Appendix 3

Background Data Summary

TOMRMS #	Region / Watershed	File in Dropbox	Parameters: Drainage Area (ha)	Imperviousness (%)	Land Use	CN Pre	CN Post	Hydraulic Grade Line (m) Chicago 25mm	HGL Chicago 2yr	HGL Chicago 5yr	HGL Chicago 10yr	HGL Chicago 25yr	HGL Chicago 50yr	HGL Chicago 100yr	HGL Timmins Regional	Flow Rate (m3/s) Pre - Development Chicago Storm Event 25mm	Pre Chicago 2yr	Pre Chicago 5yr	Pre Chicago 10yr	Pre Chicago 25yr	Pre Chicago 50yr	Pre Chicago 100yr	Post - Development Chicago Storm Event 25mm	Post Chicago 2yr	Post Chicago 5yr	Post Chicago 10yr	Post Chicago 25yr	Post Chicago 50yr	Post Chicago 100yr	Pre - Development SCS Storm Event 2yr	Pre SCS 5yr	Pre SCS 10yr	Pre SCS 25yr	Pre SCS 50yr	Pre SCS 100yr	Post - Development SCS Storm Event 2yr	Post SCS 5yr	Post SCS 10yr	Post SCS 25yr	Post SCS 50yr	Post SCS 100yr	Pre - Dev Timmins Regional	Post -Dev Timmins Regional	On-site Retention (m3) 25mm	On-site 2yr	On-site 5yr	On-site 10yr	On-site 25yr	On-site 50yr	On-site 100yr	On-site Timmins Regional	Off-site Release Rates (m3/s) 25mm	Off-site 2yr	Off-site 5yr	Off-site 10yr	Off-site 25yr	Off-site 50yr	Off-site 100yr	Off-site Timmins Regional	Spills	Precipitation Values Used (mm) Chicago 25mm	Chicago 2yr	Chicago 5yr	Chicago 10yr	Chicago 25yr	Chicago 50yr	Chicago 100yr	SCS 2yr	SCS 5yr	SCS 10yr	SCS 25yr	SCS 50yr	SCS 100yr	Timmins Regional	Potential Risks	Notes
	Silver Creek Watershed																																																																										
	Huntingwood Natural Hazard Study																																																																										
	Floodline Mapping Study of Silver Creek, Spring Creek, & Village of Angus																																																																										
	Windfall Master SWMM Report																																																																										
	Black Ash Creek Watershed																																																																										
	Georgian Meadows Subdivision		78.42	39	Res																									1.10	1.69	2.08	2.70		3.65							3.59																																		
	Phase 1		35.40				74																													0.71	1.09	1.34	1.74		2.29		3.18																																	
	Phase 1 and Phase 2 (Phase 2)		59.20				74																													1.55	2.40	3.02	3.95		5.20		4.59																																	
	Phase 1 , Phase 2 and External (Phase 3)		78.42																																	2.15	3.29	4.11	5.21		7.12		5.44																																	
	53 Brooke Ave., SWMF 1, Quality Pond, NE Side of Subdivision																																																																										
	Mair Mills Estates Subdivision (W of 10th Line, S of Mountain Rd, N of Blue Mountain Golf)		251.25		Res																																																																									
	Catchment 101		183.10				63.2																																																																						
	Catchment 103		8.70				58.5																																																																					
	Catchment 201		16.80	50																																																																								
	Catchment 202		0.95				57																																																																						
	Catchment 205		1.38				63.5																																																																					
	Catchment 206		1.00				67.5																																																																					
	Catchment 207		1.20				57																																																																						
	Catchment 300		4.55				71																																																																						
	Catchment 301		5.97				71																																																																						
	Catchment 302		16.39				65.2																																																																					
	Catchment 303		2.48				65.2																																																																					
	Catchment 304		2.90				66.6																																																																					
	Catchment 305		0.36				65.2																																																																					
	Catchment 1021		5.47				67.5																																																																					
	Mair Mills Estates Subdivision West Development Only																																																																										
	Flows to Mountain Rd Culvert (100, 101, 102, 103)		29.1 / 14.29	30		67.2	65.2									0.13	0.24	0.40		0.71		1.02	0.01	0.04	0.10		0.15		0.15													1.72	1.24																		24.97	33.75	44.07	50.59	59.08	65.65	71.77							193.00		
	Flows to East (104 / 206)		0.80 / 0.84			65.7	65.7									0.01	0.02	0.03		0.05		0.08	0.03	0.05	0.07		0.11		0.16													0.07	0.08																		24.97	33.75	44.07	50.59	59.08	65.65	71.77							193.00		
	Flows to West (105 / 207)		4.40 / 0.81			65.7	65.7									0.03	0.06	0.10		0.17		0.25	0.01	0.02	0.03		0.05		0.08													0.32	0.07																		24.97	33.75	44.07	50.59	59.08	65.65	71.77							193.00		
	Flows to SWM Pond (200, 201, 202, 203, 204, 205)		31.85	23			65.2																0.38	0.60	0.91		1.62		2.24														1.91																		24.97	33.75	44.07	50.59	59.08	65.65	71.77							193.00		
	2 Thomas Drive, SWMF 2, Quality/Quantity Pond, NE Side of Subdivision																																																																										
	Summitview Subdivision (N of Poplar Sideroad, W of High St.)		35.63		Res																																							1936	2648 / 2996	3149 / 3632	3455 / 4033	3832 / 4557	4100 / 5077	4390 / 5997	4543	0.035	0.129 / 0.322	0.431 / 0.910	0.731 / 1.459	1.176 / 2.150	1.573 / 2.176	1.918 / 2.177	2.147																	
