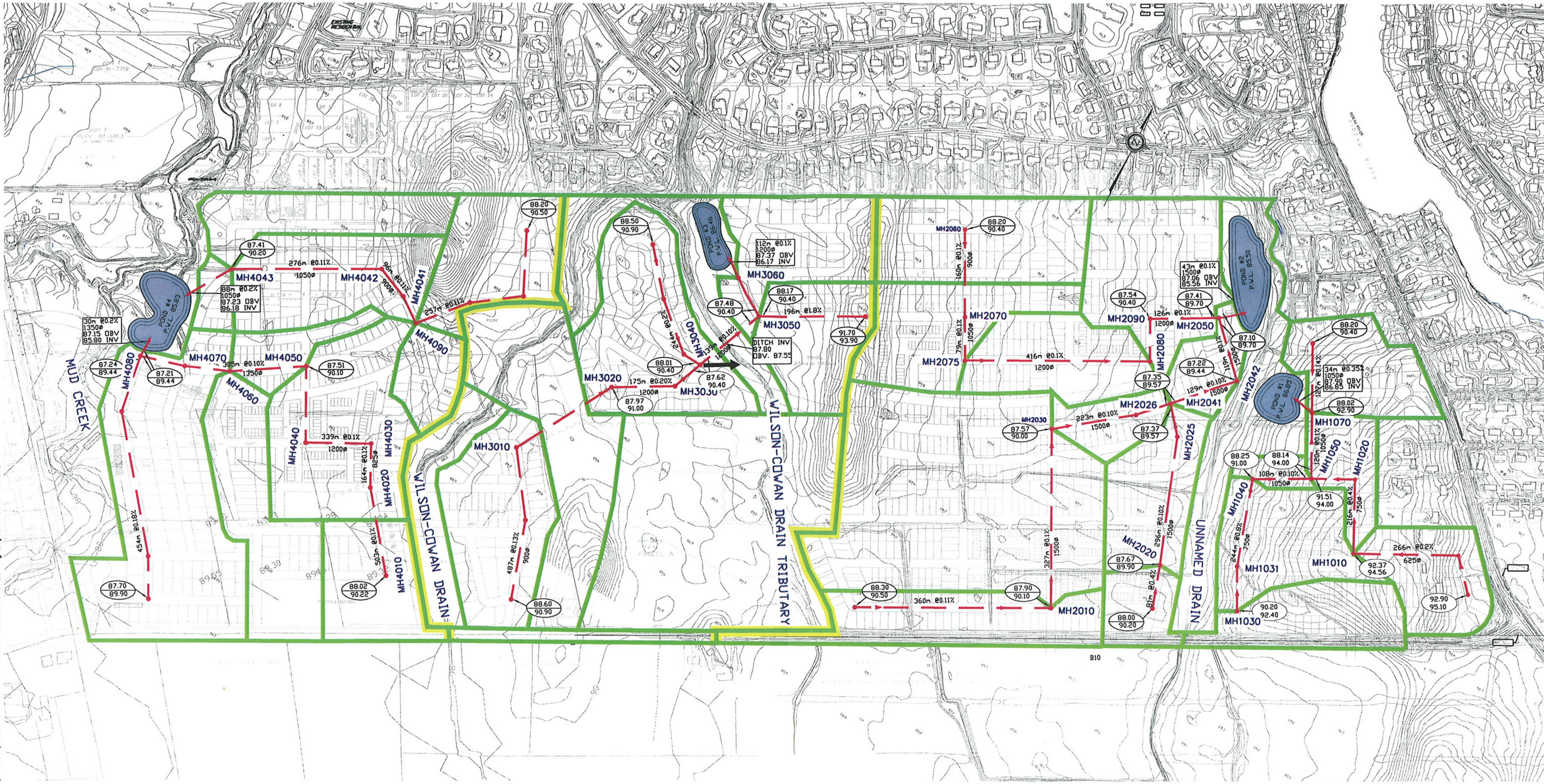
			Sheet No. FIGURE 6



NOTE: SEWER SIZES ARE INDICATED ON SIMULATED SECTIONS ONLY

LEGEND

- MANHOLE
- STORM SEWER
- SUB-CATCHMENT DRAINAGE BOUNDARIES
- CATCHMENT DRAINAGE BOUNDARIES
- MINOR SYSTEM OVERFLOW
- 88.45 → TOP OF SEWER
- 90.40 → FINISHED GRADE

J:\14167\5.9 Drawings\59civil\current\MANOTICK-26-PRELIMINARY SERVICFIGURES.dwg Layout Name: FIGURE 7

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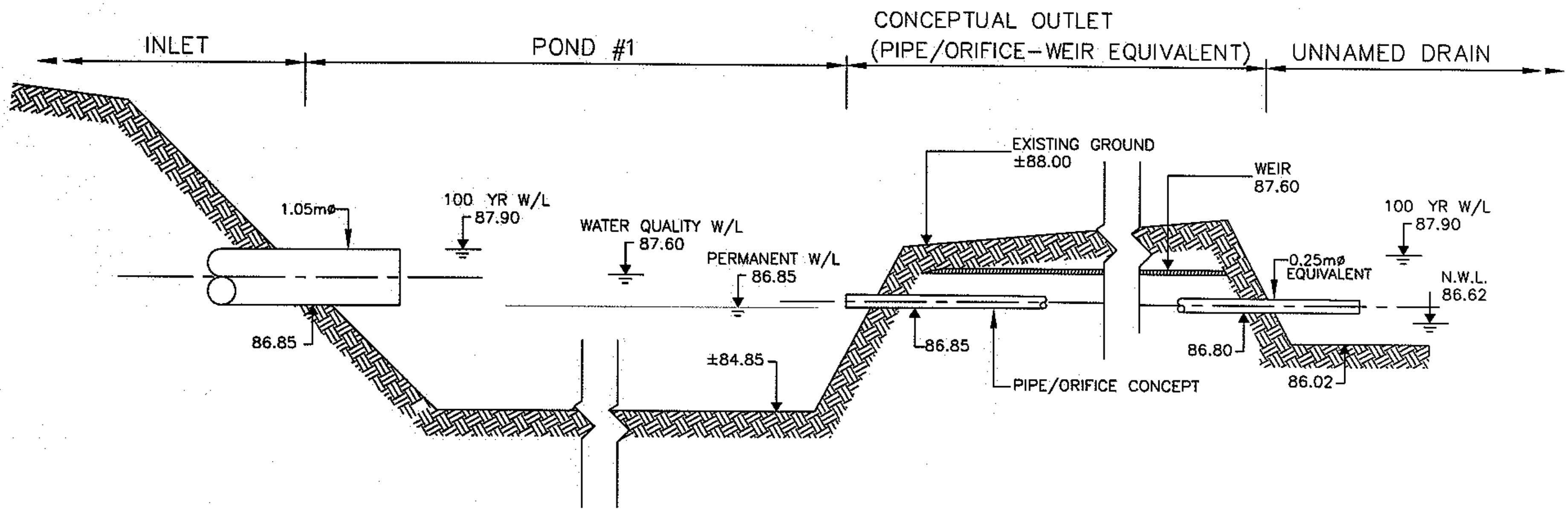

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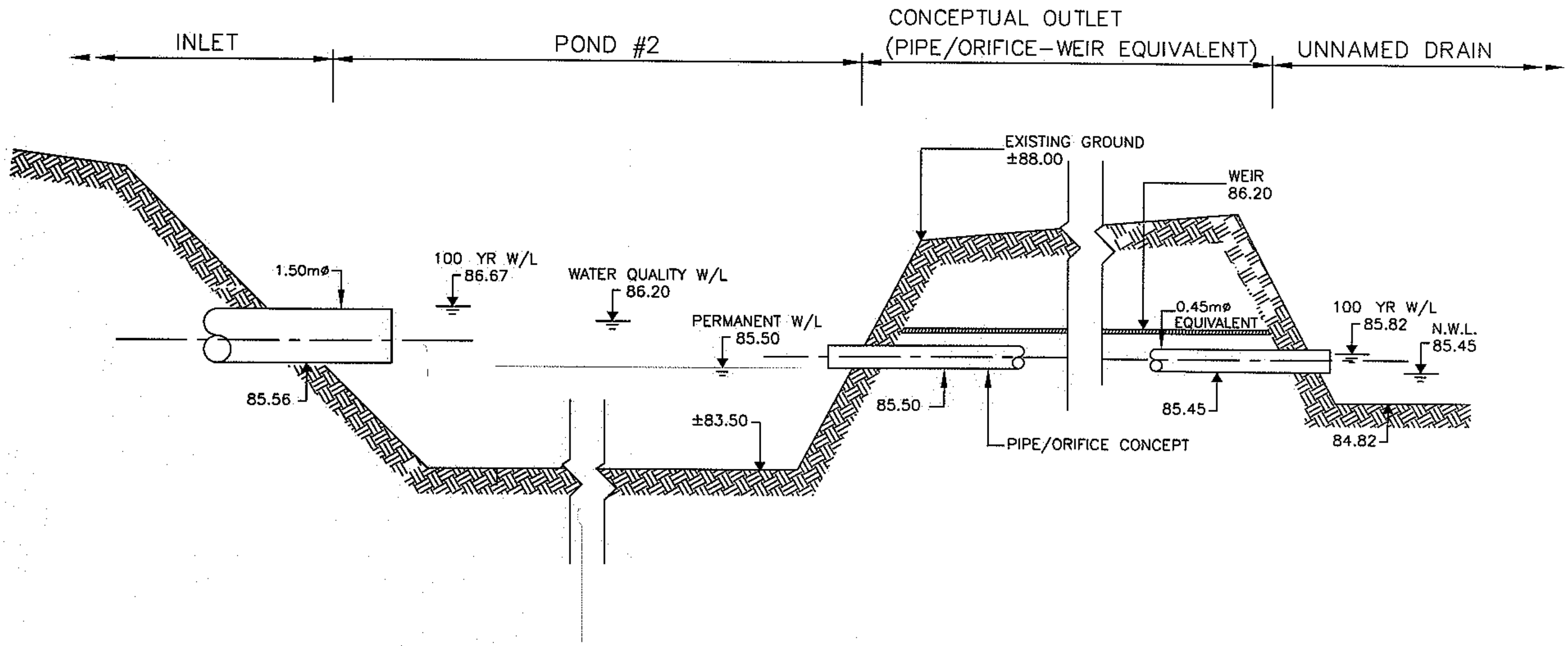
IBI GROUP

Scale	Project Title	Drawing Title	Sheet No.
N.T.S.	MAHOGANY COMMUNITY	CONCEPTUAL PROFILE POND 1	FIGURE 8



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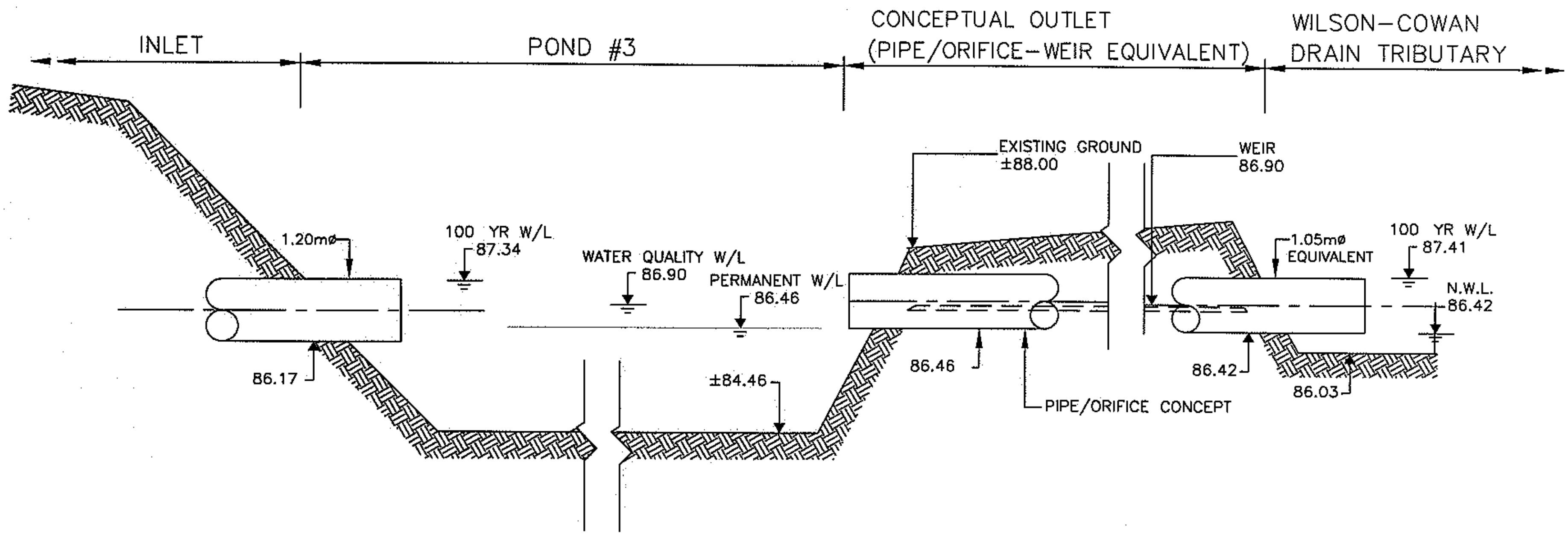
N.T.S.	MAHOGANY COMMUNITY	CONCEPTUAL PROFILE POND 2	FIGURE 9

IBI GROUP



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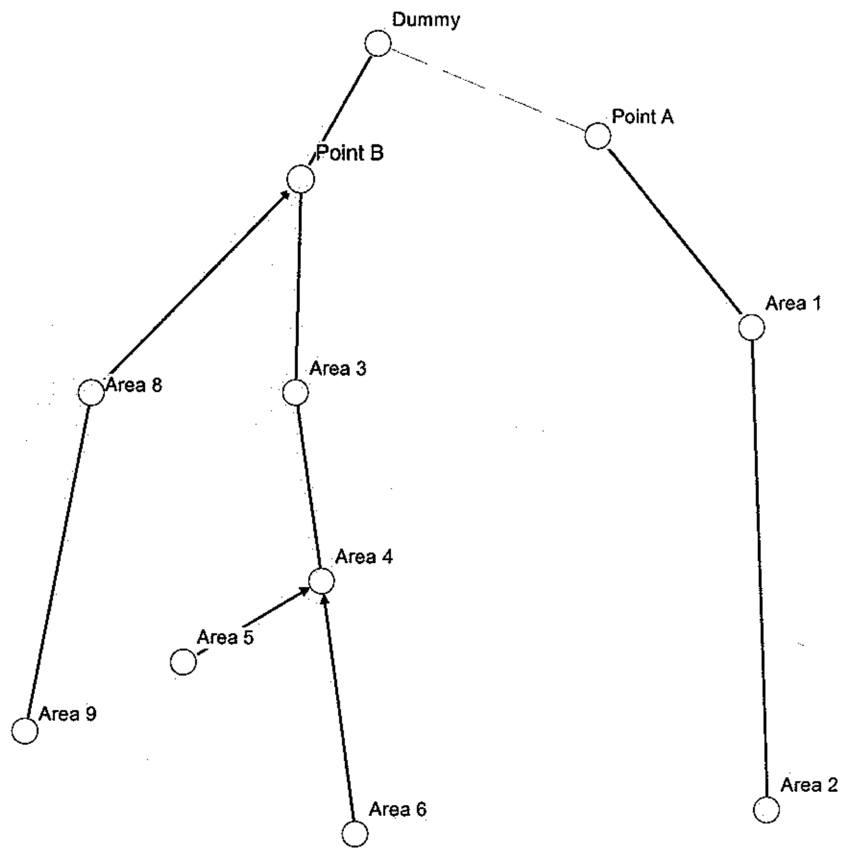
Scale	Project Title	Drawing Title	Sheet No.
N.T.S.	MAHOGANY COMMUNITY	CONCEPTUAL PROFILE POND 3	FIGURE 10

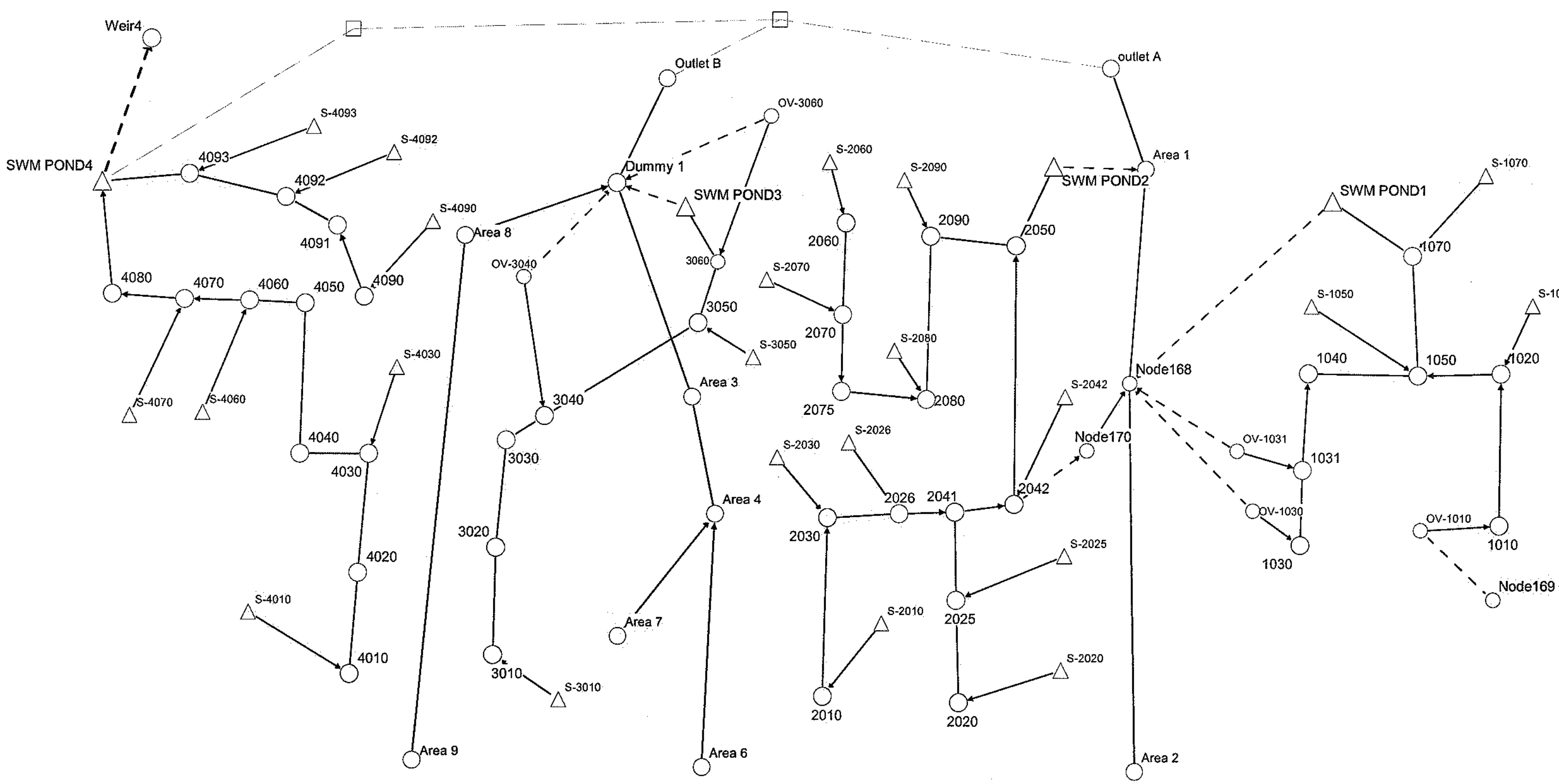
APPENDIX D
XPSWMM Output

EXISTING CONDITION XPSWMM SCHEMATIC



SWMM Version 9.12 Copyright (c) XP Software	**14167 Manotick** Licenced To: Cumming Cockburn [42-1000-1763]	07/24/07 Page 1/1

POST DEVELOPMENT XPSWMM SCHEMATIC



SWMM Version 9.12 	**3499-RS NEPEAN SOUTH** Licenced To: Cumming Cockburn [42-1000-1763]	07/24/07 Page 1/1

Minto Communities Inc.

APPENDIX 7

MAHOGANY COMMUNITY
PHASE 1
STORMWATER MANAGEMENT SERVICING

14167-5.3.1.5

MAY 2012

IBI Group
400–333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311
fax 613 225 9868

May 7, 2012

14167-5.3.1.5

Mr. Kevin Hall
City of Ottawa
110 Laurier Ave. W.
Ottawa ON K1P 1J1

Dear Mr. Hall:

MAHOGANY COMMUNITY PHASE 1
STORMWATER MANAGEMENT SERVICING

We are pleased to submit, for your review and approval, the stormwater management servicing report for the above-noted project. The report has been revised based on City comment.

This study presents the dual drainage design of Phase 1 of the Mahogany Community and comprises Appendix 7 of EXP's "Infrastructure Servicing Brief, Phase 1." The storm servicing includes water quality treatment with Vortechs® stormwater treatment units. The Vortechs® units are designed to operate off-line and do not impact the hydraulic grade line in the upstream storm sewers.

We trust this report is satisfactory. Should you have any questions, please do not hesitate to contact the undersigned.

Yours truly,

Peter Spal, P.Eng.
Associate Director

Meghan Black, P.Eng.

cc. Sue Johns, Minto Communities Inc.
Angela Jonkman, EXP

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1. INTRODUCTION

1.1 Study Objectives

Minto Communities Inc. (Minto) retained IBI Group to prepare the stormwater management servicing plan for the Mahogany Community in Manotick. The subject lands are located in a quadrant bounded by Mud Creek to the west, Manotick Main Street to the east, Century Road to the south, and Potter Drive to the north. The proposed Mahogany Community measures approximately 150 ha and is comprised of low and medium density residential development, as well as school and park areas. In 2007, IBI Group prepared the stormwater management servicing plans for the subject lands, which are presented in the "Mahogany Community Stormwater Management Servicing Report". The first phase of the Mahogany Community measures 19 ha and is located at the eastern portion of the site, east of the Unnamed Drain (refer to Figure 2).

Minto is presently proceeding with Phase 1 development. EXP was retained to complete the engineering design and IBI Group was retained to complete the stormwater management for Phase 1. This report comprises Appendix 7 of EXP's "Infrastructure Servicing Brief, Phase 1." The detailed design of the fish habitat enhancement of the Unnamed Drain will be documented in a separate study.

1.2 Synopsis of Previous Studies

The "Manotick Master Drainage Plan[1]," prepared by Robinson Consultants in 1996 addressed water quality requirements for future development. It included quantity and quality monitoring at various locations along Mud Creek, Baxter Drain, and Wilson Cowan Drain. The MDP presented hydrologic and hydraulic analyses, environmental investigations, and preliminary stormwater management recommendations.

In 2005, Marshall Macklin Monaghan & Water and Earth Science Associates prepared "Jock River Reach 2 and Mud Creek Subwatershed Study Existing Conditions Report (Draft)[2]." The ECR aims to develop integrated subwatershed plans based on ecosystem management principles that will provide guidance on how to best manage human activities that affect surface water, groundwater, and other valued resources. Phase 1 of the subwatershed study works included the collection of background information, the establishment of existing environmental conditions, and the identification of form, function and linkages of the natural system, and culminated in the ECR. Phase 2 of the works will identify a series of management plans, programs and policies to implement the recommendations of the subwatershed plan, including the completion of an Environmental Management Plan.

One component of the second phase of the subwatershed study works was completed in "Village of Manotick Environmental Management Plan Special Design Area Component[3]," Marshall Macklin Monaghan & Water and Earth Science Associates, June 2005. The SDA report provides a summary of recommendations related to environmental constraints and opportunities and stormwater management requirements applicable to the SDA lands, which are located at the southeast quadrant of First Line Road and Bankfield Road. Where appropriate, the recommendations were developed in the context of the anticipated overall Manotick EMP and subwatershed plan recommendations.

A “Natural Resource Assessment (Draft)[4]” was prepared by EcoTec Environmental Consultants Inc., June 2007. It provides information on the biophysical properties of the study area, the potential impacts that the proposed development may have on the properties and recommends mitigation/protection measures to lessen the impacts.

The “Mud Creek Subwatershed Existing Conditions – Final Draft[5],” prepared by Parish Geomorphic, April 2004, was reviewed for fluvial geomorphological data related to the study area.

Minto retained IBI Group to prepare the stormwater management servicing plan for the Mahogany Community. Based on the conclusions and recommendations of the above-mentioned studies, IBI Group prepared the "Mahogany Community Stormwater Management Servicing Report[6]" in 2007. At that time, four end-of-pipe SWM facilities were proposed to service the Mahogany Community, with the recommendation to investigate at the detail design stage the opportunity to develop a more comprehensive stormwater solution that provides environmental benefits on a broader basis.

Building on the recommendation of 2007 SWM Servicing[6], and following discussions with the Rideau Valley Conservation Authority (RVCA) and City of Ottawa, the Unnamed Drain and proposed Phase 1 development, in combination with the topographical relief of the land, provide an opportunity to construct multiple stormwater outlets along the drain, thereby enhancing the hydrological regime of the drain. Presently, the Unnamed Drain, located in an actively cultivated agricultural setting, is a poorly defined, heavily intermittent watercourse that experiences prolonged absences of base flow. The more frequent water supply to the Unnamed Drain increases the viability of overall drain enhancement with respect to net gain in fish habitat.

In January 2011, IBI prepared “Mahogany Community Phase 1 Stormwater Management and Fish Habitat Enhancement of the Unnamed Drain[7],” which provided detail on the proposed comprehensive solution of stormwater management for Phase 1 and fish habitat enhancement to the Unnamed Drain.

2. DESIGN CONSTRAINTS AND REGULATORY REQUIREMENTS

2.1 Water Quantity Control

The Unnamed Drain is the recipient watercourse of Phase 1. Downstream of the development, the Unnamed Drain flows in a northeastern direction, ultimately discharging to the Rideau River approximately 200 m downstream (refer to Figure 1).

From a broad perspective, related to the lower Rideau River SWM strategy, it was determined from studies conducted for the lower Rideau River that stormwater management facilities tributary to the watercourse do not require water quantity-peak flow control. The Unnamed Drain is located in the lower reaches of the Rideau River watershed. Therefore, water quantity control to pre-development levels could result in an increase of peak flows and velocities downstream during flood events. A review of the hydraulic regime confirmed that relatively fast runoff from the development, retained in a stormwater management facility, would be delayed and the urban peak flows could coincide with the peak flows in the river, causing adverse impacts downstream. It should be noted that the conclusions from these studies are drawn only upon the application of theoretical hydrologic principles and not on actual calculations.

The 2005 SDA[3] examined whether or not water quantity control is required for the Unnamed Drain, as well as for the other tributaries of the SDA lands. The SDA[3] identified control points in the receiving streams and evaluated pre-development flows. Analysis was conducted regarding stormwater management requirements with respect to reducing flow at control points. From that perspective, water quantity control was recommended for the Unnamed Drain to meet pre-development flow at the control point. For the other tributaries, including Mud Creek, quantity control was not considered desirable due to a net increase in flow at control points.

With respect to water quantity-runoff control, it is a desirable objective to mitigate the impact of the development on groundwater recharge according to the MDP[3]. It is proposed that increases in the total runoff volume from the Mahogany Community be mitigated with BMP’s. Utilizing infiltration techniques, infiltrative BMP’s are proposed in the residential areas to encourage groundwater recharge rates on the site.

2.2 Water Quality and Erosion Control

Water quality and erosion control are required on the Unnamed Drain. With respect to suspended solids, based on previous studies the stormwater should be treated to an Enhanced Level of Protection (80% suspended solids removal as per the MOE Stormwater Management Planning and Design Manual, March 2003).

3. HYDROLOGICAL MODELING PARAMETERS

Hydrological analysis of both existing conditions and proposed dual drainage system was conducted using SWMHYMO. This technique offers a single storm event flow generation and routing. Land use, selected modeling routines, and input parameters are discussed in the following sections. A post-development model schematic is presented in Appendix 7C and model files are included in Appendix 7D. It should be noted that hydrographs generated by the SWMHYMO model were downloaded to the XPSWMM model to evaluate the hydraulic performance of the proposed system.

3.1.1 LAND USE

The area contributing flow to the Unnamed Drain is presently rural. For existing conditions modeling simulations, it was divided into two drainage areas (refer to Figure 1). Under post-development conditions, the lands tributary to the Unnamed Drain will be predominantly developed as a mixture of low and medium density residential areas with areas designated for schools and parks. Phase 1 development was divided into drainage areas reflective of the rational method design. Future development tributary to the Unnamed Drain was divided into ten urban sub-catchments. Two rural sub-catchments representing upstream rural drainage and the Unnamed Drain corridor were included. The post-development drainage scheme is indicated in Figure 2. The detailed Phase 1 drainage areas are presented in Figure 3.

3.1.2 STORMS

Based on experience with similar types of urban watersheds, the most critical runoff estimates are those generated by the summer single event storms. There are two standard types of summer single event design storms typically used for modeling in Eastern Ontario. The first SCS Type II design storm is typically used for watersheds characterized by the rural component being significantly greater than the urban component. The second design storm, the Chicago design storm, is more critical for the modeling of fully urbanized watersheds.

Runoff simulations were performed using the 25 mm 4 hour Chicago storm (12 minute time step); 5 and 100 year 3 hour Chicago design storms (10 minute time step); the 2, 5 and 100 year 24 hour SCS Type II design storms (12 minute time step); and, the July 1 1979 historical storm (5 minute time step).

The 25 mm 4 hour Chicago storm was used to quantify the “first flush” conditions for the Vortechs® treatment units used to evaluate overall development runoff and quantify peak flows. The 5 year 3 hour Chicago design storm was used to evaluate the minor system capture in future phases of development tributary to the Unnamed Drain. The 100 year 3 hour Chicago design storm was used to evaluate the urban component of the dual drainage, specifically maximum “overland flow,” as well as the hydraulic grade line (HGL). The 24 hour SCS Type II storms were used to evaluate overall development runoff and quantify peak flows for comparison purposes in the receiving Unnamed Drain, as well as to evaluate the HGL. The July 1, 1979 historical storm was used as an analytical tool to establish the function of the system under an extreme event.

The precipitation intensities were based on those set forth by the City of Ottawa Sewer Design Guidelines, November 2004.

It should be noted that SWMHYMO was only used for the generation of runoff and routing was performed in XPSWMM.

3.1.3 DRAINAGE AREA PARAMETERS

The main hydrology parameters for existing and post-development conditions are summarized below and calculations are presented in Appendix 7A.

- **Design storms:** As discussed above, the site was evaluated using the 25 mm 4 hour Chicago storm; 5 and 100 year 3 hour Chicago design storms; the 2, 5 and 100 year 24 hour SCS Type II design storm; and, the July 1 1979 historical storm. The storms are consistent with City guidelines.
- **Minor system capture:** Minor system capture of the storm sewers throughout the drainage area is restricted to the 5 year flow, based on the revised rational method (enclosed in Appendix 7A). This is discussed in greater detail in Section 4.2. Major flow is captured by the storm sewer at two locations along Century Road.
- **Area and imperviousness:** Catchment areas and imperviousness are based on the rational method spreadsheet, completed by EXP. The conversion of runoff coefficient to imperviousness is: IMP = (c – 0.2)/0.7
- **Surface storage:** Available surface storage was accounted for in the SWMHYMO model (refer to Section 4.2 for details) and is summarized. The ponding plan, developed by EXP, is presented in Figure 4 for reference, where indicated pond volumes represent 'static' storage.
- **Infiltration:** The SCS CN method of infiltration loss was applied for existing conditions, using a CN value of 78, consistent with the approach and values used in the approved 2005 SDA[3]. The Horton method of infiltration loss was applied for post-development conditions. The values are as follows, consistent with City guidelines: f_o = 76.2 mm/h, f_c = 13.2 mm/h, k = 0.00115 s^{-1}.
- **Length:** The impervious length is based on an average of the measured length of the trunk through the catchment and the calculated length based on the SWMHYMO user's manual. The pervious length is based on an average lot depth. This approach is consistent with City of Ottawa Sewer Design Guidelines.
- **Initial Abstraction (Depression Storage):** Depression storage depths of 0.8 mm and 1.5 mm were used for impervious and pervious areas, respectively. These values are more conservative than those in the City of Ottawa Sewer Design Guidelines.
- **Manning's roughness:** Manning's roughness coefficients of 0.013 and 0.25 were used for impervious and pervious areas, respectively.
- **Slope:** A slope of 0.5% was used for impervious surfaces and a slope of 2% was used for pervious areas (lot grading).

Table 3.1 Existing conditions hydrological parameters – Rural areas

Drainage Area ID	Area (ha)	Time to Peak (h)
1	81.0	0.59
2	214.0	2.70

Table 3.2 Post-development hydrological parameters – Rural areas

Drainage Area ID	Area (ha)	Time to Peak (h)
2	214.0	2.70
10	5.23	0.15

Table 3.3 Post-development hydrological parameters – Phase 1

Vortechs® Unit	Drainage Area		Receiving MH	Impervious Ratio [Time to Peak (h)]		Length LGI (m)
	ID	Area (ha)		Timp	Ximp	
N/A	FREE5A	0.55	*Existing Pond*	[0.17]	N/A	N/A
N/A	FREE5B	0.18	*Manotick Main St Ditch via swale*	[0.17]	N/A	N/A
1	237A	0.26	237	0.46	0.46	57
1	262	0.20	262	0.33	0.33	45
1	271A	0.09	271	0.53	0.53	32
1	271B	0.17	271	0.40	0.40	68
1	267	0.37	267	0.52	0.52	61
1	287	0.31	287	0.62	0.62	53
N/A	FREE4	0.55	*Manotick Main St Ditch*	[0.17]	N/A	N/A
1	RY275	0.36	275	0.51	0.01	82
1	275	0.10	275	0.43	0.43	32
1	276	0.30	276	0.51	0.51	57
1	RY256	0.27	256	0.24	0.01	63
1	256	0.59	256	0.52	0.52	62
1	258	0.19	258	0.43	0.43	88
1	RY255	0.16	255	0.46	0.01	51
1	255	0.35	255	0.67	0.67	59
1	226	0.04	226	0.41	0.41	27
1	RY241	0.38	241	0.38	0.01	75
1	241	0.47	241	0.57	0.57	85
1	252A	0.25	252A	0.64	0.64	34
1	RY254	0.38	254	0.53	0.01	105
1	254	0.30	254	0.57	0.57	57
1	RY244	0.23	244	0.50	0.01	47
1	248	0.32	248	0.40	0.40	126
1	244	0.33	244	0.63	0.63	76
1	RY233A	0.34	233	0.51	0.01	70
1	RY233B	0.25	233	0.49	0.01	57
1	233	0.34	233	0.59	0.59	71
N/A	FREE3	0.67	*Unnamed Drain*	0.47	0.01	55
2	237B	0.25	237	0.56	0.56	61
2	RY252	0.11	252	0.47	0.01	44
2	252B	0.37	252	0.57	0.57	50
2	228	0.22	228	0.55	0.55	59
2	RY234	0.21	234	0.53	0.01	52
2	234	0.38	234	0.54	0.54	53
2	RY219A	0.03	219	0.58	0.01	14
2	RY219B	0.54	219	0.48	0.01	82

Table 3.3 Post-development hydrologic parameters – Phase 1 *(continued)*

Vortechs® Unit	Drainage Area		Receiving MH	Impervious Ratio [Time to Peak (h)]		Length LGI (m)
	ID	Area (ha)		Timp	Ximp	
2	219A	0.37	219	0.59	0.59	77
2	RY223	0.32	223	0.45	0.01	69
2	223	0.55	223	0.56	0.56	83
2	220	0.3	220	0.69	0.69	60
2	222	0.19	222	0.66	0.66	50
2	283	0.1	283	0.60	0.60	45
2	216	0.35	216	0.62	0.62	77
N/A	FREE2	0.63	*Unnamed Drain*	0.30	0.01	117
3	RY225	0.2	225	0.31	0.01	48
3	225	0.39	225	0.64	0.64	60
3	RY219C	0.73	219	[0.17]	N/A	N/A
3	219B	0.19	219	0.63	0.63	40
3	RY281	0.67	281	[0.17]	N/A	N/A
3	278	0.3	278	0.57	0.57	41
3	RY279	0.04	279	0.38	0.01	18
3	279	0.41	279	0.37	0.37	63
3	203	0.11	203	0.55	0.55	39
3	RY204	0.06	204	[0.08]	N/A	N/A
3	204	0.06	204	0.60	0.60	40
3	281	0.47	281	0.57	0.57	78
3	206	0.13	206	0.57	0.57	43
3	211	0.29	211	0.48	0.48	46
3	284	0.80	284	[0.33]	N/A	N/A
3	208	0.12	208	0.48	0.48	38
3	285	0.29	285	0.48	0.48	87
3	207	0.25	207	0.60	0.60	62
N/A	Street 7 LP	0.30	*Unnamed Drain*	0.59	0.59	92
N/A	FREE1	1.05	*Unnamed Drain*	0.43	0.01	182

Table 3.4 Post-development hydrologic parameters – Future phases tributary to the Unnamed Drain (conceptual design)

Drainage Area		Impervious Ratio		Length LGI (m)
ID	Area (ha)	Timp	Ximp	
B1	6.5	0.51	0.23	206
B2	6.1	0.51	0.23	151
B3	4.9	0.52	0.25	160
B4	4.5	0.42	0.22	256
B5	1.9	0.51	0.23	202
B6	1.8	0.51	0.23	166
B7	17.6	0.52	0.26	335
B8	4.0	0.52	0.25	230
B9	5.3	0.51	0.23	274
B10	1.9	0.51	0.23	97

4. WATER QUANTITY ANALYSIS – PEAK FLOWS

4.1 Comparison of Peak Flows

As discussed in Section 2.1, the recipient watercourse of Phase 1 is the Unnamed Drain. The control point that was considered in the evaluation of water quantity peak flow control is identified as Point A, which is located at the downstream end of the development. Point A is an arbitrarily selected location in close proximity to the Rideau River.

Point A receives flow from Phase 1 and Phase 2 development, as well as two rural areas. Water quantity control is achieved with dual drainage and on site storage on Phase 1 and 2, as well as an end-of-pipe SWM facility servicing Phase 2. Phase 1 is discretized in detail; however, Phase 2 was kept at a conceptual level, consistent with the 2007 SWM Servicing[6]. The location of the Phase 2 SWM facility has been slightly adjusted, however, remains a conceptual design.

Simulations were completed with the 25 mm 4 hour Chicago storm, and the 2, 5 and 100 year 24 hour SCS Type II storms. As noted in Section 1.1, the detailed design of the fish habitat enhancements to the Unnamed Drain will be presented in a separate study

The overall performance of the stormwater management system is summarized in the below table.

Table 4.1 Comparison of flow rates in the Unnamed Drain at Point A

Flow at Point A (cms)							
25 mm		**2 year**		**5 year**		**100 year**	
Existing	Post-Dev.	Existing	Post-Dev.	Existing	Post-Dev.	Existing	Post-Dev.
0.89	0.73	2.21	1.75	3.44	2.59	7.54	7.54

At the Point A location, during flood conditions (100 year storm event) there is no increase in flow under post-development conditions with water quantity control in place. The above comparison also indicates that in order to accomplish peak flow control, stormwater management is required. As indicated above, the stormwater management consists of a dual drainage concept, in combination with a SWM facility servicing Phase 2 lands. The following sections provide a description of stormwater management components for the site. The Unnamed Drain is not part of the stormwater management system. The proposed works to the highly degraded drain are focused on enhancing the fish habitat.

4.2 Dual Drainage Design

As discussed in Section 3.0, hydrological analysis of the proposed dual drainage system was conducted using SWMHYMO. The Phase 1 site was designed with dual drainage features, accommodating minor and major system flow.

<u>Minor system</u>
Across the majority of the site the roads are designed to accommodate on-site storage. Inlet control devices (ICDs) are proposed to control the surcharge in the minor system during infrequent storm events and maximize use of available on-site storage. The minimum minor system capture of ICDs is based on 5 year rational method flow for street segments. The dual drainage system was evaluated using the SWMHYMO hydrological model. The minor system hydraulic grade line analysis was evaluated using the XPSWMM dynamic model.

Drainage areas were considered independently, each with a 10 minute time of concentration. The 5 year flow values for each street segment are indicated on the revised rational method spreadsheet enclosed in Appendix A.

Analysis indicated that in terms of on-site detention versus cascading flow, minor system capture did not require increasing above the 5 year rational flow on the majority of street segments. Inlet control devices were sized based on the maximum 0.3 m ponding, and the ICD flow was applied as the minor system restriction in SWMHYMO. Across the majority of the site, standard Hydrovex and Ipex ICDs are proposed; however, custom ICDs are proposed at three locations. The design flow rates and number of ICDs are indicated on the revised rational method spreadsheet, enclosed in Appendix 7A. Refer to EXP submission for detailed ICD schedule. Minor system restrictions are summarized in Table 4.2.

Major flow will cascade from the eastern portion of the site downstream to the western limits of the site. Available surface storage was accounted in the SWMHYMO model and is summarized in Table 4.2. The surface storage was considered in two parts: as a 'static' storage and a 'dynamic' storage. Each storage location was examined individually. Based on the grading plan, ponding from the low point to the downstream high point (for this particular design, a depth ranging from 0.10-0.29 m) was designed as 'static' storage with the outflow-storage curve based on the minor system capture and the 'static' ponding volume. If the SWMHYMO simulation did not produce overflow, then the design of the low point was completed. If the SWMHYMO simulation indicated an overflow, the 'dynamic' routing was performed to utilize the available storage (for example, for a 'static' storage depth of 0.24 m, the corresponding 'dynamic' storage is 0.06 m). Dynamic routing was performed with a second route reservoir command.

The second outflow-storage curve was based on the normal depth of flow for the downstream street segment and available storage between the static ponding elevation (approximately 0.20 m) and max depth of 0.3 m. The outflow from this command represents the major system flow cascading to the downstream segment. Since the stage-storage curve input in SWMHYMO ranges from 0.20-0.30 m depth, any overflow from this second route reservoir would indicate that 0.3 m depth would be exceeded. Specifically for this design, minor system capture was increased at street segment 244, 233 and 234 to ensure no overflow, and therefore the depth limited to below 0.3 m. The above approach ensures that City guideline of 0.3 m ponding depth is maintained at all locations. It should be noted that if the 0.3 m of ponding was designed as the 'static' storage, then 'dynamic' storage was not available and therefore not used.

The rational method spreadsheet was completed by EXP and is enclosed in Appendix 7A for reference. The rational method design indicates that the 5 year rational flow is conveyed in the system under free flow conditions; in other words, with spare capacity.

During 100 year flow conditions, as indicated on the revised rational method spreadsheet, the total flow (for both street segments and rear yards) from the ICDs is 3744 l/s, which is approximately 218 l/s/ha on an average basis. The inflow hydrographs were exported to XPSWMM to perform dynamic routing. The revised rational method spreadsheet is enclosed in Appendix 7A for reference.

Storm sewers within future phases of development tributary to the Unnamed Drain have been sized for an inflow equivalent to the 5 year 3 hour Chicago storm event. An average value of 20 cu-m/ha was applied to the Phase 2 lands, presently at the conceptual level of design.

Table 4.2 Storage and Minor System Restriction – Phase 1

Vortechs® Unit	Drainage Area		Receiving MH	Avail. Storage (cu-m)	Minor Flow Restriction (l/s)	
	ID	Area (ha)			Rational Method Flow	ICD Flow
N/A	FREE5	0.55	*Existing Pond*	N/A	N/A	N/A
N/A	FREE5B	0.18	*Manotick Main St Ditch via swale*	N/A	N/A	N/A
1	237A	0.26	237	0	39.39	44.6
1	262	0.20	262	0	24.77	31.7
1	271A	0.09	271	0	14.95	14.95
1	271B	0.17	271	0	21.41	22.3
1	267	0.37	267	0	60.16	61.4
1	287	0.31	287	16.8	56.89	61.4
N/A	FREE4	0.55	*Manotick Main Ditch*	N/A	N/A	N/A
1	RY275	0.36	275	N/A	57.96	61.4
1	275	0.10	275	0	14.51	14.95
1	276	0.30	276	52.7	48.40	61.4
1	RY256	0.27	256	N/A	28.94	31.7
1	256	0.59	256	34.3	96.63	104.7
1	258	0.19	258	35.9 *(in Century Rd Ditch)*	275*	275.6†
1	RY255	0.16	255	N/A	24.32	31.7
1	255	0.35	255	47.8	67.52	83.7
1	226	0.04	226	0	5.66	7.0
1	RY241	0.38	241	N/A	51.21	61.4
1	241	0.47	241	0	81.36	85.9
1	252A	0.25	252A	0	46.92	61.4
1	RY254	0.38	254	N/A	62.57	83.7
1	254	0.30	254	0	51.85	61.4
1	RY244	0.23	244	N/A	36.64	41.3
1	248	0.32	248	11.0 *(in Century Rd Ditch)*	325*	325.1†
1	244	0.33	244	53.9	61.58	122.8
1	RY233A	0.34	233	N/A	54.57	61.4
1	RY233B	0.25	233	N/A	39.10	41.3
1	233	0.34	233	53.8	60.25	122.8
N/A	FREE3	0.67	*Unnamed Drain*	N/A	N/A	N/A
2	237B	0.25	237	30.9	42.87	61.4
2	RY252	0.11	252	N/A	16.92	22.3
2	252B	0.37	252	52.91	64.01	73.0
2	228	0.22	228	0	37.08	41.3
2	RY234	0.21	234	N/A	34.67	41.3
2	234	0.38	234	68.9	63.38	167.4
2	RY219A	0.03	219	N/A	5.29	7.0
2	RY219B	0.54	219	N/A	84.00	84.8†

***** *Represents total flow capture*
† *Custom ICD size required; refer to Appendix 7A and EXP submission for complete ICD schedule*

Table 4.2 Storage and Minor System Restriction – Phase 1 *(continued)*

Vortechs® Unit	Drainage Area		Receiving MH	Avail. Storage (cu-m)	Minor Flow Restriction (l/s)	
	ID	Area (ha)			Rational Method Flow	ICD Flow
2	219A	0.37	219	0	66.04	73.0
2	RY223	0.32	223	N/A	47.53	61.4
2	223	0.55	223	0	93.91	102.7
2	220	0.3	220	0	59.15	61.4
2	222	0.19	222	0	36.35	41.3
2	283	0.1	283	0	17.88	22.3
2	216	0.35	216	24.7	64.27	83.7
N/A	FREE2	0.63	*Unnamed Drain*	N/A	N/A	N/A
3	RY225	0.2	225	N/A	24.26	31.7
3	225	0.39	225	0	73.28	82.6
3	RY219C	0.73	219	N/A	44.32	61.4
3	219B	0.19	219	0	35.34	41.3
3	RY281	0.67	281	N/A	54.34	61.4
3	278	0.3	278	0	51.85	54.0
3	RY279	0.04	279	N/A	5.40	7.0
3	279	0.41	279	60.7	54.17	63.4
3	203	0.11	203	0	18.54	22.3
3	RY204	0.06	204	N/A	6.96	7.0
3	204	0.06	204	0	10.78	14.95
3	281	0.47	281	57.16	81.97	83.7
3	206	0.13	206	0	22.54	31.7
3	211	0.29	211	0	45.19	61.4
3	284	0.80	284	N/A	46.35	61.4
3	208	0.12	208	0	18.51	22.3
3	285	0.29	285	68.8	45.19	61.4
3	207	0.25	207	0	45.10	54.0
N/A	FREE1	1.05	*Unnamed Drain*	N/A	N/A	N/A
N/A	Street 7 LP	0.30	*Unnamed Drain*	64.0	53.01	61.4

***** *Represents total flow capture*

† *Custom ICD size required; refer to Appendix 7A and EXP submission for complete ICD schedule*

Table 4.3 Storage and Minor System Restriction – Future phases tributary to the Unnamed Drain (conceptual design)

Drainage Area		Est. Storage (cu-m/ha)	Minor Flow Restriction (l/s)
ID	Area (ha)		
B1	6.5	20	852
B2	6.1	20	844
B3	4.9	20	655
B4	4.5	20	484
B5	1.9	20	249
B6	1.8	20	236
B7	17.6	20	2092
B8	4.0	20	505
B9	5.3	20	658
B10	1.9	20	277

The total drainage area tributary to the Unnamed Drain is indicated on Figure 2, and the detailed Phase 1 drainage areas are included in Figure 3. Of the total Phase 1 drainage area, minor flow from 17.15 ha is conveyed to the Unnamed Drain via the storm sewer system. This includes the northern portion of Century Road, as well a portion of existing development east of Street 1. There are three storm sewer outlets to the Unnamed Drain, identified as Storm Outlet 1, 2 and 3 (refer to Figure 3).

The following areas are not connected to the storm sewer system and are considered external. They are also identified on Figure 3.

- Total flow from rear yards on Street 5 discharges to an adjacent existing pond and the roadside ditch on Manotick Main Street via a rear yard swale (Area 'Free5A' and 'Free5B', respectively).

- Total flow from the southeast corner of the site (at Century Road and Manotick Main Street) discharges to the existing roadside ditch on Manotick Main Street, and eventually to the Rideau River (Area 'Free4').

- Total flow from rear yards on Street 2 is conveyed overland to the Unnamed Drain (Area 'Free3').

- Total flow from an existing hedgerow adjacent to Street 7 is conveyed overland to the Unnamed Drain (Area 'Free2').

- Total flow from rear yards on Street 9 is conveyed overland to the Unnamed Drain (Area 'Free1').

Table 4.4 Maximum Total Flow from External Drainage Areas

Recipient	External Drainage Area	Total Flow (cms)
Existing pond and Manotick Main St. Ditch	FREE5	0.116
Existing Manotick Main St. Ditch	FREE4	0.087
Unnamed Drain	FREE3	0.188
	FREE2	0.159
	FREE1	0.260

It should be noted that the drainage area contributing flow to the existing pond measures 0.55 ha (refer to Figure 3), which represents a slight decrease from the drainage area under existing conditions (estimated at 0.6 ha). It is proposed that the landscaping buffer at the back of Lots 102, 101, 100 will act as an emergency overflow to the Manotick Main Street roadside ditch (refer to EXP Drawing 2545-GR1). Total flow from the rear yards of Lots 102, 101, 100 will also discharge to the landscaping buffer.

Overland flow from the majority of the site will be released at select discharge points directly to the Unnamed Drain. Design constraints under this scenario are the maximum quantity and depth of water conveyed on the surface segments. These design constraints become more restrictive as the generating lands become more remote from the recipient area. Overland flow from the site will be directed as follows (refer to Figure 4):

- Phase 1 development at the southeast corner of the site contributes major flow to an existing roadside ditch on Manotick Main Street. This flow will ultimately discharge to the Rideau River (Major Outlet 1).

- The existing roadside ditch on the north side of Century Road will be re-graded as part of the Phase 1 works. The high point located in the vicinity of Street 6 will be maintained and will result in major flow from the eastern-most portion of Century Road cascading east towards the existing ditch on Manotick Main Street and to the Rideau River (Major Outlet 2).

- The remainder of the site contributes overland flow to the Unnamed Drain. The major outlets are listed as follows, from south to north:

    - Generally, major flow from the southeastern portion of the site will be conveyed to the Century Road ditch, west of the high point. This flow will be picked up by the storm sewer at two locations and conveyed to the Unnamed Drain via the first storm outlet (Major Outlet 3).

    - A major flow outlet to the Unnamed Drain is located at the second storm sewer outlet, off of Street 3 (Major Outlet 4).

    - A major flow outlet to the Unnamed Drain is located off of Lane 2 (Major Outlet 5).

    - A major flow outlet to the Unnamed Drain is located off of Street 7, in the vicinity of the proposed low point. The overland flow will be conveyed by a swale from Street 7 to the drain (Major Outlet 6). Minor flow from the low point will also be conveyed to the drain via the swale. The minor flow connection is an interim measure until the Phase 2 SWM facility is constructed.

- A major flow outlet to the Unnamed Drain is located off of Street 9, represented by Block 220 between Lots 186 and 187 (Major Outlet 7).

Table 4.5 Maximum Cumulative Overland Flow at Major Storm Outlets

Recipient	Major Flow Outlet	Max. Cum. Flow (cms)	Corresponding Velocity (m/s)
Existing Manotick Main St. Ditch	1	0.229	0.4 (in ditch)
Century Road Ditch (East of high point)	2	0.040	0.8 (in ditch)
Century Road Ditch (West of high point)	3A (Total Flow)	0.275	1.2 (in ditch)
	3B (Total Flow)	0.325	0.9 (in ditch)
Unnamed Drain	4	0.472	1.3
	5	0.123	0.9
	6 (Total Flow)	0.587	N/A (to BMP)
	7	0	N/A

Simulations indicate that under post-development conditions, there is a decrease in flow to the Manotick Main Street ditch (approximately 550 l/s) in comparison to existing conditions.

The maximum resulting overland flow on subdivision streets during the 100 year 3 hour Chicago storm is presented in Table 4.6. The overland flow was evaluated at downstream locations, based on proposed grades. Using the channel routing routine in SWMHYMO, maximum normal depth and velocity of flow have been quantified and results are summarized below.

Table 4.6 Maximum Cumulative Overland Flow on Phase 1 streets

Recipient	Major Flow Outlet	Location	Max. Cum. Flow (cms)	Depth (m)	Velocity (m/s)	d x v (m^2/s)
Existing Manotick Main St. Ditch	1	Lane 1 (NW)	0.229	0.07	1.4	0.10
		Lane 1 (SE)		0.07	1.1	0.10
Century Road Ditch	3A	Street 4 (NW)	0.346	0.08	1.4	0.12
		Street 4 (NE)		0.09	1.4	0.12
	3B	Street 1	0.275	0.08	1.4	0.11
Street 3	4	Street 2	0.186	0.08	0.8	0.07
Street 3	4	Street 3 (NE of Street 2)	0.151	0.06	1.2	0.07
Unnamed Drain	4	Street 3 (SE)	0.472	0.20	1.7	0.34
	4	Street 3 (NW)		0.12	1.0	0.11
	5	Lane 2 (NE)	0.123	0.06	0.9	0.06
	6	Street 7	0.526	0.10	1.6	0.15
	7	Block 220	0	N/A	N/A	N/A

It should be noted that at each location, the d x v product is less than the maximum allowable product of 0.6 per City of Ottawa Sewer Design Guidelines.

4.3 Hydraulic Grade Line Analysis

The evaluation of the hydraulic grade line, as well as of flood levels in the Unnamed Drain, was completed using XPSWMM. The XPSWMM model represents the complete storm system: the Unnamed Drain, Phase 1 storm sewers, and Phase 2 SWM facility. The detailed design of the fish habitat enhancements to the Unnamed Drain will be presented in a separate study, however, the hydraulics of the drain were used as the starting water levels for the storm sewer system. The boundary condition at Point A was based on a tailwater developed using Rideau River water surface elevations for the 2, 5 and 100 year events (provided by RVCA). Point A is located within the Rideau River flood plain and therefore modeling of the Unnamed Drain between Point A and the Rideau River is not required. Cross-sections of the proposed fish habitat enhancements to the drain are included below and have been approved by the RVCA. A profile of the Unnamed Drain is provided on Drawings 702-704, which indicates the 100 year water surface elevations.

Minor system losses were accounted for in accordance with Appendix 6-B of the City of Ottawa Sewer Design Guidelines (November 2004). Losses at Vortechs® units were customized to reflect the design of the units.

XPSWMM simulations were conducted for the 25 mm 4 hour Chicago storm; 2, 5 and 100 year 24 hour SCS Type II storms; the 100 year 3 hour Chicago storm; and, the July 1, 1979 storm. Pipe data is summarized in the below table, along with HGL values for the 100 year 24 hour SCS Type II, 100 year 3 hour Chicago and July 1 1979 storms. A comparison of under-side of footing (USF) elevations and HGL is also included. XPSWMM model files are provided in Appendix 7D.

Table 4.7 Storm pipe data and HGL

MH	USF (m)	Inv. (m)	U/S Pipe Data			100 year 24 hour SCS Type II			100 year 3 hour Chicago			July 1 1979		
			Length (m)	Dia. (mm)	Slope (%)	HGL (m)	Sur-charge (m)	USF – HGL (m)	HGL (m)	Sur-charge (m)	USF – HGL (m)	HGL (m)	Sur-charge (m)	USF – HGL (m)
UD at #1	N/A	N/A	N/A	N/A	N/A	87.99	N/A	N/A	87.94	N/A	N/A	88.02	N/A	N/A
288	N/A	87.47	18.2	1050	0.11	88.52	0	N/A	88.46	0	N/A	88.49	0	N/A
249	N/A	87.62	57.1	900	0.51	88.74	0.22	N/A	88.67	0.15	N/A	88.71	0.19	N/A
248	N/A	88.06 (NE)	81.1	750	1.01	89.08	0.27	N/A	88.94	0.13	N/A	89.01	0.20	N/A
		87.97 (NW)	17.6	600	0.51									
245	90.3	88.33 (NW)	108.3	450	0.36	89.26	0.48	1.04	89.12	0.34	1.181	89.19	0.41	1.11
		88.33 (NE)	81	450	1.22									
233	89.9	88.87	52	300	0.4	89.60	0.43	0.30	89.51	0.34	0.39	89.54	0.37	0.36
234	89.95	89.08	-	-	-	89.39	0.01	0.56	89.34	0	0.61	89.31	0	0.64
244	91.1	89.4	96.1	375	1.18	90.41	0.63	0.69	90.21	0.43	0.894	90.34	0.56	0.77
254	92.2	90.6	32.3	300	1.46	91.48	0.58	0.72	91.18	0.28	1.024	91.43	0.53	0.78
252	92.6	91.07	-	-	-	92.17	0	0.43	91.80	0	0.797	92.14	0	0.46
243	N/A	88.95	77.9	750	0.35	89.55	0	N/A	89.44	0	N/A	89.49	0	N/A

Table 4.7 Storm pipe data and HGL *(continued)*

MH	USF (m)	Inv. (m)	U/S Pipe Data			100 year 24 hour SCS Type II			100 year 3 hour Chicago			July 1 1979		
			Length (m)	Dia. (mm)	Slope (%)	HGL (m)	Sur-charge (m)	USF – HGL (m)	HGL (m)	Sur-charge (m)	USF – HGL (m)	HGL (m)	Sur-charge (m)	USF – HGL (m)
242	N/A	89.3 (NE)	86.5	675	0.31	89.85	0	N/A	89.75	0	N/A	89.76	0	N/A
		89.6 (NW)	93.6	375	2.49									
241	93.45	91.93	24.3	375	2.39	92.25	0	1.20	92.25	0	1.20	92.25	0	1.20
240	93.45	92.52 (E)	79.8	375	0.46	92.70	0	0.75	92.70	0	0.75	92.70	0	0.75
		92.64 (N)	78.5	250	2.08									
226	94.85	94.10	108.6	250	1.35	94.15	0	0.70	94.15	0	0.70	94.15	0	0.70
237	96.2	96.2	-	-	-	95.68	0	0.52	95.68	0	0.52	95.67	0	0.53
255	94.15	93.02	12.8	250	0.94	93.09	0	1.07	93.09	0	1.06	93.09	0	1.07
256	94.15	93.14	-	-	-	92.87	0	1.28	92.87	0	1.28	92.87	0	1.28
258	N/A	89.68	17.1	675	0.23	90.28	0	N/A	90.24	0	N/A	90.27	0	N/A
257	N/A	89.72 (NE)	81	675	0.19	90.51	0	2.39	90.47	0	2.44	90.50	0	2.40
		91.48 (W)	61.1	300	1.83									
273	93.9	90.09 (NE)	47.2	450	0.34	90.78	0.24	3.12	90.72	0.18	3.18	90.78	0.24	3.12
		90.09 (NW)	35.9	450	1.09									
276	93.9	90.53	40.1	450	0.5	91.08	0.10	2.82	90.99	0.01	2.91	91.08	0.10	2.82
275	94.52	90.88	35.1	300	0.71	91.26	0.08	3.26	91.16	0	3.36	91.26	0.08	3.26
259	94.36	91.18 (N)	44.9	250	0.51	91.79	0.36	2.57	91.69	0.25	2.68	91.80	0.37	2.56
		94.1 (W)	73.1	250	1.4									
260	93.22	91.46	50.4	250	0.62	91.92	0.21	1.30	91.81	0.10	1.41	91.93	0.22	1.29
262	92.4	91.77	-	-	-	92.06	0.04	0.34	91.96	0.00	0.44	92.07	0.05	0.33
271	94.2	90.32	35.9	375	0.67	90.94	0.25	3.26	90.87	0.18	3.33	90.95	0.25	3.25
270	93.94	90.60	23.9	375	0.71	91.14	0.16	2.80	91.06	0.09	2.88	91.15	0.17	2.79
268	93.24	90.82	35.8	375	0.75	91.25	0.06	1.99	91.17	0	2.07	91.27	0.07	1.97
267	93.24	91.14	39.6	375	0.61	91.41	0	1.83	91.36	0	1.88	91.42	0	1.82
266	92.64	91.46	29.4	300	0.75	91.57	0	1.07	91.57	0	1.07	91.58	0	1.06
287	93.08	91.68	-	-	-	91.89	0	1.19	91.89	0	1.19	91.89	0	1.19
UD at #2	N/A	N/A	N/A	N/A	N/A	87.50	N/A	N/A	87.42	N/A	N/A	87.56	N/A	N/A
232	N/A	87.00	3.9	900	0.26	87.83	0	N/A	87.81	0	N/A	87.81	0	N/A
232 A	N/A	87.09 (N)	4	825	0.25	88.10	0.19	N/A	88.06	0.15	N/A	88.07	0.16	N/A
		87.16 (SE)	6.2	675	0.16									
217 A	89.4	87.22	13	675	0.23	88.14	0.24	1.27	88.10	0.20	1.30	88.10	0.20	1.30
230	89.4	87.87	24.2	450	2.11	88.17	0	1.23	88.13	0	1.27	88.13	0	1.28

Table 4.7 Storm pipe data and HGL *(continued)*

MH	USF (m)	Inv. (m)	U/S Pipe Data			100 year 24 hour SCS Type II			100 year 3 hour Chicago			July 1 1979		
			Length (m)	Dia. (mm)	Slope (%)	HGL (m)	Sur-charge (m)	USF – HGL (m)	HGL (m)	Sur-charge (m)	USF – HGL (m)	HGL (m)	Sur-charge (m)	USF – HGL (m)
229	89.4	88.45 (NE)	86.4	375	3.07	88.77	0.01	0.63	88.76	0	0.64	88.74	0	0.66
		88.38 (SE)	54.9	375	1									
228	92.25	91.1	23.3	375	2.58	91.23	0	1.02	91.23	0	1.03	91.23	0	1.02
227	92.25	91.88 (E)	78.5	250	2.76	91.80	0	0.45	91.79	0	0.46	91.79	0	0.46
		91.76 (S)	82.9	375	0.4									
217	89.4	87.21	66.3	675	0.38	88.14	0.26	1.26	88.10	0.21	1.30	88.11	0.22	1.29
216	89.1	87.68	10	450	0.9	88.50	0.37	0.60	88.43	0.30	0.67	88.47	0.34	0.63
282	89.1	87.82	85	450	1.64	88.66	0.39	0.44	88.57	0.30	0.53	88.62	0.35	0.48
223	90.6	89.28	119.5	375	2.17	89.57	0	1.03	89.54	0	1.06	89.57	0	1.03
283	89.32	88.17	78.7	375	0.99	88.78	0.23	0.54	88.68	0.14	0.64	88.76	0.21	0.56
222	90.15	89.08	119.3	250	1.28	89.44	0.11	0.71	89.27	0	0.88	89.40	0.07	0.75
UD at #3	N/A	N/A	N/A	N/A	N/A	86.86	N/A	N/A	86.78	N/A	N/A	86.91	N/A	N/A
213	N/A	86.5	10.2	900	0.19	87.40	0.004	N/A	87.37	0	N/A	87.41	0.01	N/A
214	N/A	86.52	85.6	900	0.39	87.71	0.28	N/A	87.64	0.22	N/A	87.71	0.29	N/A
207	89.05	87.16 (NW)	38	450	2.39	87.95	0.20	1.10	87.85	0.10	1.20	87.96	0.21	1.09
		87.3 (NE)	53.1	600	0.17									
208	88.75	87.35	46.4	525	0.22	88.03	0.15	0.72	87.91	0.03	0.84	88.04	0.16	0.71
284	88.55	87.46	12.4	525	0.32	88.11	0.14	0.44	87.98	0.01	0.57	88.13	0.16	0.42
212	88.55	87.59	13.8	450	0.22	88.12	0.08	0.43	87.99	0	0.56	88.14	0.10	0.41
285	88.6	87.82	68.8	250	1.24	88.15	0.08	0.45	88.01	0	0.59	88.17	0.10	0.43
211	89.6	88.7	22.6	250	3.1	88.88	0	0.72	88.86	0	0.74	88.88	0	0.72
210	89.6	89.4	-	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
206	N/A	88.24	37.4	450	2.14	88.61	0	N/A	88.55	0	N/A	88.61	0	N/A
205	91.7	89.18 (NE)	27	375	0.85	89.41	0	2.29	89.40	0	2.30	89.41	0	2.29
		89.1 (SE)	34.5	450	1.28									
281	91.7	89.61	57	375	1.54	90.23	0.25	1.47	90.22	0.23	1.49	90.23	0.24	1.47
220	91.52	90.61	39.8	375	3.14	91.08	0.10	0.44	91.04	0.05	0.48	91.08	0.09	0.44
219	92.44	91.87	89.4	300	2.19	92.05	0	0.39	92.05	0	0.39	92.05	0	0.39
225	94.75	93.78	-	-	-	93.98	0	0.77	93.98	0	0.77	93.98	0	0.77
204	91.65	89.44	44.8	375	0.76	89.74	0	1.92	89.73	0	1.92	89.74	0	1.92
203	91.35	89.86 (E)	44.4	300	1.67	90.11	0	1.24	90.11	0	1.24	90.11	0	1.24
		89.91 (NE)	45.9	250	1.66									
279	91.95	90.65	38.2	250	0.99	90.93	0.03	1.02	90.93	0.03	1.02	90.93	0.028	1.02
278	92.3	91.06	27.9	250	1.11	91.24	0	1.06	91.24	0	1.06	91.24	0.00	1.06
277	92.32	91.37	-	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
202	91.85	90.67	-	-	-	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

The minimum 0.3 m clearance between the USF and HGL is maintained across the Phase 1 site during the three storm events.

The proposed fish habitat enhancements to the Unnamed Drain previously approved by the RVCA were presented in the 2011 Unnamed Drain Report[7]. A summary of the cross-sections is presented below. The stationing has been updated to reflect the minor revisions to storm outlet locations. It should be noted that the flow and average depth were evaluated with XPSWMM and velocity was evaluated manually using the continuity equation (calculations included in Appendix A).

To STA 0+472

The drain will be enhanced with a meandering low flow channel and adjacent shallow pool/wetland areas. The channel at this location will receive flow from the upstream rural area as well as the first and second outlets. The area representing the Unnamed Drain corridor was also accounted for at this location. The typical cross-section is indicated in Chart 4.1 below. The results indicate that the maximum flow is 4.87 cms and the corresponding velocity and depth are 0.30 m/s and 1.12 m, respectively. The 100 year water levels are confined within the channel.

Chart 4.1 Typical Cross-section

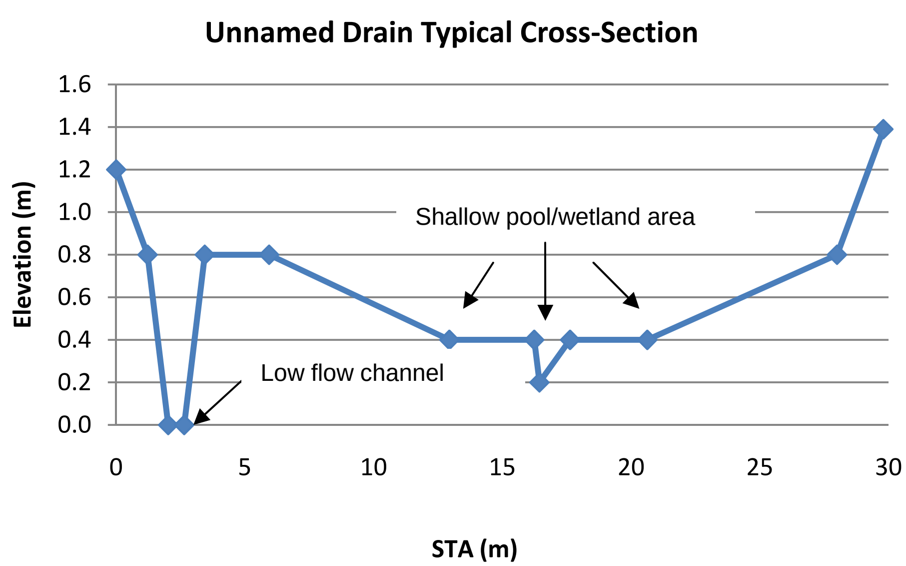

Table 4.8 To STA 0+472: Summary of hydraulic performance

	Bankfull 25 mm 4 hour Chicago Storm	Maximum 100 year 24 hour SCS Type II Storm
Flow (cms)	0.64	4.87
Velocity (m/s)	0.33	0.30
Average water depth (m)	0.52	1.12

From STA 0+472 to STA 0+550

This section of the Unnamed Drain extends to just upstream of the third storm outlet. It includes the culvert at Street 7 (refer to Drawing 713) and the typical cross-section of the drain is indicated in Chart 4.1 above. The results indicate that the maximum flow is 4.91 cms and the corresponding velocity and depth are 0.63 m/s and 0.82 m, respectively. The 100 year water levels are confined within the channel.

Table 4.9 From STA 0+472 to STA 0+550: Summary of hydraulic performance

	Bankfull	Maximum
	25 mm 4 hour Chicago Storm	100 year 24 hour SCS Type II Storm
Flow (cms)	0.64	4.91
Velocity (m/s)	1.37	0.63
Average water depth (m)	0.37	0.82

From STA 0+550 to 0+800 (end of proposed works)

At this location the channel will receive additional flow from the third outlet, and Muskellunge spawning and refuge habitat areas are proposed. The typical cross-section for the spawning and refuge habitat areas is indicated in Chart 4.2 below. The results indicate that the maximum flow is 4.94 cms and the corresponding velocity and depth are 0.80 m/s and 0.95 m, respectively. The 100 year water levels are confined within the channel.

Chart 4.2 Muskellunge Spawning and Refuge Habitat Area Typical Cross-section

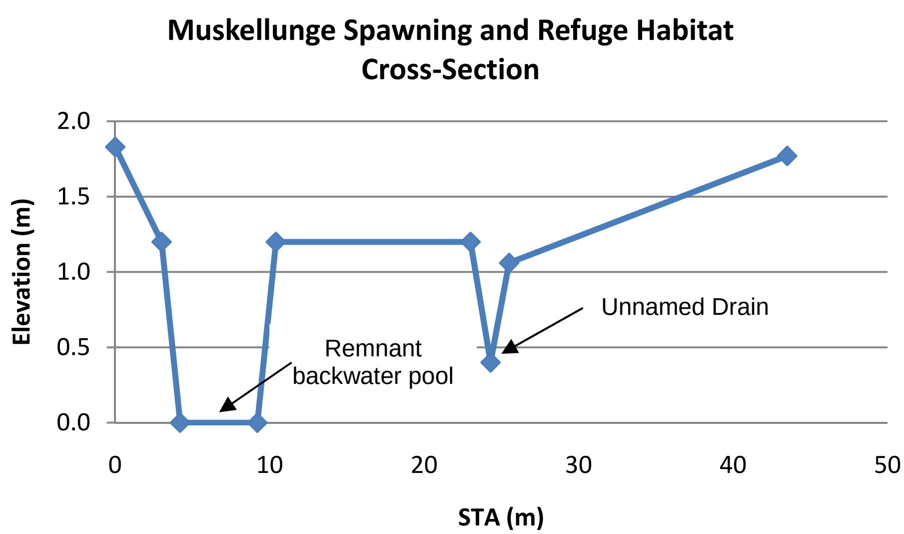

Table 4.10 From STA 0+550 to STA 0+800: Summary of hydraulic performance

	Bankfull 25 mm 4 hour Chicago Storm	Maximum 100 year 24 hour SCS Type II Storm
Flow (cms)	0.64	4.94
Velocity (m/s)	0.36	0.80
Average water depth (m)	0.33	0.95

Existing Drain Downstream of STA 0+800 (to Point A)

The future SWM facility that will service subsequent phases of development west of the Unnamed Drain will outlet to the drain in the vicinity of STA 0+800 (corresponding to the downstream end of the enhancement to the drain). The typical cross-section for the existing drain is indicated in Chart 4.3 below. Results of the hydraulic modeling were considered at Point A (refer to Section 4.1 above), located approximately 125 m downstream of the proposed works. Results indicate that the maximum flow is 7.54 cms and the corresponding velocity and depth are 0.42 m/s and 1.16 m, respectively. The 100 year water levels are confined within the channel.

Chart 4.3 Existing Unnamed Drain Typical Cross-section

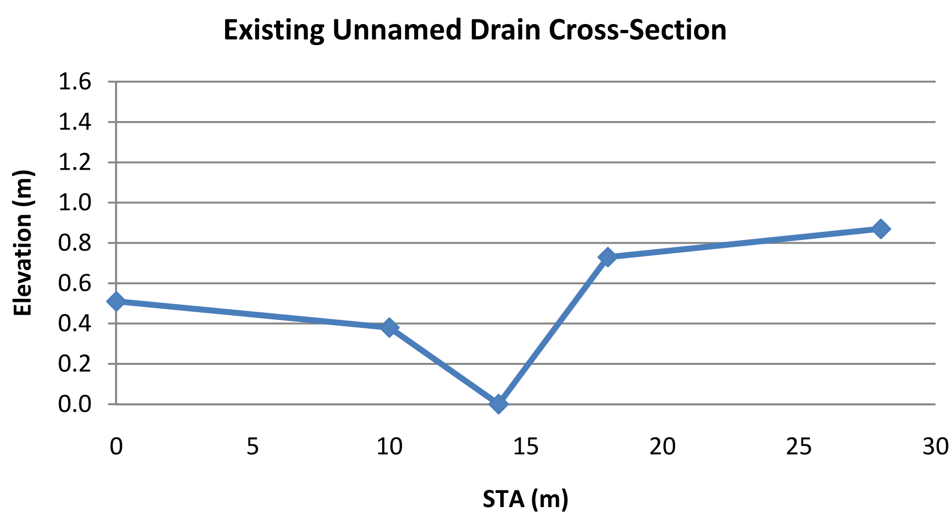

Table 4.11 Downstream of STA 0+800 (to Point A): Summary of hydraulic performance

	Bankfull	**Maximum**
	25 mm 4 hour Chicago Storm	**100 year 24 hour SCS Type II Storm**
Flow (cms)	0.73	7.54
Velocity (m/s)	0.70	0.42
Average water depth (m)	0.36	1.16

In review of the above, it can be concluded that the proposed design provides sufficient capacity for the 100 year storm event. The maximum depth of water in the Unnamed Drain ranges from 0.82 m to 1.16 m, which can be conveyed within the channel.

5. WATER QUANTITY ANALYSIS – RUNOFF VOLUME

From a water budget perspective, the changes in the land use (in this case the introduction of hard surfaces) results in some infiltration losses and increase in surface runoff from the developed area. With no BMP's in place, the majority of increased runoff is intercepted by catch basins and conveyed via storm sewers to stormwater treatment units or facilities for water quality treatment and attenuation.

In general, on a large or watershed scale, groundwater flow follows the surface topography, such as that of the Rideau River at Manotick. It is estimated that a general slope of infiltrated rainwater and subsurface flow from the subject area flows east and is intercepted by the Rideau River. In the 2007 SWM Servicing[6], it was proposed that BMP's be implemented to promote infiltration. This was based on a review of Paterson Group's "Preliminary Geotechnical Investigation – Proposed Residential Development Century Road at First Line Road[8]," January 2007, which indicated that the soils in the study area vary between silty sand and silty clay. It was recommended that during the detail design of the subdivision, areas comprised of silty sand and some clay be considered for infiltration trenches. Specifically in the vicinity of Phase 1, soils are predominantly silty sand with gravel, making the Phase 1 area suitable for consideration of infiltrative BMP's.

The Phase 1 development is therefore being provided with perforated pipes in rear yards to collect and convey stormwater runoff from adjacent grassed areas and roof surfaces. This application has been used in the City of Ottawa, particularly in rear yards of residential area. The detailed design is being completed by EXP; refer to Section 6.7 of their report for further details.

6. WATER QUALITY CONTROL

As discussed in Section 3.1.1, Phase 1 has been divided into sub-catchment areas to reflect drainage connectivity. Minor flow from the drainage areas is collected by storm sewers and conveyed to an off-line Vortechs® stormwater treatment unit for water quality treatment of the first flush, prior to being discharged to the recipient Unnamed Drain. Minor flow in excess of the first flush will be conveyed over the bypass weir and discharge directly to the drain, bypassing the Vortechs® unit. The locations of the stormwater treatment units are indicated on Figure 3. Details of the storm outlet configurations, including the Vortechs® units, are on Drawings 710-712.

The stormwater treatment units will provide water quality treatment by removing core sediments, floating debris and provide oil and grit separation. Sediments removed from the stormwater runoff will be collected within the stormwater treatment units. The units will provide treatment to achieve an Enhanced Level of Protection on a long-term basis (80% suspended solids removal as per the MOE Stormwater Management Planning and Design Manual, March 2003).

Table 6.1 Summary of Drainage Area and Flows at Vortechs® Units

Vortechs® Unit	Tributary Drainage Area (ha)	Flow (cms)	
		First flush	100 year
1	7.35	0.51	1.59
2	4.29	0.20	0.88
3	5.51	0.30	0.81

Sizing of the Vortechs® units from the manufacturer is included in Appendix 7B. TSS removal efficiency ranges from 80% to 85% for the three units, meeting or exceeding the 80% criteria.

At Major Outlet 6, as noted in Section 4.2, a minor flow connection to a proposed swale will convey minor flow to the Unnamed Drain on an interim basis. Water quality treatment will be provided by a BMP prior to the storm runoff discharging to the Unnamed Drain. The BMP measures approximately 25 m in length, and has a bottom elevation of 86.46 m, corresponding to a depth of 0.3 m. Flow will be conveyed through the BMP, prior to discharging to the Unnamed Drain via a berm and swale. At the outlet of the BMP, the berm invert is 86.76 m. The swale will be provided with a reinforced grass treatment.

Table 6.2 presents the required storage volumes based on the MOE Stormwater Management Planning and Design Manual (March 2003). The BMP was oversized to provide 53 cu-m storage. A clear stone layer extending 0.3 m below the BMP invert will promote infiltration, and prevent permanent storage in the BMP. The clear stone layer itself will provide additional storage. It is therefore anticipated that the BMP will be dry the majority of the time. Storage in the BMP was oversized and will capture more runoff than required based on the MOE manual, exceeding the enhanced level of protection.

Table 6.2 Water quality storage volumes for BMP

Enhanced Level of Protection – Infiltration			
Overall Removal Efficiency of TSS 80%			
Drainage Area (ha)	**Imperviousness Ratio (%)**	**Required Storage (cu-m)**	**Provided Storage (cu-m)**
0.30	59	9	53

7. MAINTENANCE AND MONITORING

7.1 Routine Maintenance

Routine maintenance is essential in order to ensure the Vortechs® units continue to perform as designed. Standardized forms should be developed and completed at the time of each inspection. These completed forms would be filed at the City of Ottawa office for future reference. Utilizing a standardized format will assist in the interpretation of the collected data and the identification of future maintenance needs.

7.2 Sediment Removal and Disposal

The Vortechs® units, proposed to be built at the outlet of the storm sewer system, would capture much of the solids being transported by the storm flow. Timing for cleanout would have to be scheduled during dry periods of the summer or in the autumn.

Sediment accumulation rates to the Vortechs® units will vary depending on numerous factors including the status and maturity of the upstream development, the effectiveness of the adopted silt and erosion control plan implemented during the construction activities, etc. During development of the subdivision, sediment loading to the units could be high. This would necessitate more frequent cleanout. Once construction has been completed within the upstream catchment area, then the frequency of sediment removal would lessen.

It is anticipated that once development has been completed, annual removal of sediments form the units will be required.

7.3 Water Quality Monitoring

From the time of commissioning to the 80 % development level, the developer must ensure that the water discharged from the Vortechs® units is of an acceptable quality. Effluent monitoring will determine treatment efficiency. The development of the water quality monitoring program will be dictated by the Certificate of Approval from the Ontario Ministry of the Environment and the City of Ottawa requirements. It is understood that monitoring will commence upon the commissioning of the stormwater treatment units.

8. EROSION AND SEDIMENTATION CONTROL PLAN

An erosion and sedimentation control plan has been provided in EXP's submission. This plan is to provide guidance to the contractor when they are preparing their own plan, which will need to be approved by a Professional Engineer licensed to work in the Province of Ontario. The contractor's plan must also follow the requirements outlined in the City of Ottawa specifications F-1004.

The detailed erosion and sedimentation control plan to be submitted by the contractors will provide further details regarding types, sizing and location of sediment and erosion control measures, as well as maintenance and emergency procedures. Prior to implementation, the City and Rideau Valley Conservation Authority will approve all erosion and sedimentation control plans.

Utilization of a silt fence will be required around the perimeter of the site during construction of the stormwater management system. During the construction of the outlet to the Unnamed Drain, a straw bale sediment trap should be installed downstream of the disturbed areas.

It is also recommended that the sediment and erosion control plan include standard measures to be implemented within the development site during construction, such as the placing of filter cloth beneath the catch basins and manhole covers. Any deleterious substance collected on the cloths shall be disposed off-site.

Dewatering may be required during construction. Prior to dewatering, a Permit to Take Water must be obtained from the Ontario Ministry of the Environment, which will allow temporary removal of water for the operations. During dewatering, the pumped water should be discharged to a sufficiently large siltation basin provided with an outlet protected by straw bale filters. The size and location of the siltation basin will be determined by the contractor and submitted on their sediment and erosion control plan.

In addition to the erosion and sedimentation control plan, it is also suggested to conduct visual monitoring of the sediment controls (i.e., photographs, reporting, site visits).

9. CONCLUSIONS AND RECOMMENDATIONS

Minto is presently proceeding with Phase 1 development. EXP was retained to complete the engineering design and IBI Group was retained to complete the stormwater management. The detailed design of the fish habitat enhancement of the Unnamed Drain will be documented in a separate study.

The recipient watercourse of Phase 1 is the Unnamed Drain. The control point that was considered in the evaluation of water quantity peak flow control is identified as Point A, which is located at the downstream end of the development. Point A is an arbitrarily selected location in close proximity to the Rideau River.

To accomplish peak flow control, stormwater management is required. The stormwater management system consists of a dual drainage concept, in combination with a stormwater management facility servicing Phase 2 lands. Dual drainage is based on inflow rates into the receiving junctions are limited to the minor flow restriction. Storm sewers within the Phase 1 development are sized for the 5 year flow, based on a fixed time of concentration of 10 minutes. Inlet control devices were sized based on the maximum 0.3 m ponding, and the ICD flow was applied as the minor system restriction in SWMHYMO. Storm sewers within future phases of development tributary to the Unnamed Drain have been sized for an inflow equivalent to the 5 year 3 hour Chicago storm event. Section 4 provides a summary of minor system flow restrictions, on-site storage requirements and major system flow information.

The evaluation of the hydraulic grade line, as well as of flood levels in the Unnamed Drain, was completed using XPSWMM. The XPSWMM model represents the complete storm system: the Unnamed Drain, Phase 1 storm sewers, and Phase 2 SWM facility. The detailed design of the fish habitat enhancements to the Unnamed Drain will be presented in a separate study, however, the hydraulics of the Drain were used as the starting water levels for the storm sewer system. A comparison of under-side of footing (USF) elevations and HGL is also included in Section 4. SWMHYMO and XPSWMM model files are provided in Appendix 7D.

To help maintain the runoff volume equilibrium, the Phase 1 development is being provided with perforated pipes in rear yards to collect and convey stormwater runoff from adjacent grassed areas and roof surfaces. This application has been used in the City of Ottawa, particularly in rear yards of residential area. Refer to design details in EXP's submission.

Each minor system outlet will be provided with an off-line Vortechs® stormwater treatment unit for water quality treatment of the first flush, prior to being discharged to the recipient Unnamed Drain. Minor flow in excess of the first flush will bypass the Vortechs® unit and discharge directly to the drain. The locations of the stormwater treatment units are indicated on Figure 3 and design details are provided in Drawings 710-712.

Maintenance, monitoring and sediment and erosion control are discussed in Sections 7 and 8, respectively.

Prepared by

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Associate
Manager, Water Resources

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10. REFERENCES

1. “Manotick Master Drainage Plan,” Robinson Consultants, 1996.

2. “Jock River Reach 2 and Mud Creek Subwatershed Study Existing Conditions Report (Draft),” Marshall Macklin Monaghan & Water and Earth Science Associates, 2005.

3. “Village of Manotick Environmental Management Plan Special Design Area Component,” Marshall Macklin Monaghan & Water and Earth Science Associates, 2005.

4. “Natural Resource Assessment (Draft),” EcoTec Environmental Consultants Inc., June 2007.

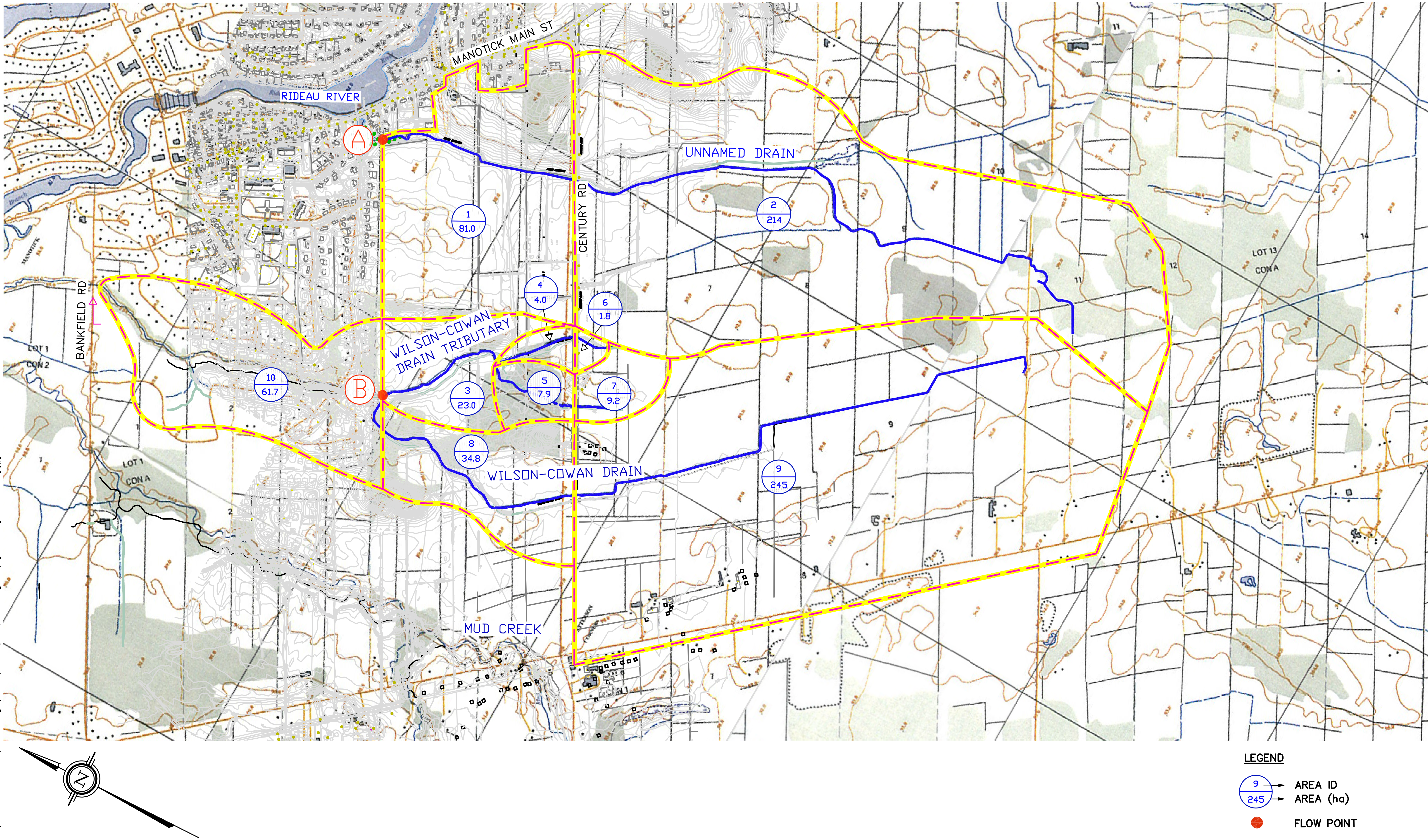
5. “Mud Creek Subwatershed Existing Conditions – Final Draft,” Parish Geomorphic, April 2004.

6. “Preliminary Geotechnical Investigation – Proposed Residential Development Century Road at First Line Road,” Paterson Group, January 2007

7. "Mahogany Community Stormwater Management Servicing Report," IBI Group July 2007.