	Outlet #1 (101) Black Ash Creek 1		9.55 / 0			62.4										0.025	0.054	0.100	0.136	0.188	0.233	0.278								0.090	0.166	0.226	0.312	0.372	0.443							0.525																																				
	Outlet #2 (102 / 202, 206) Black Ash Creek 2		4.39 / 4.33	50		62.4	69.4									0.019	0.042	0.079	0.108	0.150	0.187	0.223								0.072	0.133	0.180	0.249	0.297	0.353							0.304																																				
	Outlet #3 (115, 117 / 203) Mountaincroft		14.64 / 0.92	41		63										0.047	0.102	0.189	0.258	0.357	0.444	0.529	0.010	0.024	0.047	0.065	0.102	0.128	0.155	0.170	0.313	0.424	0.585	0.697	0.830	0.039	0.075	0.120	0.168	0.202	0.243	1.263																																				
	Outlet #3 (116 / 207) High St		6.16 / 1.51	41		62.4										0.020	0.044	0.083	0.112	0.156	0.194	0.232	0.006	0.015	0.029	0.040	0.062	0.078	0.094	0.074	0.136	0.185	0.256	0.305	0.363	0.024	0.046	0.073	0.103	0.123	0.148																																					
	Outlet #4 (103 / 205) Existing Pond		0.66 / 0.45	40		62.4	69.4									0.005	0.010	0.020	0.027	0.037	0.046	0.055	0.001	0.002	0.004	0.004	0.005	0.006	0.007	0.018	0.034	0.046	0.064	0.076	0.090	0.002	0.003	0.004	0.006	0.007	0.008	0.050	0.003																																			
	Outlet #5 (201, 208, 301) New SWM Pond		0 / 28.42	55			55.1																																																																									
	SWMF 26, Quality Pond, Oil Grit Separator																																																																													
	Van Dolders (185 Mountain Rd) Industrial Development																																																													24.97	33.75	44.07	50.59	59.08	65.65	71.77	44.60	56.50	64.40	74.40	81.80	89.20	193.00		
	Northeast AddHyd 806 (101, 102, 104)		6.60 / 0			67.4										0.109	0.200	0.330	0.427	0.559	0.665	0.774								0.197	0.299	0.372	0.470	0.546	0.625							0.512																																				
	Channel Outlet AddHyd 803 (103, 105, 106, 107 / All Catchments)		5.74 / 12.34			65.2	83.3									0.060	0.117	0.201	0.264	0.353	0.424	0.500	0.060	0.115	0.197	0.257	0.341	0.407	0.475	0.130	0.204	0.258	0.333	0.391	0.451	0.125	0.192	0.240	0.303	0.352	0.403	0.934	0.917																																		
	SWMF 25, Quality/Quantity Pond																																																																													
	Storm Pipe/Catch Basin Off Harbour St W																																																																													
	Canadian Tire / FreshCo / Galaxy Cinema Commercial Area				ICI																																																																									
	2 Mountain Rd (Private, Oil Grit Separator) NE of Staples, Amongst Spruce																																																																													
	55 Mountain Rd (Private, Oil Grit Separator) SW Corner of Parking lot, W of Triangle Island																																																																													
	SWMF 23, Oil Grit Separator) (55 Old Mountain Rd)																																																																													
	55 Mountain Rd (Exfiltration Trench) W of Parking Lot																																																																													
	Walmart Commercial Area				ICI																																																																									
	Black Ash Creek Subwatershed Plan																																																																													
	Consulate Development				ICI																																																																										
	Resort Drainage Areas																																																																												
	Condominium off Silver Glen Blvd				Res																																																																										
	Wyldewood Trailside Condominium off Brandy Ln Dr				Res																																																																										
	Blue Fairway (Tanglewood) Subdivision (Off Cranberry Trail E) Entirety		336.00	2 26	Res	64	63																																																															46.70	59.30	67.70	78.30	86.10	93.90	193.00		
	Node A Hwy 26 Box Culvert, E of Cranberry Trail																														0.84	1.20	1.49	1.89	2.24	2.57	0.98	1.49	1.80	2.26	2.54	2.83	9.65	9.58																																	
	Node B Cranberry Marsh at Hwy 26																														1.84	3.17	4.20	5.63	6.76	7.96	1.36	2.50	3.37	4.55	5.45	6.44	15.69	17.95		11000					46000	165000		0.98					2.83	9.58																		
	Blue Fairway (Tanglewood) Subdivision (Off Cranberry Trail E) Block 7																																																																													
	Node 1 (Culvert)		6.18 / 10.06	50			69																0.34	0.50	0.69	0.83	1.01	1.16	1.32														0.6																																				
	Node 2		6.69	16			67																0.10	0.14	0.20	0.23	0.28	0.32	0.36														0.37																																				
	Node 3		5.60 / 1.72	72			71																0.01													0.02	0.04	0.05	0.07	0.08	0.10		0.12																																				
	Blue Fairway (Tanglewood) Subdivision (Off Cranberry Trail E) Block 10A																																																						0.88	1.71	2.32	3.14	3.76	4.44	12.83																	
	Area 1		0.64	70																																																																											
	Area 2		0.50	70																																																																												
	Area 3		0.35	70																																																																												