8. “Mahogany Community Phase 1 Stormwater Management and Fish Habitat Enhancement of the Unnamed Drain,” IBI Group, January 2011

9. “Preliminary Geotechnical Investigation – Proposed Residential Development Century Road at First Line Road,” Paterson Group, January 2007



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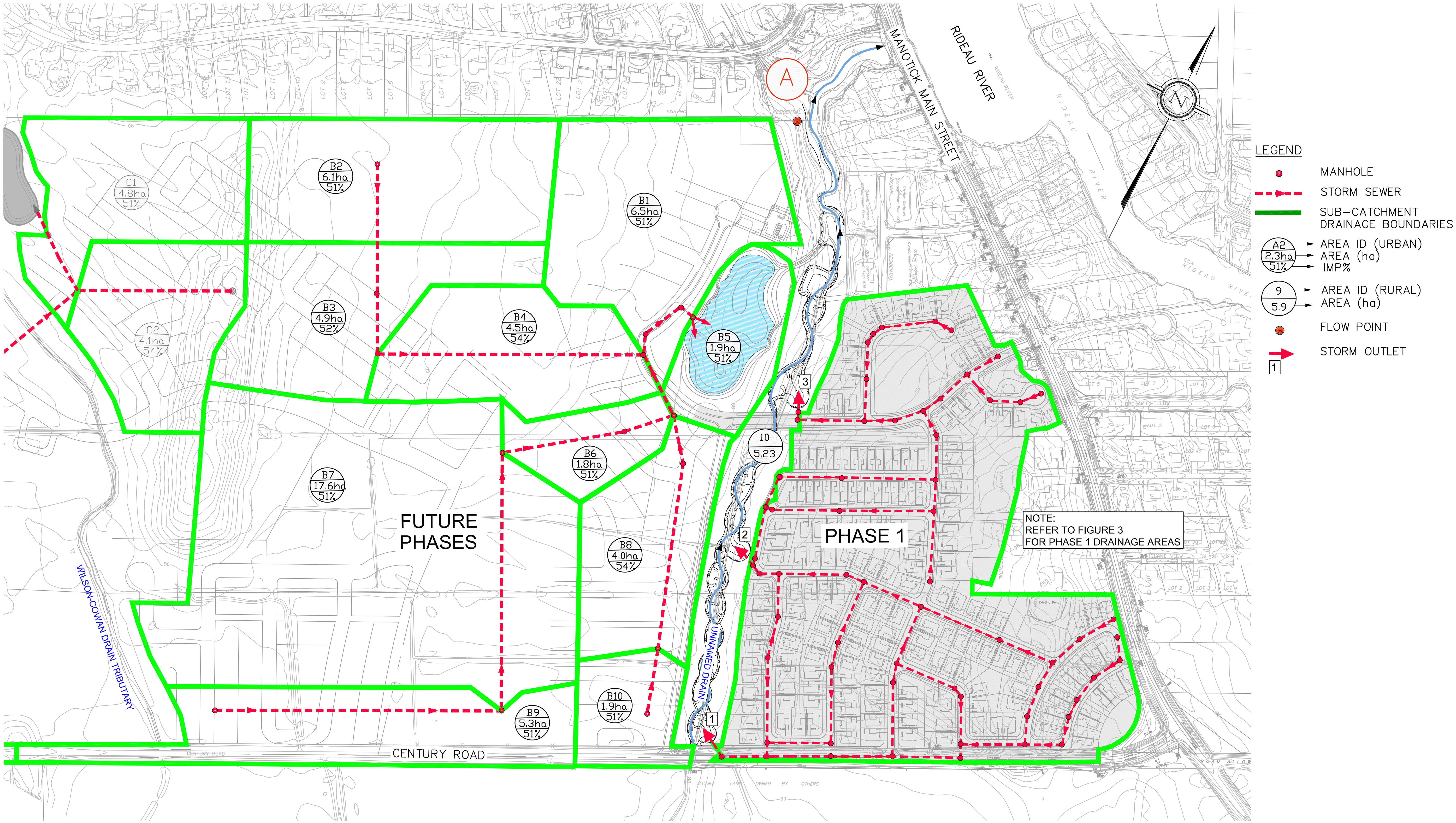
IBI GROUP	Scale 1:15 000	Project Title MAHOGANY COMMUNITY PHASE 1	Drawing Title EXISTING CONDITIONS DRAINAGE BOUNDARIES	Sheet No. FIGURE 1



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Scale

N.T.S.

Project Title

MAHOGANY COMMUNITY
PHASE 1

Drawing Title

DEVELOPMENT TRIBUTARY
TO UNNAMED DRAIN

Sheet No.

FIGURE 2

LEGEND:

DRAINAGE AREA

IMP. (%) [TIME TO PEAK (h)]
63% 0.25 — AREA (ha)
207 — AREA ID

PATHWAY
(CONCEPTUAL)

No.	REVISIONS	By	Date
14			
13			
12			
11			
10			
9			
8			
7			
6			
5			
4			
3			
2			
1	–		

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MAHOGANY PHASE 1

Drawing Title

MINOR SYSTEM
DRAINAGE AREA PLAN

Scale

1:1250

Design	Date
M.B.	NOV. 2011
Drawn	Checked
S.V.	P.S.
Project No.	Drawing No.
14167	FIGURE 3

No.	REVISIONS	By	Date
14			
13			
12			
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10			
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7			
6			
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3			
2			
1	–		

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MAHOGANY PHASE 1

Drawing Title

MAJOR SYSTEM AND PONDING PLAN

Scale

1:1250

Design	Date
M.B.	NOV. 2011
Drawn	Checked
S.V.	P.S.
Project No.	Drawing No.
14167	FIGURE 4

Appendix 7A

Relevant Calculations

Rational Method Spreadsheet (EXP)

Revised Rational Method Spreadsheet

STORM SEWER CALCULATIONS
for
MAHOGANY - PHASE 1

exp

LOCATION												PROPOSED SEWER					
STREET	FROM MH	TO MH	Total Area	Area R= 0.2	Area R= 0.9	Runoff C	INDIV. 2.78AR	ACCUM. 2.78AR	TIME OF CONC.	RAINFALL INTENSITY I	PEAK FLOW Q (l/s)	PIPE SIZE (mm)	GRADE (%)	LENGTH (m)	CAPACITY (l/s)	FULL FLOW VELOCITY (m/s)	TIME OF FLOW (min)
AREA #1																	
Lane No. 1	287	266	0.37	0.179	0.191	0.56	0.58	0.58	10.00	104.19	60.16	304.8	0.75	29.4	87.45	1.20	0.41
Lane No. 1	266	267	0.31	0.118	0.192	0.63	0.55	1.12	10.41	102.08	114.68	381	0.61	39.6	143.00	1.25	0.53
Lane No. 1	267	268	0	0.000	0.000	0.00	0.00	1.12	10.94	99.50	111.78	381	0.75	35.8	158.57	1.39	0.43
Lane No. 1	268	270	0	0.000	0.000	0.00	0.00	1.12	11.36	97.50	109.53	381	0.71	23.9	154.28	1.35	0.29
Lane No. 1	270	271	0.09	0.042	0.048	0.57	0.14	1.27	11.66	96.18	121.85	381	0.67	35.9	149.87	1.31	0.46
Century Road	CB 69	Main	0.17	0.113	0.057	0.48	0.21	0.21	10.00	104.19	21.41	203	1.00	12.8	34.16	1.06	0.20
Street No. 4	271	273	0	0.000	0.000	0.00	0.00	1.47	12.11	94.21	138.71	457.2	0.34	47.2	173.61	1.06	0.74
Street 6	262	260	0.2	0.135	0.065	0.43	0.24	0.24	10.00	104.19	24.77	254	0.62	50.4	48.90	0.97	0.87
Street 6	260	259	0	0.000	0.000	0.00	0.00	0.24	10.87	99.81	23.72	254	0.51	44.9	44.35	0.88	0.86
Street No. 5	237	259	0.26	0.140	0.120	0.52	0.38	0.38	10.00	104.19	39.39	254	1.40	73.1	73.48	1.45	0.84
Street No. 6	259	275	0	0.000	0.000	0.00	0.00	0.62	11.73	95.88	59.04	304.8	0.71	35.1	85.09	1.17	0.50
Street No. 6	CB 76	Main	0.36	0.177	0.183	0.56	0.56	0.56	15.00	83.56	46.48	254	2.00	6.8	87.82	1.73	0.07
Street No. 6	275	276	0.1	0.057	0.043	0.50	0.14	1.31	15.07	83.35	109.29	457.2	0.50	40.1	210.53	1.28	0.52
Street No. 6	276	273	0.3	0.147	0.153	0.56	0.46	1.78	15.59	81.71	145.10	457.2	1.09	35.9	310.84	1.89	0.32
Street No. 4	273	257	0	0.000	0.000	0.00	0.00	3.25	15.90	80.75	262.29	685.8	0.19	81.0	382.63	1.04	1.30
Street No. 4	CB 68	CBMH 67	0.23	0.178	0.052	0.36	0.23	0.23	15.00	83.56	19.17	203	2.00	32.2	48.31	1.49	0.36
Street No. 4	CBMH 67	main	0.04	0.026	0.014	0.45	0.05	0.28	15.36	82.41	22.99	203	2.00	11.3	48.31	1.49	0.13
Street No. 4	256	257	0.59	0.282	0.308	0.57	0.93	1.21	15.49	82.02	98.95	304.8	1.83	61.1	136.61	1.87	0.54
Century Road	257	258	0	0.000	0.000	0.00	0.00	4.45	17.21	77.05	343.21	685.8	0.23	17.1	420.99	1.14	0.25
Century Road	CBMH 64	Main	0.19	0.109	0.081	0.50	0.26	0.26	10.00	104.19	27.41	533.4	2.00	5.5	635.14	2.84	0.03
Century Road	258	242	0	0.000	0.000	0.00	0.00	4.72	17.46	76.38	360.33	685.8	0.31	86.5	488.75	1.32	1.09
Street No. 4	256	255	0	0.000	0.000	0.00	0.00	0.00	10.00	104.19	0.00	254	0.94	12.8	60.21	1.19	0.18
Street No. 4	CB 66	main	0.16	0.089	0.074	0.52	0.23	0.23	15.00	83.56	19.50	203	1.00	11.5	34.16	1.06	0.18
Street No. 4	255	240	0.35	0.117	0.233	0.67	0.65	0.88	15.18	82.98	73.13	381	0.46	79.8	124.18	1.09	1.22
Street No. 1	226	240	0.04	0.024	0.017	0.49	0.05	0.05	10.00	104.19	5.66	254	2.08	78.5	89.56	1.77	0.74
Street No. 1	240	241	0	0.000	0.000	0.00	0.00	0.94	16.40	79.28	74.19	381	2.39	24.3	283.06	2.48	0.16
Street No. 1	CB 65	CBMH 75	0.35	0.206	0.144	0.49	0.47	0.47	15.00	83.56	39.67	254	2.78	26.2	103.54	2.04	0.21
Street No. 1	CBMH 75	Main	0.03	0.027	0.003	0.27	0.02	0.50	15.21	82.87	41.22	254	2.00	13.3	87.82	1.73	0.13
Street No. 1	241	242	0.47	0.203	0.267	0.60	0.78	2.21	16.57	78.82	174.50	381	2.49	93.6	288.92	2.53	0.62
Century Road	242	243	0.00	0.000	0.000	0.00	0.00	6.93	18.55	73.61	510.26	762	0.35	77.9	687.79	1.51	0.86
Century Road	243	248	0	0.000	0.000	0.00	0.00	6.93	19.41	71.58	496.17	762	1.01	81.1	1168.38	2.56	0.53
Street No. 2	252	254	0.25	0.090	0.160	0.65	0.45	0.45	10.00	104.19	46.92	304.8	1.46	32.3	122.02	1.67	0.32
Street No. 2	CB 70	Main	0.38	0.180	0.200	0.57	0.60	0.60	15.00	83.56	50.17	304.8	2.00	36.4	142.81	1.96	0.31
Street No. 2	254	244	0.30	0.130	0.170	0.60	0.50	1.55	15.31	82.57	127.85	457.2	1.18	96.1	323.42	1.97	0.81
Street No. 2	CB 63	CBMH 73	0.21	0.101	0.109	0.56	0.33	0.33	15.00	83.56	27.48	254	1.00	26.9	62.10	1.23	0.37
Street No. 2	CBMH 73	244	0.02	0.013	0.007	0.45	0.02	0.35	15.37	82.39	29.14	254	1.00	10.0	62.10	1.23	0.14
Street No. 2	244	245	0.33	0.172	0.198	0.64	0.59	2.49	16.12	80.10	199.69	533.4	1.22	81.0	496.06	2.22	0.61
Street No. 2	234	233	0	0.000	0.000	0.00	0.00	0.00	10.00	104.19	0.00	304.8	0.40	52.0	63.87	0.88	0.99
Street No. 2	CB 60	Main	0.34	0.168	0.172	0.55	0.52	0.52	15.00	83.56	43.76	254	1.00	39.6	62.10	1.23	0.54
Street No. 2	CB 72	CBMH 61	0.20	0.093	0.107	0.57	0.32	0.32	15.00	83.56	26.69	203	1.75	28.0	45.19	1.40	0.33
Street No. 2	CBMH 61	Main	0.05	0.034	0.016	0.43	0.06	0.38	15.33	82.49	31.23	254	2.00	11.5	87.82	1.73	0.11
Street No. 2	233	245	0.34	0.140	0.200	0.61	0.58	1.48	15.54	81.86	121.19	457.2	0.36	108.3	178.64	1.09	1.66
Century Road	245	248	0	0.000	0.000	0.00	0.00	3.97	17.20	77.07	306.25	762	0.51	17.6	830.25	1.82	0.16
Century Road	CBMH 62	Main	0.32	0.192	0.128	0.48	0.43	0.43	15.00	83.56	35.68	533.4	1.00	8.2	449.11	2.01	0.07
Century Road	248	249	0	0.000	0.000	0.00	0.00	11.33	17.36	76.64	868.48	1066.8	0.51	57.4	2036.50	2.28	0.42
Century Road	249	288	0	0.000	0.000	0.00	0.00	11.33	17.78	75.54	856.01	1066.8	0.11	18.2	945.79	1.06	0.29

STORM SEWER CALCULATIONS
for
MAHOGANY - PHASE 1

exp

LOCATION												PROPOSED SEWER					
STREET	FROM MH	TO MH	Total Area	Area R= 0.2	Area R= 0.9	Runoff C	INDIV. 2.78AR	ACCUM. 2.78AR	TIME OF CONC.	RAINFALL INTENSITY I	PEAK FLOW Q (l/s)	PIPE SIZE (mm)	GRADE (%)	LENGTH (m)	CAPACITY (l/s)	FULL FLOW VELOCITY (m/s)	TIME OF FLOW (min)
AREA #2																	
Street No. 5	237	226	0.25	0.110	0.140	0.59	0.41	0.41	10.00	104.19	42.87	254	1.35	108.6	72.16	1.42	1.27
Street No. 3	226	227	0	0.000	0.000	0.00	0.00	0.41	11.27	97.93	40.29	254	2.76	78.5	103.17	2.04	0.64
Street No. 2	CB 58	main	0.11	0.058	0.052	0.53	0.16	0.16	15.00	83.56	13.57	203	1.00	8.5	34.16	1.06	0.13
Street No. 2	252	227	0.37	0.160	0.210	0.60	0.61	0.78	15.13	83.13	64.57	381	0.40	82.9	115.80	1.02	1.36
Street No. 3	227	228	0	0.000	0.000	0.00	0.00	1.19	16.49	79.02	93.89	381	2.58	23.3	294.10	2.58	0.15
Street No. 3	228	229	0.22	0.100	0.120	0.58	0.36	1.54	16.65	78.59	121.35	381	3.07	86.4	320.81	2.81	0.51
Street No. 2	CB 59	main	0.21	0.098	0.112	0.57	0.33	0.33	15.00	83.56	27.97	254	2.00	11.3	87.82	1.73	0.11
Street No. 2	234	229	0.38	0.176	0.204	0.58	0.61	0.94	15.11	83.21	78.46	457.2	1.00	54.9	297.73	1.81	0.50
Street No. 3	229	230	0	0.000	0.000	0.00	0.00	2.49	17.16	77.18	191.95	457.2	2.11	24.2	432.48	2.63	0.15
Street No. 3	230	217A	0.00	0.000	0.000	0.00	0.00	2.49	17.31	76.77	190.92	685.8	0.23	13.0	420.99	1.14	0.19
Street No. 3	217A	232A	0.00	0.000	0.000	0.00	0.00	2.49	17.50	76.26	189.67	685.8	0.16	6.2	351.13	0.95	0.11
Lane No. 2	220	222	0.3	0.094	0.206	0.68	0.57	0.57	10.00	104.19	59.15	304.8	1.28	119.3	114.25	1.57	1.27
Lane No. 2	222	283	0.19	0.065	0.125	0.66	0.35	0.92	11.27	97.93	89.76	381	0.99	78.7	182.18	1.60	0.82
Lane No. 2	283	216	0.1	0.000	0.069	0.62	0.17	1.09	12.09	94.31	102.63	381	0.97	42.1	180.33	1.58	0.44
Street No. 3	CB 53	main	0.03	0.013	0.018	0.61	0.05	0.05	15.00	83.56	4.24	203	1.00	11.6	34.16	1.06	0.18
Street No. 3	CB 55	main	0.54	0.280	0.260	0.54	0.81	0.81	15.00	83.56	67.36	254	2.50	39.9	98.19	1.94	0.34
Street No. 3	219	223	0.37	0.150	0.220	0.62	0.63	1.49	15.34	82.46	122.94	381	2.17	119.5	269.72	2.37	0.84
Street No. 3	CB 56	CBMH 57	0.27	0.143	0.127	0.53	0.40	0.40	15.00	83.56	33.19	203	2.21	28.5	50.78	1.57	0.30
Street No. 3	CBMH 57	MAIN	0.05	0.030	0.020	0.48	0.07	0.46	15.30	82.59	38.29	254	2.00	11.5	87.82	1.73	0.11
Street No. 3	223	282	0.55	0.244	0.306	0.59	0.90	2.86	16.19	79.91	228.21	457.2	1.64	85.0	381.29	2.32	0.61
Street No. 3	282	216	0	0.000	0.000	0.00	0.00	2.86	16.80	78.17	223.24	457.2	0.90	10.0	282.45	1.72	0.10
Street No. 3	216	217	0.35	0.133	0.217	0.63	0.62	4.56	16.89	77.90	355.30	685.8	0.38	66.3	541.12	1.46	0.75
Street No. 3	217	232A	0	0.000	0.000	0.00	0.00	4.56	17.50	76.26	347.82	838.2	0.25	4.0	749.51	1.36	0.05
Street No. 3	232A	232	0	0.000	0.000	0.00	0.00	7.05	17.61	75.98	535.47	914.4	0.26	3.9	963.96	1.47	0.04

STORM SEWER CALCULATIONS
for
MAHOGANY - PHASE 1

exp

LOCATION												PROPOSED SEWER					
STREET	**FROM MH**	**TO MH**	**Total Area**	**Area R= 0.2**	**Area R= 0.9**	**Runoff C**	**INDIV. 2.78AR**	**ACCUM. 2.78AR**	**TIME OF CONC.**	**RAINFALL INTENSITY I**	**PEAK FLOW Q (l/s)**	**PIPE SIZE (mm)**	**GRADE (%)**	**LENGTH (m)**	**CAPACITY (l/s)**	**FULL FLOW VELOCITY (m/s)**	**TIME OF FLOW (min)**
AREA #3																	
Street No. 1	CB 54	main	0.2	0.138	0.063	0.42	0.23	0.23	15.00	83.56	19.45	203	1.00	8.3	34.16	1.06	0.13
Street No. 1	225	219	0.39	0.140	0.250	0.65	0.70	0.94	15.13	83.14	77.83	304.8	2.19	89.4	149.44	2.05	0.73
Street No. 1	CB 52	main	0.73	0.720	0.010	0.21	0.43	0.43	15.00	83.56	35.54	254	1.00	43.7	62.10	1.23	0.59
Street No. 1	219	220	0.19	0.070	0.120	0.64	0.34	1.70	15.86	80.88	137.55	304.8	3.14	39.8	178.94	2.45	0.27
Street No. 1	CB 50	CBMH 51	0.63	0.580	0.050	0.26	0.45	0.45	15.00	83.56	37.40	254	3.36	35.1	113.83	2.25	0.26
Street No. 1	CBMH 51	main	0.04	0.020	0.020	0.55	0.06	0.51	16.13	80.08	40.74	254	2.00	9.3	87.82	1.73	0.09
Street No. 1	220	281	0	0.000	0.000	0.00	0.00	2.21	16.22	79.82	176.35	381	1.54	57.0	227.22	1.99	0.48
Street No. 1	281	205	0.47	0.200	0.270	0.60	0.79	3.00	16.70	78.45	235.06	457.2	1.28	34.5	336.85	2.05	0.28
Street No. 11	277	278	0	0.000	0.000	0.00	0.00	0.00	10.00	104.19	0.00	254	1.11	27.9	65.43	1.29	0.36
Street No. 11	278	279	0.3	0.130	0.170	0.60	0.50	0.50	10.36	102.33	50.92	254	0.99	38.2	61.79	1.22	0.52
Street No. 11	CB 48	main	0.04	0.025	0.015	0.47	0.05	0.05	15.00	83.56	4.33	203	2.00	8.1	48.31	1.49	0.09
Street No. 11	279	203	0.41	0.260	0.150	0.46	0.52	1.07	15.09	83.27	89.04	304.8	1.67	44.4	130.50	1.79	0.41
Street No. 7	202	203	0	0.000	0.000	0.00	0.00	0.00	10.00	104.19	0.00	254	1.66	45.9	80.01	1.58	0.48
Street No. 7	203	204	0.11	0.050	0.060	0.58	0.18	1.25	15.50	81.96	102.23	381	0.76	44.8	159.62	1.40	0.53
Street No. 7	CB 49	main	0.06	0.043	0.017	0.40	0.07	0.07	15.00	83.56	5.58	203	2.00	14.2	48.31	1.49	0.16
Street No. 7	204	205	0.06	0.024	0.036	0.62	0.10	1.42	16.04	80.35	113.89	381	0.85	27.0	168.81	1.48	0.30
Street No. 7	205	206	0.00	0.000	0.000	0.00	0.00	4.41	16.98	77.67	342.83	533.4	2.14	37.4	656.99	2.94	0.21
Street No. 7	206	207	0.13	0.056	0.074	0.60	0.22	4.63	17.19	77.10	356.95	533.4	2.39	38.8	694.31	3.11	0.21
Street No. 9	210	211	0.00	0.000	0.000	0.00	0.00	0.00	10.00	104.19	0.00	254	3.10	22.6	109.34	2.16	0.17
Street No. 9	211	285	0.29	0.150	0.140	0.54	0.43	0.43	10.17	103.28	44.79	254	1.24	68.8	69.15	1.36	0.84
Street No. 9	285	212	0.29	0.150	0.140	0.54	0.43	0.87	11.01	99.12	85.97	457.2	0.22	13.8	139.65	0.85	0.27
Street No. 9	212	284	0.00	0.000	0.000	0.00	0.00	0.87	11.29	97.86	84.88	533.4	0.32	12.4	254.05	1.14	0.18
Street No. 9	CBMH 83	284	0.80	0.800	0.000	0.20	0.44	0.44	15.00	83.56	37.17	254	1.76	15.9	82.39	1.63	0.16
Street No. 9	284	208	0.00	0.000	0.000	0.00	0.00	1.31	15.16	83.03	108.95	533.4	0.22	46.4	210.65	0.94	0.82
Street No. 9	208	207	0.12	0.063	0.057	0.53	0.18	1.49	15.98	80.51	119.94	609.6	0.17	53.1	264.38	0.91	0.98
Street No. 7	207	214	0.25	0.099	0.151	0.62	0.43	6.55	17.40	76.54	501.53	914.4	0.39	85.6	1180.61	1.80	0.79
Street No. 7	214	213	0	0.000	0.000	0.00	0.00	6.55	18.19	74.49	488.13	914.4	0.19	10.6	824.05	1.25	0.14

REVISED STORM SEWER DESIGN SHEET
MAHOGANY - PHASE 1
IBI GROUP

STREET	FROM MH	TO MH	IBI GROUP ID	RECEIVING MH	AREA	Runoff C	INDIV. 2.78AR	ACCUM. 2.78AR	TIME OF CONC.	RAINFALL INTENSITY I	PEAK FLOW Q (l/s)	CB IDs	No. of ICDs per plan	ICD RESTRICTED FLOW (l/s) Inlet: 75VHV-1 7.00	X 14.95	A 22.3	B 31.7	C 41.3	D 61.4	F 83.7	Custom	ICD Capture (l/s)
AREA #1																						
Street No. 5			RY FREE 5		0.73	0.48	0.97	0.97	10.00	104.19	101.50											N/A (overland to pond)
Street No. 5	237	259	237A	237	0.26	0.52	0.38	0.38	10.00	104.19	39.39	32, 32A	2			2						44.6
Street No. 6	262	260	262	262	0.20	0.43	0.24	0.24	10.00	104.19	24.77	44, T44	1				1					31.7
Lane No. 1	270	271	271A	271	0.09	0.57	0.14	0.14	10.00	104.19	14.95	43, T43	1		1							14.95
Century Road	CB 69	Main	271B	271	0.17	0.48	0.21	0.21	10.00	104.19	21.41	69	1			1						22.3
Lane No. 1	287	266	267	267	0.37	0.56	0.58	0.58	10.00	104.19	60.16	43A, T43A	1						1			61.4
Lane No. 1	266	267	287	287	0.31	0.63	0.55	0.55	10.00	104.19	56.89	42, T42	1						1			61.4
Lane No. 1			RY FREE 4		0.55	0.40	0.61	0.61	10.00	104.19	63.72											N/A (overland to Manotick Main St ditch)
Street No. 6	CB 76	Main	RY275	275	0.36	0.56	0.56	0.56	10.00	104.19	57.96	76	1						1			61.4
Street No. 6	275	276	275	275	0.10	0.50	0.14	0.14	10.00	104.19	14.51	45, T45	1		1							14.95
Street No. 6	276	273	276	276	0.30	0.56	0.46	0.46	10.00	104.19	48.40	46, T46	1						1			61.4
Street No. 4	CB 68	CBMH 67	RY256	256	0.27	0.37	0.28	0.28	10.00	104.19	28.94	CBMH 67	1				1					31.7
Street No. 4	256	257	256	256	0.59	0.57	0.93	0.93	10.00	104.19	96.63	40, T40, 41, 74	3				2	1				104.7
Century Road	CBMH 64	Main	258	258	0.19	0.50	0.26	0.26	10.00	104.19	27.41	CBMH 64	1								275.6	275.6
Street No. 4	CB 66	main	RY255	255	0.16	0.52	0.23	0.23	10.00	104.19	24.32	66	1				1					31.7
Street No. 4	255	240	255	255	0.35	0.67	0.65	0.65	10.00	104.19	67.52	39, T39	1					0		1		83.7
Street No. 1	226	240	226	226	0.04	0.49	0.05	0.05	10.00	104.19	5.66	17	1	1								7.0
Street No. 1	CB 65	CBMH 75	RY241	241	0.38	0.47	0.49	0.49	10.00	104.19	51.21	CBMH 75	1						1			61.4
Street No. 1	241	242	241	241	0.47	0.60	0.78	0.78	10.00	104.19	81.36	18, T18, 19, 20	3			2		1				85.9
Street No. 2	252	254	252A	252A	0.25	0.65	0.45	0.45	10.00	104.19	46.92	37, T37	1						1			61.4
Street No. 2	CB 70	Main	RY254	254	0.38	0.57	0.60	0.60	10.00	104.19	62.57	70	1							1		83.7
Street No. 2	254	244	254	254	0.30	0.60	0.50	0.50	10.00	104.19	51.85	36, T36	1						1			61.4
Street No. 2	CB 63	CBMH 73	RY244	244	0.23	0.55	0.35	0.35	10.00	104.19	36.64	CBMH 73	1					1				41.3
Century Road	CBMH 62	Main	248	248	0.32	0.48	0.43	0.43	10.00	104.19	44.49	CBMH 62	1								325.1	325.1
Street No. 2	244	245	244	244	0.33	0.64	0.59	0.59	10.00	104.19	61.58	35, 35A	1						2			122.8
Street No. 2	CB 60	Main	RY233A	233	0.34	0.55	0.52	0.52	10.00	104.19	54.57	60	1						1			61.4
Street No. 2	CB 72	CBMH 61	RY233B	233	0.25	0.54	0.38	0.38	10.00	104.19	39.10	CBMH 61	1					1				41.3
Street No. 2	233	245	233	233	0.34	0.61	0.58	0.58	10.00	104.19	60.25	34, 76	2						2			122.8
Street No. 2			RY FREE 3		0.67	0.53	0.99	0.99	10.00	104.19	102.86											N/A (overland to drain)
AREA #2																						
Street No. 5	237	226	237B	237	0.25	0.59	0.41	0.41	10.00	104.19	42.87	30, T30	1						1			61.4
Street No. 2	CB 58	main	RY252	252	0.11	0.53	0.16	0.16	10.00	104.19	16.92	58	1			1						22.3
Street No. 2	252	227	252B	252	0.37	0.60	0.61	0.61	10.00	104.19	64.01	38, T38, 29	2				1	1				73.0
Street No. 3	228	229	228	228	0.22	0.58	0.36	0.36	10.00	104.19	37.08	28, T28	1					1				41.3
Street No. 2	CB 59	main	RY234	234	0.21	0.57	0.33	0.33	10.00	104.19	34.67	59	1					1				41.3
Street No. 2	234	229	234	234	0.38	0.58	0.61	0.61	10.00	104.19	63.38	33, 33A	1							2		167.4
Street No. 3	CB 53	main	RY219A	219	0.03	0.61	0.05	0.05	10.00	104.19	5.29	53	1	1								7.0
Street No. 3	CB 55	main	RY219B	219	0.54	0.54	0.81	0.81	10.00	104.19	84.00	55	1								84.8	84.8
Street No. 3	219	223	219A	219	0.37	0.62	0.63	0.63	10.00	104.19	66.04	24, T24, 25, T25	2				1	1				73.0
Street No. 3	CB 56	Main	RY223	223	0.32	0.51	0.46	0.46	10.00	104.19	47.53	57	1						1			61.4
Street No. 3	223	282	223	223	0.55	0.59	0.90	0.90	10.00	104.19	93.91	26, 26A	2					1	1			102.7
Lane No. 2	220	222	220	220	0.3	0.68	0.57	0.57	10.00	104.19	59.15	21, T21	1						1			61.4
Lane No. 2	222	283	222	222	0.19	0.66	0.35	0.35	10.00	104.19	36.35	22, T22	1					1				41.3
Lane No. 2	283	216	283	283	0.1	0.62	0.17	0.17	10.00	104.19	17.88	23, T23	1			1						22.3
Street No. 3	216	217	216	216	0.35	0.63	0.62	0.62	10.00	104.19	64.27	27, 76	1							1		83.7
Lane No. 2			RY FREE 2		0.63	0.41	0.72	0.72	10.00	104.19	74.82											N/A (overland to drain)

REVISED STORM SEWER DESIGN SHEET
MAHOGANY - PHASE 1
IBI GROUP

STREET	FROM MH	TO MH	IBI GROUP ID	RECEIVING MH	AREA	Runoff C	INDIV. 2.78AR	ACCUM. 2.78AR	TIME OF CONC.	RAINFALL INTENSITY I	PEAK FLOW Q (l/s)	CB IDs	No. of ICDs per plan	ICD RESTRICTED FLOW (l/s) Inlet 75VHV-1 7.00	X 14.95	A 22.3	B 31.7	C 41.3	D 61.4	F 83.7	Custom	ICD Capture (l/s)
AREA #3																						
Street No. 1	CB 54	main	RY225	225	0.2	0.42	0.23	0.23	10.00	104.19	24.26	54	1				1					31.7
Street No. 1	225	219	225	225	0.39	0.65	0.70	0.70	10.00	104.19	73.28	15, T15, 16, T16	2					2				82.6
Street No. 1	CB 52	main	RY219C	219	0.73	0.21	0.43	0.43	10.00	104.19	44.32	52	1						1			61.4
Street No. 1	219	220	219B	219	0.19	0.64	0.34	0.34	10.00	104.19	35.34	14, T14	1					1				41.3
Street No. 1	CB 50	CBMH 51	RY281	281	0.67	0.28	0.52	0.52	10.00	104.19	54.34	CBMH 51	1						1			61.4
Street No. 11	278	279	278	278	0.3	0.60	0.50	0.50	10.00	104.19	51.85	12, 80	2			1	1					54.0
Street No. 11	CB 48	main	RY279	279	0.04	0.47	0.05	0.05	10.00	104.19	5.40	48	1	1								7.0
Street No. 11	279	203	279	279	0.41	0.46	0.52	0.52	10.00	104.19	54.17	81, 11	2				2					63.4
Street No. 7	203	204	203	203	0.11	0.58	0.18	0.18	10.00	104.19	18.54	9	1			1						22.3
Street No. 7	CB 49	main	RY204	204	0.06	0.40	0.07	0.07	10.00	104.19	6.96	49	1	1								7.0
Street No. 7	204	205	204	204	0.06	0.62	0.10	0.10	10.00	104.19	10.78	8	1		1							14.95
Street No. 1	281	205	281	281	0.47	0.60	0.79	0.79	10.00	104.19	81.97	13, T13	1							1		83.7
Street No. 7	206	207	206	206	0.13	0.60	0.22	0.22	10.00	104.19	22.54	7, T7	1				1					31.7
Street No. 9	211	285	211	211	0.29	0.54	0.43	0.43	10.00	104.19	45.19	1, T1	1						1			61.4
Street No. 9	CBMH 83	284	284	284	0.80	0.20	0.44	0.44	10.00	104.19	46.35	CBMH 83	1						1			61.4
Street No. 9	208	207	208	208	0.12	0.53	0.18	0.18	10.00	104.19	18.51	3, T3	1			1						22.3
Street No. 9	285	212	285	285	0.29	0.54	0.43	0.43	10.00	104.19	45.19	2, T2	1						1			61.4
Street No. 7	207	214	207	207	0.25	0.62	0.43	0.43	10.00	104.19	45.10	5, T5, 6, T6	2			1	1		0			54.0
Street No. 7			LP		0.3	0.61	0.51	0.51	10.00	104.19	53.01	4, T4	1						1			61.4
Lane No. 2			RY FREE 1		1.05	0.50	1.46	1.46	10.00	104.19	152.07											N/A (overland to drain)
											2597											**3744**

Appendix 7A

Impervious length

The impervious length parameter was determined as per the City of Ottawa Sewer Design Guidelines (November 2004) and based on calculations from Appendix 8.

The length parameter (LGI) is based on the average between the trunk sewer length and a calculated length based on area, as outlined below:

L_M = measured length of trunk sewer within the sub-catchment area

$L_C = \sqrt{\frac{A}{1.5}}$ *where: A = area in m^2*

LGI = (L_M + L_C) / 2

ID	Area (ha)	Lm (m)	Lc (m)	LGI (m)
237A	0.26	72	41.6	57
262	0.20	53	36.5	45
271A	0.09	40	24.5	32
271B	0.17	102	33.7	68
267	0.37	73	49.7	61
287	0.31	61	45.5	53
RY275	0.36	115	49.0	82
275	0.10	38	25.8	32
276	0.30	69	44.7	57
RY256	0.27	83	42.4	63
256	0.59	61	62.7	62
258	0.19	140	35.6	88
RY255	0.16	70	32.7	51
255	0.35	70	48.3	59
226	0.04	38	16.3	27
RY241	0.38	100	50.3	75
241	0.47	115	56.0	85
252A	0.25	28	40.8	34
RY254	0.38	160	50.3	105
254	0.30	70	44.7	57
RY244	0.23	55	39.2	47
248	0.32	205	46.2	126
244	0.33	106	46.9	76
RY233A	0.34	93	47.6	70
RY233B	0.25	74	40.8	57
233	0.34	95	47.6	71
RY FREE 3	0.67	44	66.8	55
237B	0.25	82	40.8	61
RY252	0.11	60	27.1	44
252B	0.37	50	49.7	50
228	0.22	80	38.3	59
RY234	0.21	67	37.4	52
234	0.38	55	50.3	53

ID	Area (ha)	Lm (m)	Lc (m)	LGI (m)
RY219A	0.03	13	14.1	14
RY219B	0.54	103	60.0	82
219A	0.37	105	49.7	77
RY223	0.32	92	46.2	69
223	0.55	105	60.6	83
220	0.3	75	44.7	60
222	0.19	65	35.6	50
283	0.1	65	25.8	45
216	0.35	105	48.3	77
RY FREE 2	0.63	170	64.8	117
RY225	0.2	60	36.5	48
225	0.39	70	51.0	60
219B	0.19	45	35.6	40
278	0.3	37	44.7	41
RY279	0.04	19	16.3	18
279	0.41	74	52.3	63
203	0.11	50	27.1	39
204	0.06	59	20.0	40
281	0.47	100	56.0	78
206	0.13	57	29.4	43
211	0.29	48	44.0	46
208	0.12	47	28.3	38
285	0.29	130	44.0	87
207	0.25	83	40.8	62
LP	0.3	140	44.7	92
B1	6.5	204	208.2	206
B2	6.1	100	201.7	151
B3	4.9	139	180.7	160
B4	4.5	338	173.2	256
B5	1.9	291	112.5	202
B6	1.8	222	109.5	166
B7	17.6	327	342.5	335
B8	4	296	163.3	230
B9	5.3	360	188	274

Calculation of velocity in the Unnamed Drain

Flow and average depth were evaluated with XPSWMM and velocity was evaluated manually using the continuity equation, Q = AV.

To STA 0+472

Cross-section: refer to Chart 4.1

25 mm
Depth of flow = 0.52 m
Corresponding cross-sectional area = 1.943 m^2

Solving for v:

$$v = 0.64\ m^3/s\ /\ 1.943\ m^2 = 0.33\ m/s$$

100 year
Depth of flow = 1.12 m
Corresponding cross-sectional area = 16.107 m^2

Solving for v:

$$v = 4.87\ m^3/s\ /\ 16.107\ m^2 = 0.30\ m/s$$

From STA 0+472 to STA 0+550

Cross-section: refer to Chart 4.1

25 mm
Depth of flow = 0.37 m
Corresponding cross-sectional area = 0.466 m^2

Solving for v:

$$v = 0.64\ m^3/s\ /\ 0.466\ m^2 = 1.37\ m/s$$

100 year
Depth of flow = 0.82 m
Corresponding cross-sectional area = 7.762 m^2

Solving for v:

$$v = 4.91\ m^3/s\ /\ 7.762\ m^2 = 0.63\ m/s$$

<u>From STA 0+550 to 0+800 (end of proposed works)</u>

Cross-section: refer to Chart 4.2

25 mm
Depth of flow = 0.33 m
Corresponding cross-sectional area = 1.759 m^2

Solving for v:

$$v = 0.64\ m^3/s\ /\ 1.759\ m^2 = 0.36\ m/s$$

100 year
Depth of flow = 0.95 m
Corresponding cross-sectional area = 6.174 m^2

Solving for v:

$$v = 4.94\ m^3/s\ /\ 6.174\ m^2 = 0.80\ m/s$$

<u>Existing Drain Downstream of STA 0+800 (to Point A)</u>

Cross-section: refer to Chart 4.3

25 mm
Depth of flow = 0.36 m
Corresponding cross-sectional area = 1.037 m^2

Solving for v:

$$v = 0.73\ m^3/s\ /\ 1.037\ m^2 = 0.70\ m/s$$

100 year
Depth of flow = 1.16 m
Corresponding cross-sectional area = 17.813 m^2

Solving for v:

$$v = 7.54\ m^3/s\ /\ 17.813\ m^2 = 0.42\ m/s$$

Sizing of Custom Orifices

The majority of inlet control devices (ICDs) in Phase 1 are standard Ipex and Hydrovex ICDs. There are, however, three locations at which custom ICDs will be required. They are sized using the orifice formula: $Q = C_v A(2gh)^{0.5}$, using a C_v value of 0.6.

Sizing is summarized in the below table.

	CB ID	Location	Approx. Head (m)	Target Flow Qt (l/s)	Area a x a (m)	Actual Flow Qa (l/s)
1	CBMH 64	Century Road Ditch	1.52	275	0.290	275.6
2	CBMH 62	Century Road Ditch	1.52	325	0.315	325.1
3	55	RY219B	1.22	84	0.170	84.8

Appendix 7B

Vortechs® Manufacturer's Information

Sizing Estimate

Provided by Jennifer Knowles on March 16, 2012

Mahogany Phase 1, Ottawa, ON
Stormwater Treatment System Design Summary

Information provided by Engineer (IBI Group):

Structure ID	Drainage Area (ha)	Runoff Coefficient	Tc (min)	Required Treatment Flow Rate (L/s)	100-Year Controlled Storm Event (L/s)	Mainline Pipe Size (mm)	Pipe Size Recommended to Off-line Vortechs (mm)
1	7.35	0.56	17.85	449	1589	1050	600
2	4.29	0.59	17.60	301	935	900	450
3	5.51	0.43	18.40	320	783	900	450

- Sediment removal efficiency required = 80%
- Sediment particle gradation = 50 microns and larger

Sizing Summary:

The Vortechs® Stormwater Treatment System is a hydrodynamic separator designed to enhance gravitational separation of floating and settleable materials from stormwater flows. Stormwater flows enter the unit tangentially to the treatment chamber, which promotes a gentle swirling motion. As stormwater circles the treatment chamber, pollutants migrate toward the center of the unit where velocities are the lowest. Sediments accumulate in the bottom of the swirl chamber, while floating debris, oil and grease form a floating layer trapped upstream of the floatables baffle wall.

For this project the Vortechs system was designed to remove at least 80% of an average particle size of 80 microns based on historical rainfall data. For this site CONTECH Construction Products recommends the following:

Structure ID	Vortechs Model & Configuration	Peak Treatment Capacity (l/s)	Sediment Storage Capacity (cubic meters)	Oil Spill Capacity (liters)	Total Holding Capacity (liters)	Heaviest Pick Weight (kg)
OGS 1	11000 off-line	495	4.28	2378	13592	22050
OGS 2	7000 off-line	312	3.06	1687	9515	15700
OGS 3	7000 off-line	312	3.06	1687	9515	15700

We have supplied project specific efficiency, flow and bypass calculations for your use and review. Please note that these off-line models will require a bypass and junction manhole.

Maintenance:

Like any stormwater best management practice, the Vortechs system requires regular inspection and maintenance to ensure optimal performance. Maintenance frequency will be driven by site conditions. Quarterly visual inspections are recommended, at which time the accumulation of pollutants can be determined. On average, the Vortechs system requires annual removal of accumulated pollutants.

Thank you for the opportunity to present this information to you and your client.

VORTECHS SYSTEM® ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON AN AVERAGE PARTICLE SIZE OF 80 MICRONS
MAHOGANY PHASE 1
OTTAWA, ON
MODEL 11000 OFF-LINE
SITE DESIGNATION OGS 1

CONTECH CONSTRUCTION PRODUCTS INC.

Design Ratio[1] = $\frac{(7.35 \text{ hectares}) \times (0.56) \times (2.775)}{(7.3 \text{ m2})}$ **= 1.56**

Bypass occurs at an elevation of 88.04m (at approximately 11 l/s/m2)

Rainfall Intensity mm/hr	Operating Rate[2] % of capacity	Flow Treated (l/s)	% Total Rainfall Volume[3]	Rmvl. Effcy[4] (%)	Rel. Effcy (%)
0.5	1.2	5.8	10.7%	98.0%	10.5%
1.0	2.3	11.5	9.3%	98.0%	9.1%
1.5	3.5	17.3	10.3%	98.0%	10.1%
2.0	4.6	23.0	8.6%	98.0%	8.4%
2.5	5.8	28.8	6.7%	98.0%	6.6%
3.0	7.0	34.6	5.8%	98.0%	5.7%
3.6	8.1	40.3	5.0%	96.9%	4.9%
4.1	9.3	46.1	4.4%	96.3%	4.2%
4.6	10.5	51.8	2.3%	96.0%	2.2%
5.1	11.6	57.6	4.2%	95.3%	4.0%
6.4	14.5	72.0	7.4%	92.8%	6.9%
7.6	17.4	86.4	4.0%	89.9%	3.6%
8.9	20.3	100.8	3.4%	87.3%	2.9%
10.2	23.2	115.2	1.5%	85.7%	1.3%
11.4	26.1	129.6	2.8%	84.3%	2.4%
12.7	29.1	144.0	0.9%	82.6%	0.8%
19.1	43.6	216.0	2.7%	72.8%	2.0%
25.4	58.1	287.9	1.1%	59.3%	0.6%
38.1	87.2	431.9	0.9%	22.7%	0.2%
					86.3%

% rain falling at >38.1 mm/hr or bypassing treatment =	8.0%
Assumed removal efficiency for bypassed flows =	0.0%
Estimated reduction in efficiency[5] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**80%**

1 - Design Ratio = (Total Drainage Area) x (Runoff Coefficient) x (Rational Method Conversion) / Grit Chamber Area
- The Total Drainage Area and Runoff Coefficient are specified by the site engineer.
- The rational method conversion based on the units in the above equation is 2.775.

2 - Operating Rate (% of capacity) = percentage of peak operating rate of 68 l/s/m².

3 - Based on 10 years of rainfall data from Canadian Station 6105976, Ottawa CDA, ON

4 - Based on Contech Construction Products laboratory verified removal of 38 to 500 micron particles with an average particle size of 80 microns (see Vortechs Guide).

5- Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Calculated by:	JAK	3/16	Checked by:

VORTECHS SYSTEM® FLOW CALCULATIONS

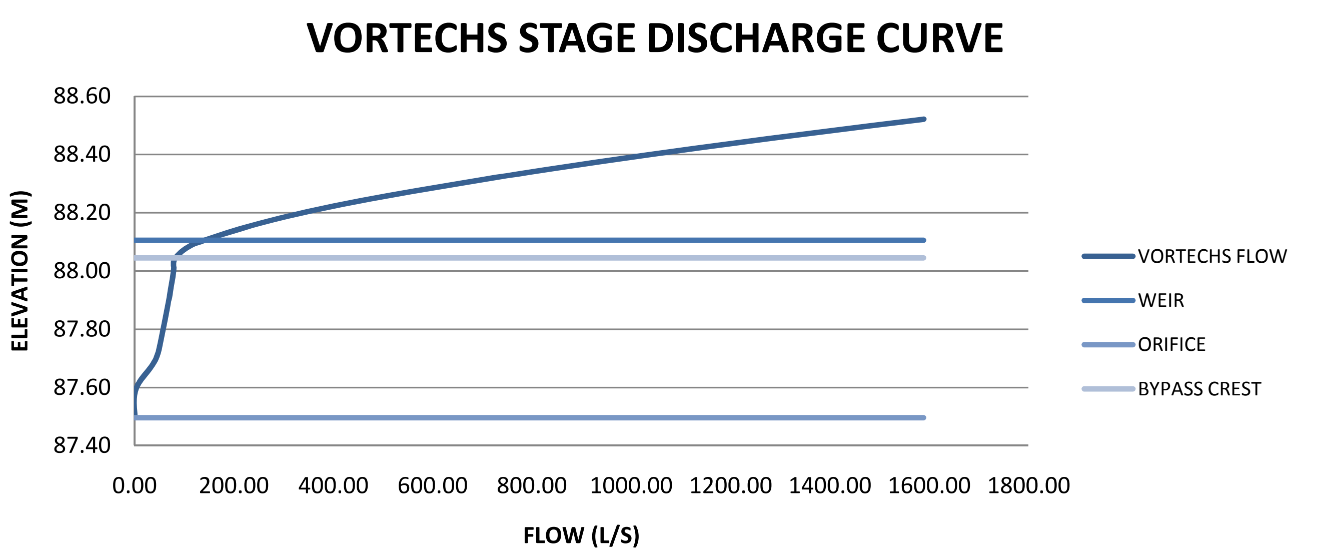
CONTECH CONSTRUCTION PRODUCTS INC.