	Area 4		0.71	70																																																																												
	SWMF 12, Quality/Quantity Pond																																																																													
	Bridgewater at Georgian Bay Subdivision (Off Bartlett and Princeton Shore Blvd)	Bridgewater	79.6 / 89.9	65	Res																																																																								
	Northern Drain (INT1)		14.20																																																																													
	Eastern Drain (INT2, EX2, EX3)		72.70																																																																													
	Western Drain (INT3, EX1, EX4)		41.20																																																																													
	Balmoral Village Blocks A & D	Balmoral	9.49		Res																																																																									
	Cranberry Mews	Cranberry	2.88		ICI												0.257	0.345		0.513		0.803		0.45	0.59		0.88		1.26																																																	
	Outlet 1 (A1)		0.19 / 0.17														0.017	0.023		0.034		0.047		0.02	0.03		0.04		0.06																																																	
	Outlet 2 (A2)		0.54 / 0.12														0.027	0.035		0.052		0.071		0.02	0.03		0.04		0.05																																																	
	Outlet 3 (A3, E1)		0.66 / 0.82														0.093	0.121		0.18		0.27		0.13	0.17		0.25		0.36																																																	
	Outlet 4 (A4, E2)		1.49 / 1.77														0.127	0.166		0.247		0.415		0.28	0.37		0.54		0.79																																																	
	Cove Cres. (Private, Oil Grit Separator) N of Hwy 26, W of Cove Cres.																																																																													
	19 Balsam St (Private, Oil Grit Separator) Parking Lot directly North																																																																													
	Harbour St and Balsam St (Private, Oil Grit Separator) Cranberry Harbour																																																																													
	Urban Town Centre																																																																												
	Black Ash Meadows (Creekside) Subdivision	BAM sub	22.36	42	Res																																							2096	3729	4697	5658	6957	7856	8416		0.03	0.07	0.14	0.15	0.17	0.21	0.35			24.97	33.75	44.07	50.59	59.08	65.65	71.77	46.56	59.12	67.50	78.07	85.84	93.62	193.00		
	Outlet 1: Node 301, Flows from Site(existing culvert at 6th St and High St draining N to First St) (catchment 101, 102)		14.39 / 20.56			75	74									0.03	0.08	0.15	0.2	0.28	0.34	0.41	0.03	0.03	0.14	0.15	0.16	0.17	0.27	0.10	0.18	0.23	0.31	0.37	0.41	0.07	0.14	0.15	0.17	0.21	0.35																																					
	Outlet 1: Node 307, Total Flow (catchment 101, 102, 103, 104, 105)		24.31 / 25.55			75	75									0.05	0.13	0.24	0.33	0.46	0.57	0.67	0.04	0.07	0.20	0.24	0.28	0.32	0.44	0.17	0.29	0.39	0.51	0.61	0.71	0.09	0.22	0.25	0.30	0.33	0.52																																					
	Outlet 2: Node 306, Total Flow (draining ditch at the South limit of the development that drains east across High St) (catchment 201, 202 / 201, 202, 203)		15.74 / 12.17			59	51									0.02	0.05	0.11	0.15	0.21	0.26	0.32	0.02	0.04	0.08	0.11	0.15	0.20	0.27	0.07	0.13	0.17	0.24	0.29	0.34	0.05	0.09	0.13	0.17	0.23	0.31																																					
	SWMF 3, Quality/Quantity Pond																																																																													
	Mountaincroft Subdivision			44.1	Res																																							2254	3707	5238	5972	6820	7481	8257	13861	0.05	0.07	0.22	0.35	0.55	0.71	0.82	3.1		24.97	33.75	44.07	50.59	59.08	65.65	71.77	46.29	58.78	67.11	77.61	85.35	92.88	193.00		
	North-West External (115)		10.59			49.5										0.01	0.03	0.06		0.11		0.16	0.01	0.03	0.06		0.11		0.16	0.03	0.05		0.08		0.12	0.03	0.05		0.08		0.12	0.37	0.37																																		
	West External (117)		22.47			49.5										0.03	0.06	0.12		0.22		0.33	0.03	0.06	0.12		0.22		0.33	0.06	0.10		0.17		0.24	0.06	0.10		0.17		0.24	0.79	0.79																																		
	South Corner External (118)		7.89			49.5										0.01	0.03	0.05		0.10		0.15	0.01	0.03	0.05		0.10		0.15	0.02	0.04		0.07		0.09	0.02	0.04		0.07		0.09	0.31	0.31																																		
	South External (119 / 219)		10.23			49.5										0.01	0.03	0.06		0.11		0.17	0.01	0.03	0.06		0.11		0.17	0.03	0.05		0.08		0.12	0.03	0.05		0.08		0.12	0.38	0.38																																		
	Subject Site Plus External (1169 / 1200)		81.06			49.9										0.11	0.24	0.45		0.86		1.3	0.05	0.08	0.22		0.56		0.82	0.21	0.36		0.64		0.91	0.11	0.28		0.58		0.80	2.96	3.1																																		
	Culvert Crossing Campbell St (142)		97.93			51.1										0.15	0.31	0.58		1.08		1.6	0.17	0.25	0.38		0.67		1.09	0.29	0.48		0.83		1.17	0.14	0.34		0.71		1.01	3.69	3.83																																		
	Total Flow to Oak St Canal (148)															0.92	1.53	2.44		4.35		6.32	0.94	1.55	2.46		4.22		6.32	1.06	1.69		2.85		3.88	0.93	1.45		2.60		3.67	11.09	11.41																																		
	SWMF 5, Quality/Quantity Pond																																																																													
	Subdivision off Saunders St																																																																													
	(SWMF 6, Quality/Quantity Pond)																																																																													
	Glen Eton Subdivision (N of Telfer Rd)	Glen Eaton	2.07		Res													0.054				0.13			0.10				0.26						0.15						0.26				103																																	
	SWMF 4, Quality/Quantity Pond	Telfer Rd Pond																																																																													
	Riverside Subdivision off Williams Street		21.47		Res																																																																										
	North Section		13.80																																																																													
	South Section		7.67																																																																													
	SWMF 7, Quality/Quantity Pond																																																																													
	Walker Heights Subdivision (off Shannon Court)		4.00		Res																																																																										
	SWMF 9, Quantity Pond																																																																													
	Eden Oak (McNabb) Subdivision (South of Brock Crescent, East of Hurontario)		25.27	70	Res																																																																										
	Area 301 North Westerly		11.45													0.04	0.11	0.21	0.28	0.38	0.47	0.56								0.13	0.19		0.44		0.58							1.177																																					
	Combined Area 302, 303, 304		12.11													0.04	0.12	0.23	0.31	0.42	0.52	0.62								0.15	0.21		0.49		0.64							1.185																																					
	Area 304 only		4.56													0.02	0.05	0.10	0.14	0.19	0.23	0.28								0.06	0.09		0.22		0.29							0.472																																					
	Westerly Pond (500, 505)		8.73	70											192.89									0.01	0.02	0.04	0.05	0.06	0.07	0.07							0.03	0.04		0.06		0.07		0.592																																			
	Easterly Pond (501, 502, 503, 504, 511)		12.54	70											191.8									0.018	0.02	0.03	0.03	0.03	0.03	0.04							0.02	0.03		0.04		0.04		0.58																																			
	Golfview Storm Sewer (Westerly Pond, 509)		8.76																						0.02	0.04	0.05	0.06	0.07	0.07							0.03	0.04		0.06		0.07		0.594																																			
	Downstream (Easterly Pond, 510, 512)		14.68																						0.05	0.08	0.10	0.13	0.16	0.19							0.06	0.07		0.15		0.19		0.684																																			
	Tracey Lane (506)		0.24																																																																													
	Lockhart Road (507)		1.42						185.185																																																																								
	Municipal Storm Sewer (508)		0.17																																																																													
	SWMF 24, West Quality/Quantity Pond																																																																													
	SWMF 24, East Quality/Quantity Pond																																																																													
	River Run Subdivision SWMF 8, Quality/Quantity Pond)		1.44		Res																																																																											
	Collingwood Shipyards / Mackinaw Village				Res																																																																										
	Condo B		0.70																																																																													
	Condo D		0.51																																																																													
	SWMF 14-18, Oil Grit Separator																																																																													
	Admiral Collingwood																																																																													
	Collingwood Public Library (SWMF 19, Oil Grit Separator)																																																																													
	Olde Town (2 Callart Cres.) (SWMF 20, Oil Grit Separator)																																																																														
	Hume St and Raglan St (SWMF 21, Oil Grit Separator)																																																																														
	85 Paterson St, Central Park Parking Lot (SWMF 22, Oil Grit Separator)																																																																														
	300 First St (Private, Oil Grit Separator) Esso Gas Station, in front landscaping																																																																														
	390 First St (Private, Oil Grit Separator) Boston Pizza																																																																													
	399 First St (Private, Oil Grit Separator) Kelsey's Parking Lot by Fence																																																																														
	240 Erie St (Private, Oil Grit Separator) Hospice Georgian Triangle																																																																														
	4 Hurontario St (Private, Oil Grit Separator) NW Corner of Rexall Parking Lot																																																																														
	Hwy 26 & Elliot Ave (Private, Oil Grit Separator)																																																																														
	90 High St (Private, Oil Grit Separator)																																																																														
	Stewart Rd (Private, Oil Grit Separator) Behind Pond																																																																														
	Fire Hall Outlet 1 (Catchment 200)		0.78	56	ICI																																											310.4					0.011	0.012	0.012	0.013	0.013	0.014																		
	Fire Hall Outlet 2 (Catchment 201)		0.16	40	ICI																																																	0.013	0.017	0.02	0.026	0.031	0.036																		
	393 First St																																																																													
	100 Pretty River Parkway																																																																														