MAHOGANY PHASE 1
OTTAWA, ON
MODEL 11000 OFF-LINE
OGS 1

Vortechs Orifice	**Vortechs Weir**	**Bypass Weir**
Cd = 308	Cd = 1861	Cd = 1888
A (m^2) = 0.048	Weir Crest Length (m) = 0.762	Crest Length (m) = 1.829
Crest Elevation (m) = 87.50	Crest Elevation (m) = 88.11	Crest Elev. (m) = 88.05

Head (m)	Elevation (m)	Orifice Flow (l/s)	Weir Flow (l/s)	Bypass Flow (l/s)	Total Flow (l/s)
0.00	87.50	0.00	0.00	0.00	0.00
0.10	87.60	2.73	0.00	0.00	2.73
0.20	87.70	42.21	0.00	0.00	42.21
0.30	87.80	56.75	0.00	0.00	56.75
0.40	87.90	68.26	0.00	0.00	68.26
0.50	88.00	78.09	0.00	0.00	78.09
0.55	88.05	82.54	0.00	0.00	82.54
0.60	88.10	86.82	0.00	37.65	124.47
0.70	88.20	94.74	38.36	194.22	327.32
0.80	88.30	102.05	117.51	417.28	636.85
0.90	88.40	108.87	221.51	690.80	1021.18
1.00	88.50	115.29	345.39	1006.74	1467.42
1.03	88.52	116.86	379.57	1092.88	1589.32

Calculated by: JAK | 3/16



VORTECHS SYSTEM® BYPASS CALCULATIONS
MAHOGANY PHASE 1
OTTAWA, ON
MODEL 11000 OFF-LINE
SITE DESIGNATION OGS 1

CONTECH CONSTRUCTION PRODUCTS INC.

Vortechs System Specifications and Site Specific Information:

Vortechs System flow capacity, Q_V =	496 l/s	Actual length of bypass weir crest =	1.829 m
Design flow rate at recurrence interval, Q_D =	1589 l/s		
Recurrence Interval, I =	100 yr	Peak water surface elevation, E_P =	88.52 m
		Discharge coefficient, C_D =	1888

Notation:

Q_B = Flow over bypass weir, l/s
E_B = Elevation of bypass weir crest, m
h = Depth of flow over bypass weir crest, m

Calculations:

$Q_B = Q_P - Q_V$ - Calculate the flow over the bypass weir during the design-year storm
= 1588 - 496
= **1093 l/s**

$Q_B = C_D L_B h^{3/2}$ - Francis formula for rectangular weir.

h = (QB / 1888 LB)2/3 - Use this arrangement of the Francis formula to solve for h.
= (1093 / 1888 * 1.829)^2/3
= **0.45 m**

$\mathbf{E_B} = E_P - h$ - Solve for bypass weir crest elevation (E_B).
= 88.52 - 0.45
= **88.05 m**

Conclusion:

The bypass weir crest should be set at an elevation of 88.05 m with a total length of 1.829 m.

Calculated by: JAK	3/16	Checked by:

VORTECHS SYSTEM® ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON AN AVERAGE PARTICLE SIZE OF 80 MICRONS
MAHOGANY PHASE 1
OTTAWA, ON
MODEL 7000 OFF-LINE
SITE DESIGNATION OGS 2

CONTECH CONSTRUCTION PRODUCTS INC.

Design Ratio[1] = $\frac{(4.29 \text{ hectares}) \times (0.59) \times (2.775)}{(4.7 \text{ m2})}$ **= 1.5**

Bypass occurs at an elevation of 87.5m (at approximately 14 l/s/m2)

Rainfall Intensity mm/hr	Operating Rate[2] % of capacity	Flow Treated (l/s)	% Total Rainfall Volume[3]	Rmvl. Effcy[4] (%)	Rel. Effcy (%)
0.5	1.1	3.5	10.7%	98.0%	10.5%
1.0	2.2	7.0	9.3%	98.0%	9.1%
1.5	3.3	10.4	10.3%	98.0%	10.1%
2.0	4.5	13.9	8.6%	98.0%	8.4%
2.5	5.6	17.4	6.7%	98.0%	6.6%
3.0	6.7	20.9	5.8%	98.0%	5.7%
3.6	7.8	24.3	5.0%	97.6%	4.9%
4.1	8.9	27.8	4.4%	96.9%	4.2%
4.6	10.0	31.3	2.3%	96.0%	2.2%
5.1	11.2	34.8	4.2%	95.3%	4.0%
6.4	14.0	43.5	7.4%	93.8%	6.9%
7.6	16.7	52.1	4.0%	90.6%	3.7%
8.9	19.5	60.8	3.5%	88.0%	3.1%
10.2	22.3	69.5	1.8%	86.1%	1.6%
11.4	25.1	78.2	3.7%	84.9%	3.2%
12.7	27.9	86.9	1.2%	83.8%	1.0%
19.1	41.9	130.4	3.8%	75.0%	2.8%
25.4	55.8	173.8	1.5%	61.3%	0.9%
38.1	83.7	260.7	1.2%	30.1%	0.4%
					89.3%

% rain falling at >38.1 mm/hr or bypassing treatment =	4.5%
Assumed removal efficiency for bypassed flows =	0.0%
Estimated reduction in efficiency[5] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**83%**

1 - Design Ratio = (Total Drainage Area) x (Runoff Coefficient) x (Rational Method Conversion) / Grit Chamber Area
- The Total Drainage Area and Runoff Coefficient are specified by the site engineer.
- The rational method conversion based on the units in the above equation is 2.775.

2 - Operating Rate (% of capacity) = percentage of peak operating rate of 68 l/s/m².

3 - Based on 10 years of rainfall data from Canadian Station 6105976, Ottawa CDA, ON

4 - Based on Contech Construction Products laboratory verified removal of 38 to 500 micron particles with an average particle size of 80 microns (see Vortechs Guide).

5- Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Calculated by:	JAK	3/16	Checked by:

VORTECHS SYSTEM® FLOW CALCULATIONS
MAHOGANY PHASE 1
OTTAWA, ON
MODEL 7000 OFF-LINE

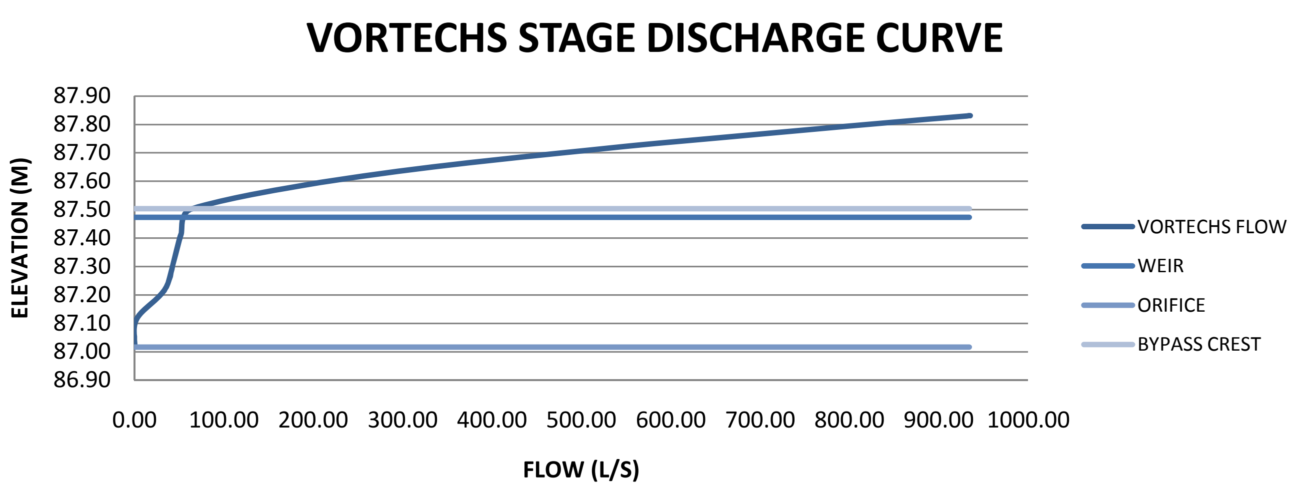
CONTECH CONSTRUCTION PRODUCTS INC.

SITE DESIGNATION OGS 2

Vortechs Orifice	**Vortechs Weir**	**Bypass Weir**
Cd = 308	Cd = 1861	Cd = 1883
A (m^2) = 0.036	Weir Crest Length (m) = 0.585	Crest Length (m) = 1.829
Crest Elevation (m) = 87.02	Crest Elevation (m) = 87.47	Crest Elev. (m) = 87.50

Head (m)	Elevation (m)	Orifice Flow (l/s)	Weir Flow (l/s)	Bypass Flow (l/s)	Total Flow (l/s)
0.00	87.02	0.00	0.00	0.00	0.00
0.10	87.12	2.48	0.00	0.00	2.48
0.20	87.22	33.24	0.00	0.00	33.24
0.30	87.32	43.75	0.00	0.00	43.75
0.40	87.42	52.19	0.00	0.00	52.19
0.49	87.50	58.55	5.56	0.00	64.11
0.60	87.62	65.90	58.60	126.41	250.91
0.70	87.72	71.78	130.05	327.28	529.11
0.80	87.82	77.21	218.26	583.09	878.56
0.81	87.83	77.98	232.47	624.68	935.13

Calculated by: JAK | 3/16



VORTECHS SYSTEM® BYPASS CALCULATIONS
MAHOGANY PHASE 1
OTTAWA, ON
MODEL 7000 OFF-LINE
SITE DESIGNATION OGS 2

CONTECH CONSTRUCTION PRODUCTS INC.

Vortechs System Specifications and Site Specific Information:

Vortechs System flow capacity, Q_V =	312	l/s	Actual length of bypass weir crest =	1.829	m
Design flow rate at recurrence interval, Q_D =	935	l/s			
Recurrence Interval, I =	100	yr	Peak water surface elevation, E_P =	87.83	m
			Discharge coefficient, C_D =	1883	

Notation:

Q_B = Flow over bypass weir, l/s

E_B = Elevation of bypass weir crest, m

h = Depth of flow over bypass weir crest, m

Calculations:

$Q_B = Q_P - Q_V$ - Calculate the flow over the bypass weir during the design-year storm.

= 935 - 312

= **623 l/s**

$Q_B = C_D L_B h^{3/2}$ - Francis formula for rectangular weir.

h = (QB / 1883 LB)2/3 - Use this arrangement of the Francis formula to solve for h.

= (623 / 1883 * 1.829)^2/3

= **0.33 m**

$\mathbf{E_B}$ **=** E_P - h - Solve for bypass weir crest elevation (E_B).

= 87.83 - 0.33

= **87.5 m**

Conclusion:

The bypass weir crest should be set at an elevation of 87.5 m with a total length of 1.829 m.

Calculated by: JAK	3/16	Checked by:

VORTECHS SYSTEM® ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON AN AVERAGE PARTICLE SIZE OF 80 MICRONS
MAHOGANY PHASE 1
OTTAWA, ON
MODEL 7000 OFF-LINE
SITE DESIGNATION OGS 3

CONTECH CONSTRUCTION PRODUCTS INC.

Design Ratio[1] = $\dfrac{\text{(5.51 hectares) x (0.43) x (2.775)}}{\text{(4.7 m2)}}$ **= 1.4**

Bypass occurs at an elevation of 87.13m (at approximately 24 l/s/m2)

Rainfall Intensity mm/hr	Operating Rate[2] % of capacity	Flow Treated (l/s)	% Total Rainfall Volume[3]	Rmvl. Effcy[4] (%)	Rel. Effcy (%)
0.5	1.0	3.3	10.7%	98.0%	10.5%
1.0	2.1	6.5	9.3%	98.0%	9.1%
1.5	3.1	9.8	10.3%	98.0%	10.1%
2.0	4.2	13.0	8.6%	98.0%	8.4%
2.5	5.2	16.3	6.7%	98.0%	6.6%
3.0	6.3	19.5	5.8%	98.0%	5.7%
3.6	7.3	22.8	5.0%	97.6%	4.9%
4.1	8.4	26.0	4.4%	96.9%	4.2%
4.6	9.4	29.3	2.3%	96.3%	2.2%
5.1	10.4	32.5	4.2%	96.0%	4.0%
6.4	13.1	40.7	7.4%	93.8%	6.9%
7.6	15.7	48.8	4.0%	91.8%	3.7%
8.9	18.3	56.9	3.5%	88.8%	3.1%
10.2	20.9	65.0	1.8%	87.3%	1.6%
11.4	23.5	73.2	3.8%	85.7%	3.2%
12.7	26.1	81.3	1.4%	84.3%	1.2%
19.1	39.2	122.0	5.1%	76.8%	3.9%
25.4	52.2	162.6	2.1%	62.9%	1.3%
38.1	78.3	243.9	1.6%	38.2%	0.6%
					91.4%

% rain falling at >38.1 mm/hr or bypassing treatment =	1.9%
Assumed removal efficiency for bypassed flows =	0.0%
Estimated reduction in efficiency[5] =	6.5%
Predicted Net Annual Load Removal Efficiency =	**85%**

1 - Design Ratio = (Total Drainage Area) x (Runoff Coefficient) x (Rational Method Conversion) / Grit Chamber Area
- The Total Drainage Area and Runoff Coefficient are specified by the site engineer.
- The rational method conversion based on the units in the above equation is 2.775.

2 - Operating Rate (% of capacity) = percentage of peak operating rate of 68 l/s/m^2.

3 - Based on 10 years of rainfall data from Canadian Station 6105976, Ottawa CDA, ON

4 - Based on Contech Construction Products laboratory verified removal of 38 to 500 micron particles with an average particle size of 80 microns (see Vortechs Guide).

5- Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Calculated by:	JAK	3/16	Checked by:

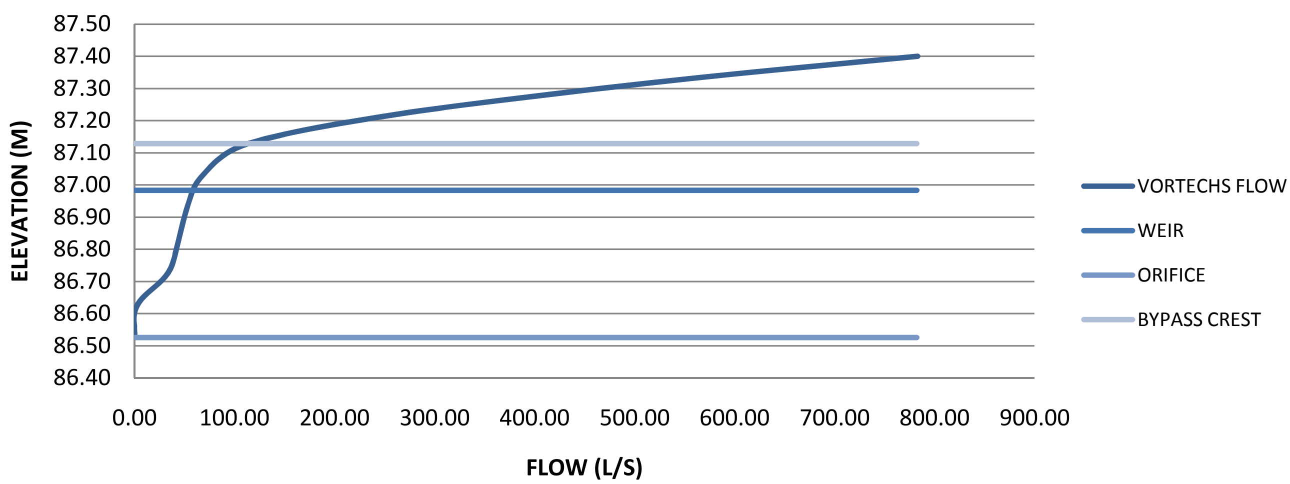
VORTECHS SYSTEM® FLOW CALCULATIONS
MAHOGANY PHASE 1
OTTAWA, ON
MODEL 7000 OFF-LINE
SITE DESIGNATION OGS 3

Vortechs Orifice	Vortechs Weir	Bypass Weir
Cd = 308	Cd = 1861	Cd = 1681
A (m^2) = 0.036	Weir Crest Length (m) = 0.457	Crest Length (m) = 1.829
Crest Elevation (m) = 86.53	Crest Elevation (m) = 86.98	Crest Elev. (m) = 87.13

Head (m)	Elevation (m)	Orifice Flow (l/s)	Weir Flow (l/s)	Bypass Flow (l/s)	Total Flow (l/s)
0.00	86.53	0.00	0.00	0.00	0.00
0.10	86.63	2.48	0.00	0.00	2.48
0.20	86.73	33.24	0.00	0.00	33.24
0.30	86.83	43.75	0.00	0.00	43.75
0.40	86.93	52.19	0.00	0.00	52.19
0.50	87.03	59.44	7.47	0.00	66.91
0.60	87.13	66.03	46.85	0.00	112.88
0.70	87.23	71.78	101.60	101.88	275.27
0.80	87.33	77.21	170.52	293.04	540.77
0.87	87.40	81.02	228.98	473.05	783.05

Calculated by: JAK | 3/16

VORTECHS STAGE DISCHARGE CURVE



CONTECH® CONSTRUCTION PRODUCTS INC.

VORTECHS SYSTEM® BYPASS CALCULATIONS
MAHOGANY PHASE 1
OTTAWA, ON
MODEL 7000 OFF-LINE
SITE DESIGNATION OGS 3

Vortechs System Specifications and Site Specific Information:

Vortechs System flow capacity, Q_V =	312	l/s	Actual length of bypass weir crest =	1.829	m
Design flow rate at recurrence interval, Q_D =	783	l/s			
Recurrence Interval, I =	100	yr	Peak water surface elevation, E_P =	87.40	m
			Discharge coefficient, C_D =	1681	

Notation:

Q_B = Flow over bypass weir, l/s

E_B = Elevation of bypass weir crest, m

h = Depth of flow over bypass weir crest, m

Calculations:

$Q_B = Q_P - Q_V$ — - Calculate the flow over the bypass weir during the design-year storm.

= 784 - 312

= **473 l/s**

$Q_B = C_D L_B h^{3/2}$ — - Francis formula for rectangular weir.

h = (QB / 1681 LB)2/3 — - Use this arrangement of the Francis formula to solve for h.

= (473 / 1681 * 1.829)^2/3

= **0.27 m**

$\mathbf{E_B} = E_P - h$ — - Solve for bypass weir crest elevation (E_B).

= 87.4 - 0.27

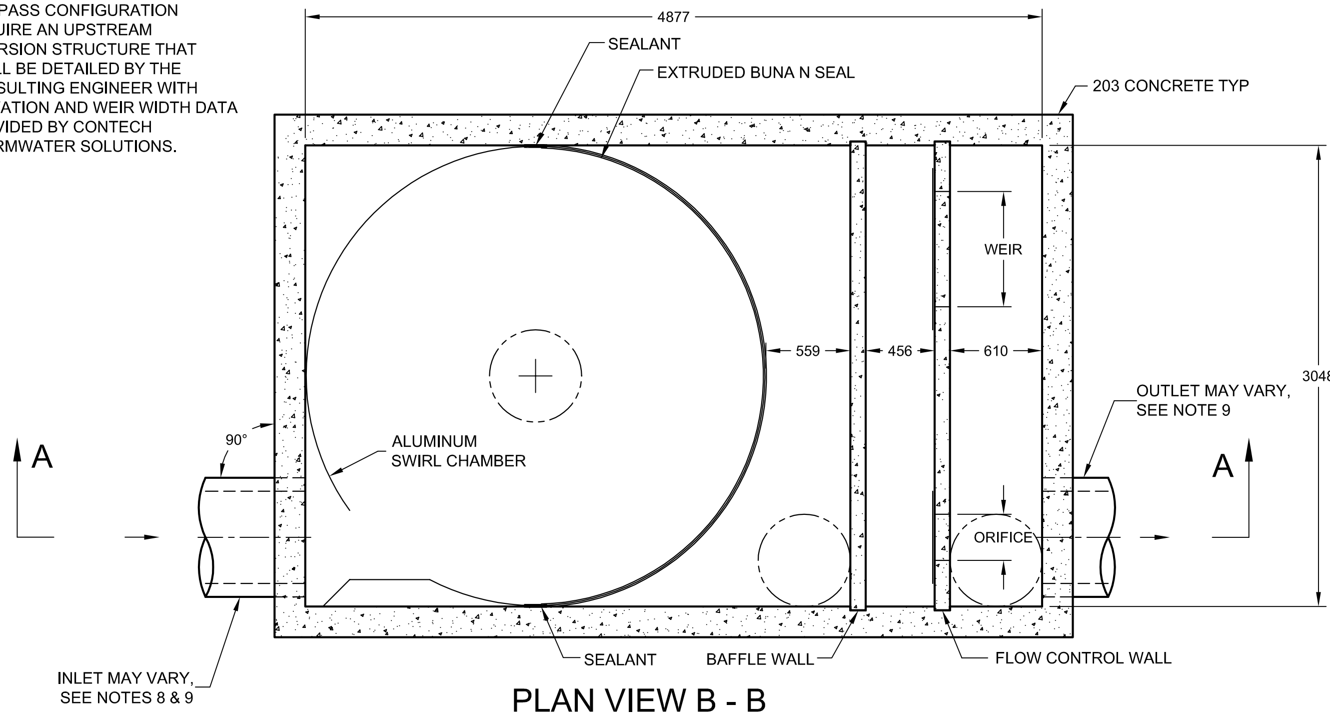
= **87.13 m**

Conclusion:

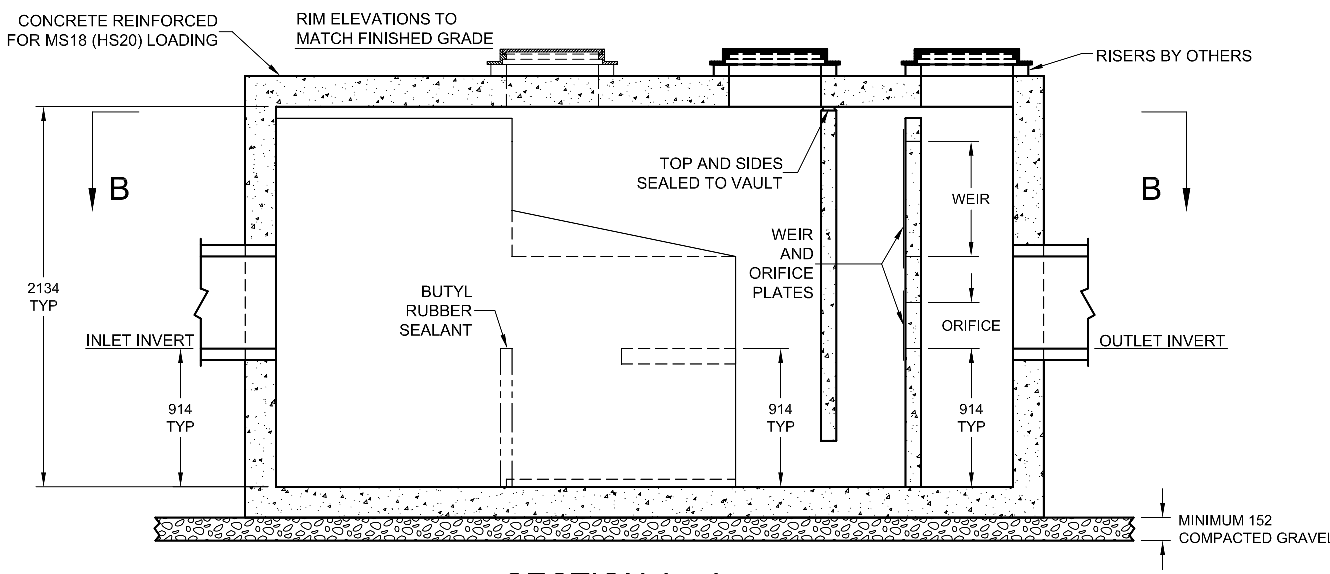
The bypass weir crest should be set at an elevation of 87.13 m with a total length of 1.829 m.

Calculated by: JAK	3/16	Checked by:

NOTE:
VORTECHS SYSTEMS INSTALLED IN A BYPASS CONFIGURATION REQUIRE AN UPSTREAM DIVERSION STRUCTURE THAT SHALL BE DETAILED BY THE CONSULTING ENGINEER WITH ELEVATION AND WEIR WIDTH DATA PROVIDED BY CONTECH STORMWATER SOLUTIONS.



PLAN VIEW B - B



SECTION A - A

NOTES:

1. STORMWATER TREATMENT SYSTEM (SWTS) SHALL HAVE:
   PEAK TREATMENT CAPACITY: 0.496 CMS
   SEDIMENT STORAGE: 4.28 CU M
   SEDIMENT CHAMBER DIA: 3048 MIN
2. SWTS SHALL BE CONTAINED IN ONE RECTANGULAR STRUCTURE
3. SWTS REMOVAL EFFICIENCY SHALL BE DOCUMENTED BASED ON PARTICLE SIZE
4. SWTS SHALL RETAIN FLOATABLES AND TRAPPED SEDIMENT UP TO AND INCLUDING PEAK TREATMENT CAPACITY
5. SWTS INVERTS IN AND OUT ARE TYPICALLY AT THE SAME ELEVATION
6. SWTS SHALL NOT BE COMPROMISED BY EFFECTS OF DOWNSTREAM TAILWATER
7. SWTS SHALL HAVE NO INTERNAL COMPONENTS THAT OBSTRUCT MAINTENANCE ACCESS
8. INLET PIPE MUST BE PERPENDICULAR TO THE STRUCTURE
9. PIPE ORIENTATION MAY VARY; SEE SITE PLAN FOR SIZE AND LOCATION
10. PURCHASER SHALL NOT BE RESPONSIBLE FOR ASSEMBLY OF UNIT
11. MANHOLE FRAMES AND PERFORATED COVERS SUPPLIED WITH SYSTEM, NOT INSTALLED
12. PURCHASER TO PREPARE EXCAVATION AND PROVIDE CRANE FOR OFF-LOADING AND SETTING AT TIME OF DELIVERY
13. VORTECHS SYSTEMS BY CONTECH STORMWATER SOLUTIONS; PORTLAND, OR (800) 548-4667; SCARBOROUGH, ME (877) 907-8676; LINTHICUM, MD (866) 740-3318.

PROPRIETARY INFORMATION - NOT TO BE USED FOR CONSTRUCTION PURPOSES

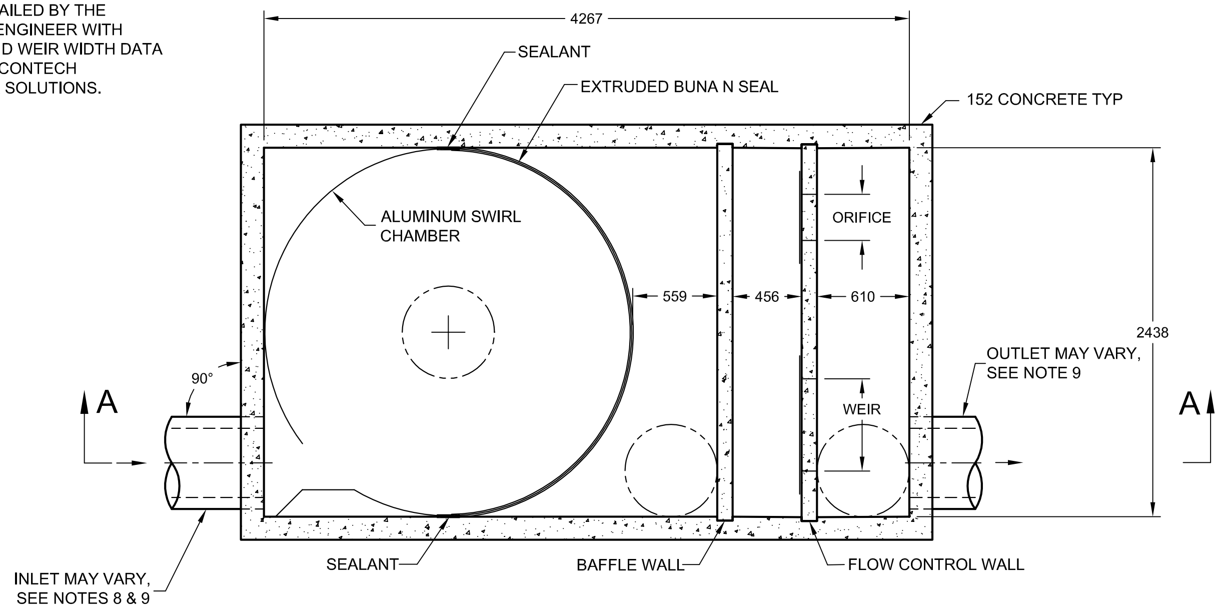
CONTECH® STORMWATER SOLUTIONS INC.
contechstormwater.com

STANDARD DETAIL
STORMWATER TREATMENT SYSTEM
VORTECHS® MODEL 11000 METRIC

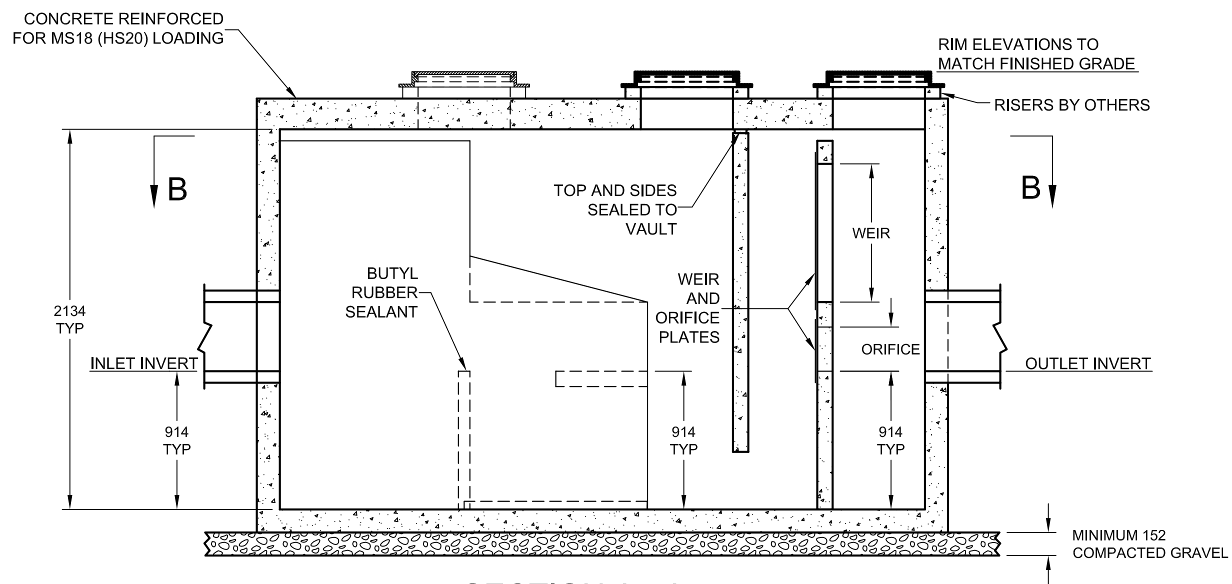
U.S. PATENT No. 5,759,415

DATE: 4/8/06	SCALE: NONE	FILE NAME: STD11KM	DRAWN: GMC	CHECKED: NDG

NOTE:
VORTECHS SYSTEMS INSTALLED IN A BYPASS CONFIGURATION REQUIRE AN UPSTREAM DIVERSION STRUCTURE THAT SHALL BE DETAILED BY THE CONSULTING ENGINEER WITH ELEVATION AND WEIR WIDTH DATA PROVIDED BY CONTECH STORMWATER SOLUTIONS.



PLAN VIEW B - B



SECTION A - A

NOTES:

1. STORMWATER TREATMENT SYSTEM (SWTS) SHALL HAVE:
   PEAK TREATMENT CAPACITY: 0.311 CMS
   SEDIMENT STORAGE: 3.06 CU M
   SEDIMENT CHAMBER DIA: 2438 MIN
2. SWTS SHALL BE CONTAINED IN ONE RECTANGULAR STRUCTURE
3. SWTS REMOVAL EFFICIENCY SHALL BE DOCUMENTED BASED ON PARTICLE SIZE
4. SWTS SHALL RETAIN FLOATABLES AND TRAPPED SEDIMENT UP TO AND INCLUDING PEAK TREATMENT CAPACITY
5. SWTS INVERTS IN AND OUT ARE TYPICALLY AT THE SAME ELEVATION
6. SWTS SHALL NOT BE COMPROMISED BY EFFECTS OF DOWNSTREAM TAILWATER
7. SWTS SHALL HAVE NO INTERNAL COMPONENTS THAT OBSTRUCT MAINTENANCE ACCESS
8. INLET PIPE MUST BE PERPENDICULAR TO THE STRUCTURE
9. PIPE ORIENTATION MAY VARY; SEE SITE PLAN FOR SIZE AND LOCATION
10. PURCHASER SHALL NOT BE RESPONSIBLE FOR ASSEMBLY OF UNIT
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12. PURCHASER TO PREPARE EXCAVATION AND PROVIDE CRANE FOR OFF-LOADING AND SETTING AT TIME OF DELIVERY
13. VORTECHS SYSTEMS BY CONTECH STORMWATER SOLUTIONS; PORTLAND, OR (800) 548-4667; SCARBOROUGH, ME (877) 907-8676; LINTHICUM, MD (866) 740-3318.

PROPRIETARY INFORMATION - NOT TO BE USED FOR CONSTRUCTION PURPOSES

contechstormwater.com

STANDARD DETAIL
STORMWATER TREATMENT SYSTEM
VORTECHS® MODEL 7000 METRIC

U.S. PATENT No. 5,759,415

DATE: 4/5/06	SCALE: NONE	FILE NAME: STD7KM	DRAWN: GMC	CHECKED: NDG

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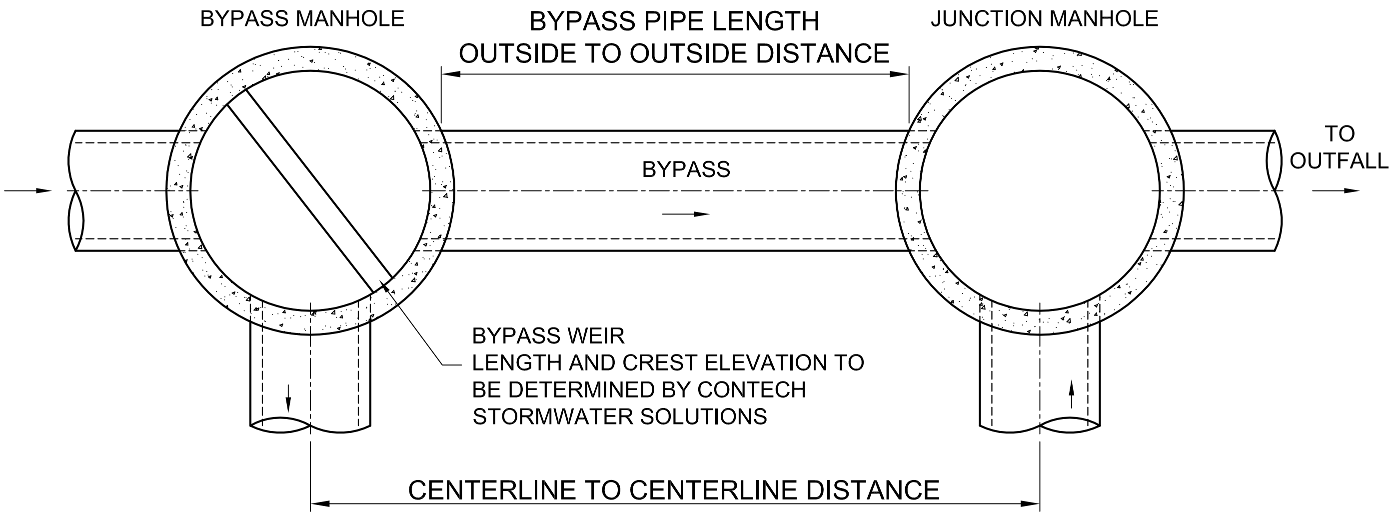
-BYPASS AND JUNCTION STRUCTURES NOT SUPPLIED BY CONTECH STORMWATER SOLUTIONS-



NOTE: BYPASS AND JUNCTION MANHOLE DIAMETERS ARE ASSUMED BASED ON THE TREATMENT CAPACITY OF THE VORTECHS SYSTEM. THESE DIAMETERS MAY CHANGE DEPENDING ON SPECIFIC SITE CONDITIONS. CONTACT YOUR CONTECH STORMWATER SOLUTIONS DESIGN ENGINEER.

Vortechs Model Size	Vortechs Dims		Recommended Pipe Size Diameter in / mm	Typical Bypass Manhole Diameter	Typical Junction Manhole Diameter	Approximate Center to Center Distance ft / mm	Approximate Bypass Pipe Length Outside ft / mm
	Length ft / mm	Width ft / mm					
1000	9 / 2743	3 / 914	10 / 250	4 / 1200	4 / 1200	7.5 / 2286	3.5 / 1067
2000	10 / 3048	4 / 1219	12 / 300	4 / 1200	4 / 1200	8.5 / 2591	4.42 / 1347
3000	11 / 3353	5 / 1524	15 / 375	5 / 1500	4 / 1200	9.25 / 2819	4.75 / 1448
4000	12 / 3658	6 / 1829	15 / 375	5 / 1500	4 / 1200	10.25 / 3124	5.75 / 1753
5000	13 / 3962	7 / 2134	18 / 450	6 / 1800	5 / 1500	11.17 / 3405	5.67 / 1728
7000	14 / 4267	8 / 2438	18 / 450	6 / 1800	5 / 1500	12.17 / 3709	6.67 / 2033
9000	15 / 4572	9 / 2743	21 / 525	6 / 1800	6 / 1800	11.83 / 3606	5.83 / 1777
11000	16 / 4877	10 / 3048	24 / 600	6 / 1800	6 / 1800	12.67 / 3862	6.67 / 2033
16000	18 / 5486	12 / 3658	27 / 675	6 / 1800	6 / 1800	14.58 / 4444	8.58 / 2615

CONTECH® STORMWATER SOLUTIONS INC.
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TYPICAL BYPASS & JUNCTION MANHOLE LAYOUT
WITH SPECIFICATIONS TABLE FOR
VORTECHS® STORMWATER TREATMENT SYSTEM

DATE: 1/24/07	SCALE: NONE	FILE NAME: TYPTBLVXBPRmet	DRAWN: GMC	CHECKED: NDG

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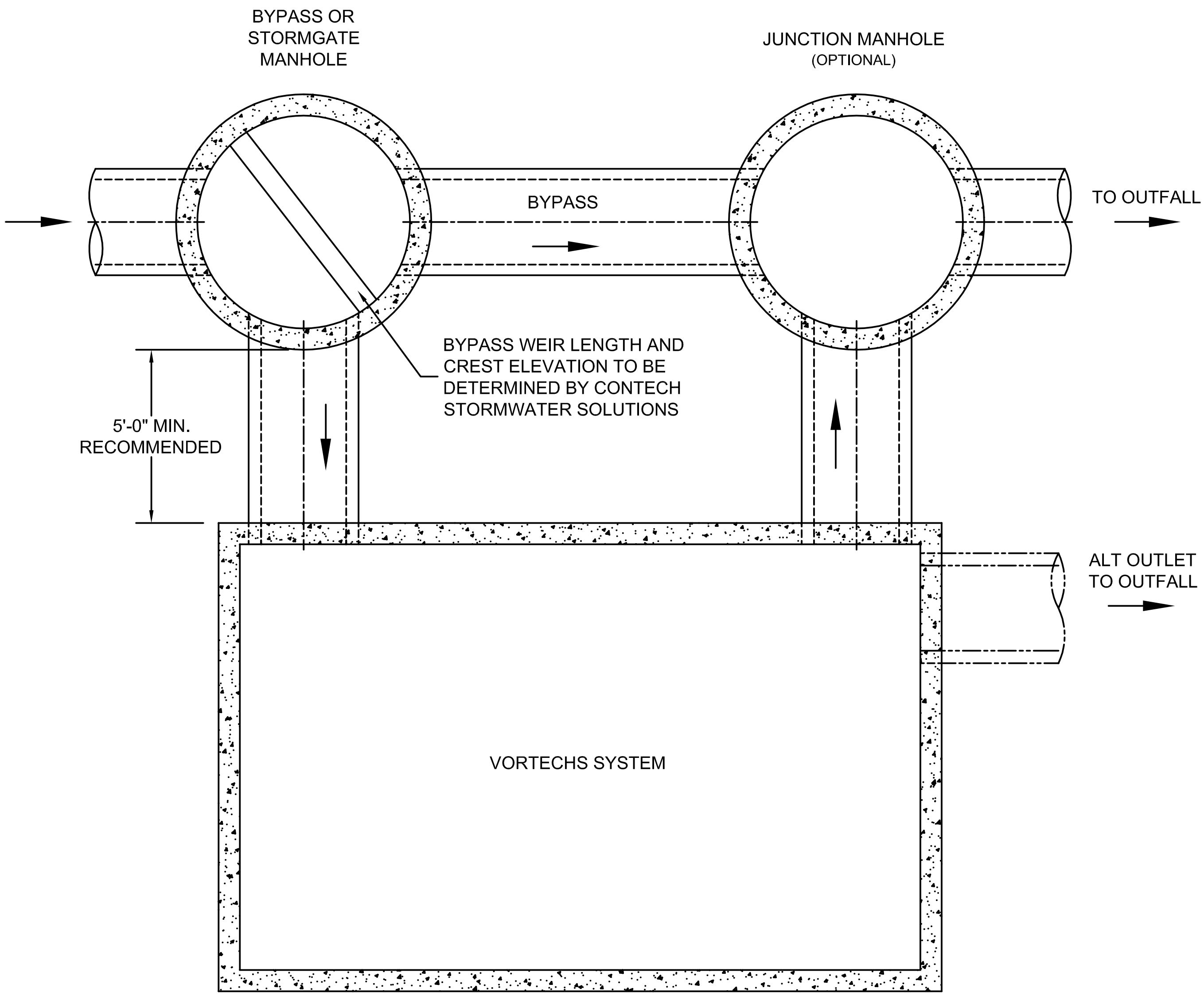
- BYPASS AND JUNCTION STRUCTURES NOT SUPPLIED BY CONTECH STORMWATER SOLUTIONS -



ACTUAL ORIENTATION AND LAYOUT MAY VARY
DUE TO SITE SPECIFIC CONSIDERATIONS

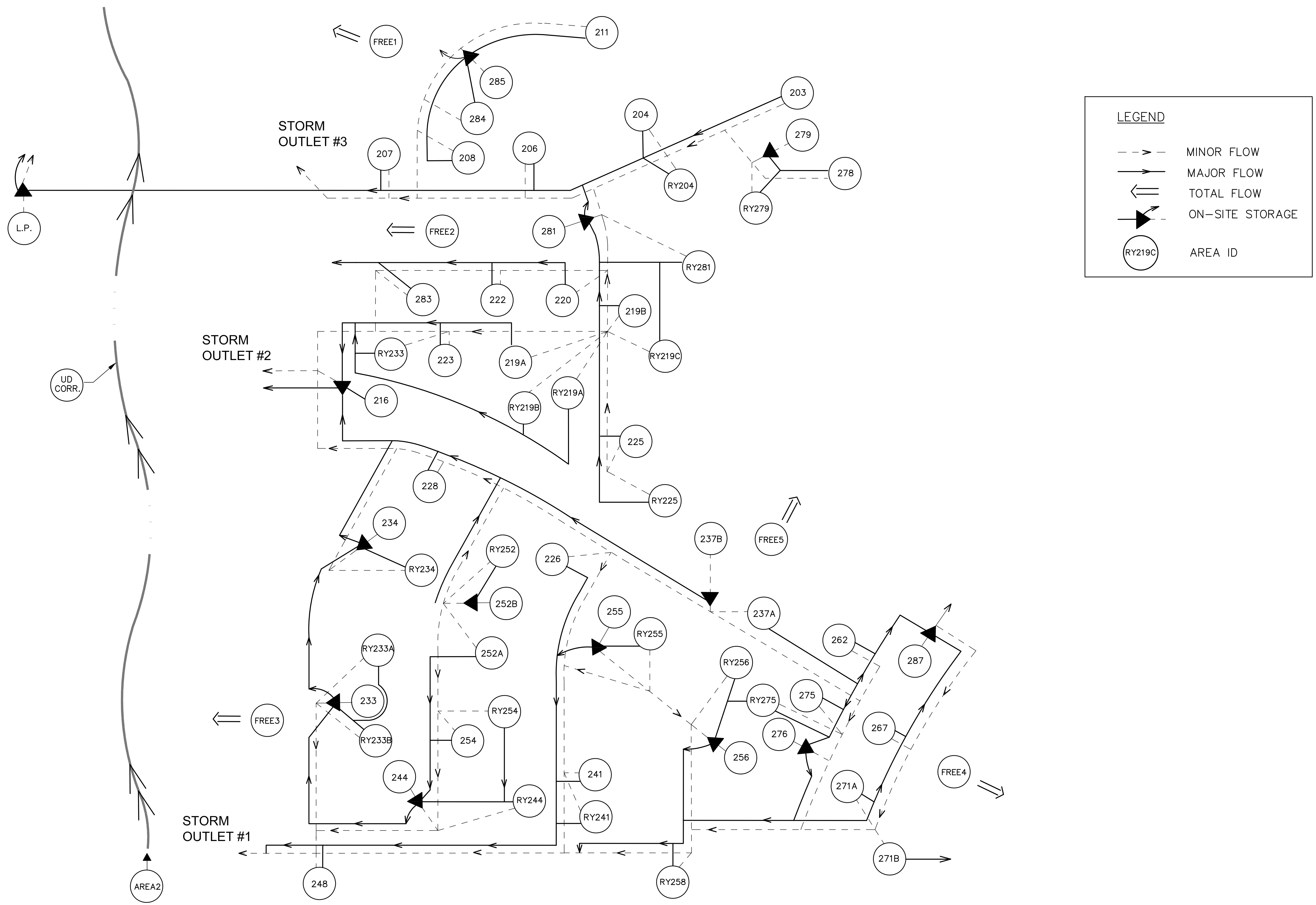
CONTECH® STORMWATER SOLUTIONS INC.
contechstormwater.com

TYPICAL BYPASS LAYOUT
VORTECHS® STORMWATER TREATMENT SYSTEM

DATE: 6/15/06	SCALE: NONE	FILE NAME: TYPVXBPLOR	DRAWN: GMC	CHECKED: NDG

Appendix 7C

SWMHYMO Model Schematic



Scale

N.T.S.

Project Title

MAHOGANY PHASE 1

Drawing Title

PHASE 1
SWMHYMO SCHEMATIC

Sheet No.

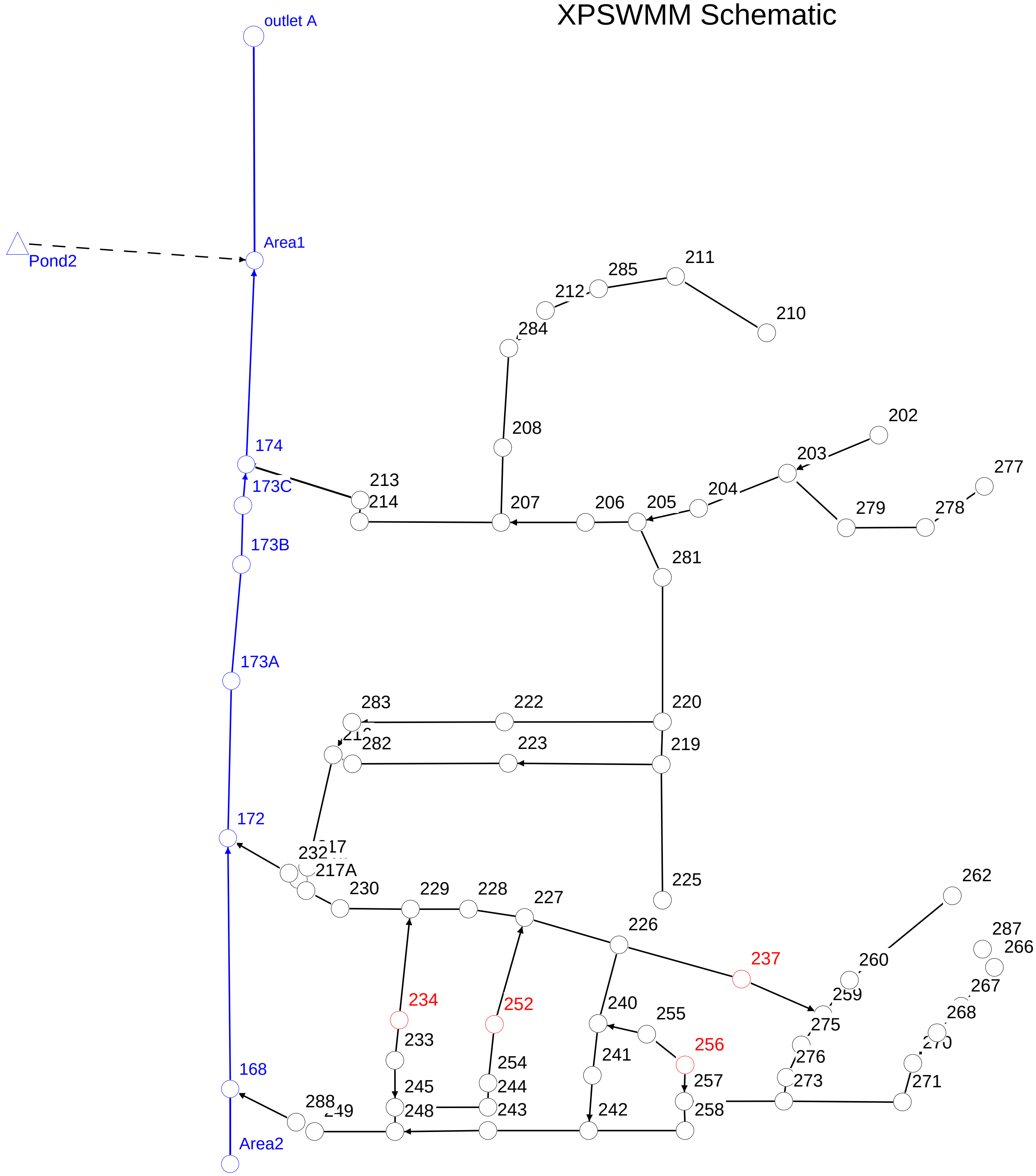
IBI GROUP

Appendix 7D

XPSWMM Model Schematic

Model Files (CD)

XPSWMM Schematic



SWMM Version 9.12 Copyright (c) XP Software	**MANOTICK** Licenced To: IBI Group [42-1100-1763]	Page 1/1

DRAFT

WILSON COWAN DRAIN FLUVIAL GEOMORPHIC EXISTING CONDITIONS

MINTO MAHOGANY, MANOTICK

156380-25016-504

Report Prepared for:
MINTO COMMUNITIES INC.

Prepared by:
MATRIX SOLUTIONS INC.

May 2017
Guelph, Ontario

Unit 7B - 650 Woodlawn Rd. W
Guelph, ON N1K 1B8
T 519.772.3777 F 226.314.1908
www.matrix-solutions.com

DRAFT

WILSON COWAN DRAIN FLUVIAL GEOMORPHIC EXISTING CONDITIONS

MINTO MAHOGANY, MANOTICK

156380-25016-504

Report prepared for Minto Communities Inc., May 2017

	reviewed by
Matthew McCombs, M.A.Sc., P.Eng.	**John Parish, P.Geo.**
Water Resources Engineer	**Principal Geomorphologist**

DISCLAIMER

DRAFT

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APPENDIX

Appendix A Site Photographs and Detailed Survey Locations

1 INTRODUCTION

Matrix Solutions Inc. was retained by Minto Communities Inc. to provide a fluvial geomorphic existing conditions assessment of the Wilson Cowan Municipal Drain and its Tributary within the Minto Mahogany development area (Figure 1). The Drain and Tributary are under consideration as receiving channels for future stormwater management practices. The purpose of this report is to identify the existing conditions of the two watercourses and provide erosion threshold estimates in support of stormwater management design.

The following work was completed in support of this study:

- a background review of past geomorphic and environmental studies of the site and current and historical aerial imagery
- a field investigation to understand the existing conditions (stability, form, function, and processes) and delineate study reaches
- detailed geomorphic surveys in the main branch of the Drain and within the Tributary for the purposes of quantifying erosion threshold estimates
- erosion threshold analyses of each channel using collected field data

1.1 Background Review

1.1.1 Available Reporting

The report entitled *Natural Resource Existing Conditions Report – Part Lot 4 and 5 Concession A Former Geographic Township of Rideau, City of Ottawa* (EcoTech, 2008) was completed to provide a biophysical inventory of the property in order to assess the existing woodlands and wetland features, delineate vegetation community boundaries, determine fisheries populations, conduct geomorphological survey of the watercourses, and determine potential land use restrictions.

Channel dimensions, velocities, and material composition were determined throughout the study area including the current subject reaches. Overall, the majority of the channels were found to have low channel bed slopes and were composed of silty clay. The results presented in the 2008 report have been compared to the results of this current assessment.

1.1.2 Historical Aerial Imagery

Based on available historical imagery dating back to 1976, little discernable change has occurred to the planform of the channel over the past 41 years. This is consistent with the stability found within the channel observed during the field investigation. Urban development has occurred downstream of the study area since 1976 but the land use through the study area and upstream has remained agricultural with little change.

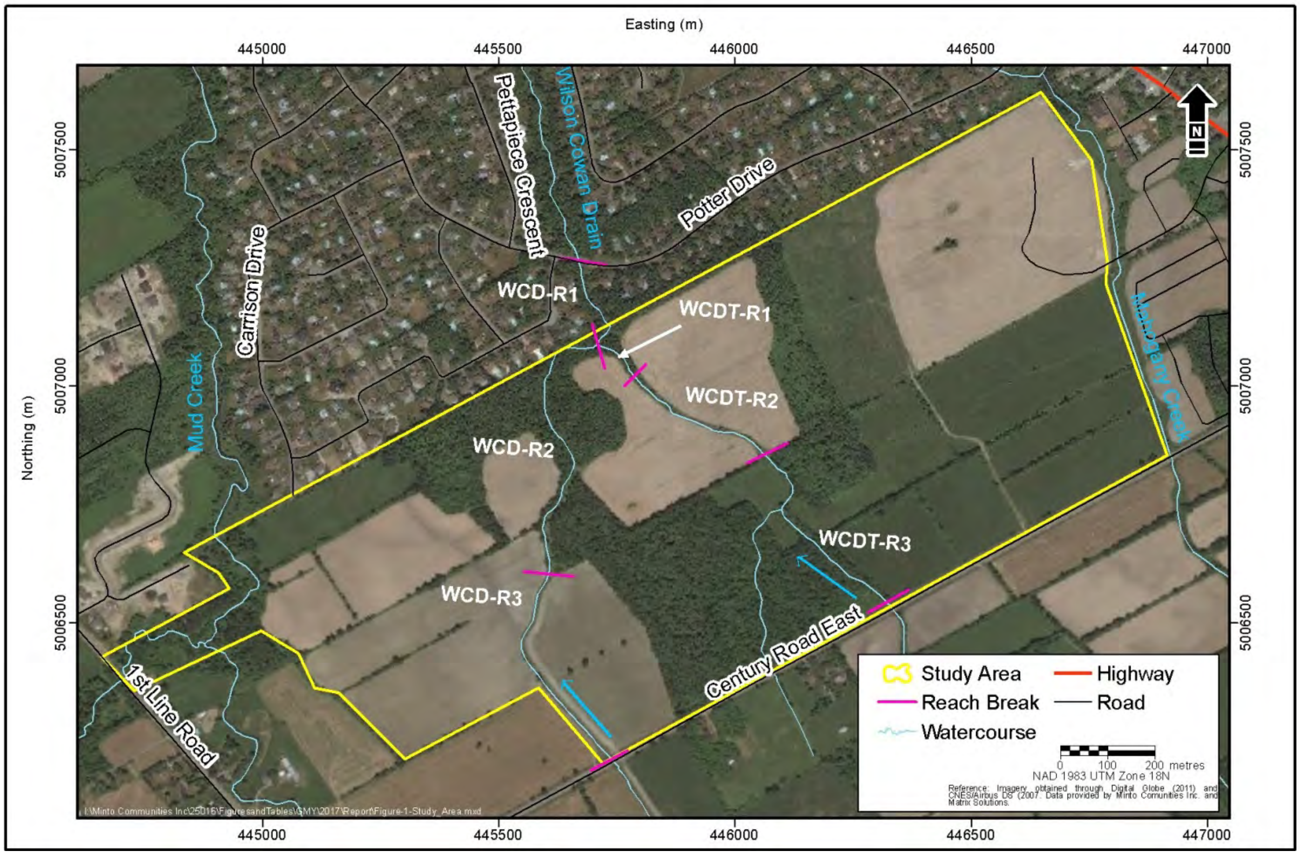

FIGURE 1 Study Area and Subject Watercourses

2 EXISTING CONDITIONS

The channels were investigated on April 12 and 13, 2017 to identify forms of natural channel adjustment, note general channel properties, and take measurements of channel geometry. During the initial site visit on April 12, channel conditions along the study reaches were evaluated using an established synoptic survey: the Rapid Geomorphic Assessment (RGA). A summary of this assessment is provided in Table 1. Detailed surveys of the Wilson Cowan Drain and its Tributary were completed on April 13 in locations displaying the greatest potential for erosion. Each survey included five cross-sections and a longitudinal profile of the centre of channel.

2.1 Rapid Geomorphic Assessment

The RGA was designed by the Ontario Ministry of Environment (2003) to assess reaches in rural and urban channels. This qualitative technique documents indicators of channel instability. Observations are quantified using an index that identifies channel sensitivity based on the presence or absence of evidence of aggradation, degradation, channel widening, and planimetric adjustment. Examples of these include the presence of bar forms, exposed infrastructure, head cutting due to knickpoint migration, fallen or leaning trees and exposed tree roots, channel scour along the bank toe, transition of the channel from single thread to multiple thread, and cut-off channels. Overall, the index produces values that indicate whether the channel is in regime (score ≤ 0.20), stressed (score 0.21 to 0.40), or adjusting (score ≥ 0.41).

TABLE 1 Summary of RGA Results for the Mahogany Site

Reach	Aggradation	Degradation	Widening	Planimetric Adjustment	Condition
WCD-R1	0.22	0	0.25	0	In Regime
WCD-R2	0.22	0	0	0	In Regime
WCD-R3	0.22	0	0.13	0	In Regime
WCDT-R1	0.11	0.29	0.25	0	In Regime
WCDT-R2	0.11	0	0	0	In Regime
WCDT-R3	0.11	0	0	0	In Regime

2.1.1 Wilson Cowan Drain

The Wilson Cowan Drain was divided into three reaches (WCD-R1 to WCD-R3) based on land use, channel form, and channel function. Overall the channel is highly stable under existing conditions. The channel is straight and likely historically dredged to serve its function as a municipal drain. The system is aggradational throughout with a large amount of its bed composition consisting of agricultural runoff, as made evident by its composition (sandy silt), and in some locations, based on its organic content (top soil compared to typical alluvial sediment). Throughout the watercourse, the bed material was loose and, in reach WCD-R3, the soil was both loose and unconsolidated. To accommodate municipal drain requirements for surrounding lands, the channel's relatively large cross-sectional area and low slope have resulted in a mainly depositional system. In some locations, immediately adjacent to agricultural lands, concentrated runoff volumes carrying loose sediment have created small gullies that flow into the drain. The bed sediment at and immediately downstream of these locations were composed of sandy and silty, highly organic material.

WCD-R1 represents the furthest reach of channel downstream from the confluence with the Tributary. This reach was assessed to the nearest downstream edge of property. This was the extent of where access was permitted at the time of the survey. Based on aerial imagery, this reach extends to Potter Drive, at which point the channel widens significantly before narrowing through an approximately

35 m wide wetland floodplain, dominated by tall grasses, to Bankfield Road. WCD-R1 has a bankfull width of 7.4 m and a bankfull depth of 1 m. The channel bottom was composed of soft but consolidated silty clay and had a low channel slope. Where present, coarser materials were embedded and there was evidence of deposition in and around woody debris. These processes are indicative of aggradation. Although some evidence of widening was noted in the form of organic debris and falling trees, these observations were likely not a result of channel widening, but rather naturally falling trees and branches broken from high winds.

Upstream of the confluence with the Tributary, to the end of the surrounding woodlot (approximate 600 m channel length), WCD-R2 is similar to its upstream neighbour in form and function but has a slightly smaller cross-sectional profile, with a 5.5 m bankfull width and 0.85 m bankfull depth. The majority of the bank and bed below the bankfull level were exposed and lacking in vegetation. This reach is assumed to the most susceptible to erosion, given its bare bed and banks, which suggests that this stretch of channel represents the least depositional reach of the system.

WCD-R3 extends from the end of the woodlot to the site boundary at Century Road East (approximate 470 m reach length). In this reach, the bankfull width and depth were approximately 6.3 m and 1.3 m, respectively. The channel bed in this location was composed of soft, unconsolidated silt, and organic soil with a large amount of instream vegetation, dominated by cattails. The material and condition of the drain suggested a high sediment load from neighbouring agricultural lands. Through this reach, there is little to no riparian buffer and the majority of the banks are lined with tall grasses.

2.1.2 Wilson Cowan Drain Tributary

The Tributary to the Wilson Cowan Drain was also divided into three reaches (WCDT-R1 to WCDT-R3). The Tributary exhibited a good deal of stability throughout and was found to be in regime along its entire length. The downstream (approximately 90 m) portion of the channel was composed of a steep step/riffle sequence to the confluence with the main branch of the Wilson Cowan Drain. Upstream of this area, the channel contained short, less defined banks that were void of channel processes. This is typical of intermittent or ephemeral streams. These upstream reaches were flooded at the time of the survey due to recent rains and snow melt. The bed of the channel in these low gradient portions of the channel contained instream grasses or decaying leaves.

Through WCDT-R1, small round boulders were observed along the banks and overbanks of the channel. The steps/riffles were mostly composed of these larger stone sizes. Between larger boulder steps, the bed was mostly composed of gravels and sands, except in locations where channel obstructions (woody debris, etc.) had formed pockets of fine sand and silt deposits from surrounding agricultural lands. The average bankfull width and depth of the reach were 4.0 m and 0.3 m, respectively.

WCDT-R2 extended from WCDT-R1, 350 m upstream to the edge of the woodlot. In this area the channel was an average of 6 m wide and 0.7 m deep and contained instream grasses and a low channel gradient. The channel bottom was composed of a silty clay substrate.

WCDT-R3 begins adjacent to a woodlot with a channel width and depth of 3.3 m and 0.30 m, respectively. In this location the channel did not contain instream vegetation and the beds and banks were composed of highly organic soils and decaying leaves. During the time of the investigation (April 12, 2017), a level of flooding was observed throughout this reach. In some locations large ponds had formed, submerging overbank trees. In the upstream 300 m of channel to Century Rd. East, the flooding expanded to form a 30 m wide pond and no defined channel was observed. No evidence of fluvial processes was observed where a defined channel was present, and EcoTech Environmental Consultants Inc. (2008), observed little to no flow within the channel in May and June 2007, suggest that the channel through this reach is intermittent or ephemeral.

2.2 Detailed Survey

2.2.1 Profile and Cross-sections

A detailed geomorphic survey was completed of approximately 170 m of the main branch of the Wilson Cowan Drain (WCD-R2). The length of the Wilson Cowan Drain surveyed had a low average bed slope of approximately 0.01%. Points surveyed of bankfull locations suggested that water elevations at during bankfull flows produce water elevation slopes between 0.05% and 0.14%, which are more consistent with channel slopes observed by EcoTech Environmental Consultants Inc. (2008) and more representative of the average channel slope. Given the uniformity of the channel, the five cross-sections collected were representative of the watercourse.

The entire 90 m length of WCDT-R1 was surveyed as it exhibited the most forms of channel adjustment and is likely to see the most rapid response to changing flow conditions given its bed steepness and exposed boulder step sequence. Five cross-sections were collected as part of the survey. The average channel slope of the surveyed area was 1.2%.

Values of discharge, velocity, and shear stress provided in Table 2 were quantified using a panelled approach between surveyed points of each cross-section and averaged. Manning's n values were chosen based on channel conditions and the roughness associated with the channel materials observed.

TABLE 2 Average Bankfull Cross-section Parameters

Parameter	WCD-R2	WCDT-R1
Width (m)	5.52	3.76
Average Depth (m)	0.54	0.27
Maximum Depth (m)	0.85	0.41
Width: Depth	10.38	14.08
Cross-sectional Area (m^2)	3.06	0.99
Representative Bed Slope (%)	0.05	1.2
Left Bank Angle (^{o})	26	18
Right Bank Angle (^{o})	20	17
Discharge (m^3/s)	1.68	1.46
Average Velocity (m/s)	0.46	1.25
Maximum Velocity (m/s)	0.66	1.86
Average Shear Stress (N/m^2)	2.55	30.20
Maximum Shear Stress (N/m^2)	4.13	47.6
Manning's n	0.030	0.037

2.2.2 Sediment Characteristics

The bed material through the surveyed section of WCD-R2 was composed of clayey silt with trace sands. The material was characterised in the field as a loose, lean, clayey soil. The banks, up to the bankfull level were mainly composed of this lean, clayey soil but more compact than the bed material.

Through WCDT-R1 the step feature materials were composed of very coarse gravel (3 to 6 cm) to small boulders (25 to 50 cm). Between these areas of coarser material, the material was mostly composed of gravels embedded in sandy silt with trace clays. For the threshold analysis, coarse gravels to small cobbles were considered as these are representative of the mean grain size of the reach.

3 EROSION THRESHOLD ANALYSIS

3.1 Methods

The general procedure for estimating erosion thresholds is to calculate a critical flow, shear stress, or permissible velocity at which a sediment particle of a given grain size will begin to mobilize. Once a suitable value is determined, a model is used which increases the volume of the channel incrementally until values of shear stress or water velocity equal critical values. Matrix uses established entrainment relationships to calculate erosion thresholds based on critical shear stress and permissible velocity (velocity at which the channel lining will begin to actively erode). The model results are then examined for convergence and compatibility with field observations. Selection of appropriate thresholds is also based on an understanding of site conditions and of the assumptions and range of conditions under which the entrainment relationships are applicable.

Through WCD-R2, loose, lean, clayey soils dominate the bed composition. For coarse materials, the median grain size (D_{50}) is commonly used in the determination of an erosion threshold value. In cases where fine, cohesive materials are considered, a median grain size would produce unrealistically low values of critical shear stress as the cohesion between these finer particles would not be taken into consideration. Although fine-grained particles are typically more vulnerable to erosion, the cohesion between the silt and clay particles adds resistance to shear stresses depending on the compactness and void ratio of the soil and must be taken into account in the threshold analysis. In the case of WCD-R2, the analysis must rely on relationships developed through studies of maximum permissible shear stresses for cohesive sediment. The method by Chow (1959) provides estimates of critical shear stress based on the void ratio or compactness of various cohesive materials (Figure 2).

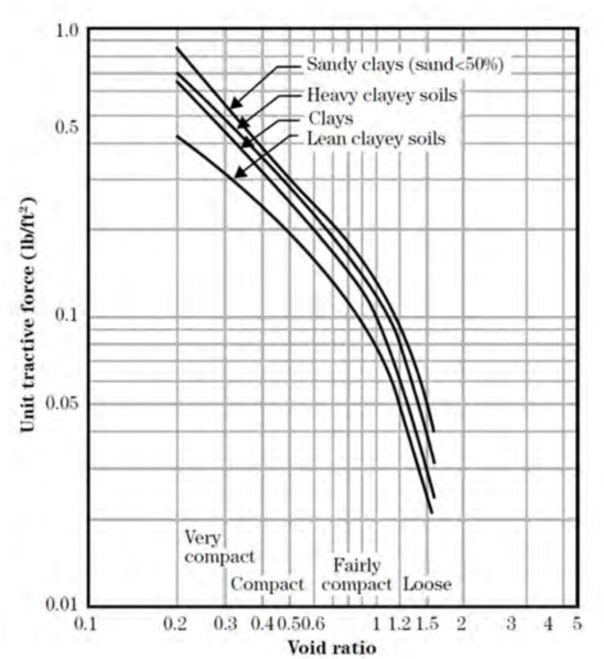

FIGURE 2 Allowable Shear Stress in Cohesive Material (Chow 1959)

In contrast, WCDT-R1 is dominated by non-cohesive, granular sediment. The Modified Shields Curve (Yalin and da Silva, 2001) was used to estimate a critical shear stress for incipient motion of the coarse gravels and small cobbles observed on site. The Modified Shields Curve applies to fluvial sediment transport rather than cohesive clays and muds (Figure 3).

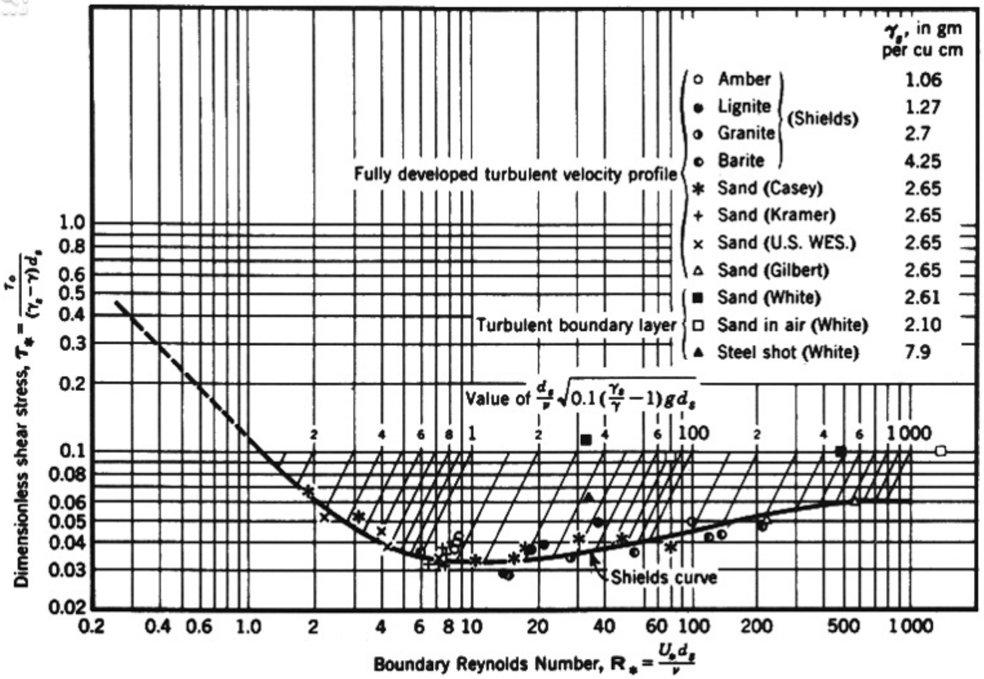

FIGURE 3 Shields Diagram for Initiation of Motion

Once the critical shear stresses were determined based on the methods described above, the thresholds were then calculated for each cross-section using the average cross-sectional dimensions. The hydraulic inputs to the iterative model are provided in Table 2. Bed and bank shear stresses were estimated using the method described by Javid and Mohammadi (2012) which accounts for secondary currents and variable eddy viscosity.

3.2 Results

3.2.1 Wilson Cowan Drain – Main Channel

Based on the method by Chow (1959), the range of loose, lean, clayey soils was considered in this analysis. The range of results is provided in Table 3. Critical shear stresses range from 1.01 to 2.39 N/m^2 for loose, lean, clayey soils. Based on field observations, water clarity was high during the field visit and little evidence of active sediment transport was noted. At the time of the survey, centre of channel wetted depths averaged 0.34 m. Based on these observations, it is assumed that the erosion threshold is only exceeded above this water level. A critical discharge of 0.29 m^3/s, equivalent to a critical average depth of approximately 0.40 m, is recommended.

TABLE 3 WCD-R2 Erosion Threshold Results Summary

Parameter	Low Range	High Range	Recommended Values
Approximate Bankfull Discharge (m^3/s)	1.68	1.68	-
Critical Shear Stress (N/m^2)	1.01	2.39	1.85
Critical Discharge (m^3/s)	0.10	0.45	0.29
Critical Average Depth (m)	0.21	0.53	0.40
Critical Average Velocity (m/s)	0.22	0.35	0.30

3.2.2 Wilson Cowan Drain - Tributary

When considering WCDT-R1, two grain sizes were considered to provide a range of critical shear stresses based on the Modified Shields Curve (Yalin and da Silva, 2001). Coarse gravels to small cobbles (3 to 7 cm diameter) were chosen as the representative material of the channel. This material represents the lower distribution within the riffles/steps and the embedded materials in the pools and transition zones between steps. During the field investigation, sediment transport was observed from adjacent agricultural lands (possible tile drain outlet locations), but observations of instream material transport were made. This suggests that the erosion threshold of the representative bed material occurs above the average water level observed (0.13 m). A value in the middle of the range considered (0.19 m) is recommended. This equates to a critical discharge of 0.24 m^3/s. The range of results and recommended values are provided in Table 4.

TABLE 4 WCDT-R1 Erosion Threshold Results Summary

Parameter	Low Range	High Range	Recommended Values
Approximate Bankfull Discharge (m^3/s)	1.46	1.46	-
Critical Shear Stress (N/m^2)	13.24	30.90	22.39
Critical Discharge (m^3/s)	0.11	0.39	0.24
Critical Average Depth (m)	0.12	0.26	0.19
Critical Average Velocity (m/s)	0.60	0.88	0.76

4 CONCLUSIONS AND RECOMMENDATIONS

A fluvial geomorphic assessment of the Wilson Cowan Drain and its Tributary through the Minto Mahogany development area was completed. As part of this study, the existing conditions of the watercourses were discussed and erosion threshold discharges were estimated for both channels to support future stormwater management practices.

Field observations of channel process noted that both channels exhibited depositional characteristics, with significant sediment inputs from surrounding agricultural lands. In low lying areas, gullying was present along channel banks where sediment heavy surface runoff from agricultural fields has caused the slope failures. These gullies provide significant sediment sources that make up the majority of the bed material through the site, especially in the main branch of the Wilson Cowan Drain. The channel showed no signs of active erosion.

The upstream reaches of the Tributary were low gradient depositional channels that are likely intermittent or ephemeral. The downstream reach was found to be much steeper with a step/riffle-pool sequence to its confluence with the main branch of the Drain. This channel was also found to be in regime and stable with little evidence of active erosion. Based on conditions during the site investigation (high water table and post freshet), the thresholds of upstream reaches are rarely exceeded as flows generally spill into the surrounding floodplain before attaining sufficient energy to cause erosion and natural channel processes.

Erosion thresholds were estimated using the methods by Chow (1959) and the Modified Shields Curve (Yalin and da Silva, 2001) to approximate the critical shear stress of the materials of each watercourse. Based on channel geometry and composition critical discharge values of 0.29 and 0.24 m^3/s for the Wilson Cowan Drain and its Tributary, respectively, are recommended for future stormwater management practices.

REFERENCES

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Yalin M.S. and da Silva A.M.F. 2001. *Fluvial processes*. International Association of Hydraulic Engineering and Research Monograph.

DRAFT

APPENDIX A
Site Photographs and Detailed Survey Locations

Matrix Solutions Inc.
April 12, 2017

1. WCD-R1: View looking downstream from Century Road. Agricultural fields on both sides of drain. Note presence of instream vegetation.

Matrix Solutions Inc.
April 12, 2017

2. WCD-R1: View looking upstream towards Century Road. Riparian zone consists of tall grasses and intermittent shrubs.

Matrix Solutions Inc.
April 12, 2017

3. WCD-R2: View looking downstream. Riparian zone consists of deciduous trees and grasses. Note the lack of vegetation along both bank toes.

Matrix Solutions Inc.
April 12, 2017

4. WCD-R2: Gully formation originating from agricultural field resulting in sandy depositional feature.

Matrix Solutions Inc.
April 12, 2017

5. WCD-R2: Wooden retaining wall behind houses along Watterson St. No active erosion observed.

Matrix Solutions Inc.
April 12, 2017

6. WCD-R2: Confluence of tributary (right side of photo) with the main channel of Wilson Cowan Drain.

Matrix Solutions Inc.
April 12, 2017

7. WCD-R1: View looking downstream. Some fallen trees, not due to erosion.

Matrix Solutions Inc.
April 12, 2017

8. WCD-R1: View looking downstream at step-pool formation. Large stones (potentially placed) across channel creating small drop.

Matrix Solutions Inc.
April 12, 2017

9. WCD-R1: View looking upstream from Watterson St. Large quantities of instream vegetation.

Matrix Solutions Inc.
April 12, 2017

10. WCDT-R1: View looking upstream. Substrate consists of small-large cobble within a riffle-pool sequence.

Matrix Solutions Inc.
April 12, 2017

11. WCDT-R1: Woody debris build up in channel.

Matrix Solutions Inc.
April 12, 2017

12. WCDT-R1: Tributary within wooded buffer with agricultural fields on both sides.

Matrix Solutions Inc.
April 12, 2017

13. WCDT-R2: View looking upstream. Shows transition from agricultural field to beginning of wooded buffer.

Matrix Solutions Inc.
April 12, 2017

14. WCDT-R2: Channel has lost definition and has much lower grade.

Matrix Solutions Inc.
April 12, 2017

15. WCDT-R3: Where channel enters wooded area it regains some definition.

Matrix Solutions Inc.
April 12, 2017

16. WCDT-R3: Water spreads out and creates small pond.

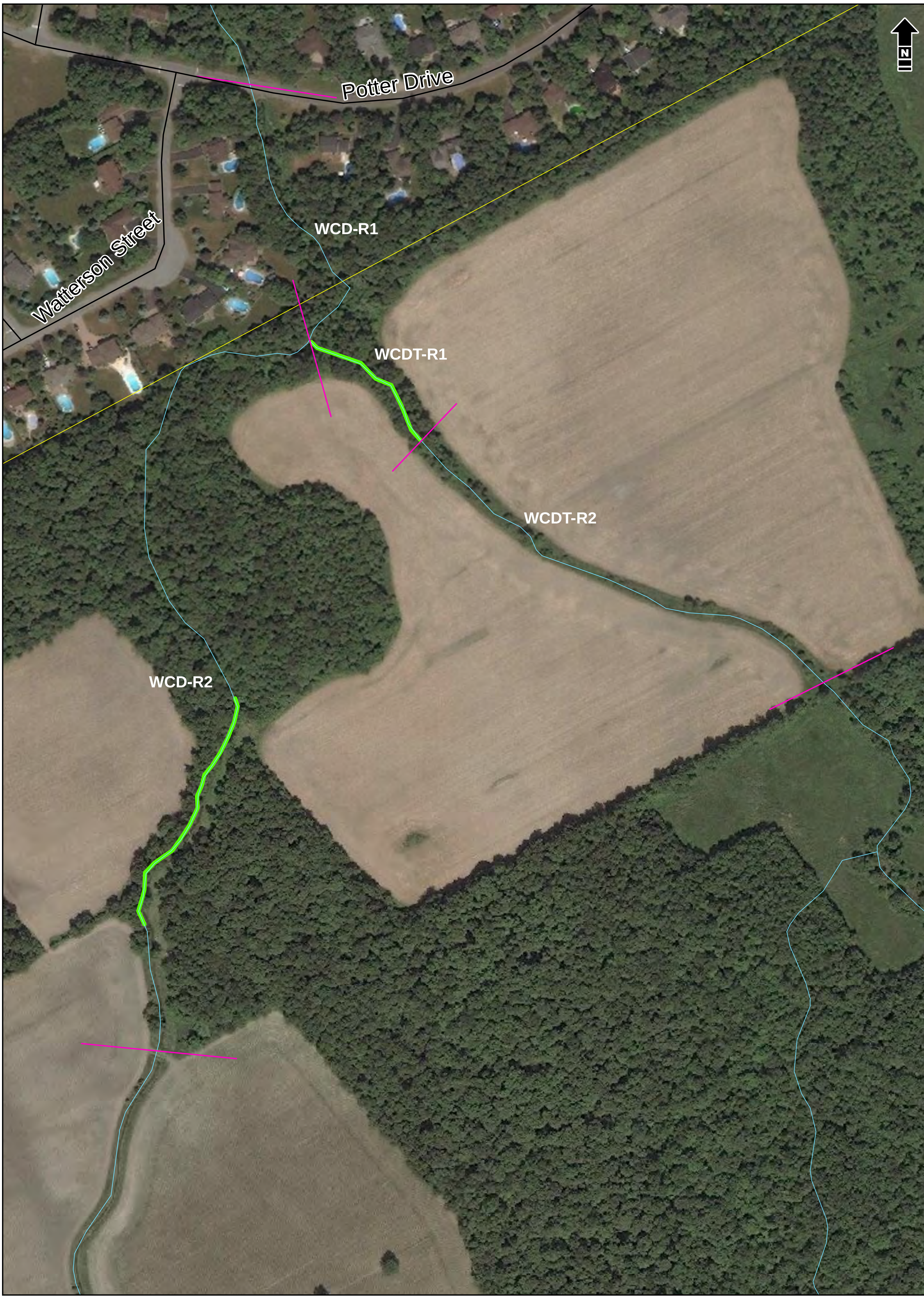
Matrix Solutions Inc.
April 12, 2017

17. WCDT-R3: Channel remains undefined and flooded up to culvert under Century Rd.

I:\Minto Communities Inc\25016\FiguresandTables\GMY\2017\Report\Figure-B-Geomorphic_Detailed_Survey_Locations.mxd

Easting (m)

Northing (m)



Study Area
Survey Location
Reach Break
Watercourse
Road

1:2,600
25 0 25 50 m
NAD 1983 UTM Zone 18N

Reference:Imagery obtained through DigitalGlobe (2011) and CNES/Airbus DG (2007). Data obtained from Minto Communities Inc. and Matrix Solutions

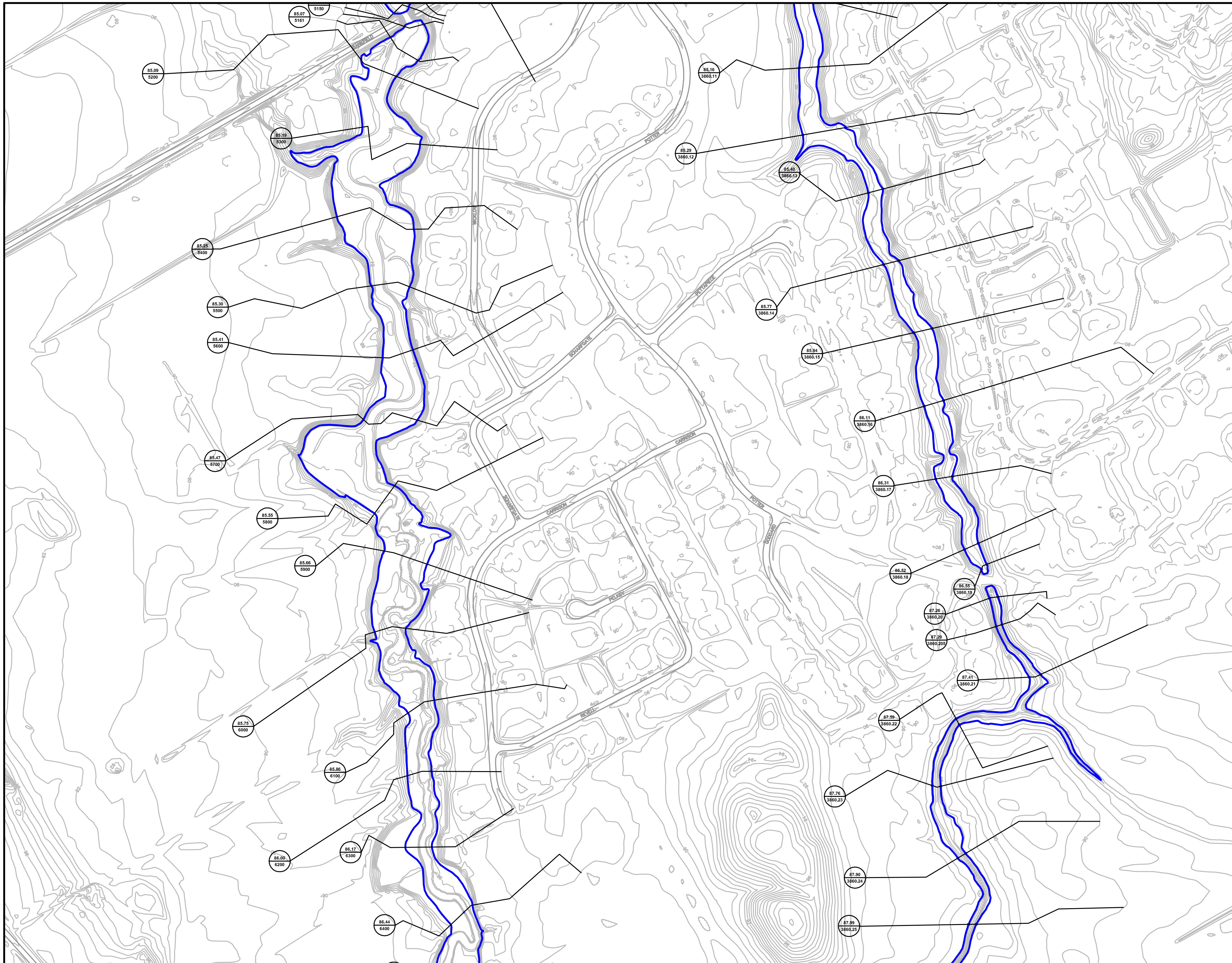
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Minto Communities Inc.
Mahogany

Geomorphic Detailed Survey Locations

Date:	Project:	Technical:	Reviewer:	Drawn:
02 May 2017	25016-504	J. Parish	M. McCombs	E. Wilkinson

Figure
B



Ottawa

JOCK RIVER REACH 2, & MUD CREEK SUBWATERSHED

FIGURE 3.5.2.11

Mud Creek Floodline Delineation
Sheet 2

100yr Floodline

85.60 — 100 yr Elevation
3860.05 — Cross Section #

0 50 100 150 200 250m

1:5000

Marshall Macklin Monaghan

WESA
A Better Environment For Business

CROSS-SECTION REPORT: 2/13/2018 **all water levels in metres above sea-level (masl)*

Rideau - Reach 2 West - 19530

River:	Rideau
Reach:	Reach 2 West
Station:	19530
Regulated Flood Level - 100 Year:	85.54 *
Regulated Q - 100 Year (cms):	212.7

Assoc. Events	Water Level *	Q (cms)
2 Year	84.73	117.49
5 Year	85.03	148.28
10 Year	85.18	166.95
20 Year	85.29	181.21
50 Year	85.43	199.75
100 Year	85.52	212.70
200 Year	85.60	225.08
350 Year	85.65	232.61
500 Year	85.70	239.92

C.2 CONCEPTUAL STORM SEWER DESIGN SHEET

Stantec	Minto Mahogany		STORM SEWER DESIGN SHEET (City of Ottawa)
	DATE:	2018-05-10	
	REVISION:	2	
	DESIGNED BY:	DT	FILE NUMBER: 160410140
	CHECKED BY:	AMP	

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

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)
L203B	203	202	1.17	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.644	0.644	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	137.3
L202A	202	201	4.40	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	2.201	2.845	0.000	0.000	0.000	0.000	0.000	0.000	13.12	66.58	90.15	105.61	154.28	0.0	0.0	526.1
																				16.74							
L207A	207	206	1.26	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.691	0.691	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	147.4
C206A	206	205	0.00	2.55	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.000	0.691	1.533	1.533	0.000	0.000	0.000	0.000	14.33	63.40	85.79	100.48	146.75	0.0	0.0	486.9
L205A	205	204	3.02	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	1.662	2.352	0.000	1.533	0.000	0.000	0.000	0.000	16.47	58.51	79.10	92.61	135.20	0.0	0.0	719.0
L204B, L204A	204	201	9.70	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.00	5.665	8.018	0.000	1.533	0.000	0.000	0.000	0.000	18.37	54.81	74.05	86.67	126.50	0.0	0.0	1536.0
																				19.54							
	201	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	10.862	0.000	1.533	0.000	0.000	0.000	0.000	19.54	52.78	71.27	83.41	121.70	0.0	0.0	1895.8
																				20.10							
L104B, L104A	104	103	5.90	0.00	0.00	0.00	0.00	0.52	0.00	0.00	0.00	3.096	3.096	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	660.5
L103A	103	102	7.38	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	4.062	7.157	0.000	0.000	0.000	0.000	0.000	0.000	16.35	58.75	79.43	93.00	135.77	0.0	0.0	1168.1
																				19.68							
C108A	108	106	0.00	1.14	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.000	0.000	0.681	0.681	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	197.1
																				13.48							
L107A	107	106	1.54	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.848	0.848	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	180.9
																				14.98							
L110A, C110A	110	109	2.94	1.56	0.00	0.00	0.00	0.60	0.60	0.00	0.00	1.762	1.762	0.938	0.938	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	647.3
C109A, L109A	109	106	2.34	0.71	0.00	0.00	0.00	0.55	0.60	0.00	0.00	1.288	3.050	0.425	1.363	0.000	0.000	0.000	0.000	12.69	67.81	91.84	107.60	157.20	0.0	0.0	922.3
																				15.05							
C106A, L106B, L106A	106	105	5.72	0.59	0.00	0.00	0.00	0.47	0.60	0.00	0.00	2.681	6.579	0.352	2.396	0.000	0.000	0.000	0.000	15.05	61.64	83.38	97.64	142.59	0.0	0.0	1681.3
L105B, C105A, L105A	105	102	5.90	0.45	0.00	0.00	0.00	0.65	0.60	0.00	0.00	3.829	10.407	0.271	2.667	0.000	0.000	0.000	0.000	17.66	56.12	75.84	88.78	129.58	0.0	0.0	2184.3
																				19.74							
L115A	115	114	3.89	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	2.335	2.335	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	498.2
	114	113	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	2.335	0.000	0.000	0.000	0.000	0.000	0.000	12.79	67.54	91.47	107.16	156.56	0.0	0.0	438.1
L113A	113	112	1.51	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.908	3.243	0.000	0.000	0.000	0.000	0.000	0.000	14.56	62.82	84.99	99.54	145.37	0.0	0.0	565.9
C112A, L112A	112	111	1.85	1.58	0.00	0.00	0.00	0.60	0.60	0.00	0.00	1.111	4.354	0.946	0.946	0.000	0.000	0.000	0.000	15.97	59.57	80.54	94.31	137.69	0.0	0.0	932.2
C111A, L111A	111	102	2.81	0.78	0.00	0.00	0.00	0.55	0.60	0.00	0.00	1.546	5.901	0.466	1.412	0.000	0.000	0.000	0.000	18.26	55.00	74.31	86.98	126.94	0.0	0.0	1193.0
																				20.22							
C102A	102	101	0.00	1.34	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.000	23.466	0.806	4.885	0.000	0.000	0.000	0.000	20.22	51.67	69.76	81.64	119.11	0.0	0.0	4314.8
L101A	101	100	1.46	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	0.805	24.270	0.000	4.885	0.000	0.000	0.000	0.000	21.81	49.29	66.51	77.82	113.51	0.0	0.0	4225.4
																				22.22							

PIPE SELECTION

AREA ID NUMBER	FROM M.H.	TO M.H.	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)
L203B	203	202	158.7	525	525	CIRCULAR	CONCRETE	-	0.20	200.6	**68.43%**	0.90	0.85	3.12
L202A	202	201	197.8	975	975	CIRCULAR	CONCRETE	-	0.10	739.3	**71.16%**	0.96	0.91	3.62
L207A	207	206	224.3	525	525	CIRCULAR	CONCRETE	-	0.20	200.6	**73.45%**	0.90	0.86	4.33
C206A	206	205	115.6	900	900	CIRCULAR	CONCRETE	-	0.10	597.2	**81.52%**	0.91	0.90	2.14
L205A	205	204	113.2	1050	1050	CIRCULAR	CONCRETE	-	0.10	900.9	**79.82%**	1.01	0.99	1.90
L204B, L204A	204	201	97.7	1350	1350	CIRCULAR	CONCRETE	-	0.15	2156.5	**71.22%**	1.46	1.39	1.18
	201	200	42.4	1500	1500	CIRCULAR	CONCRETE	-	0.10	2332.0	**81.30%**	1.28	1.27	0.56
				1500	1500									
L104B, L104A	104	103	369.5	1050	1050	CIRCULAR	CONCRETE	-	0.10	900.9	**73.32%**	1.01	0.97	6.35
L103A	103	102	259.0	1200	1200	CIRCULAR	CONCRETE	-	0.15	1575.3	**74.15%**	1.35	1.30	3.33
C108A	108	106	174.8	600	600	CIRCULAR	CONCRETE	-	0.15	248.1	**79.47%**	0.85	0.84	3.48
L107A	107	106	242.9	600	600	CIRCULAR	CONCRETE	-	0.15	248.1	**72.90%**	0.85	0.81	4.98
L110A, C110A	110	109	155.1	1050	1050	CIRCULAR	CONCRETE	-	0.10	898.5	**72.05%**	1.01	0.96	2.69
C109A, L109A	109	106	149.3	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**71.71%**	1.10	1.05	2.36
C106A, L106B, L106A	106	105	190.7	1500	1500	CIRCULAR	CONCRETE	-	0.10	2326.8	**72.26%**	1.28	1.22	2.61
L105B, C105A, L105A	105	102	190.2	1500	1500	CIRCULAR	CONCRETE	-	0.15	2856.1	**76.48%**	1.57	1.52	2.08
L115A	115	114	151.4	900	900	CIRCULAR	CONCRETE	-	0.10	597.2	**83.42%**	0.91	0.91	2.79
	114	113	93.3	900	900	CIRCULAR	CONCRETE	-	0.10	597.2	**73.36%**	0.91	0.87	1.78
L113A	113	112	78.9	975	975	CIRCULAR	CONCRETE	-	0.10	739.3	**76.54%**	0.96	0.93	1.41
C112A, L112A	112	111	144.8	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**72.48%**	1.10	1.05	2.29
C111A, L111A	111	102	153.6	1200	1200	CIRCULAR	CONCRETE	-	0.15	1575.3	**75.73%**	1.35	1.31	1.96
C102A	102	101	173.3	1800	1800	CIRCULAR	CONCRETE	-	0.15	4644.4	**92.90%**	1.77	1.82	1.59
L101A	101	100	44.4	1800	1800	CIRCULAR	CONCRETE	-	0.15	4644.4	**90.98%**	1.77	1.81	0.41
				1800	1800									

C.3 WILSON COWAN MUNICIPAL DRAIN MONITORING PROGRAM DATA

Memo

To:	File	From:	Marc Telmosse, P. Eng. Stantec's Ottawa (ON) Office
File:	1604-10140	Date:	March 15, 2018

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

Stantec completed a 4 month long (June to October 2017) stream flow monitoring program in the Wilson Cowan Municipal drain and tributary stream in Manotick (ON). The data from this program will be used to calibrate and validate the existing conditions model of the contributing area.