Region | Parameters

TOMRMS #	Watershed	File in Dropbox	Drainage Area (ha)	Imperviousness (%)	Land Use	CN Pre	CN Post	Hydraulic Grade Line (m) Chicago 25mm	Chicago 2yr	Chicago 5yr	Chicago 10yr	Chicago 25yr	Chicago 50yr	Chicago 100yr	Timmins Regional	Flow Rate (m3/s) Pre - Development Chicago Storm Event 25mm	2yr	5yr	10yr	25yr	50yr	100yr	Post - Development Chicago Storm Event 25mm	2yr	5yr	10yr	25yr	50yr	100yr
	370 Raglan St		0.40		ICI																								
	65 First St (included in Sidelaunch design)		0.39		ICI																								
	4 High St		0.42	82.7	ICI																								
	South Collingwood SWM Report																												
	Oak Street Canal Study																												
	Pretty River Watershed																												
	Pretty River Estates		17.54	55	Res												0.08	0.16		0.31		0.45	0.02	0.05	0.08		0.24		0.43
	(SWMF 13, Quality/Quantity Pond)																												
	Eden Oak Industrial		184.90 / 181.30																										
	West: Raglan Street Crossing (Node 1000 - 100, 101 / 100, 3101, 3102, 3103, 3106)		268.40 / 268.03														0.47	0.98		2.14		3.31		0.48	1.02		2.21		3.37
	West: Confluence with Pretty River Main Trib. (Node 1001 - 100, 101, 102 / 100, 102, 3101, 3102, 3103, 3106)		269.57 / 269.20														0.47	0.98		2.14		3.32		0.70	1.04		2.18		3.33
	East: Sanford Fleming Drive (Node 2001 - 200, 201, 2010, 202, 2020 / 200, 4202, to 4215, 4209, 2010, 202, 2020)		85.80 / 85.01														2.18	2.95		4.64		5.93		2.26	3.05		4.79		6.10
	East: Highway 26 Crossing (Node 2003 - 200, 201, 2010, 202, 2020, 203, 204 / 200, 4202, to 4215, 4209, 2010, 202, 2020, 203, 204)		187.10 / 186.31														10.16	14.35		24.8		32.26		10.03	14.17		24.37		31.54
	Pretty River Dyke																												
	Georgian College																												
	CC Tatham Pretty River Hydrology and Hydraulic Report																												
3 14	McEwan Gas Station and Tim Hortons (7618 Poplar Sideroad)		0.81	69	ICI																								
	Batteaux Creek, Hwy 26 & Beechwood Rd																												
	Blue Shores Condominium (Newport) with Retention Ponds (Waterfront Circle)		22.70	55	Res																								
	Subcatchment A		1.47	13																									
	Subcatchment B		2.00	57																									
	Subcatchment C		1.97	63																									
	Subcatchment D		1.12	0																									
	SWMF 27, Oil Grit Separator																												
	Lakeside Pointe Subdivision (E of Huronia Pathway, N of HWY 26)		157.04	38	Res																								
	South External (100)		147.00			71.7											0.39	0.72		1.31		1.88		0.39	0.72		1.31		1.88
	External Plus Hwy. Swale (100+104/100+202+205)		147.50 / 149.69			71.7	71.9										0.39	0.72		1.31		1.88		0.43	0.80		1.44		2.08
	West Side of Site (101)		3.98			80											0.06	0.1		0.19		0.27							
	East Side of Site (102)		3.93			79.7											0.06	0.11		0.21		0.3							
	Major Flow from developed Site (204)		3.93																					0.00	0.00		0.20		0.50
	Minor Flow - to SWM Wetland																							0.17	0.34		0.41		0.42
	SWMF 11, Quality Pond																												
	Habitat for Humanity (SWMF 10, Quality/Quantity Pond)				ICI																								
	2281 Fairgrounds Rd (Private, Oil Grit Separator) Hwy 26, SE Corner																												
3 15	Esso Station (10150 Hwy 26)		0.64	71	ICI																								

Watershed	Flow Rate (m3/s) Pre - Development SCS Storm Event 2yr	5yr	10yr	25yr	50yr	100yr	Post - Development SCS Storm Event 2yr	5yr	10yr	25yr	50yr	100yr	Pre - Dev Timmins Regional	Post -Dev Timmins Regional	On-site Retention (m3) 25mm	2yr	5yr	10yr	25yr	50yr	100yr	Timmins Regional	Off-site Release Rates (m3/s) 25mm	2yr	5yr	10yr	25yr	50yr	100yr	Timmins Regional
370 Raglan St															23.5									0.01	0.01	0.02	0.04	0.05	0.06	
65 First St (included in Sidelaunch design)																														
4 High St																														
South Collingwood SWM Report																														
Oak Street Canal Study																														
Pretty River Watershed																														
Pretty River Estates	0.12	0.19		0.33		0.46	0.06	0.11		0.27		0.44		1.61																
(SWMF 13, Quality/Quantity Pond)																														
Eden Oak Industrial																														
West: Raglan Street Crossing (Node 1000 - 100, 101 / 100, 3101, 3102, 3103, 3106)	0.77	1.37		2.50		3.72	0.78	1.43		2.55		3.77		8.777																
West: Confluence with Pretty River Main Trib. (Node 1001 - 100, 101, 102 / 100, 102, 3101, 3102, 3103, 3106)	0.78	1.37		2.51		3.73	0.83	1.41		2.53		3.72		8.815																
East: Sanford Fleming Drive (Node 2001 - 200, 201, 2010, 202, 2020 / 200, 4202, to 4215, 4209, 2010, 202, 2020)	0.89	1.32		2.11		2.91	0.86	1.22		1.89		2.54		5.059																
East: Highway 26 Crossing (Node 2003 - 200, 201, 2010, 202, 2020, 203, 204 / 200, 4202, to 4215, 4209, 2010, 202, 2020, 203, 204)	4.69	6.60		9.49		12.24	4.55	6.33		9.08		11.64		16.519																
Pretty River Dyke																														
Georgian College																														
CC Tatham Pretty River Hydrology and Hydraulic Report																														
McEwan Gas Station and Tim Hortons (7618 Poplar Sideroad)															201										0.059	0.059	0.059		0.059	
Batteaux Creek, Hwy 26 & Beechwood Rd																														
Blue Shores Condominium (Newport) with Retention Ponds (Waterfront Circle)															1310								0.02							
Subcatchment A																														
Subcatchment B																														
Subcatchment C																														
Subcatchment D																														
SWMF 27, Oil Grit Separator																														
Lakeside Pointe Subdivision (E of Huronia Pathway, N of HWY 26)																								0.17	0.34		0.41		0.42	0.42
South External (100)													6.00	6.00																
External Plus Hwy. Swale (100+104/100+202+205)													6.02	6.23																
West Side of Site (101)													0.35																	
East Side of Site (102)													0.36																	
Major Flow from developed Site (204)														0.42																
Minor Flow - to SWM Wetland														0.42																
SWMF 11, Quality Pond																														
Habitat for Humanity (SWMF 10, Quality/Quantity Pond)																														
2281 Fairgrounds Rd (Private, Oil Grit Separator) Hwy 26, SE Corner																														
Esso Station (10150 Hwy 26)																									0.0419	0.0464	0.0538	0.0598	0.0663	

Watershed	Spills	Precipitation Values Used (mm) Chicago 25mm	Chicago 2yr	Chicago 5yr	Chicago 10yr	Chicago 25yr	Chicago 50yr	Chicago 100yr	SCS 2yr	SCS 5yr	SCS 10yr	SCS 25yr	SCS 50yr	SCS 100yr	Timmins Regional	Potential Risks	Notes
370 Raglan St																	
65 First St (included in Sidelaunch design)																	
4 High St																	
South Collingwood SWM Report																	
Oak Street Canal Study																	
Pretty River Watershed																	
Pretty River Estates		25.00	33.76	44.16	50.64	58.23	65.46	71.47	47.30	59.30	67.30	77.10		92.30	193.00		
(SWMF 13, Quality/Quantity Pond)																	
Eden Oak Industrial																	
West: Raglan Street Crossing (Node 1000 - 100, 101 / 100, 3101, 3102, 3103, 3106)																	
West: Confluence with Pretty River Main Trib. (Node 1001 - 100, 101, 102 / 100, 102, 3101, 3102, 3103, 3106)																	
East: Sanford Fleming Drive (Node 2001 - 200, 201, 2010, 202, 2020 / 200, 4202, to 4215, 4209, 2010, 202, 2020)																	
East: Highway 26 Crossing (Node 2003 - 200, 201, 2010, 202, 2020, 203, 204 / 200, 4202, to 4215, 4209, 2010, 202, 2020, 203, 204)																	
Pretty River Dyke																	
Georgian College																	
CC Tatham Pretty River Hydrology and Hydraulic Report																	
McEwan Gas Station and Tim Hortons (7618 Poplar Sideroad)																	
Batteaux Creek, Hwy 26 & Beechwood Rd																	
Blue Shores Condominium (Newport) with Retention Ponds (Waterfront Circle)		24.96															
Subcatchment A																	
Subcatchment B																	
Subcatchment C																	
Subcatchment D																	
SWMF 27, Oil Grit Separator																	
Lakeside Pointe Subdivision (E of Huronia Pathway, N of HWY 26)		24.97	33.75	44.07	50.59	59.08	65.65	71.77									
South External (100)																	
External Plus Hwy. Swale (100+104/100+202+205)																	
West Side of Site (101)																	
East Side of Site (102)																	
Major Flow from developed Site (204)																	
Minor Flow - to SWM Wetland																	
SWMF 11, Quality Pond																	
Habitat for Humanity (SWMF 10, Quality/Quantity Pond)																	
2281 Fairgrounds Rd (Private, Oil Grit Separator) Hwy 26, SE Corner																	
Esso Station (10150 Hwy 26)																	