DATA GATHERING

Solinst's levelloggers and a barologger were used to obtain continuous (5-min) water levels. A total of four (4) site visits were completed to perform stream monitoring to obtain flow rates and to develop flow curves for each site. The site visit dates, recorded water depths, and corresponding calculated flows are listed in **Table 1.** Further details about the stream monitoring and flow determination are provided below.

Stream Monitoring

At all three sites (presented in **Appendix A**), a cross-section of the stream was selected where the stream was relatively straight and with minimal vegetation. The cross-sections were identified with wooden stakes on each bank to perform the stream measurements at the same location for the subsequent site visits.

Velocity measurements were taken using a current meter across the stream, at an interval of approximately 50cm. A measuring tape was laid out across the stream, connecting the stakes on both banks, and it was used to determine the length of the cross-section, as well as determining the distance from the velocity measurements to the bank. The water depth was measured at each velocity measurement station, and the velocity was measured as such:

- If the water depth is less than 75cm, the velocity measurement was taken at 60% of the depth (from the surface).
- If the water depth is greater than 75cm, the velocity measurement was taken at 20%, and 80% of the depth (from the surface). The average of both velocity measurements was used in the flow calculation.

Flow Determination

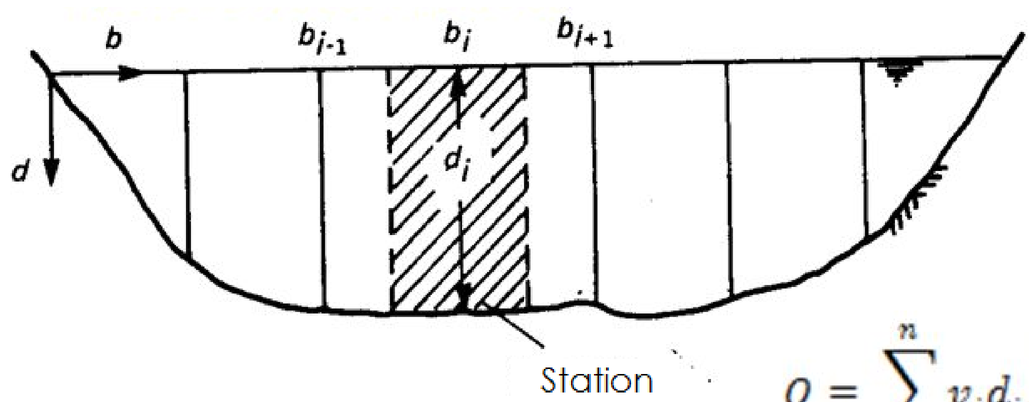
Using the velocity and water depth data gathered as part of the stream monitoring program, the flow was calculated using the Standard Mid-Section Method for each site and every site visits. For this method, the stream is divided into panels, which are defined as one half of the distance to the previous station (i.e. velocity measurement location) plus one half of the distance to the next section. The partial flow was calculated for each panel by multiplying the velocity, depth, and the width of the panel. The total flow at each site was determined by taking the sum of the partial flows. The Mid-Section Method is summarized in **Figure 1**. Sample calculations are provided in **Appendix B**.

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

Table 1: Flow Monitoring Program Details and Findings

Site Visit	Date	Water Depth (m)			Calculated Flow (m³/s)		
		Site A	Site B	Site C	Site A	Site B	Site C
1	16-Jun-17	0.52	0.29	0.00	0.000[1]	0.019	0.000
2	30-Jun-17	0.78	0.66	0.25	0.220	0.362	0.032
3	4-Aug-17	0.42	0.34	0.05	0.050	0.052	0.002
4	5-Oct-17	0.51	0.19	0.00	0.007	0.004	0.000

[1] Standing water (i.e. no flow).



$$Q = \sum_{i=1}^{n} v_i d_i \cdot \frac{b_{i+1} - b_{i-1}}{2}$$

Figure 1: Standard Mid-Section Method

RAINFALL DATA & FREQUENCY OF MEASUREMENTS

Attempts were made to complete the site visits following rainfall events, or after a few consecutive rainy days. Several large rain events occurred during the flow monitoring periods, as listed in **Table 2**, and presented in **Figure 2**. The rainfall data was gathered from Environmental Canada Historical Data.

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

Table 2: Top 6 Rain Events (June 16 to October 1, 2017)

Date	Total Daily Rainfall (mm)	Date	Total Daily Rainfall (mm)
29-Jun-2017	32.4	24-Jul-2017	79.0
1-Jul-2017	42.0	22-Aug-2017	30.2
14-Jul-2017	42.6	7-Sep-2017	21.8

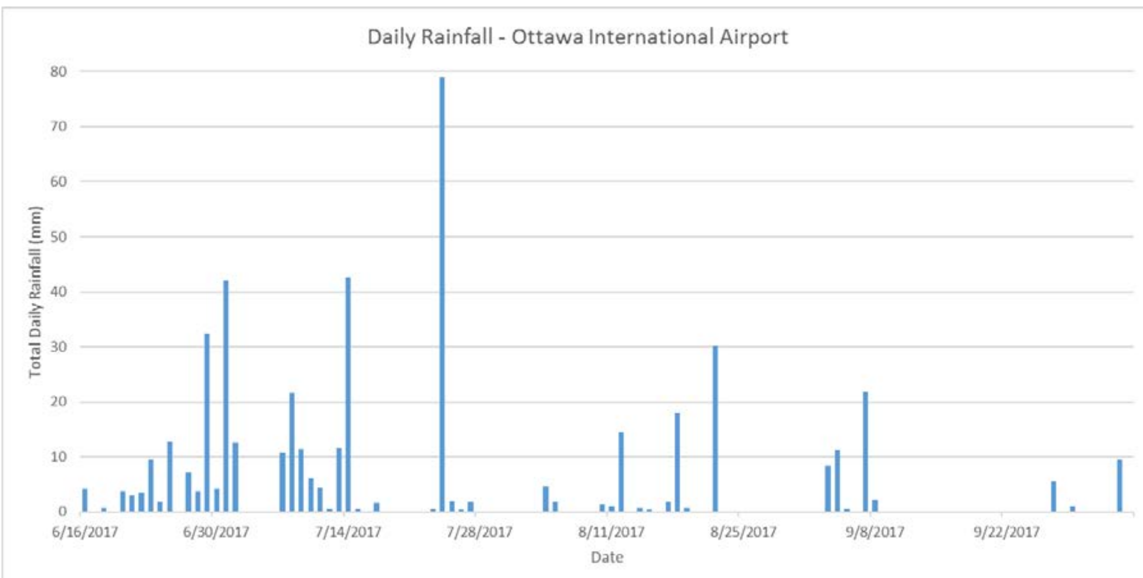


Figure 2: Daily Rainfall (June 16 – October 1, 2017)

STAGE-DISCHARGE CURVES DETERMINATION

The recorded water level data (levelloggers) was used with the measured velocity/flow data to establish representative stage-discharge curves for each of the sites. The recorded depths for all three sites are shown for the entire program in **Figure 5** (**Appendix C**). The established stage-discharge curves based on the 4 field measurements are shown in **Figures 6**, **7**, and **8** (**Appendix D**).

CALCULATED HYDROGRAPHS

Flow hydrographs were computed using the stage-discharge curves. Due to the limitation of the data quality (see **Limitations** Section), the flow at Site A was calculated using the Difference Basin Method (i.e. Site A = Site B – Site C). The calculated flows at each site are shown in **Figure 3** below.

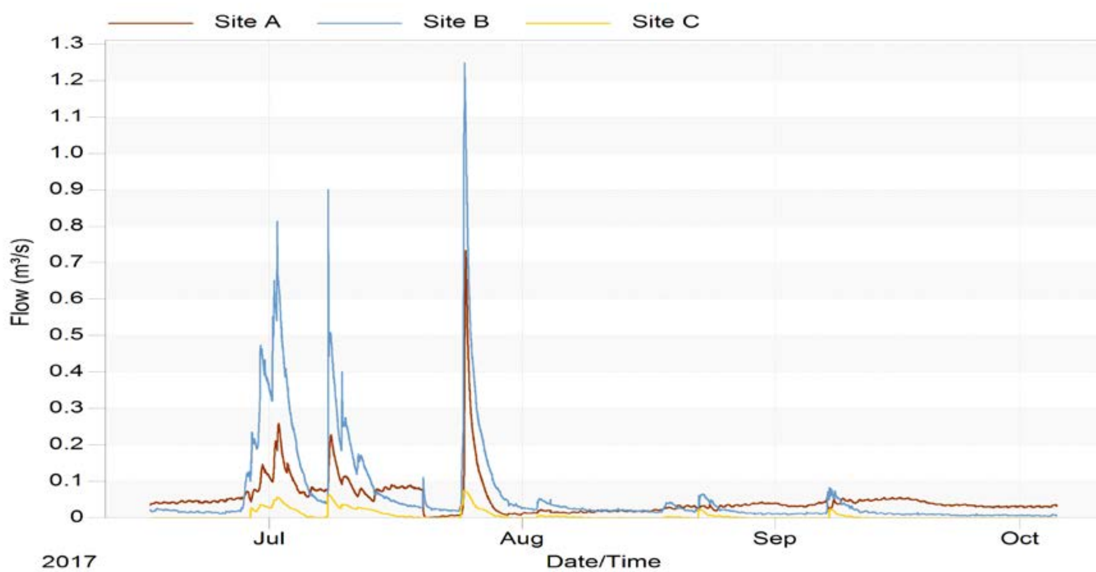


Figure 3: Hydrographs (5-min timestep)

PRELIMINARY CALIBRATION EFFORTS

The existing PCSWMM model was used in an attempt to calibrate to the measured and calculated stream flow data. The parameters used for each site in this preliminary calibration are shown in **Table 3.** The resulting volumes, peak flows, and fits for the three events observed and considered are summarized in **Table 4**. Comparison hydrographs (modeled versus measured/calculated) are presented in **Appendix E**.

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

The model was originally set up using CN values, which did not provide enough volume or a high enough peak flow to satisfy our calibration targets (+25/-15% on peak flow and +20/-10% on volume). Further iterations using Horton's Method, while adjusting the infiltration values, were then completed and found to produce better fits to the flow data. However, due to limitations with the calculated flows, further discussed in the **Limitations** section, a good fit was not achieved for all the sites and events. Generally, the fits between monitored and modelled results are better for Site A and B, but the modelled flows and volumes are overestimated at Site C.

LIMITATIONS

There are limitations to the validity of the established flow curves. These are due to difference in the magnitude of the measured depths and calculated flows when compared to the monitored peak depth and extrapolated flows from the largest event that was recorded on July 24-26th, 2017. This July 24th, 2017 event saw approximately 80mm over a 24hr period, which is more than double the intensity of the largest measured event that occurred on June 30th (~72mm over a 72hr period).

Additionally, the depth at Site A dropped by approximately 40cm on July 20th. We initially suspected that an equipment malfunction was responsible, however a review of the field measurements corroborates this drop. It is suspected that some type of blockage was removed downstream and caused this drop. We also observed that there was approximately 60cm of stagnant water during our first installation visit to Site A on June 16, 2017. Further consideration of the interpretation of the flows at this site is recommended due to the observed variability.

CONCLUSION

A flow monitoring program was completed in the Wilson Cowan Municipal drain and tributary stream in Manotick (ON). A total of (3) three sites were monitored over a 4-months period. The data from this program was used in preliminary calibration efforts of an existing PCSWMM model of the contributing area.

Due to limitations of the data (i.e. changed site conditions and difference in magnitude of measured to monitored depths) a good fit between the monitored and modelled data was not achieve at all sites for the entire period. It is recommended that further refinement and/or interpretation is warranted to reconcile the calibration of the model to the extrapolated flows.

STANTEC CONSULTING LTD.

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Phone: (613) 724-4092
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Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

Table 3: Preliminary Calibration Analysis Parameters[1]

Site	Slope (%)	N Impervious	N Pervious	Impervious Depression Storage Depth (mm)	Previous Depression Storage Depth (mm)	Max Infiltration Rate (mm/hr)	Min Infiltration Rate (mm/hr)	Decay Constant (1/hr)
A	0.1%	0.013	0.25	1.57	4.67	76.2	0.45	4.14
B	0.1%	0.013	0.25	1.57	4.67	76.2	0.45	4.14
C	0.1%	0.013	0.25	1.57	4.67	92	7.1	4.14

[1] A drying time of 7 days was assumed due to expected saturation from this year's storm events.

Table 4: Preliminary Calibration Analysis Results and Fits

Site	Event 1: June 27th to July 8th, 2017				Event 2: July 8th to July 15th, 2017				Event 3: July 24th to August 3rd, 2017			
	Modeled Volume (m^3)	Volume Fit (%)	Modeled Peak Flow (m^3/s)	Peak Flow Fit (%)	Modeled Volume (m^3)	Volume Fit (%)	Modeled Peak Flow (m^3/s)	Peak Flow Fit (%)	Modeled Volume (m^3)	Volume Fit (%)	Modeled Peak Flow (m^3/s)	Peak Flow Fit (%)
A	140,763	-35%	0.932	30%	122,256	3%	0.785	-1%	181,111	24%	2.375	119%
B	194,911	-9%	1.396	72%	198,512	1%	1.923	114%	277,009	89%	4.374	250%
C	278,798	30%	1.671	105%	295,643	150%	2.202	145%	309,131	111%	4.486	259%

APPENDIX A: FLOW MONITORING SITE LOCATIONS

Stantec

Legend

Flow Monitoring Sites

0 250 500 metres

1:12,500 (At Original document size of 8.5x11)

Project Location
Manotick, Ontario

Client/Project
Mahogany Stage 2-Development
1604-10140

Figure No.
4

Title
Flow Monitoring Site Locations

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

APPENDIX B: EXAMPLE FLOW CALCULATIONS

Table 5: Site B, June 16th, 2017

Location	Distance from Stake (m)	Total Depth W.S. to Bottom (m)	Panel Width (m)	60% Depth (m)	Measured Velocity (m/s)	Partial Flow (m^3/s)
Water Edge Left	6.65	0.00	0.000	0.000	0.000	0.000
Station 1	7.50	0.25	0.675	0.150	0.020	0.003
Station 2	8.00	0.34	0.500	0.204	0.030	0.005
Station 3	8.50	0.34	0.500	0.204	0.040	0.007
Station 4	9.00	0.28	0.500	0.168	0.020	0.003
Station 5	9.50	0.11	0.550	0.066	0.010	0.001
Water Edge Right	10.10	0.00	0.000	0.000	0.000	0.000
					Total Flow (m^3/s)	**0.019**

Table 6: Site A, June 30th, 2017

Location	Distance from Stake (m)	Total Depth W.S. to Bottom (m)	Panel Width (m)	20% Depth (m)	60% Depth (m)	80% Depth (m)	Measured Velocity 20% Depth (m/s)	Measured Velocity 60% Depth (m/s)	Measured Velocity 80% Depth (m/s)	Partial Flow (m^3/s)
Water Edge Left	1.90	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Station 1	2.20	0.18	0.400	0.000	0.108	0.000	-	0.000	-	0.000
Station 2	2.70	0.34	0.500	0.000	0.204	0.000	-	0.020	-	0.003
Station 3	3.20	0.50	0.500	0.000	0.300	0.000	-	0.040	-	0.010
Station 4	3.70	0.75	0.500	0.000	0.000	0.000	-	0.020	-	0.008
Station 5	4.20	0.98	0.500	0.196	0.000	0.784	0.010	0.000	0.040	0.012
Station 6	4.70	1.00	0.500	0.200	0.000	0.800	0.040	0.000	0.080	0.030
Station 7	5.20	1.06	0.500	0.212	0.000	0.848	0.110	0.000	0.100	0.056
Station 8	5.70	1.01	0.500	0.202	0.000	0.808	0.140	0.000	0.080	0.056
Station 9	6.20	0.96	0.500	0.192	0.000	0.768	0.030	0.000	0.070	0.024
Station 10	6.70	0.77	0.500	0.154	0.000	0.616	0.020	0.000	0.030	0.010
Station 11	7.20	0.43	0.575	0.000	0.258	0.000	-	0.050	-	0.012
Water Edge Right	7.85	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
									Total Flow (m^3/s)	**0.220**

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

APPENDIX C: RECORDED WATER LEVELS

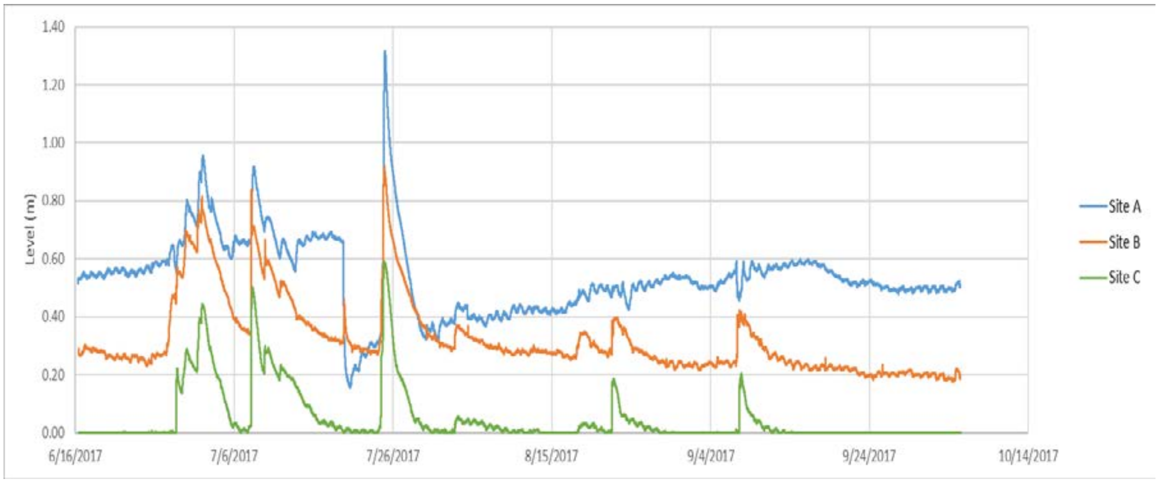


Figure 5: Recorded Water Levels (5-min timestep)

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

APPENDIX D: STAGE-DISCHARGE CURVES

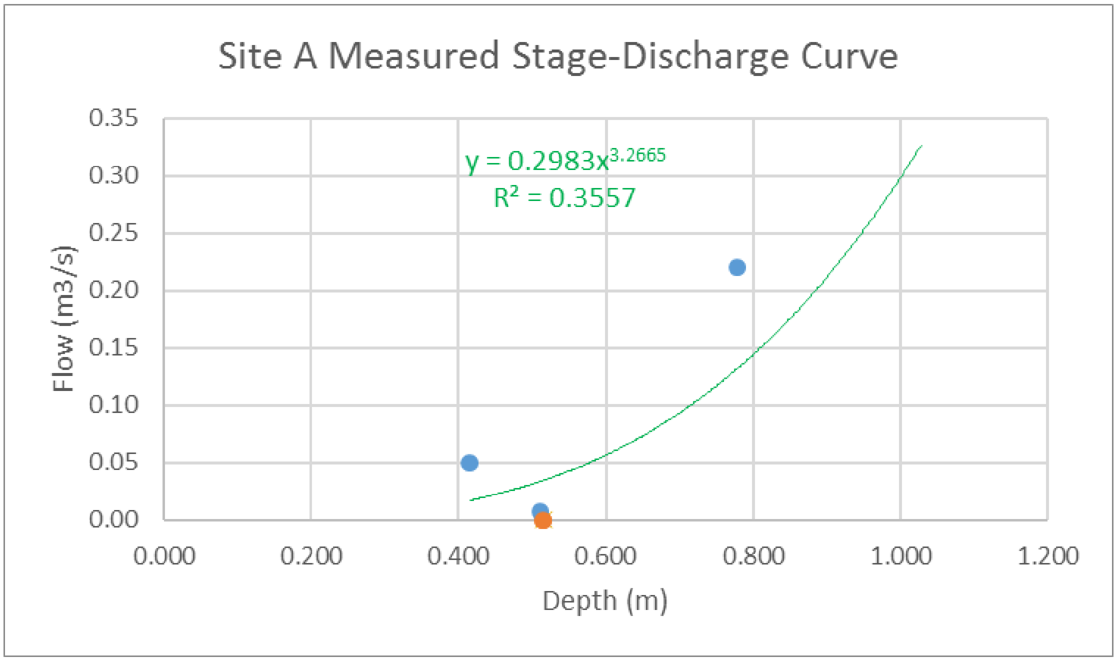


Figure 6: Site A Stage-Discharge Curve.

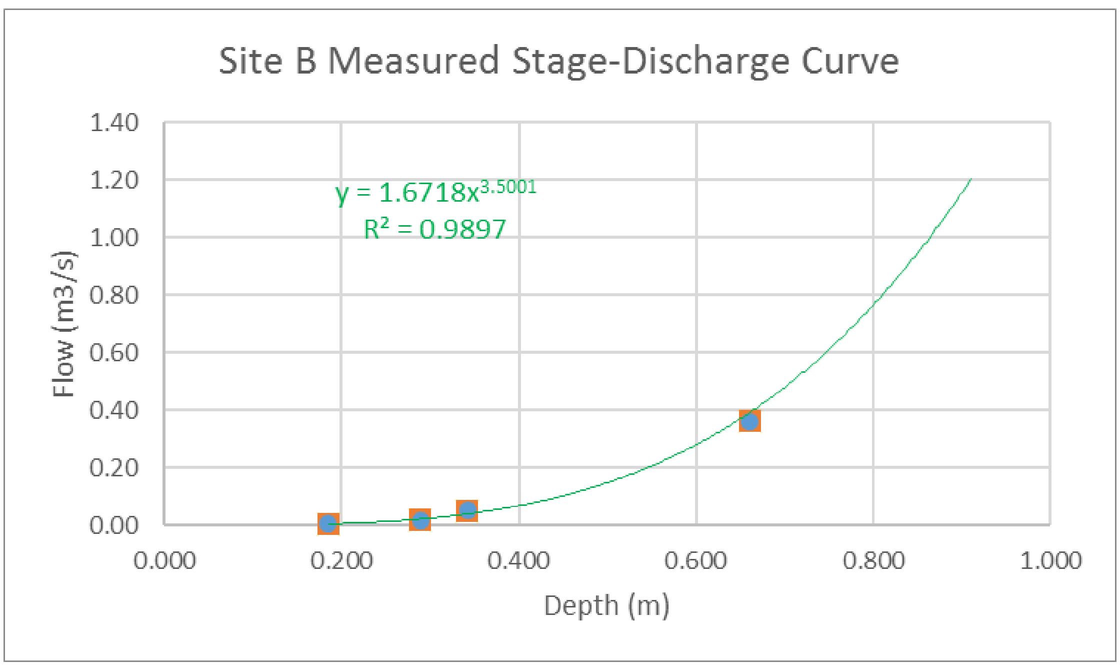


Figure 7: Site B Stage-Discharge Curve

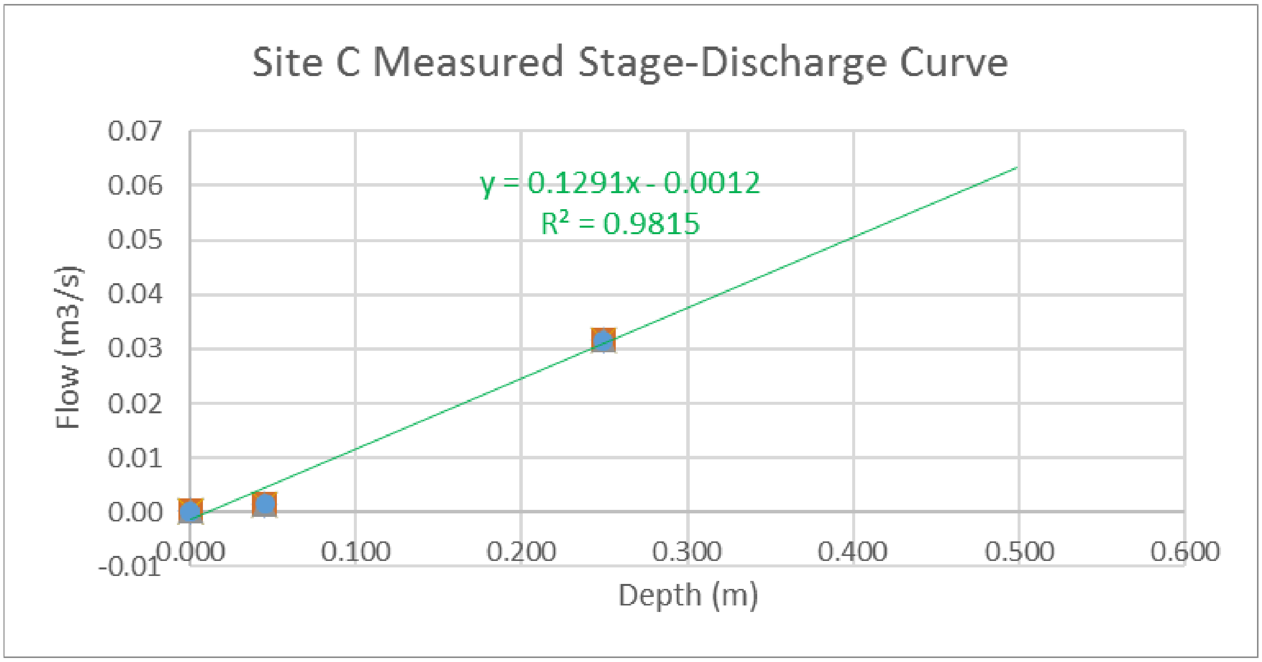


Figure 8: Site C Stage-Discharge Curve

APPENDIX E: PRELIMINARY CALIBRATION RESULTS

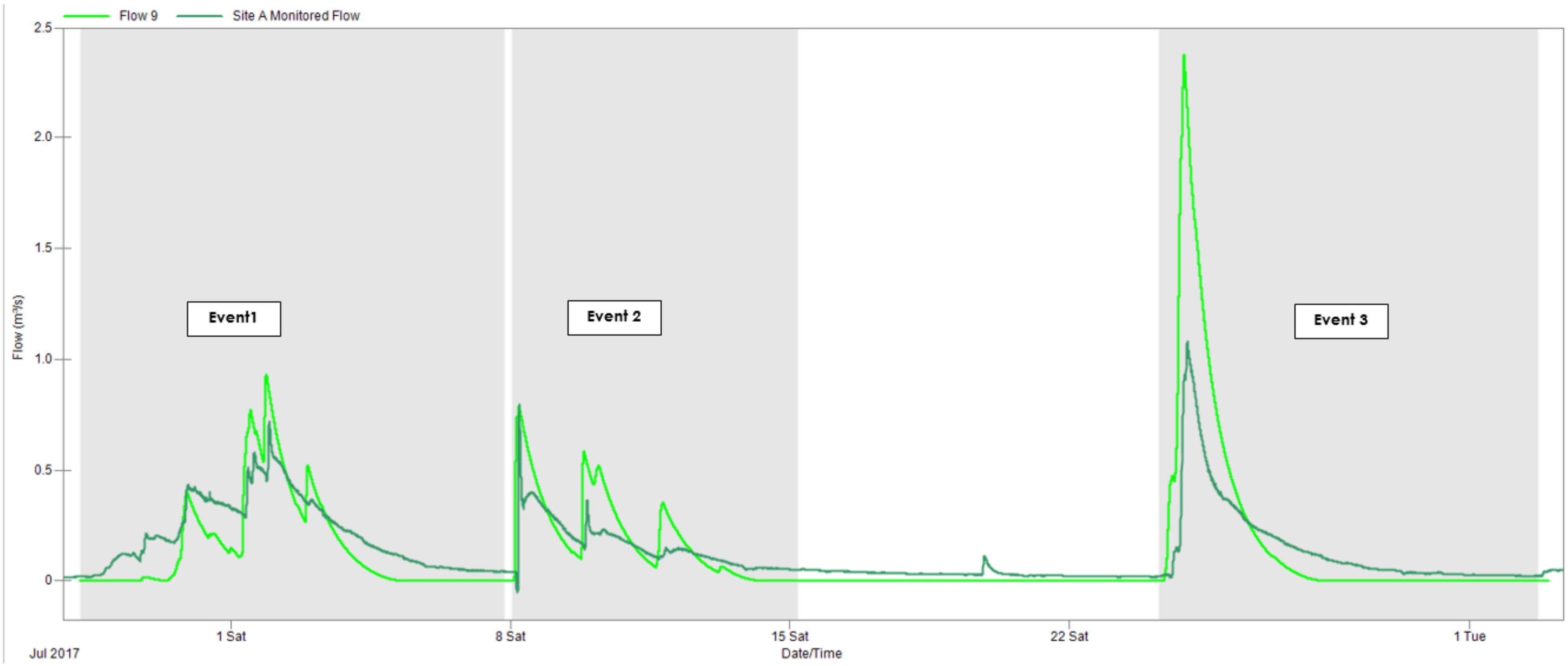


Figure 9: Site A Hydrograph Comparison

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

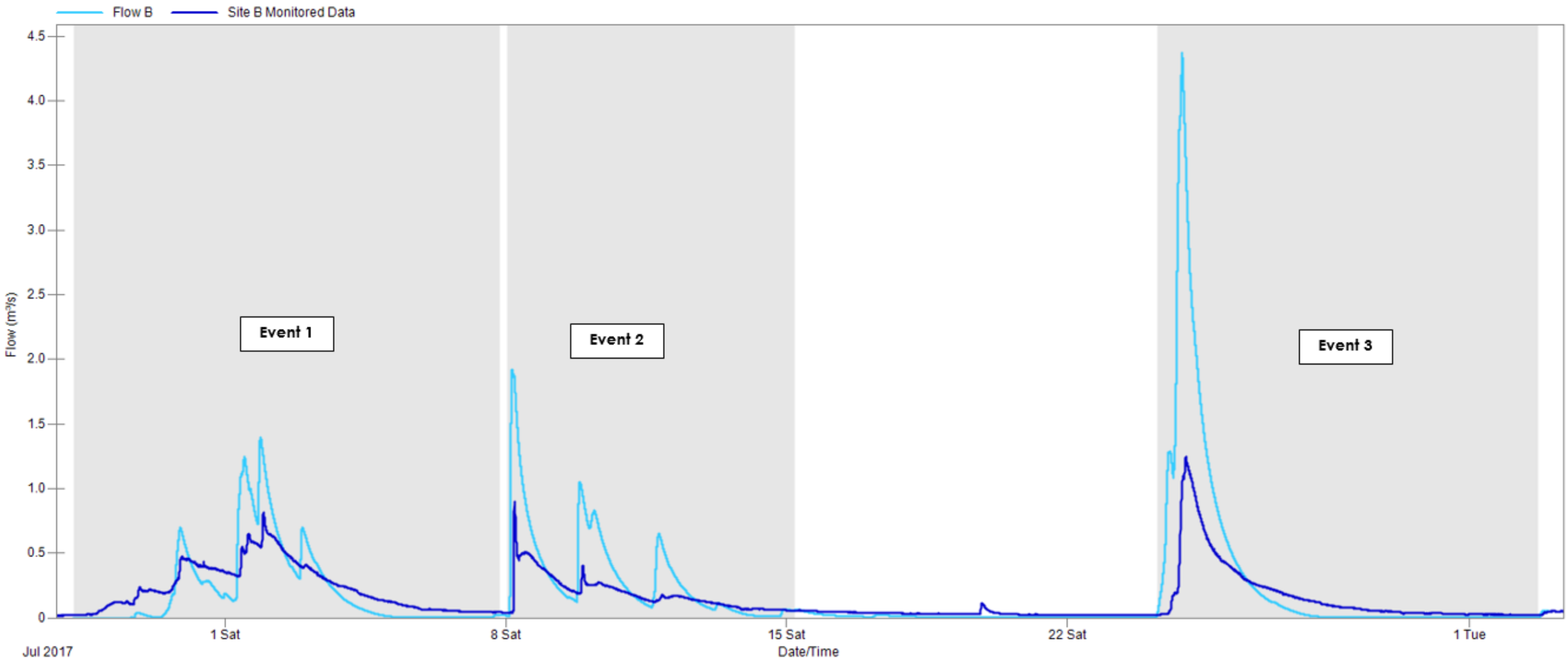


Figure 10: Site B Hydrograph Comparison

Reference: Mahogany Stage 2-Development (Stream Flow Monitoring): Progress Memo

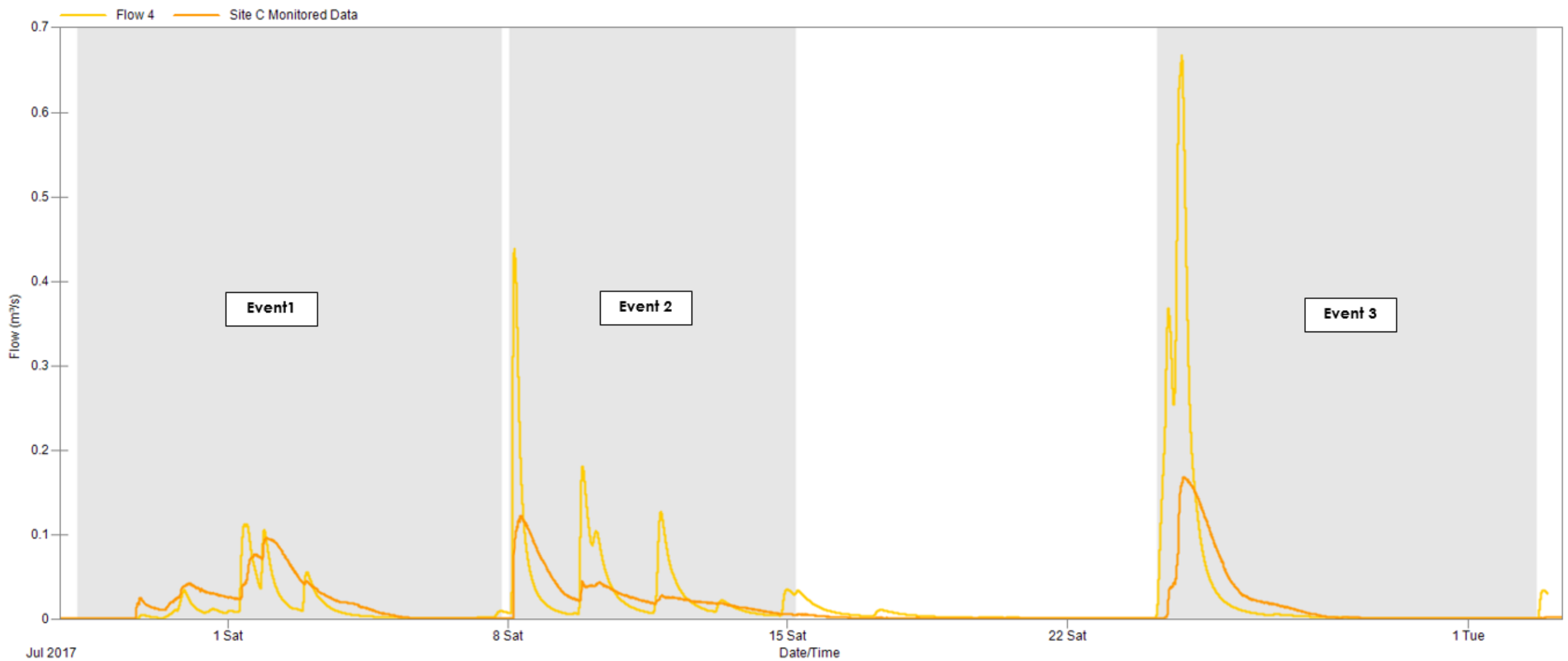


Figure 11: Site C Hydrograph Comparison

C.4 WILSON COWAN MUNICIPAL DRAIN EXISTING CONDITION MODEL - CALIBRATED

```
[TITLE]


[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
START_DATE           06/27/2017
START_TIME           05:00:00
REPORT_START_DATE    06/27/2017
REPORT_START_TIME    05:00:00
END_DATE             06/29/2017
END_TIME             17:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             5
REPORT_STEP          00:01:00
WET_STEP             00:01:00
DRY_STEP             00:01:00
ROUTING_STEP         5
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         1.167
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              2

[FILES]
USE HOTSTART "W:\active\1 planning_landscape\1604 Projects\160410140_Mahogany Stage
2+ Development\design\analysis\SWM\WC Drain Calibration\Final\PCSWMM\100SCS.HSF"

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

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
002SCS           INTENSITY 0:12   1.0    TIMESERIES 5SCS_24hr_IBI
100 YR SCSGage   INTENSITY 0:12:00 1      TIMESERIES 100 YR SCS
Manotick_Full    VOLUME    0:05   1.0    TIMESERIES ManotickRG
RG-1             INTENSITY 0:12   1.0    TIMESERIES 100SCS_24hr_IBI

[SUBCATCHMENTS]
;;                                                   Total    Pcnt.             Pcnt.
  Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope
```

```
  Length   Pack
;;-------------- ---------------- ---------------- -------- -------- --------
-------- -------- --------
;0.20
3-PRE            RG-1             S4               2.861    0        30       0.1
  0
;0.20
4-PRE            RG-1             Jun-4            3.34     0        100      0.1
  0
;0.20
5-PRE            RG-1             Jun-2            10.14    0        450      0.1
  0
;0.20
8-PRE1           RG-1             S9               9.426    0        444      0.1
  0
;0.20
8-PRE2           RG-1             S9               5.262    0        213      0.1
  0
Area 3           RG-1             S4               2.4479   0        150      0.1
  0
Area 6           RG-1             S6               1.8      0        66.667   0.1
  0
Area 7           RG-1             S5-7             9.2      0        450      0.1
  0
Area 8           RG-1             8-PRE1           13.504225 0       444      0.1
  0
Area_4           RG-1             Jun-4            0.66     0        100      0.1
  0
;0.60
FUT              RG-1             S9               6.607775 0        444      0.1
  0
;0.55
S1               RG-1             S4               6.8411   0        275      0.1
  0
;0.50
S2               RG-1             S3               8.61     0        480      0.1
  0
Sub9A            RG-1             9A               263.0403 0        2400     0.01
  0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo
PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ----------
----------
3-PRE            0.013      0.25       1.57       4.67       0          PERVIOUS
100
4-PRE            0.013      0.25       1.57       4.67       0          PERVIOUS
100
5-PRE            0.013      0.25       1.57       4.67       0          PERVIOUS
100
8-PRE1           0.013      0.25       1.57       4.67       0          PERVIOUS
100
8-PRE2           0.013      0.25       1.57       4.67       0          PERVIOUS
100
Area 3           0.013      0.25       1.57       4.67       0          PERVIOUS
100
Area 6           0.013      0.25       1.57       4.67       0          PERVIOUS
100
Area 7           0.013      0.25       1.57       4.67       0          PERVIOUS
100
Area 8           0.013      0.25       1.57       4.67       0          PERVIOUS
100
```

```
Area_4           0.013      0.25       1.57       4.67       0          PERVIOUS
100
FUT              0.013      0.25       1.57       4.67       0          PERVIOUS
100
S1               0.013      0.25       1.57       4.67       0          PERVIOUS
100
S2               0.013      0.25       1.57       4.67       0          PERVIOUS
100
Sub9A            0.013      0.25       1.57       4.67       0          PERVIOUS
100

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
3-PRE            35         3          4.14       7          0
4-PRE            35         3          4.14       7          0
5-PRE            35         3          4.14       7          0
8-PRE1           35         3          4.14       7          0
8-PRE2           35         3          4.14       7          0
Area 3           35         3          4.14       7          0
Area 6           35         3          4.14       7          0
Area 7           35         3          4.14       7          0
Area 8           35         3          4.14       7          0
Area_4           35         3          4.14       7          0
FUT              35         3          4.14       7          0
S1               35         3          4.14       7          0
S2               35         3          4.14       7          0
Sub9A            35         1          4.14       7          0

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
Dummy            85.99      FIXED        87.26            NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve
Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params
Area     Frac.    Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- --------
-------- -------- -----------------------
9A               89       3        0        FUNCTIONAL 0.01     0        0        0
      0
Jun-1            88.813   3.187    0        FUNCTIONAL 0.01     0        0        0
      0
Jun-2            88.8     0.965    0        FUNCTIONAL 0.01     0        0        0
      0
Jun-3            88.679   0.956    0        FUNCTIONAL 0.01     0        0        0
      0
Jun-4            88.677   0.969    0        FUNCTIONAL 0.01     0        0        0
      0
Jun-5            90       2        0        FUNCTIONAL 0.01     0        0        0
      0
Jun-6            88.278   5.722    0        FUNCTIONAL 19354    2.143    0        0
      0
Point B          86.03    2.49     0        FUNCTIONAL 0        0        0        0
      0
S3               86.72    2        0        FUNCTIONAL 0        0        0        0
      0
S4               88.66    1.1      0        FUNCTIONAL 0        0        1        0
      0
S5-7             88.9     3.1      0        FUNCTIONAL 0        0        1        0
```

```
      0
S6                88.69    0.87     0        FUNCTIONAL 0        0        1        0
      0
S8                86.04    2.34     0        FUNCTIONAL 0        0        0        0
      0
S9                88.26    2.34     0        FUNCTIONAL 0        0        0        0
      0

[CONDUITS]
;;                Inlet            Outlet                            Manning    Inlet
Outlet     Init.      Max.
;;Name            Node             Node             Length     N          Offset
Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ----------
---------- ---------- ----------
1                 Jun-6            S9               56.751     0.024      0
0          0          0
1_1               9A               Jun-6            2269.226   0.03       0
0          0          0
2                 Jun-5            Jun-1            146.077    0.03       0
0          0          0
Flow 5_1          S5-7             Jun-1            173.143    0.03       0
0          0          0
Flow 5_3          Jun-1            Jun-2            29.311     0.024      0
0          0          0
Flow 5_4          Jun-2            S4               351.811    0.03       0
0          0          0
Flow 6_1          S6               Jun-3            208.159    0.03       0
0          0          0
Flow 6_3          Jun-3            Jun-4            29.919     0.024      0
0          0          0
Flow 6_4          Jun-4            S4               301.106    0.03       0
0          0          0
;FM Site A
Flow 9            S9               S8               950        0.03       0
0          0          0
;FM Site B
Flow B            Point B          Dummy            20         0.03       0
0          0          0
Flow B1           S3               Point B          20         0.04       0
0.49       0          0
Flow B2           S8               Point B          20         0.03       0
0          0          0
;FM Site C
Flow_4            S4               S3               594.851    0.03       0
0          0          0

[XSECTIONS]
;;Link            Shape        Geom1            Geom2      Geom3      Geom4
Barrels
;;-------------- ------------ ---------------- ---------- ---------- ----------
----------
1                 CIRCULAR     1.5              0          0          0          1

1_1               IRREGULAR    2406-REV         0          0          0          1

2                 IRREGULAR    1706-REV         0          0          0          1

Flow 5_1          IRREGULAR    1706-REV         0          0          0          1

Flow 5_3          CIRCULAR     0.264            0          0          0          1

Flow 5_4          IRREGULAR    1706-REV         0          0          0          1
```

```
Flow 6_1        IRREGULAR    1706-REV        0          0          0          1
Flow 6_3        CIRCULAR     0.264           0          0          0          1
Flow 6_4        IRREGULAR    1706-REV        0          0          0          1
Flow 9          IRREGULAR    2406-REV        0          0          0          1
Flow B          TRAPEZOIDAL  2               3          8          8          1
Flow B1         TRAPEZOIDAL  2               3          8          8          1
Flow B2         TRAPEZOIDAL  2               3          8          8          1
Flow_4          IRREGULAR    1153-REV        0          0          0          1

[TRANSECTS]

NC 0.060    0.060    0.030
X1 1153              6        6.300    13.400   0.0       0.0       0.0      0.00
0.0
GR 88.85    0        88.49    6.3      87.78    9         87.78     9.6      88.57
13.4
GR 88.88    22.4

NC 0.06     0.06     0.05
X1 1153-REV          6        6.3      13.4     0.0       0.0       0.0      0.0
0.0
GR 1.07     0        0.71     6.3      0        9         0         9.6      0.79
13.4
GR 1.1      22.4

NC 0.060    0.060    0.030
X1 1706              6        7.000    12.100   0.0       0.0       0.0      0.00
0.0
GR 89.38    0        89.08    7        88.51    8.95      88.51     9.55     88.96
12.1
GR 89.38    32

NC 0.2      0.2      0.2
X1 1706-REV          8        7        12.1     0.0       0.0       0.0      0.0
0.0
GR 1        -30      0.87     0        0.57     7         0         8.95     0
9.55
GR 0.45     12.1     0.87     32       1        62

NC 0.060    0.060    0.030
X1 2                 5        10.000   18.000   0.0       0.0       0.0      0.00
0.0
GR 86.85    0        86.72    10       86.34    14        87.07     18       87.21
28

NC 0.060    0.060    0.030
X1 2406              7        14.900   25.500   0.0       0.0       0.0      0.00
0.0
GR 88.61    0        88.16    14.9     86.93    17.55     86.71     19       86.98
21.8
GR 88.34    25.5     89.05    31.8

NC 0.2      0.2      0.2
X1 2406-REV          7        14.9     25.5     0.0       0.0       0.0      0.0
```

```
0.0
GR 1.9      0         1.45      14.9      0.22      17.55     0         19        0.27
21.8
GR 1.63     25.5      2.34      31.8

NC 0.06     0.06      0.03
X1 2-REV             5         10        18        0.0        0.0        0.0       0.0
0.0
GR 0.51     0         0.38      10        0         14        0.73      18        0.87
28

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------

[INFLOWS]
;;                                                Param    Units    Scale
Baseline Baseline
;;Node           Parameter        Time Series      Type     Factor   Factor   Value
  Pattern
;;-------------- ---------------- ---------------- -------- -------- --------
-------- --------
9A               FLOW             ""               FLOW     1.0      1        0.04

[TIMESERIES]
```