Appendix 4

Data Collection

Contents

1. Airborne LiDAR

In collaboration with the Grey Sauble Conservation Authority (GSCA), the Town of Collingwood engaged the LiDAR provider ATLIS to collect airborne LiDAR to create a highly accurate, up-to-date digital elevation model (DEM), with which Greenland would update the overland stormwater pathways and major spill routes, fill in manhole rim elevations for minor system development, and cut channel cross sections for the development of riverine hydraulic models. The LiDAR quickly became the largest risk for the project as the date of the LiDAR being flown continued to be pushed back, then once it was flown, receiving the data from the LiDAR provider was a lengthy process.

The LiDAR was originally scheduled to be flown during leaf-off conditions, however was not flown until mid-June 2019, creating the risk that the data would not be within the accuracy tolerance. If this were the case, then the project would have been put on hold until late fall or the following spring when LiDAR could be flown again. Upon receipt of the accuracy report from the LiDAR provider, all points were well within tolerance (+/- 10 cm) on both hard surface and vegetated points and the project could proceed as planned.

The LiDAR was flown in Canada's new standard vertical datum: the Canadian Geodetic Vertical Datum of 2013 (CGVD2013). The GSCA has taken the step forward to begin converting all existing data into CCGVD2013; however, the Town of Collingwood made the decision to continue to use the recently replaced reference system: the Canadian Geodetic Vertical Datum of 1928 (CGVD28). Due to the redefinition of the vertical reference system in Canada, differences in height between the two datums are approximately 37 cm in Collingwood (CGVD2013 elevations are ~37 cm lower). To maintain a consistent datum through all their records, the Town made the decision to convert the LiDAR data, rather than convert all their existing data.

To accomplish the conversion of the LiDAR data, Greenland pursued multiple methods. This was a new request, therefore a method to convert between the datums had to be created from scratch. Initially, the decision was made to convert each point to the new datum using the GPS-H tool released by Natural Resources Canada, developed to convert between vertical datums. However, due to the extremely large data file of approximately 40 million points, processing was extremely slow, and errors weren't noticed until significant effort had been put into each attempt. This then became a new unexpected risk to the project schedule and budget, as conversion was a slow going process, and much of the work could not proceed until this conversion was complete.

Eventually, it was decided that using a uniform value to raise the entire DEM to an approximation of the CGVD28 elevation values would be sufficient for conversion. Through the Town, difference between the two datums ranged between 35 and 39 cm, therefore an average value of 37 cm was chosen to raise the DEM while maintaining an accuracy of +/- 2 cm to the original data. The Town provided Greenland the LiDAR data in raster format, with each raster a 1 km by 1 km grid tile. Using ESRI's ArcMap software, the tiles were mosaiced into a single DEM for the Town, then using the Raster Calculator tool, heights of each cell we increased by a uniform value of 37 cm.

Once the conversion was complete, the new DEM (Town-wide DEM) was then used to complete the minor-major system model and hydraulic models.

During the update to the existing hydraulic model for the Pretty River, a comparison of the Town-wide DEM to surveyed sections of the Pretty River was completed. A large discrepancy in elevations between the two elevations was noted by Greenland, and brought to attention of the Town and GSCA, with concerns of the LiDAR accuracy in the vegetated channel slopes. Elevation differences were seen to be greater than 30cm on some sections of the channel slope. To confirm whether the previously surveyed sections of the Pretty River were accurate or the LiDAR data was correct, a field survey was conducted for a small section of the Pretty River and compared to the other data sources. The field survey confirmed the accuracy of the model cross-sections and also found large elevation differences between the LiDAR and surveyed values on the channel slopes.

Once the validity of the LiDAR data was in question, Greenland then compared the Town-wide DEM to surveyed manhole rim elevations (completed as a part of this study, refer to next section). After this analysis, it was confirmed that the LiDAR data was accurate on flat surfaces, and that the main areas of concerns were solely in steeply sloped areas. This issue was brought to the LiDAR provider, who explained that accuracy on steep slopes could not be guaranteed, per the Federal Airborne LiDAR Data Acquisition Guidelines (2018). Within the town, these areas are primarily limited to the Pretty River and Black Ash Creek, which as dyked / constructed channels, consist of relatively steep slopes. In order to account for the discrepancy, existing data was used in conjunction with the LiDAR data to update the hydraulic models for both these watercourses.