C.5 POND 2 PCSWMM INPUT FILE (MAHOGANY CREEK)

```
[TITLE]

[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
START_DATE           01/01/1995
START_TIME           01:00:00
REPORT_START_DATE    01/01/1995
REPORT_START_TIME    01:00:00
END_DATE             01/03/1995
END_TIME             01:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             5
REPORT_STEP          00:01:00
WET_STEP             00:01:00
DRY_STEP             00:01:00
ROUTING_STEP         5
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  SLOPE
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         ELEVATION
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              2

[FILES]
USE HOTSTART "C:\ana's\minto\modeling\PCSWMM\100CHI_HOT.HSF"

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

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
RAINGAGE         INTENSITY 0:10   1      TIMESERIES 100yr3hrChicago-IBI

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.
  Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope
  Length   Pack
;;-------------- ---------------- ---------------- -------- -------- --------
-------- -------- --------
;0.60
```

```
C102A                RAINGAGE         C102A-S          1.343523 57.1     444      0.5
 0
;0.60
C105A                RAINGAGE         C105A-S          0.451128 57.1     173      0.5
 0
;0.60
C106A                RAINGAGE         C106A-S          0.586046 57.1     210      0.5
 0
;0.60
C108A                RAINGAGE         C108A-S          1.135278 57.1     306      0.5
 0
;0.60
C109A                RAINGAGE         C109A-S          0.708703 57.1     141      0.5
 0
;0.60
C110A                RAINGAGE         C110A-S          1.563146 57.1     348      0.5
 0
;0.60
C111A                RAINGAGE         C111A-S          0.775898 57.1     169      0.5
 0
;0.60
C112A                RAINGAGE         C112A-S          1.577445 57.1     428      0.5
 0
;0.55
L101A                RAINGAGE         L101A-S          1.463042 50       788      1
 0
;0.55
L103A                RAINGAGE         L103A-S          7.38545  14.3     2651     1
 0
;0.55
L104A                RAINGAGE         L104A-S          5.299193 50       2102     1
 0
;0.30
L104B                RAINGAGE         L104B-S          0.604025 14.3     135      1
 0
;0.60
L105A                RAINGAGE         L105A-S          3.008836 57.1     1382     1
 0
;0.70
L105B                RAINGAGE         L105B-S          2.890668 71.4     650      1
 0
;0.60
L106A                RAINGAGE         L106A-S          3.221312 57.1     1564     1
 0
;0.30
L106B                RAINGAGE         L106B-S          2.493932 14.3     560      1
 0
;0.55
L107A                RAINGAGE         L107A-S          1.541354 50       250      1
 0
;0.55
L109A                RAINGAGE         L109A-S          2.341961 50       1067     1
 0
;0.60
L110A                RAINGAGE         L110A-S          2.936461 57.1     1163     1
 0
;0.55
L111A                RAINGAGE         L111A-S          2.811561 50       1106     1
 0
;0.60
L112A                RAINGAGE         L112A-S          1.852279 57.1     693      1
 0
;0.60
```

```
L113A            RAINGAGE         L113A-S          1.512982 57.1     721      1
  0
;0.60
L115A            RAINGAGE         L115A-S          3.891973 57.1     1374     1
  0
;0.50
POND2            RAINGAGE         100-S            3.282099 42.9     738      1
  0
;0.40
UNC1             RAINGAGE         100-S            0.717575 28.6     162      1
  0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo
PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ----------
----------
C102A            0.013      0.25       1.57       4.67       0          OUTLET
C105A            0.013      0.25       1.57       4.67       0          OUTLET
C106A            0.013      0.25       1.57       4.67       0          OUTLET
C108A            0.013      0.25       1.57       4.67       0          OUTLET
C109A            0.013      0.25       1.57       4.67       0          OUTLET
C110A            0.013      0.25       1.57       4.67       0          OUTLET
C111A            0.013      0.25       1.57       4.67       0          OUTLET
C112A            0.013      0.25       1.57       4.67       0          OUTLET
L101A            0.013      0.25       1.57       4.67       0          OUTLET
L103A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L104A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L104B            0.013      0.25       1.57       4.67       0          PERVIOUS
100
L105A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L105B            0.013      0.25       1.57       4.67       0          OUTLET
L106A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L106B            0.013      0.25       1.57       4.67       0          PERVIOUS
100
L107A            0.013      0.25       1.57       4.67       0          OUTLET
L109A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L110A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L111A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L112A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L113A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L115A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
POND2            0.013      0.25       1.57       4.67       0          PERVIOUS
100
UNC1             0.013      0.25       1.57       4.67       0          PERVIOUS
100

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
C102A            76.2       13.2       4.14       7          0
C105A            76.2       13.2       4.14       7          0
C106A            76.2       13.2       4.14       7          0
```

```
C108A            76.2       13.2       4.14       7          0
C109A            76.2       13.2       4.14       7          0
C110A            76.2       13.2       4.14       7          0
C111A            76.2       13.2       4.14       7          0
C112A            76.2       13.2       4.14       7          0
L101A            76.2       13.2       4.14       7          0
L103A            76.2       13.2       4.14       7          0
L104A            76.2       13.2       4.14       7          0
L104B            76.2       13.2       4.14       7          0
L105A            76.2       13.2       4.14       7          0
L105B            76.2       13.2       4.14       7          0
L106A            76.2       13.2       4.14       7          0
L106B            76.2       13.2       4.14       7          0
L107A            76.2       13.2       4.14       7          0
L109A            76.2       13.2       4.14       7          0
L110A            76.2       13.2       4.14       7          0
L111A            76.2       13.2       4.14       7          0
L112A            76.2       13.2       4.14       7          0
L113A            76.2       13.2       4.14       7          0
L115A            76.2       13.2       4.14       7          0
POND2            76.2       13.2       4.14       7          0
UNC1             76.2       13.2       4.14       7          0

[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name           Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
101              84.667     5.022      0          0          0
102              84.987     4.888      0          0          0
103              85.975     4.156      0          0          0
104              86.495     4.049      0          0          0
105              85.572     4.492      0          0          0
106              85.765     4.489      0          0          0
107              87.029     3.523      0          0          0
108              86.927     3.123      0          0          0
109              86.214     4.19       0          0          0
110              86.518     4.039      0          0          0
111              85.817     4.212      0          0          0
112              85.965     4.209      0          0          0
113              86.269     3.984      0          0          0
114              86.437     3.909      0          0          0
115              86.664     3.833      0          0          0
PH1-213          86.5       2.78       0          1.1        0
PH1-232          86.945     3.445      0          1.1        0
PH1-288          87.47      2.53       0          1.1        0

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
outlet A         84.766     TIDAL        OutletA_100YRCHI_Stantec_revised NO


[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve
Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params
Area     Frac.    Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- --------
-------- -------- -----------------------
100-S            83.5     4.93     0        TABULAR    Pond2_Storage_Curve
0     0
168              87.087   1.913    0        FUNCTIONAL 0        0        0        0
```

0

172	86.517	1.983	0	FUNCTIONAL	0	0	0	0	0
173A	86.286	1.714	0	FUNCTIONAL	0	0	0	0	0
173B	86.211	2.439	0	FUNCTIONAL	0	0	0	0	0
173C	86.174	2.476	0	FUNCTIONAL	0	0	0	0	0
174	86.104	1.896	0	FUNCTIONAL	0	0	0	0	0
Area1	85	2.5	0	FUNCTIONAL	0	0	0	0	0
Area2	87.27	2.93	0	FUNCTIONAL	0	0	0	0	0
C102A-S	87.99	2.25	0	FUNCTIONAL	0	0	0	0	0
C105A-S	87.73	2.6	0	TABULAR	C105A			0	0
C106A-S	87.94	2.5	0	TABULAR	C106A			0	0
C108A-S	88.15	2.5	0	TABULAR	C108A			0	0
C109A-S	88.13	2.5	0	TABULAR	C109A			0	0
C110A-S	88.41	2.5	0	TABULAR	C110A			0	0
C111A-S	87.73	2.5	0	TABULAR	C111A			0	0
C112A-S	88.18	2.5	0	TABULAR	C112A			0	0
L101A-S	87.65	2.5	0	TABULAR	L101A			0	0
L103A-S	87.8	2.5	0	TABULAR	L103A			0	0
L104A-S	87.8	2.5	0	TABULAR	L104A			0	0
L104B-S	88.08	2.4	0	FUNCTIONAL	0	0	0	0	0
L105A-S	87.82	2.5	0	TABULAR	L105A			0	0
L105B-S	88.2	2.5	0	TABULAR	L105B			0	0
L106A-S	88.01	2.5	0	TABULAR	L106A			0	0
L106B-S	88.29	2.4	0	FUNCTIONAL	0	0	0	0	0
L107A-S	88.15	2.5	0	TABULAR	L107A			0	0
L109A-S	88.22	2.5	0	TABULAR	L109A			0	0
L110A-S	88.5	2.5	0	TABULAR	L110A			0	0
L111A-S	88.13	2.5	0	TABULAR	L111A			0	0
L112A-S	88.18	2.5	0	TABULAR	L112A			0	0
L113A-S	88.2	2.5	0	TABULAR	L113A			0	0
L115A-S	88.2	2.5	0	TABULAR	L115A			0	0
SU1	89.85	0.35	0	FUNCTIONAL	0	0	0	0	0

```
SU10             90.23    0.35     0        FUNCTIONAL 0        0        0        0
      0
SU2              89.7     0.6      0        FUNCTIONAL 0        0        0        0
      0
SU3              90.27    0.35     0        FUNCTIONAL 0        0        0        0
      0
SU4              90.06    0.35     0        FUNCTIONAL 0        0        0        0
      0
SU5              90.18    0.35     0        FUNCTIONAL 0        0        0        0
      0
SU6              89.87    0.45     0        FUNCTIONAL 0        0        0        0
      0
SU7              89.7     0.45     0        FUNCTIONAL 0        0        0        0
      0
SU8              90.55    0.35     0        FUNCTIONAL 0        0        0        0
      0
SU9              90.25    0.35     0        FUNCTIONAL 0        0        0        0
      0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet
Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset
Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ----------
---------- ---------- ----------
1                C106A-S          SU4              2          0.013      90.09
90.06      0          0
10               SU3              SU4              100        0.013      90.27
90.06      0          0
13               L106A-S          SU4              20         0.013      90.16
90.06      0          0
15               L105B-S          SU6              10         0.013      90.35
90.3       0          0
16               L106B-S          SU4              5          0.025      90.09
90.06      0          0
17               L104B-S          SU1              5          0.025      89.88
89.85      0          0
18               SU1              SU2              10         0.013      89.85
89.7       0          0
19               su10             su5              10         0.013      90.23
90.18      0          0
2                SU4              SU6              100        0.013      90.06
89.87      0          0
20               L103A-S          SU1              20         0.013      89.95
89.85      0          0
21               SU8              SU3              20         0.013      90.55
90.27      0          0
22               L107A-S          SU3              2          0.013      90.3
90.27      0          0
23               L111A-S          su5              20         0.013      90.28
90.18      0          0
5                C110A-S          SU8              2          0.013      90.56
90.55      0          0
6                L113A-S          SU9              20         0.013      90.35
90.25      0          0
7                SU9              SU10             10         0.013      90.25
90.23      0          0
8                L110A-S          SU8              2          0.013      90.65
90.55      0          0
9                C112A-S          SU10             20         0.013      90.33
90.23      0          0
C1               L104A-S          SU1              20         0.013      89.95
```

```
89.85      0        0
C2               C108A-S        SU3          2          0.013      90.3
90.27      0        0
C3               C105A-S        SU6          2          0.013      89.88
89.87      0        0
C4               L112A-S        SU10         20         0.013      90.33
90.23      0        0
C5               C111A-S        SU6          2          0.013      89.88
89.87      0        0
Culvert          173B           173C         23         0.013      86.211
86.174     0        0
Link236          173C           174          55         0.045      86.174
86.104     0        0
ORF              100-S          Area1        50         0.013      85.5
85         0        0
P168             168            172          270        0.045      87.087
86.517     0        0
P172             172            173A         130        0.045      86.517
86.286     0        0
P173             173A           173B         42         0.045      86.286
86.211     0        0
P174             174            Area1        190        0.045      86.104
85         0        0
PArea1           Area1          outlet A     125        0.03       85
84.766     0        0
PArea2           Area2          168          30         0.045      87.27
87.087     0        0
Pipe_100         110            109          155.107    0.013      86.818
86.664     0        0
Pipe_101         109            106          149.274    0.013      86.514
86.365     0        0
Pipe_102         111            102          153.586    0.013      86.117
85.887     0        0
Pipe_103         112            111          144.757    0.013      86.265
86.12      0        0
Pipe_104         113            112          78.898     0.013      86.569
86.49      0        0
Pipe_105         114            113          93.337     0.013      86.737
86.644     0        0
Pipe_106         115            114          151.423    0.013      86.948
86.797     0        0
Pipe_12-S        L109A-S        SU3          20         0.013      90.37
90.27      0        0
Pipe_16-S        SU2            100-S        20         0.025      89.7
87         0        0
Pipe_19-S        L105A-S        SU1          20         0.013      89.97
89.87      0        0
Pipe_1-S         SU7            100-S        20         0.025      89.7
89.3       0        0
Pipe_4-S         L101A-S        SU7          20         0.013      89.8
89.7       0        0
Pipe_5-S         C102A-S        SU7          17         0.013      89.79
89.7       0        0
Pipe_6-S         SU6            C102A-S      17         0.013      89.87
89.79      0        0
Pipe_7-S         C109A-S        SU3          2          0.013      90.28
90.27      0        0
Pipe_8-S         SU5            SU6          20         0.013      90.18
89.87      0        0
Pipe_91          101            100-S        44.44      0.013      84.967
84.9       0        0
Pipe_92          102            101          173.311    0.013      85.287
85.027     0        0
```

```
Pipe_93          103              102              259.036    0.013      86.275
85.887     0          0
Pipe_94          104              103              369.452    0.013      86.795
86.425     0          0
Pipe_95          105              102              190.197    0.013      85.872
85.587     0          0
Pipe_96          106              105              190.691    0.013      86.065
85.875     0          0
Pipe_97          108              106              174.826    0.013      87.08
86.81      0          0
Pipe_98          107              106              242.92     0.013      87.329
86.965     0          0
Pipe_9-S         L115A-S          SU9              20         0.013      90.35
90.25      0          0
ST213            PH1-213          174              12.3       0.013      86.5
86.49      0          0
ST232            PH1-232          172              4          0.013      86.945
86.944     0          0
ST288            PH1-288          168              10         0.013      87.47
87.46      0          0

[WEIRS]
;;               Inlet            Outlet           Weir         Crest      Disch.
 Flap End      End
;;Name           Node             Node             Type         Height     Coeff.
 Gate Con.     Coeff.     Surcharge  RoadWidth  RoadSurf
;;-------------- ---------------- ---------------- ------------ ----------
---------- ---- -------- ---------- ---------- ---------- ----------
pond2weir        100-S            Area1            TRANSVERSE   86         1.7
 NO   0        2.6        YES

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet
Qcoeff/                     Flap
;;Name           Node             Node             Height     Type
QTable           Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- ----------------
---------------- ---------- ----
C102A-IC         C102A-S          102              87.99      TABULAR/HEAD
C102A-IC                    NO
C105A-IC         C105A-S          105              87.73      TABULAR/HEAD
C105A-IC                    NO
C106A-IC         C106A-S          106              87.94      TABULAR/HEAD
C106A-IC                    NO
C108A-IC         C108A-S          108              88.15      TABULAR/HEAD
C108A-IC                    NO
C109A-IC         C109A-S          109              88.13      TABULAR/HEAD
C109A-IC                    NO
C110A-IC         C110A-S          110              88.41      TABULAR/HEAD
C110A-IC                    NO
C111A-IC         C111A-S          111              87.73      TABULAR/HEAD
C111A-IC                    NO
C112A-IC         C112A-S          112              88.18      TABULAR/HEAD
C112A-IC                    NO
L101A-IC         L101A-S          101              87.65      TABULAR/HEAD
L101A-IC                    NO
L103A-IC         L103A-S          103              87.8       TABULAR/HEAD
L103A-IC                    NO
L104A-IC         L104A-S          104              87.8       TABULAR/HEAD
L104A-IC                    NO
L104B-IC         L104B-S          104              88.08      TABULAR/HEAD
L104B-IC                    NO
L105A-IC         L105A-S          105              87.82      TABULAR/HEAD
```

L105A-IC		NO			
L105B-IC	L105B-S		105	88.2	TABULAR/HEAD
L105B-IC		NO			
L106A-IC	L106A-S		106	88.01	TABULAR/HEAD
L106A-IC		NO			
L106B-IC	L106B-S		106	88.29	TABULAR/HEAD
L106B-IC		NO			
L107A-IC	L107A-S		107	88.15	TABULAR/HEAD
L107A-IC		NO			
L109A-IC	L109A-S		109	88.22	TABULAR/HEAD
L109A-IC		NO			
L110A-IC	L110A-S		110	88.5	TABULAR/HEAD
L110A-IC		NO			
L111A-IC	L111A-S		111	88.13	TABULAR/HEAD
L111A-IC		NO			
L112A-IC	L112A-S		112	88.18	TABULAR/HEAD
L112A-IC		NO			
L113A-IC	L113A-S		113	88.2	TABULAR/HEAD
L113A-IC		NO			
L115A-IC	L115A-S		115	88.2	TABULAR/HEAD
L115A-IC		NO			

[XSECTIONS]

;;Link	Shape	Geom1	Geom2	Geom3	Geom4	Barrels
;;--------------	------------	----------------	----------	----------	----------	----------
1	IRREGULAR	18mROW	0	0	0	1
10	IRREGULAR	26mROW	0	0	0	1
13	IRREGULAR	16.5mROW	0	0	0	1
15	IRREGULAR	16.5mROW	0	0	0	1
16	TRIANGULAR	0.6	3.6	0	0	1
17	TRIANGULAR	0.6	3.6	0	0	1
18	IRREGULAR	18mROW	0	0	0	1
19	IRREGULAR	26mROW	0	0	0	1
2	IRREGULAR	26mROW	0	0	0	1
20	IRREGULAR	18mROW	0	0	0	1
21	IRREGULAR	26mROW	0	0	0	1
22	IRREGULAR	16.5mROW	0	0	0	1
23	IRREGULAR	18mROW	0	0	0	1
5	IRREGULAR	26mROW	0	0	0	1
6	IRREGULAR	16.5mROW	0	0	0	1
7	IRREGULAR	18mROW	0	0	0	1
8	IRREGULAR	16.5mROW	0	0	0	1
9	IRREGULAR	26mROW	0	0	0	1

C1	IRREGULAR	18mROW	0	0	0	1
C2	IRREGULAR	26mROW	0	0	0	1
C3	IRREGULAR	18mROW	0	0	0	1
C4	IRREGULAR	18mROW	0	0	0	1
C5	IRREGULAR	18mROW	0	0	0	1
Culvert	RECT_CLOSED	1.5	2.4	1	1	1
Link236	IRREGULAR	2010-10-01Unnamed01	0	0	0	1
ORF	CIRCULAR	0.35	1	1	1	1
P168	IRREGULAR	2010-10-01Unnamed01	0	0	0	1
P172	IRREGULAR	2010-10-01Unnamed01	0	0	0	1
P173	IRREGULAR	2010-10-01Unnamed01	0	0	0	1
P174	IRREGULAR	2010-11-15Unnamed02	0	0	0	1
PArea1	IRREGULAR	2-relative	0	0	0	1
PArea2	IRREGULAR	2010-10-01Unnamed01	0	0	0	1
Pipe_100	CIRCULAR	1.05	0	0	0	1
Pipe_101	CIRCULAR	1.2	0	0	0	1
Pipe_102	CIRCULAR	1.2	0	0	0	1
Pipe_103	CIRCULAR	1.2	0	0	0	1
Pipe_104	CIRCULAR	0.975	0	0	0	1
Pipe_105	CIRCULAR	0.9	0	0	0	1
Pipe_106	CIRCULAR	0.9	0	0	0	1
Pipe_12-S	IRREGULAR	18mROW	0	0	0	1
Pipe_16-S	TRAPEZOIDAL	0.6	2	3	3	1
Pipe_19-S	IRREGULAR	18mROW	0	0	0	1
Pipe_1-S	TRAPEZOIDAL	0.45	5	10	10	1
Pipe_4-S	IRREGULAR	18mROW	0	0	0	1
Pipe_5-S	IRREGULAR	26mROW	0	0	0	1
Pipe_6-S	IRREGULAR	26mROW	0	0	0	1
Pipe_7-S	IRREGULAR	18mROW	0	0	0	1
Pipe_8-S	IRREGULAR	26mROW	0	0	0	1
Pipe_91	CIRCULAR	1.8	0	0	0	1
Pipe_92	CIRCULAR	1.8	0	0	0	1

```
Pipe_93          CIRCULAR     1.2              0          0          0          1
Pipe_94          CIRCULAR     1.05             0          0          0          1
Pipe_95          CIRCULAR     1.5              0          0          0          1
Pipe_96          CIRCULAR     1.5              0          0          0          1
Pipe_97          CIRCULAR     0.75             0          0          0          1
Pipe_98          CIRCULAR     0.6              0          0          0          1
Pipe_9-S         IRREGULAR    16.5mROW         0          0          0          1
ST213            CIRCULAR     0.9              1          1          1          1
ST232            CIRCULAR     0.9              1          1          1          1
ST288            CIRCULAR     1.05             1          1          1          1
pond2weir        RECT_OPEN    1                5          0          0

[TRANSECTS]

NC 0.060    0.060    0.030
X1 1153             5        6.300    13.400   0.0       0.0       0.0      0.00
0.0
GR 88.85    0        88.49    6.3       87.78    9.3       88.57    13.4     88.88
22.4

;Full street, width = 8.5m, curb = 0.15m , cross-slope = 0.03m/m, 1.8m sidewalk on
one side, bank-slope = 0.02m/m, 4m bank.
NC 0.025    0.025    0.013
X1 16.5mROW         8        10       20.3     0.0       0.0       0.0      0.0
0.0
GR 0.35     0        0.15     10        0        10        0.13     14.25    0
18.5
GR 0.15     18.5     0.19     20.3      0.35     28.3

NC 0.060    0.060    0.030
X1 1706             6        7.000    12.100   0.0       0.0       0.0      0.00
0.0
GR 89.38    0        89.08    7         88.51    9         88.51    9.8      88.96
12.1
GR 89.38    32

;Full street, width = 8.5m, curb = 0.15m , cross-slope = 0.03m/m, bank-slope =
0.02m/m, bank-height = 0.245m, one sided 1.8m sidewalk.
NC 0.025    0.025    0.013
X1 18mROW           8        10       20.3     0.0       0.0       0.0      0.0
0.0
GR 0.35     0        0.15     10        0        10        0.13     14.25    0
18.5
GR 0.15     18.5     0.19     20.3      0.35     28.3

NC 0.060    0.060    0.030
X1 2                5        10.000   18.000   0.0       0.0       0.0      0.00
0.0
GR 86.85    0        86.72    10        86.34    14        87.07    18       87.21
28

NC 0.060    0.060    0.045
```

```
X1 2010-10-01Unnamed01 13        38.970   65.750   0.0       0.0       0.0      0.00
   0.0
GR 88.2      37.75    87.8     38.97    87       39.77    87       40.39    87.8
41.19
GR 87.8      43.69    87.4     50.69    87.4     53.99    87.2     54.19    87.4
55.38
GR 87.4      58.38    87.8     65.75    88.39    67.55

NC 0.060    0.060    0.045
X1 2010-11-15Unnamed02 9         3.000    25.500   0.0       0.0       0.0      0.00
   0.0
GR 86.56     0        85.93    3        84.73    4.2      84.73    9.2      85.93
10.4
GR 85.93     23       85.13    24.3     85.79    25.5     86.5     43.5

NC 0.060    0.060    0.030
X1 2406             7        14.900   25.500   0.0       0.0       0.0      0.00
0.0
GR 88.61     0        88.16    14.9     86.93    17.55    86.71    19       86.98
21.8
GR 88.34     25.5     89.05    31.8

;Full street, width = 11m, curb = 0.15m , cross-slope = 0.03m/m, bank-slope =
0.02m/m, bank-height = 0.15m, two sided 2m sidewalk.
NC 0.025    0.025    0.013
X1 26mROW           9        8        23       0.0       0.0       0.0      0.0
0.0
GR 0.35      0        0.19     8        0.15     10       0        10       0.165
15.5
GR 0         21       0.15     21       0.19     23       0.35     31

NC 0.060    0.060    0.030
X1 2-relative       5        10.000   18.000   0.0       0.0       0.0      0.00
0.0
GR 0.51      0        0.38     10       0        14       0.73     18       0.87
28

NC 0.06     0.06     0.03
X1 existing         5        14       17       0.0       0.0       0.0      0.0
0.0
GR 1.11      0        0.85     14       0        15.7     0.8      17       1.17
24

NC 0.03     0.03     0.03
X1 Rideau           3        0.0      58.83    0.0       0.0       0.0      0.0
0.0
GR 86.11     0        84.65    33.62    86.74    58.53

[LOSSES]
;;Link          Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------
Pipe_102        0          1.32       0          NO         0
Pipe_103        0          0.06       0          NO         0
Pipe_104        0          1.32       0          NO         0
Pipe_105        0          1.32       0          NO         0
Pipe_106        0          1.32       0          NO         0
Pipe_92         0          1.32       0          NO         0
Pipe_93         0          0.02       0          NO         0
Pipe_94         0          0.02       0          NO         0
Pipe_95         0          0.06       0          NO         0
Pipe_96         0          0.06       0          NO         0
Pipe_97         0          0.06       0          NO         0
Pipe_98         0          1.32       0          NO         0
```

[INFLOWS]

;;Node	Parameter	Time Series	Param Type	Units Factor	Scale Factor	Baseline Value	Baseline Pattern
;;--------------	---------------	---------------	--------	--------	--------	--------	--------
PH1-213	FLOW	ST213_100YRCHI	FLOW	1.0	1	0	
PH1-232	FLOW	ST232_100YRCHI	FLOW	1.0	1	0	
PH1-288	FLOW	ST288_100YRCHI	FLOW	1.0	1	0	
168	FLOW	168_100YRCHI	FLOW	1.0	1	0	
173A	FLOW	173A_100YRCHI	FLOW	1.0	1	0	
173B	FLOW	173B_100YRCHI	FLOW	1.0	1	0	
174	FLOW	174_100YRCHI	FLOW	1.0	1	0	
Area1	FLOW	AREA1_100YRCHI	FLOW	1.0	1	0	
Area2	FLOW	AREA2_100YRCHI	FLOW	1.0	1	0	

[CURVES]

;;Name	Type	X-Value	Y-Value
;;--------------	----------	----------	----------
105A-IC	Rating	0	0
105A-IC		1.8	0.07
105A-IC		2.15	0.072
C102A-IC	Rating	0	0
C102A-IC		1.8	0.240
C102A-IC		2.15	0.245
C103A-IC	Rating	0	0
C103A-IC		1.8	0.150
C103A-IC		2.15	0.152
C104A-IC	Rating	0	0
C104A-IC		3.65	0.16
C104A-IC		3.85	0.162
C104A-IC		4	0.162
C104B-IC	Rating	0	0
C104B-IC		2.6	0.24
C104B-IC		2.8	0.242
C104B-IC		2.95	0.242
C105A-IC	Rating	0	0
C105A-IC		1.8	0.08
C105A-IC		2.15	0.082
C105A-IC		2.5	0.082
C106A-IC	Rating	0	0
C106A-IC		1.8	0.110
C106A-IC		2.15	0.112
C106A-IC		2.5	0.112
C107A-IC	Rating	0	0

```
C107A-IC                     3.264       0.150
C107A-IC                     3.464       0.152
C107A-IC                     3.614       0.152

C108A-IC          Rating     0           0
C108A-IC                     1.8         0.2
C108A-IC                     2.15        0.204
C108A-IC                     2.5         0.204

C109A-IC          Rating     0           0
C109A-IC                     1.8         0.120
C109A-IC                     2.15        0.122
C109A-IC                     2.5         0.122

C110A-IC          Rating     0           0
C110A-IC                     1.8         0.280
C110A-IC                     2.15        0.286
C110A-IC                     2.5         0.286

C111A-IC          Rating     0           0
C111A-IC                     1.8         0.140
C111A-IC                     2.15        0.143
C111A-IC                     2.5         0.143

C112A-IC          Rating     0           0
C112A-IC                     1.8         0.280
C112A-IC                     2.15        0.286
C112A-IC                     2.5         0.286

C116A-IC          Rating     0           0
C116A-IC                     1.8         0.210
C116A-IC                     2.15        0.212

C119A-IC          Rating     0           0
C119A-IC                     1.8         0.12
C119A-IC                     2.15        0.122

C120A-IC          Rating     0           0
C120A-IC                     1.8         0.39
C120A-IC                     2.15        0.392

L101A-IC          Rating     0           0
L101A-IC                     1.8         0.160
L101A-IC                     2.15        0.163
L101A-IC                     2.5         0.163

L102A-IC          Rating     0           0
L102A-IC                     1.8         0.330
L102A-IC                     2.15        0.332
L102A-IC                     2.5         0.334

L102B-IC          Rating     0           0
L102B-IC                     1.8         0.003
L102B-IC                     2.10        0.003
L102B-IC                     2.7         0.004

L103A-IC          Rating     0           0
L103A-IC                     1.8         0.180
L103A-IC                     2.15        0.184
L103A-IC                     2.5         0.184

L104A-IC          Rating     0           0
L104A-IC                     1.8         0.490
```

```
L104A-IC                   2.15       0.5
L104A-IC                   2.5        0.5

L104B-IC        Rating     0          0
L104B-IC                   1.8        0.005
L104B-IC                   2.4        0.005

L105A-IC        Rating     0          0
L105A-IC                   1.8        0.340
L105A-IC                   2.15       0.347
L105A-IC                   2.5        0.347

L105B-IC        Rating     0          0
L105B-IC                   1.8        0.440
L105B-IC                   2.15       0.449
L105B-IC                   2.5        0.449

L106A-IC        Rating     0          0
L106A-IC                   1.8        0.370
L106A-IC                   2.15       0.377
L106A-IC                   2.5        0.377

L106B-IC        Rating     0          0
L106B-IC                   1.8        0.010
L106B-IC                   2.4        0.01

L107A-IC        Rating     0          0
L107A-IC                   1.8        0.160
L107A-IC                   2.15       0.163
L107A-IC                   2.5        0.163

L108A-IC        Rating     0          0
L108A-IC                   1.8        0.37
L108A-IC                   2.15       0.372
L108A-IC                   2.5        0.373

L109A-IC        Rating     0          0
L109A-IC                   1.8        0.220
L109A-IC                   2.15       0.224
L109A-IC                   2.5        0.224

L110A-IC        Rating     0          0
L110A-IC                   1.8        0.320
L110A-IC                   2.15       0.326
L110A-IC                   2.5        0.326

L110B-IC        Rating     0          0
L110B-IC                   1.8        0.01
L110B-IC                   2.10       0.01
L110B-IC                   2.7        0.011

L111A-IC        Rating     0          0
L111A-IC                   1.8        0.260
L111A-IC                   2.15       0.265
L111A-IC                   2.5        0.265

L111B-IC        Rating     0          0
L111B-IC                   1.8        0.44
L111B-IC                   2.1        0.442
L111B-IC                   2.5        0.442

L112A-IC        Rating     0          0
L112A-IC                   1.8        0.2
```

L112A-IC		2.15	0.204
L112A-IC		2.5	0.204
L113A-IC	Rating	0	0
L113A-IC		1.8	0.170
L113A-IC		2.15	0.173
L113A-IC		2.5	0.173
L114A-IC	Rating	0	0
L114A-IC		1.8	0.13
L114A-IC		2.15	0.132
L114B-IC	Rating	0	0
L114B-IC		1.8	0.003
L114B-IC		2.4	0.003
L114B-IC		2.75	0.004
L115A-IC	Rating	0	0
L115A-IC		1.8	0.410
L115A-IC		2.15	0.418
L115A-IC		2.5	0.418
L116A-IC	Rating	0	0
L116A-IC		1.8	0.25
L116A-IC		2.15	0.252
L116A-IC		2.5	0.252
L118A-IC	Rating	0	0
L118A-IC		1.8	0.25
L118A-IC		2.15	0.252
L118A-IC		2.5	0.252
L120A-IC	Rating	0	0
L120A-IC		1.8	0.55
L120A-IC		2.15	0.552
L120A-IC		2.5	0.552
C105A	Storage	0	0
C105A		1.8	0
C105A		2.15	26
C105A		2.5	26
C106A	Storage	0	0
C106A		1.8	0
C106A		2.15	39
C106A		2.5	39
C108A	Storage	0	0
C108A		1.8	0
C108A		2.15	83
C108A		2.5	83
C109A	Storage	0	0
C109A		1.8	0
C109A		2.15	48
C109A		2.5	48
C110A	Storage	0	0
C110A		1.8	0
C110A		2.15	130
C110A		2.5	130
C111A	Storage	0	0

```
C111A                        1.8         0
C111A                        2.15        45
C111A                        2.50        45

C112A            Storage     0           0
C112A                        1.8         0
C112A                        2.15        148
C112A                        2.5         148

L101A            Storage     0           0
L101A                        1.8         0
L101A                        2.15        91
L101A                        2.5         91

L103A            Storage     0           0
L103A                        1.8         0
L103A                        2.15        564
L103A                        2.5         564

L104A            Storage     0           0
L104A                        1.8         0
L104A                        2.15        418
L104A                        2.5         418

L105A            Storage     0           0
L105A                        1.8         0
L105A                        2.15        262
L105A                        2.5         262

L105B            Storage     0           0
L105B                        1.8         0
L105B                        2.15        3000
L105B                        2.5         3000

L106A            Storage     0           0
L106A                        1.8         0
L106A                        2.15        247
L106A                        2.5         247

L107A            Storage     0           0
L107A                        1.8         0
L107A                        2.15        112
L107A                        2.50        112

L109A            Storage     0           0
L109A                        1.8         0
L109A                        2.15        207
L109A                        2.5         207

L110A            Storage     0           0
L110A                        1.8         0
L110A                        2.15        304
L110A                        2.5         304

L111A            Storage     0           0
L111A                        1.8         0
L111A                        2.15        253
L111A                        2.5         253

L112A            Storage     0           0
L112A                        1.8         0
L112A                        2.15        174
L112A                        2.5         174
```

```
L113A            Storage    0          0
L113A                       1.8        0
L113A                       2.15       142
L113A                       2.5        142

L115A            Storage    0          0
L115A                       1.8        0
L115A                       2.15       324
L115A                       2.5        324

Pond2_Storage_Curve Storage    0          10000
Pond2_Storage_Curve            2          14000
Pond2_Storage_Curve            2.7        17000
Pond2_Storage_Curve            3.2        20000
Pond2_Storage_Curve            4.93       21000
```

C.6 POND 3 PCSWMM INPUT FILE (WCMD)

```
[TITLE]


[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           CMS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
START_DATE           06/27/2017
START_TIME           05:00:00
REPORT_START_DATE    06/27/2017
REPORT_START_TIME    05:00:00
END_DATE             06/29/2017
END_TIME             17:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             5
REPORT_STEP          00:01:00
WET_STEP             00:01:00
DRY_STEP             00:01:00
ROUTING_STEP         5
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         1.167
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         ELEVATION
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              2

[FILES]
USE HOTSTART "W:\active\1 planning_landscape\1604 Projects\160410140_Mahogany Stage 
2+ Development\design\analysis\SWM\Second Submission - March 2018\Pond 
3\PCSWMM\100CHI.HSF"

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

[RAINGAGES]
;;               Rain      Time   Snow   Data      
;;Name           Type      Intrvl Catch  Source    
;;-------------- --------- ------ ------ ----------
RG1              INTENSITY 0:10   1      TIMESERIES 100 YR Chicago 3 hr

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    
  Curb     Snow            
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    
  Length   Pack            
;;-------------- ---------------- ---------------- -------- -------- --------
```

```
-------- -------- --------
;0.20
3-PRE            RG1              S4               2.861    0        30       0.1
  0
;0.20
4-PRE            RG1              Jun-4_nc         3.34     0        100      0.1
  0
;0.20
5-PRE            RG1              Jun-2_nc         10.14    0        450      0.1
  0
;0.20
8-PRE1           RG1              SiteA            9.426    0        444      0.1
  0
;0.20
8-PRE2           RG1              SiteA            5.262    0        213      0.1
  0
9-PRE            RG1              9A_nc            263.0403 0        2400     0.01
  0
Area 6_nc        RG1              S6_nc            1.8      0        66.667   0.1
  0
Area 7_nc        RG1              S5-7_nc          9.2      0        450      0.1
  0
;0.60
C206A            RG1              C206A-S          2.554276 57.143   829      1
  0
;0.60
FUT              RG1              FUT-S            6.607775 57.143   1487     1
  0
;0.50
L202A            RG1              L202A-S          4.402029 57.143   1237     1
  0
;0.55
L203B            RG1              L203B-S          1.170178 57.143   450      1
  0
;0.55
L204A            RG1              L204A-S          3.091784 57.143   1016     1
  0
;0.55
L205A            RG1              L205A-S          3.021067 57.143   967      1
  0
;0.55
L207A            RG1              L207A-S          1.255982 57.143   283      1
  0
;0.70
POND3            RG1              200-S            1.364137 57.143   489      1
  0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo
PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ----------
----------
3-PRE            0.013      0.25       1.57       4.67       0          PERVIOUS
100
4-PRE            0.013      0.25       1.57       4.67       0          PERVIOUS
100
5-PRE            0.013      0.25       1.57       4.67       0          PERVIOUS
100
8-PRE1           0.013      0.25       1.57       4.67       0          PERVIOUS
100
8-PRE2           0.013      0.25       1.57       4.67       0          PERVIOUS
100
9-PRE            0.013      0.25       1.57       4.67       0          PERVIOUS
```

```
100
Area 6_nc        0.013      0.25       1.57       4.67       0          PERVIOUS
100
Area 7_nc        0.013      0.25       1.57       4.67       0          PERVIOUS
100
C206A            0.013      0.25       1.57       4.67       0          OUTLET
FUT              0.013      0.25       1.57       4.67       0          PERVIOUS
30
L202A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L203B            0.013      0.25       1.57       4.67       0          OUTLET
L204A            0.013      0.25       1.57       4.67       0          PERVIOUS
30
L205A            0.013      0.25       1.57       4.67       0          OUTLET
L207A            0.013      0.25       1.57       4.67       0          OUTLET
POND3            0.013      0.25       1.57       4.67       0          PERVIOUS
100

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
3-PRE            35         3          4.14       7          0
4-PRE            35         3          4.14       7          44
5-PRE            35         3          4.14       7          44
8-PRE1           35         3          4.14       7          0
8-PRE2           35         3          4.14       7          0
9-PRE            35         1          4.14       7          0
Area 6_nc        35         3          4.14       7          44
Area 7_nc        35         3          4.14       7          44
C206A            76.2       13.2       4.14       7          0
FUT              76.2       13.2       4.14       7          0
L202A            76.2       13.2       4.14       7          0
L203B            76.2       13.2       4.14       7          0
L204A            76.2       13.2       4.14       7          0
L205A            76.2       13.2       4.14       7          0
L207A            76.2       13.2       4.14       7          0
POND3            76.2       13.2       4.14       7          0

[OUTFALLS]
;;               Invert     Outfall      Stage/Table      Tide
;;Name           Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
Outlet B         85.99      FIXED        87.26            NO

[STORAGE]
;;               Invert   Max.     Init.    Storage    Curve
Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params
Area     Frac.    Infiltration parameters
;;-------------- -------- -------- -------- ---------- -------- -------- --------
-------- -------- -----------------------
200-S            84.46    4.855    2        TABULAR    SWM POND3_Storage_Curve
    0 0
201              85.342   4.778    1.118    FUNCTIONAL 0        0        1.13     0
      0
202              86.065   4.166    0.395    FUNCTIONAL 0        0        1.13     0
      0
203              86.833   3.628    0        FUNCTIONAL 0        0        1.13     0
      0
204              85.639   4.579    0.821    FUNCTIONAL 0        0        1.13     0
      0
205              86.052   3.789    0.408    FUNCTIONAL 0        0        1.13     0
      0
```

```
206                 86.318   3.664    0.142    FUNCTIONAL 0        0        1.13     0
      0
207                 87.141   2.479    0        FUNCTIONAL 0        0        1.13     0
      0
9A_nc               89       3        0        FUNCTIONAL 0.01     0        0        0
      0
C206A-S             87.62    2.5      0        FUNCTIONAL 0        0        0        0
      0
Drain1              86.04    2.34     0        FUNCTIONAL 0        0        0        0
      0
Drain2              86.03    2.49     0        FUNCTIONAL 0        0        0        0
      0
Drain3              86.72    2        0        FUNCTIONAL 0        0        0        0
      0
FUT-POND            86       4.85     2        TABULAR    FUT_SWM_POND               0
      0
FUT-S               88.54    3.96     0        FUNCTIONAL 0        0        0        0
      0
J1                  87.547   2.34     0        FUNCTIONAL 0        0        0        0
      0
Jun-1_nc            88.813   3.187    0        FUNCTIONAL 0.01     0        0        0
      0
Jun-2_nc            88.8     0.97     0        FUNCTIONAL 0.01     0        0        0
      0
Jun-3_nc            88.679   0.956    0        FUNCTIONAL 0.01     0        0        0
      0
Jun-4_nc            88.677   0.969    0        FUNCTIONAL 0.01     0        0        0
      0
Jun-5_nc            90       2        0        FUNCTIONAL 0.01     0        0        0
      0
Jun-6_nc            88.278   5.722    0        FUNCTIONAL 19354    2.143    0        0
      0
L201A-S             90.12    0.6      0        FUNCTIONAL 0        0        0        0
      0
L202A-S             88       2.5      0        FUNCTIONAL 0        0        0        0
      0
L203B-S             88.1     2.5      0        FUNCTIONAL 0        0        0        0
      0
L204A-S             88       2.5      0        FUNCTIONAL 0        0        0        0
      0
L205A-S             87.65    2.5      0        FUNCTIONAL 0        0        0        0
      0
L207A-S             87.47    2.75     0        FUNCTIONAL 0        0        0        0
      0
S4                  88.66    1.1      0        FUNCTIONAL 0        0        1        0
      0
S5-7_nc             88.9     3.1      0        FUNCTIONAL 0        0        1        0
      0
S6_nc               88.69    0.87     0        FUNCTIONAL 0        0        1        0
      0
SiteA               88.26    2.34     0        FUNCTIONAL 0        0        0        0
      0

[CONDUITS]
;;                  Inlet            Outlet                      Manning    Inlet
Outlet     Init.      Max.
;;Name              Node             Node             Length     N          Offset
Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ----------
---------- ---------- ----------
1_1_nc              9A_nc            Jun-6_nc         2269.226   0.03       89
88.278     0          0
1_nc                Jun-6_nc         SiteA            56.751     0.024      88.278
```

```
88.26      0          0
2_nc                Jun-5_nc         Jun-1_nc         146.077     0.03        90
88.813     0          0
3                   L205A-S          C206A-S          5           0.013       89.8
89.77      0          0
4                   L203B-S          L202A-S          20          0.013       90.25
90.15      0          0
C1                  L202A-S          L201A-S          5           0.013       90.15
90.12      0          0
C3                  L207A-S          Drain2           5           0.025       89.62
89.3       0          0
C4                  FUT-S            FUT-POND         20          0.013       92.15
92.05      0          0
Flow 4              S4               Drain3           594.891     0.03        88.66
86.72      0          0
Flow 5              Jun-2_nc         S4               351.811     0.03        88.8
88.66      0          0
Flow 5_1_nc         S5-7_nc          Jun-1_nc         173.143     0.03        88.9
88.813     0          0
Flow 5_3_nc         Jun-1_nc         Jun-2_nc         29.311      0.024       88.813
88.8       0          0
Flow 6              Jun-4_nc         S4               301.106     0.03        88.677
88.66      0          0
Flow 6_1_nc         S6_nc            Jun-3_nc         208.159     0.03        88.69
88.679     0          0
Flow 6_3_nc         Jun-3_nc         Jun-4_nc         29.919      0.024       88.679
88.677     0          0
Flow 9_1            SiteA            J1               305.023     0.03        88.26
87.547     0          0
Flow 9_2            J1               Drain1           644.977     0.03        87.547
86.04      0          0
Flow B              Drain2           Outlet B         20          0.03        86.03
85.99      0          0
Flow B1             Drain3           Drain2           20          0.04        86.72
86.52      0          0
Flow B2             Drain1           Drain2           20          0.03        86.04
86.03      0          0
FUT-IC              FUT-S            FUT-POND         360         0.013       88.54
88         0          0
Maj_in              L201A-S          200-S            20          0.025       90.12
88.8       0          0
Min_in              201              200-S            42.39       0.013       85.642
85.6       0          0
Pipe_108            202              201              197.769     0.013       86.365
86.167     0          0
Pipe_109            203              202              158.698     0.013       87.133
86.815     0          0
Pipe_116            204              201              97.733      0.013       85.939
85.792     0          0
Pipe_117            205              204              113.222     0.013       86.2
86.09      0          0
Pipe_118            206              205              115.608     0.013       86.47
86.35      0          0
Pipe_123            207              206              224.321     0.013       87.36
86.918     0          0
Pipe_22-S           L204A-S          L201A-S          5           0.013       90.15
90.12      0          0
Pipe_24-S           C206A-S          S4               5           0.013       89.77
89.75      0          0

[ORIFICES]
;;                  Inlet            Outlet           Orifice      Crest       Disch.
 Flap Open/Close
```

```
;;Name           Node             Node             Type         Height     Coeff.
 Gate Time
;;-------------- ---------------- ---------------- ------------ ----------
---------- ---- ----------
C2               FUT-POND         J1               SIDE         88         0.65
 NO   0
OR1              FUT-POND         J1               SIDE         88.5       0.65
 NO   0
Orifice-1        200-S            Drain2           SIDE         86.46      0.61
 NO   0
Orifice-2        200-S            Drain2           SIDE         87.1       0.65
 NO   0

[WEIRS]
;;               Inlet            Outlet           Weir         Crest      Disch.
 Flap End      End
;;Name           Node             Node             Type         Height     Coeff.
 Gate Con.     Coeff.     Surcharge  RoadWidth  RoadSurf
;;-------------- ---------------- ---------------- ------------ ----------
---------- ---- -------- ---------- ---------- ---------- ----------
W1               FUT-POND         J1               TRANSVERSE   88.8       1.7
 NO   0        0          YES
Weir-P3          200-S            Drain2           TRANSVERSE   87.3       1.7
 NO   0        0          YES

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet
Qcoeff/                     Flap
;;Name           Node             Node             Height     Type
QTable           Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- ----------------
---------------- ---------- ----
C206A-IC         C206A-S          206              87.62      TABULAR/HEAD
C206A-IC                    NO
L202A-IC         L202A-S          202              88         TABULAR/HEAD
L202A-IC                    NO
L203B-IC         L203B-S          203              88.1       TABULAR/HEAD
L203B-IC                    NO
L204A-IC         L204A-S          204              88         TABULAR/HEAD
L204A-IC                    NO
L205-IC          L205A-S          205              87.65      TABULAR/HEAD
L205A-IC                    NO
L207A-IC         L207A-S          207              87.47      TABULAR/HEAD
L207A-IC                    NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4
Barrels
;;-------------- ------------ ---------------- ---------- ---------- ----------
----------
1_1_nc           IRREGULAR    2406             0          0          0          1

1_nc             CIRCULAR     1.5              0          0          0          1

2_nc             IRREGULAR    1706             0          0          0          1

3                IRREGULAR    18mROW           0          0          0          1

4                IRREGULAR    18mROW           0          0          0          1

C1               IRREGULAR    18mROW           0          0          0          1

C3               TRAPEZOIDAL  0.6              3          5          5          1
```

```
C4               IRREGULAR    18mROW          0          0          0          1

Flow 4           IRREGULAR    1153            0          0          0          1

Flow 5           IRREGULAR    1706            0          0          0          1

Flow 5_1_nc      IRREGULAR    1706            0          0          0          1

Flow 5_3_nc      CIRCULAR     0.264           0          0          0          1

Flow 6           IRREGULAR    1706            0          0          0          1

Flow 6_1_nc      IRREGULAR    1706            0          0          0          1

Flow 6_3_nc      CIRCULAR     0.264           0          0          0          1

Flow 9_1         IRREGULAR    2406            0          0          0          1

Flow 9_2         IRREGULAR    2406            0          0          0          1

Flow B           TRAPEZOIDAL  2               3          8          8          1

Flow B1          TRAPEZOIDAL  2               3          8          8          1

Flow B2          TRAPEZOIDAL  2               3          8          8          1

FUT-IC           CIRCULAR     1.05            0          0          0          1

Maj_in           TRAPEZOIDAL  0.6             3          5          5          1

Min_in           CIRCULAR     1.5             0          0          0          1

Pipe_108         CIRCULAR     0.975           0          0          0          1

Pipe_109         CIRCULAR     0.525           0          0          0          1

Pipe_116         CIRCULAR     1.35            0          0          0          1

Pipe_117         CIRCULAR     1.2             0          0          0          1

Pipe_118         CIRCULAR     1.05            0          0          0          1

Pipe_123         CIRCULAR     0.6             0          0          0          1

Pipe_22-S        IRREGULAR    18mROW          0          0          0          1

Pipe_24-S        IRREGULAR    26mROW          0          0          0          1

C2               CIRCULAR     0.1             0          0          0
OR1              CIRCULAR     0.1             0          0          0
Orifice-1        CIRCULAR     0.15            0          0          0
Orifice-2        CIRCULAR     0.15            0          0          0
W1               RECT_OPEN    0.5             20         0          0
Weir-P3          RECT_OPEN    0.55            35         0          0

[TRANSECTS]

NC 0.060    0.060    0.05
X1 1153             5        6.300    13.400    0.0       0.0       0.0      0.00
0.0
GR 88.85    0        88.49    6.3      87.78     9.3       88.57     13.4     88.88
22.4
```

```
NC 0.06      0.06     0.05
X1 1153-REV          6        6.3      13.4     0.0      0.0       0.0      0.0
0.0
GR 1.07      0        0.71     6.3      0        9        0        9.6      0.79
13.4
GR 1.1       22.4

NC 0.025     0.025    0.013
X1 16.5mROW          8        10       20.3     0.0      0.0       0.0      0.0
0.0
GR 0.35      0        0.15     10       0        10       0.13     14.25    0
18.5
GR 0.15      18.5     0.19     20.3     0.35     28.3

NC 0.2       0.2      0.2
X1 1706              8        7.000    12.100   0.0      0.0       0.0      0.00
0.0
GR 89.51     -30      89.38    0        89.08    7        88.51    9        88.51
9.8
GR 88.96     12.1     89.38    32       89.51    62

NC 0.06      0.06     0.03
X1 1706-REV          8        7        12.1     0.0      0.0       0.0      0.0
0.0
GR 1         -30      0.87     0        0.57     7        0        8.95     0
9.55
GR 0.45      12.1     0.87     32       1        62

NC 0.025     0.025    0.013
X1 18mROW            8        10       20.3     0.0      0.0       0.0      0.0
0.0
GR 0.35      0        0.15     10       0        10       0.13     14.25    0
18.5
GR 0.15      18.5     0.19     20.3     0.35     28.3

NC 0.060     0.060    0.045
X1 2                 5        10.000   18.000   0.0      0.0       0.0      0.00
0.0
GR 86.85     0        86.72    10       86.34    14       87.07    18       87.21
28

NC 0.2       0.2      0.2
X1 2406              7        14.900   25.500   0.0      0.0       0.0      0.00
0.0
GR 88.61     0        88.16    14.9     86.93    17.55    86.71    19       86.98
21.8
GR 88.34     25.5     89.05    31.8

NC 0.06      0.06     0.05
X1 2406-REV          7        14.9     25.5     0.0      0.0       0.0      0.0
0.0
GR 1.9       0        1.45     14.9     0.22     17.55    0        19       0.27
21.8
GR 1.63      25.5     2.34     31.8

NC 0.025     0.025    0.013
X1 26mROW            9        8        23       0.0      0.0       0.0      0.0
0.0
GR 0.35      0        0.19     8        0.15     10       0        10       0.165
15.5
GR 0         21       0.15     21       0.19     23       0.35     31
```

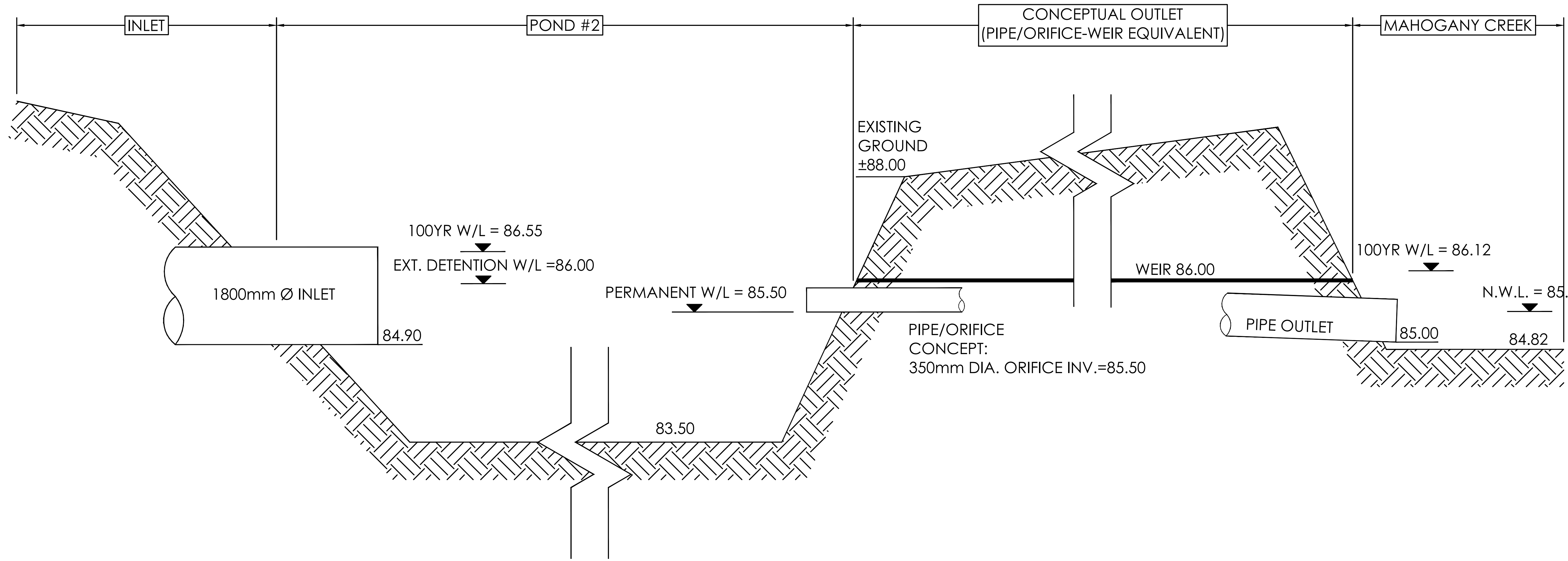
```
NC 0.06     0.06     0.03
X1 2-REV           5         10        18        0.0        0.0        0.0       0.0
0.0
GR 0.51     0        0.38      10        0         14        0.73      18        0.87
28

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------
Pipe_108         0          0.64       0          NO         0
Pipe_109         0          0.02       0          NO         0
Pipe_116         0          0.21       0          NO         0
Pipe_117         0          1.32       0          NO         0
Pipe_118         0          1.32       0          NO         0
Pipe_123         0          1.32       0          NO         0

[INFLOWS]
;;                                                  Param    Units    Scale
Baseline Baseline
;;Node           Parameter        Time Series      Type     Factor   Factor   Value
 Pattern
;;-------------- ---------------- ---------------- -------- -------- --------
-------- --------
9A_nc            FLOW             ""               FLOW     1.0      1        0.04


[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
C206A-IC         Rating     0          0
C206A-IC                    1.8        0.480
C206A-IC                    2.15       0.490
C206A-IC                    2.5        0.490

FUT-IC           Rating     0          0
FUT-IC                      1.8        0.650
FUT-IC                      2.15       0.663
FUT-IC                      2.5        0.663

L202A-IC         Rating     0          0
L202A-IC                    1.8        0.450
L202A-IC                    2.15       0.459
L202A-IC                    2.5        0.459

L203B-IC         Rating     0          0
L203B-IC                    1.8        0.14
L203B-IC                    2.15       0.143
L203B-IC                    2.5        0.143

L204A-IC         Rating     0          0
L204A-IC                    1.8        0.32
L204A-IC                    2.15       0.326
L204A-IC                    2.5        0.326

L205A-IC         Rating     0          0
L205A-IC                    1.8        0.370
L205A-IC                    2.15       0.377
L205A-IC                    2.5        0.377

L207A-IC         Rating     0          0
L207A-IC                    1.8        0.15
L207A-IC                    2.15       0.153
L207A-IC                    2.75       0.153
```

```
FUT_SWM_POND      Storage    0          602
FUT_SWM_POND                 2          1045.2
FUT_SWM_POND                 2.44       1248
FUT_SWM_POND                 3.04       1521
FUT_SWM_POND                 5.14       2740

L201A-S           Storage    0          0
L201A-S                      3.499      2000
L201A-S                      3.849      2000

L204B             Storage    0          0
L204B                        1.8        0
L204B                        2.15       1000
L204B                        2.5        1000

S-1020_Storage_Curve Storage    0          1.00
S-1020_Storage_Curve            1.3        1.00
S-1020_Storage_Curve            1.4        1100.00
S-1020_Storage_Curve            1.55       2200.00

S-1050_Storage_Curve Storage    0          1.00
S-1050_Storage_Curve            1.3        1.00
S-1050_Storage_Curve            1.4        335.00
S-1050_Storage_Curve            1.55       670.00

S-1070_Storage_Curve Storage    0          1.00
S-1070_Storage_Curve            1.3        1.00
S-1070_Storage_Curve            1.4        1850.00
S-1070_Storage_Curve            1.55       3700.00

S-2010_Storage_Curve Storage    0          1.00
S-2010_Storage_Curve            1.3        1.00
S-2010_Storage_Curve            1.4        2500.00
S-2010_Storage_Curve            1.55       5000.00

S-2020_Storage_Curve Storage    0          1.00
S-2020_Storage_Curve            1.3        1.00
S-2020_Storage_Curve            1.4        900.00
S-2020_Storage_Curve            1.55       1800.00

S-2025_Storage_Curve Storage    0          1.00
S-2025_Storage_Curve            1.3        1.00
S-2025_Storage_Curve            1.4        1900.00
S-2025_Storage_Curve            1.55       3800.00

S-2026_Storage_Curve Storage    0          1.00
S-2026_Storage_Curve            1.3        1.00
S-2026_Storage_Curve            1.4        850.00
S-2026_Storage_Curve            1.55       1700.00

S-2030_Storage_Curve Storage    0          1.00
S-2030_Storage_Curve            1.3        1.00
S-2030_Storage_Curve            1.4        8400.00
S-2030_Storage_Curve            1.55       16800.00

S-2042_Storage_Curve Storage    0          1.00
S-2042_Storage_Curve            1.3        1.00
S-2042_Storage_Curve            1.4        900.00
S-2042_Storage_Curve            1.55       1800.00

S-2060_Storage_Curve Storage    0          1.00
S-2060_Storage_Curve            1.3        1.00
```

```
S-2060_Storage_Curve             1.4        2900.00
S-2060_Storage_Curve             1.55       5800.00

S-2070_Storage_Curve Storage     0          1.00
S-2070_Storage_Curve             1.3        1.00
S-2070_Storage_Curve             1.4        2350.00
S-2070_Storage_Curve             1.55       4700.00

S-2080_Storage_Curve Storage     0          1.00
S-2080_Storage_Curve             1.3        1.00
S-2080_Storage_Curve             1.4        2150.00
S-2080_Storage_Curve             1.55       4300.00

S-2090_Storage_Curve Storage     0          1.00
S-2090_Storage_Curve             1.3        1.00
S-2090_Storage_Curve             1.4        3100.00
S-2090_Storage_Curve             1.55       6200.00

S-3010_Storage_Curve Storage     0.0        1.00
S-3010_Storage_Curve             1.3        1.00
S-3010_Storage_Curve             1.4        3000.00
S-3010_Storage_Curve             1.55       6000.00

S-3050_Storage_Curve Storage     0          1.00
S-3050_Storage_Curve             1.3        1.00
S-3050_Storage_Curve             1.4        1950.00
S-3050_Storage_Curve             1.55       3900.00

S-4010_Storage_Curve Storage     0.0        1.00
S-4010_Storage_Curve             1.3        1.00
S-4010_Storage_Curve             1.4        1900.00
S-4010_Storage_Curve             1.55       3810.00

S-4030_Storage_Curve Storage     0          1.00
S-4030_Storage_Curve             1.3        1.00
S-4030_Storage_Curve             1.4        3760.00
S-4030_Storage_Curve             1.55       7520.00

S-4060_Storage_Curve Storage     0.0        1.00
S-4060_Storage_Curve             1.3        1.00
S-4060_Storage_Curve             1.4        3600.00
S-4060_Storage_Curve             1.55       7300.00

S-4070_Storage_Curve Storage     0.0        1.00
S-4070_Storage_Curve             1.3        1.00
S-4070_Storage_Curve             1.4        5800.00
S-4070_Storage_Curve             1.55       11700.00

S-4090_Storage_Curve Storage     0          1.00
S-4090_Storage_Curve             1.3        1.00
S-4090_Storage_Curve             1.4        3150.00
S-4090_Storage_Curve             1.55       6300.00

S-4092_Storage_Curve Storage     0          1.00
S-4092_Storage_Curve             1.3        1.00
S-4092_Storage_Curve             1.4        2700.00
S-4092_Storage_Curve             1.55       5400.00

S-4093_Storage_Curve Storage     0          1.00
S-4093_Storage_Curve             1.3        1.00
S-4093_Storage_Curve             1.4        2150.00
S-4093_Storage_Curve             1.55       4300.00
```

```
SWM POND1_Storage_Curve Storage    0          1200.00
SWM POND1_Storage_Curve            1          1500.00
SWM POND1_Storage_Curve            2          1900.00
SWM POND1_Storage_Curve            2.65       2200.00

SWM POND2_Storage_Curve Storage    0          3000.00
SWM POND2_Storage_Curve            1          4000.00
SWM POND2_Storage_Curve            2          5000.00
SWM POND2_Storage_Curve            3          6000.00

SWM POND3_Storage_Curve Storage    0          1506
SWM POND3_Storage_Curve            2          2613
SWM POND3_Storage_Curve            2.44       3120
SWM POND3_Storage_Curve            3.04       3802
SWM POND3_Storage_Curve            5.14       6849

SWM POND4_Storage_Curve Storage    0          2800.00
SWM POND4_Storage_Curve            1          3300.00
SWM POND4_Storage_Curve            2.         4500.00
SWM POND4_Storage_Curve            3.17       5200.00

outlet A_Tidal_Curve Tidal      0          84
outlet A_Tidal_Curve            6          85.45
outlet A_Tidal_Curve            13.5       85.82
outlet A_Tidal_Curve            15         85.45
outlet A_Tidal_Curve            20         84

Outlet B_100YR_Tidal_Curve Tidal      0          86.42
Outlet B_100YR_Tidal_Curve            13.5       87.30
Outlet B_100YR_Tidal_Curve            15         86.42
Outlet B_100YR_Tidal_Curve            20         86.42

Weir4_Tidal_Curve Tidal      0          85.50
Weir4_Tidal_Curve            13.5       86.82
Weir4_Tidal_Curve            16         85.5
Weir4_Tidal_Curve            20         85.5
```

C.7 CONCEPTUAL PROFILE POND 2



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2018/05/10 8:32 AM By: Thiffault, Dustin

ORIGINAL SHEET - ANSI B

APRIL, 2018
160410140

Stantec

Stantec Consulting Ltd.
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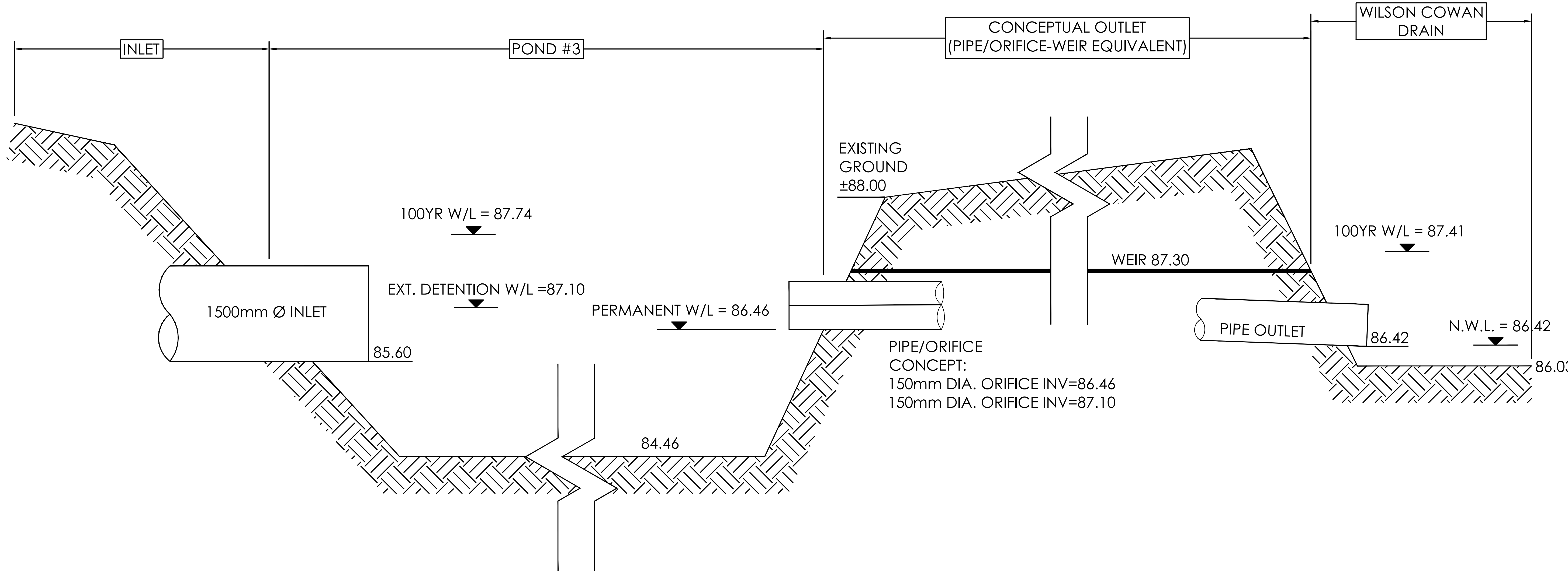
Client/Project
MINTO GROUP INC.
MAHOGANY SUBDIVISION
PHASES 2-4

Figure No.
1.0

Title
CONCEPTUAL POND PROFILE
POND #2

C.8 CONCEPTUAL PROFILE POND 3



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2018/05/10 8:32 AM By: Thiffault, Dustin

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MAHOGANY SUBDIVISION
PHASES 2-4

Figure No.
2.0

Title
CONCEPTUAL POND PROFILE
POND #3

C.9 CONCEPTUAL SWM POND CALCULATIONS

Project No. 160410140 - Mahogany Stage 2 Pond 2

Stormwater Quality Volumetric Requirements

Pond	Drainage Area (ha)	Actual % Imp.	MOE Control Level	Water Quality Unit Volume Requirments			Water Quality Volume Requirements			Water Quality Volumes Provided			
				Total Unit Volume (m^3/ha)	Permanent Pool (m^3/ha)	Extended Detention (m^3/ha)	Permanent Pool (m^3)	Extended Detention (m^3)	Total MOE Volume	Permanent Pool (m^3)	Extended Detention (m^3)	Total MOE Volume	Actual Provided Unit Volume (m^3/ha)
Mahogany Pond 2	55.40	51.6	Enhanced - 80% TSS Removal	181.5	141.5	40	7,839	2,216	10,055	23,098	7,750	30,848	557

- Water quality unit volume requirements based on interpolation for imperviousness requirements from Table 3.2, Stormwater Management Planning & Design Manual (MOE, 2003)

For use in Interpolation of above formulae

	Wetpond					Wetland			
%	0	35	55	70	85	35	55	70	85
Enhanced - 80% TSS Removal	0	140	190	225	250	80	105	120	140
Normal - 70% TSS Removal	0	90	110	130	150	60	70	80	90
Basic - 60% TSS Removal	0	60	75	85	95	60	60	60	60

Project No. 160410140 - Mahogany Stage 2 Pond 2
Stage-Storage-Discharge Summary

The stage-storage-discharge relationship used to identify components required in PC-SWMM model which will incorporate backwater conditions.

Stage	Discharge	Storage		Depth	Forebay			Main Cell			
		Active	Total*		Area	Incremental Volume	Accumulated Volume	Area	Incremental Volume	Accumulated Volume	
(m)	(m^3/s)	(m^3)	(m^3)	(m)	(m^2)	(m^3)	(m^3)	(m^2)	(m^3)	(m^3)	
83.50		0	0	0.00	3,000	0	0	7,000	0	0	
85.50		0	23,098	2.00	4,800	7,800	7,800	9,200	16,200	16,200	Permanent Pool
86.20		10,850	33,948	0.70	4,800	3,360	11,160	12,200	7,490	23,690	
86.70		20,100	43,198	1.20	4,800	2,400	13,560	15,200	6,850	30,540	
87.00		26,250	49,348	1.50	4,800	1,440	15,000	16,200	4,710	35,250	

* Total pond including forebay, excluding sediment storage (see forebay calculations)

Project No. 160410140 - Mahogany Stage 2 Pond 2

Detailed Outlet Structure Discharge Calculations

Elevation	Discharge (m^3/s)								
	Overflow Outlet			Piped Outlet					Total
(m)		Spillway	Total	Orifice 1	Orifice 2		Control	Weir 1	Discharge
83.50									
85.50									0.000
86.20		0.000	0.000	0.214	0.000		0.000	0.760	**0.974**
86.70		0.550	0.550	0.280	0.000		0.000	4.978	**5.808**
87.00		4.402	4.402	0.313	0.000		0.000	8.500	**13.215**
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000

Parameters

Spillway Weir		Orifice 1	
		Orifice Centre	Perimeter
		85.675 m	1.100 m
		Orifice Invert	Area
		85.50 m	0.0962 m^2
		Orifice Diameter	Orifice Coeff.
		350 mm	0.65
		Orientation	Permanent Pool
		Vertical	85.50 m
Crest Elevation		**Orifice 2**	
86.6 m		Orifice Centre	Perimeter
Crest Width		100.15 m	0.942 m
10 m*		Orifice Invert	Area
		100.00 m	0.0707 m^2
Weir Coeff.	1.740	Orifice Diameter	Orifice Coeff.
		300 mm	0.61
		Orientation	
		Vertical	
		Weir 1	
		Top of Weir Structure	Max Perimeter
		87.00 m	5.000 m
		Weir Crest Invert	Max Open Area
		86.00 m	5.000 m^2
		Weir Dimensions (Height x Length)	
		1.00 m Height	5.00 m Len
		Side Walls	Weir Coeff.
		Vertical	1.700

1. Outlet structure consists of reverse-sloped lowflow pipe connected to orifice #1 (created by equivalent sluice gate orientation)
2. Secondary outlet is Weir#1 in weir wall inside structure
3. Tertiary outlet is Overflow Weir#1 on outside face of outlet structure

5 m long weir at inv. = 86
350 mm lowflow outlet at inv. = 85.5 m

Water Quality Extended Detention Summary

Required Extended Detention Time	24-48 hrs for water quality drawdown		
Actual Extended Detention Time	27 hrs	Q_{peak}	0.129 m^3/s
Extended Detention Elevation	86.00 m	Q_{avg}	0.064 m^3/s

Watershed Area (ha)	55.40
Percent Impervious	51.6%
Water Quality Criteria	Enhanced - 80% TSS Removal
Req'd Ext. Det. Volume (m^3/ha)	40
Req'd Ext. Det. Volume (m^3)	2,216
Provided Ext. Det. (m^3)	7,750
Req'd Perm. Pool Volume (m^3/ha)	181.5
Req'd Perm. Pool Volume (m^3)	7,839
Provided Perm. Pool Volume (m^3)	23,098

Discharge Rates from PCSWMM (m^3/s)

Storm	Pond Inflow	Pond Outflow	Water Level	Pond Volume (m^3)
25mm, 4hr Chi	2.41	0.129	85.76	4030
2-yr, 24hr SCS	3.49	0.143	86.00	7750
5-yr, 24hr SCS	4.68	0.768	86.17	10385
100-yr, 24hr SCS	12.51	3.563	86.55	17325
100-yr, 3hr Chi	15.65	3.670	86.55	17325
100-yr+20, 3hr Chi	19.96	5.377	86.73	20715
July 1st, 1979	11.16	4.849	86.69	19915

$$Q = CA\sqrt{2g\left(h_2 - h_1 + \frac{D}{2000}\right)}$$

Where,
h2 = elevation at stage 2 (m)
h1 = elevation at stage 1 (m)
D = orifice diameter (mm)
C = orifice coefficient
A = orifice open area (m^2)

$$Q = CL\,(h_2 - h_1)^{1.5}$$

h2 = elevation at stage 2 (m)
h1 = elevation at stage 1 (m)
L = weir crest length (m)
C = weir coefficient

Weir flow calculation for orifice below centreline:

$$\theta = 2\cos^{-1}\left(1 - \frac{2h}{D}\right) = 2\,\mathrm{acos}\left(1 - \frac{2h}{D}\right)$$

$$P_W = \frac{D\theta}{2}$$

h = water level stage (m)
D = orifice diameter (m)
θ = angle based on water level (radians)
P_W = Wetted Perimeter = Crest Length (m)

Project No. 160410140 - Mahogany Stage 2 Pond 3

Stormwater Quality Volumetric Requirements

Pond	Drainage Area (ha)	Actual % Imp.	MOE Control Level	Water Quality Unit Volume Requirments			Water Quality Volume Requirements			Water Quality Volumes Provided			Actual Provided Unit Volume (m^3/ha)
				Total Unit Volume (m^3/ha)	Permanent Pool (m^3/ha)	Extended Detention (m^3/ha)	Permanent Pool (m^3)	Extended Detention (m^3)	Total MOE Volume	Permanent Pool (m^3)	Extended Detention (m^3)	Total MOE Volume	
Mahogany Pond 3	16.90	57.0	Enhanced - 80% TSS Removal	194.7	154.7	40	2,614	676	3,290	3,967	#NAME?	#NAME?	#NAME?

*Enhanced Water Level protection as specified by Gloucester EUC Phase 2 ISSU (September 2013)

- Water quality unit volume requirements based on interpolation between 60% and 70% imperviousness requirements from Table 3.2, Stormwater Management Planning & Design Manual (MOE, 2003)

For use in Interpolation of above formulae

	Wetpond					Wetland			
%	0	35	55	70	85	35	55	70	85
Enhanced - 80% TSS Removal	0	140	190	225	250	80	105	120	140
Normal - 70% TSS Removal	0	90	110	130	150	60	70	80	90
Basic - 60% TSS Removal	0	60	75	85	95	60	60	60	60

Project No. 160410140 - Mahogany Stage 2 Pond 3
Stage-Storage-Discharge Summary

The stage-storage-discharge relationship used to identify components required in PC-SWMM model which will incorporate backwater conditions.

Stage	Discharge	Storage		Depth	Forebay			Main Cell			
		Active	Total*		Area	Incremental Volume	Accumulated Volume	Area	Incremental Volume	Accumulated Volume	
(m)	(m^3/s)	(m^3)	(m^3)	(m)	(m^2)	(m^3)	(m^3)	(m^2)	(m^3)	(m^3)	
84.46		0	0	0.00	497	0	0	1,009	0	0	
86.46		0	3,967	2.00	784	1,281	1,281	1,829	2,838	2,838	Permanent Pool
86.90		1,261	5,229	0.44	784	345	1,626	2,336	916	3,754	
87.50		3,338	7,305	1.04	784	470	2,096	3,018	1,606	5,361	
89.60		14,521	18,489	3.14	784	1,646	3,743	6,065	9,537	14,898	

* Total pond including forebay, excluding sediment storage (see forebay calculations)

Project No. 160410140 - Mahogany Stage 2 Pond 3

Detailed Outlet Structure Discharge Calculations

Elevation	Discharge (m^3/s)								
	Overflow Outlet			Piped Outlet					Total
(m)		Spillway	Total	Orifice 1	Orifice 2		Control	Weir 1	Discharge
84.46									
86.46									0.000
86.90		0.000	0.000	0.031	0.000		0.000	0.000	**0.031**
87.50		0.000	0.000	0.048	0.030		0.030	5.322	**5.399**
89.60		49.215	49.215	0.083	0.074		0.074	207.543	**256.915**
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000
		0.000	0.000		0.000		0.000	0.000	0.000

Parameters

Spillway Weir		Orifice 1	
		Orifice Centre	Perimeter
		86.535 m	0.471 m
		Orifice Invert	Area
		86.46 m	0.0177 m^2
		Orifice Diameter	Orifice Coeff.
		150 mm	0.65
		Orientation	Permanent Pool
		Vertical	86.46 m
Crest Elevation		**Orifice 2**	
87.6 m		Orifice Centre	Perimeter
Crest Width		87.175 m	0.471 m
10 m*		Orifice Invert	Area
		87.10 m	0.0177 m^2
Weir Coeff.	1.740	Orifice Diameter	Orifice Coeff.
		150 mm	0.61
		Orientation	
		Vertical	
		Weir 1	
		Top of Weir Structure	Max Perimeter
		89.18 m	35.000 m
		Weir Crest Invert	Max Open Area
		87.30 m	65.800 m^2
		Weir Dimensions (Height x Length)	
		1.88 m Height	35.00 m Len
		Side Walls	Weir Coeff.
		Vertical	1.700

1. Outlet structure consists of reverse-sloped lowflow pipe connected to orifice #1 (created by equivalent sluice gate orientation)
2. Secondary outlet is Weir#1 in weir wall inside structure
3. Tertiary outlet is Overflow Weir#1 on outside face of outlet structure

35 m long weir at inv. = 87.3
150 mm lowflow outlet at inv. = 86.46 m

Water Quality Extended Detention Summary

Required Extended Detention Time	24-48 hrs for water quality drawdown		
Actual Extended Detention Time	35 hrs	Q_{peak}	0.029 m^3/s
Extended Detention Elevation	87.10 m	Q_{avg}	0.015 m^3/s

Watershed Area (ha)	16.90
Percent Impervious	57.0%
Water Quality Criteria	Enhanced - 80% TSS Removal
Req'd Ext. Det. Volume (m^3/ha)	40
Req'd Ext. Det. Volume (m^3)	676
Provided Ext. Det. (m^3)	#NAME?
Req'd Perm. Pool Volume (m^3/ha)	194.7
Req'd Perm. Pool Volume (m^3)	2,614
Provided Perm. Pool Volume (m^3)	3,967

Discharge Rates from PCSWMM (m^3/s)

Storm	Pond Inflow	Pond Outflow	Water Level	Volume (m3)
25mm, 4hr Chi	0.977	0.029	86.91	1297
2-yr, 24hr SCS	1.340	0.055	87.25	2478
5-yr, 24hr SCS	2.119	1.103	87.37	2878
100-yr, 24hr SCS	3.565	3.874	87.46	3202
100-yr, 3hr Chi	4.519	4.804	87.49	3288
100-yr+20, 3hr Chi	5.344	5.720	87.51	3383
July 1, 1979	3.289	3.573	87.45	3172

Where, $$Q = CA\sqrt{2g\left(h_2 - h_1 + \frac{D}{2000}\right)}$$

h2 = elevation at stage 2 (m)
h1 = elevation at stage 1 (m)
D = orifice diameter (mm)
C = orifice coefficient
A = orifice open area (m^2)

$$Q = CL(h_2 - h_1)^{1.5}$$

h2 = elevation at stage 2 (m)
h1 = elevation at stage 1 (m)
L = weir crest length (m)
C = weir coefficient

Weir flow calculation for orifice below centreline:

$$\theta = 2\cos^{-1}\left(1 - \frac{2h}{D}\right) = 2\,\mathrm{acos}\left(1 - \frac{2h}{D}\right)$$

$$P_w = \frac{D\theta}{2}$$

h = water level stage (m)
D = orifice diameter (m)
θ = angle based on water level (radians)
P_W = Wetted Perimeter = Crest Length (m)

Appendix D : GEOTECHNICAL INVESTIGATION EXCERPTS

Table 3: Permissible Grade Raise at Borehole Locations

Borehole Number	Ground Elev. (m)	Permissible Grade Raise - No LWF		Permissible Grade Raise - LWF	
		Raise (m)	Fin. Grade (m)	Raise (m)	Fin. Grade (m)
Mahogany Stage 2					
BH 55-17	89.20	1.50	90.70	1.90	91.10
BH 56-17	88.80	2.00	90.80	2.40	91.20
BH 12-07	88.60	2.50	91.10	2.90	91.50
BH 17-07	89.10	2.00	91.10	2.40	91.50
BH 18-07	89.00	2.00	91.00	2.40	91.40
BH 22-07	89.30	2.00	91.30	2.40	91.70
BH 23-07	89.40	2.50	91.90	2.90	92.30
BH 3-04B	88.90	2.50	91.40	2.90	91.80
BH 4-04B	89.30	2.50	91.80	2.90	92.20
Mahogany Stage 3					
BH 54-17	89.20	1.50	90.70	1.90	91.10
BH 34-07	88.90	1.80	90.70	2.20	91.10
BH 5-04B	89.20	2.50	91.70	2.90	92.10
Mahogany Stage 4					
BH 52-17	89.30	2.20	91.50	2.60	91.90
BH 28-07	89.30	2.20	91.50	2.60	91.90
BH 9-04	89.00	2.20	91.20	2.60	91.60
BH 10-04	88.90	2.20	91.10	2.60	91.50

Notes:
1. "Permissible Grade Raises - No LWF" are based on conventional wood-frame single home or town home housing construction with normal weight fill within garage, porch or floor slabs-on-grade (for back-to-back town home homes).
2. "Permissible Grade Raises - LWF" are based on installing EPS LWF in garages and porches and/or under slab-on-grade floors. Up to 0.4 to 0.6 m of additional grade raise can be achieved using LWF in garages and porches for singles and town homes.
3 Permissible Grade Raises - No LWF values for boreholes not listed can be taken to be 3.0 m and may be greater, based on specific geotechnical review.

PERMISSIBLE GRADE RAISE LEGEND:

AREAS OF SPECIFIC GRADE RAISE RESTRICTIONS

87.15	INTERPRETED ORIGINAL GROUND ELEVATION (m)
0.70	PERMISSIBLE GRADE RAISE (m)
87.85	PERMISSIBLE FINISHED GRADE (m)
88.25	MAX. FINISHED GRADE LIGHTWEIGHT FILL (LWF)

NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH ACCOMPANYING FILE PG4008-REP.01
2. WHERE PERMISSIBLE GRADE RAISE IS NOT SPECIFIED, IT IS AT LEAST 3.0m. HIGHER GRADE RAISES COULD BE PERMISSIBLE TO BE CONFIRMED BY GEOTECHNICAL ENGINEER ON A CASE-BY-CASE BASIS.
3. PHASE/STAGE 5 IS NOT INCLUDED IN THE GRADE RAISE ANALYSIS AND RECOMMENDATIONS.

LEGEND:

BOREHOLE LOCATION, CURRENT 2017 INVESTIGATION

BOREHOLE LOCATION, PREVIOUS INVESTIGATION (PATERSON GROUP REPORT PG0675-6) 2007-2008

BOREHOLE LOCATION, PREVIOUS INVESTIGATION (PATERSON GROUP REPORT PG0834-1) 2006

BOREHOLE LOCATION, PREVIOUS INVESTIGATION (PATERSON GROUP REPORT PG0328-1) 2004

BOREHOLE LOCATION, PREVIOUS INVESTIGATION (PATERSON GROUP REPORT PG0219-1) 2004

TEST PIT LOCATION, PREVIOUS INVESTIGATION (JDPA REPORT G7840-1) 2000

88.56	GROUND SURFACE ELEVATION (m)
90.0	APPROX. GROUND SURFACE ELEVATION (m)
(76.39)	PRACTICAL REFUSAL TO AUGERING/DCPT ELEVATION (m)

BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD. APPROXIMATE GROUND ELELEVATIONS AT OLDER TEST HOLES INTERPOLATED FROM TOPOGRAPHY.

SCALE: 1:4000

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NO.	REVISIONS	DATE	INITIAL
0			

MINTO COMMUNITIES INC.

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT - MAHOGANY COMMUNITY
OTTAWA (MANOTICK), ONTARIO

Title:

PERMISSIBLE GRADE RAISE PLAN

Stamp:

Scale:	1:4000
Drawn by:	RCG
Checked by:	AJT
Approved by:	AJT
Date:	06/2017
Report No.:	PG4008-REP.01
Drawing No.:	PG4008-2
Revision No.:	0

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Appendix E : DRAWINGS