For the remaining watercourses, in order ensure a level of high accuracy, the LiDAR point files were obtained from the GSCA for sections surrounding Silver Creek and Batteaux Creek. These point files were used to confirm elevations for a 50 metre radius surrounding the watercourses (creating a modified DEM), using the original collected measurements rather than the interpolated DEM, where accuracy can be lost as multiple points are averaged to create a single cell in the DEM.

2. Field Survey

In order to complete the minor system drainage models, the Town provided Greenland with its GIS database of municipal storm drainage infrastructure, including mapping of every manhole, catch basin and storm sewer within the town limits. Greenland completed a data gap analysis at the offset of the project to determine the extent of additional data that needed to be collected from existing As-Built information and/or topographic survey to be able to successfully model the minor system.

Upon receipt of the database, it became evident that a significant portion of the town did not have invert elevation data for the storm sewers or manholes. **Figure A4- 1**, below, shows the storm sewer having missing invert data. To fix this issue, it was decided to conduct a field survey of the manholes throughout the Town to determine upstream and downstream inverts of the storm sewers.

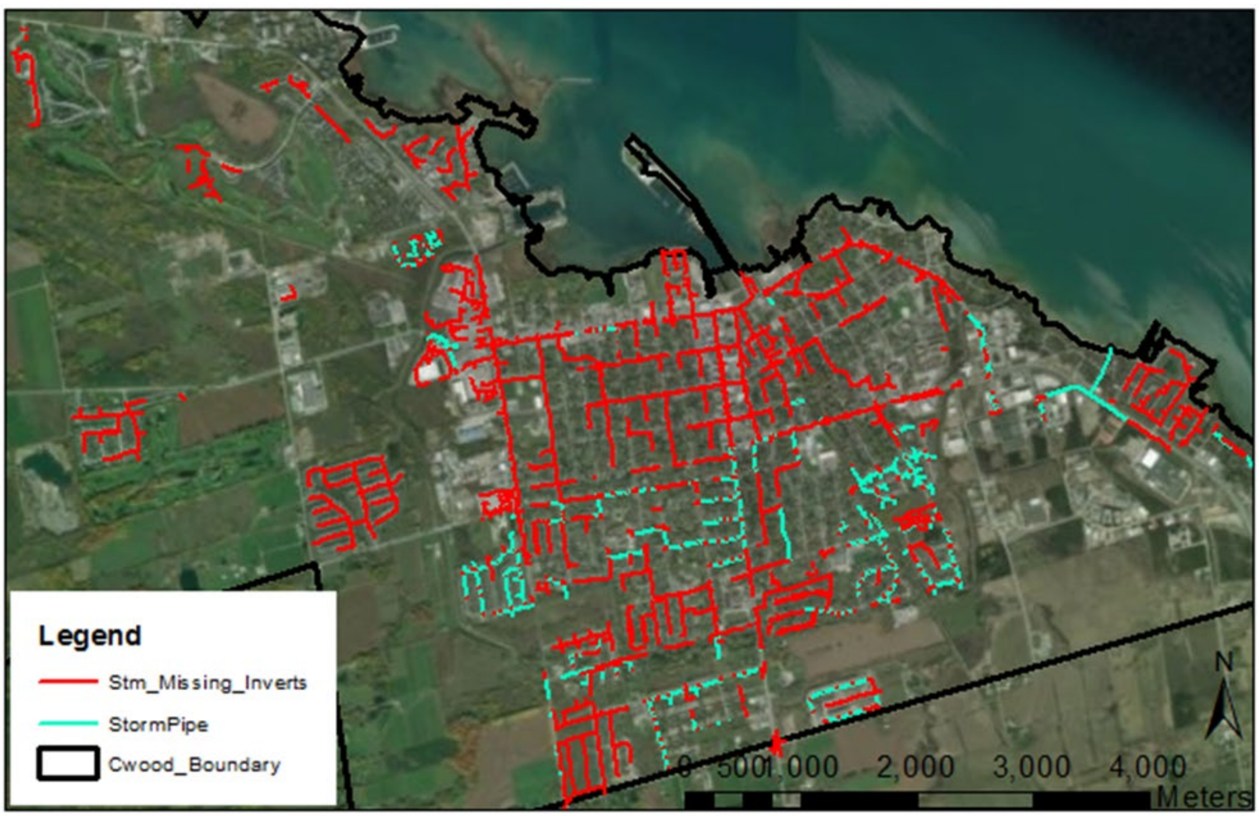


Figure A4- 1 Storm Sewers Missing Invert Elevations

Better Measures Inc. was contracted to undertake the field survey of the Town. A GNSS survey was completed in the NAD83 (CSRS) UTM Zone 17N horizontal datum and CGVD2013 vertical datum. Elevation measurements were taken at the manhole rim and at the invert of manholes, catch basin manholes and catchbasins along main storm sewer lines The survey data was converted to the CGVD28 vertical datum using the GPS-H tool released by Natural Resources Canada.

Prior to surveying, the town was divided into varous sub-sections, for data to be intermittently sent to Greenland to enter into the storm sewer database as the survey was being completed (see **Figure A4- 2**).

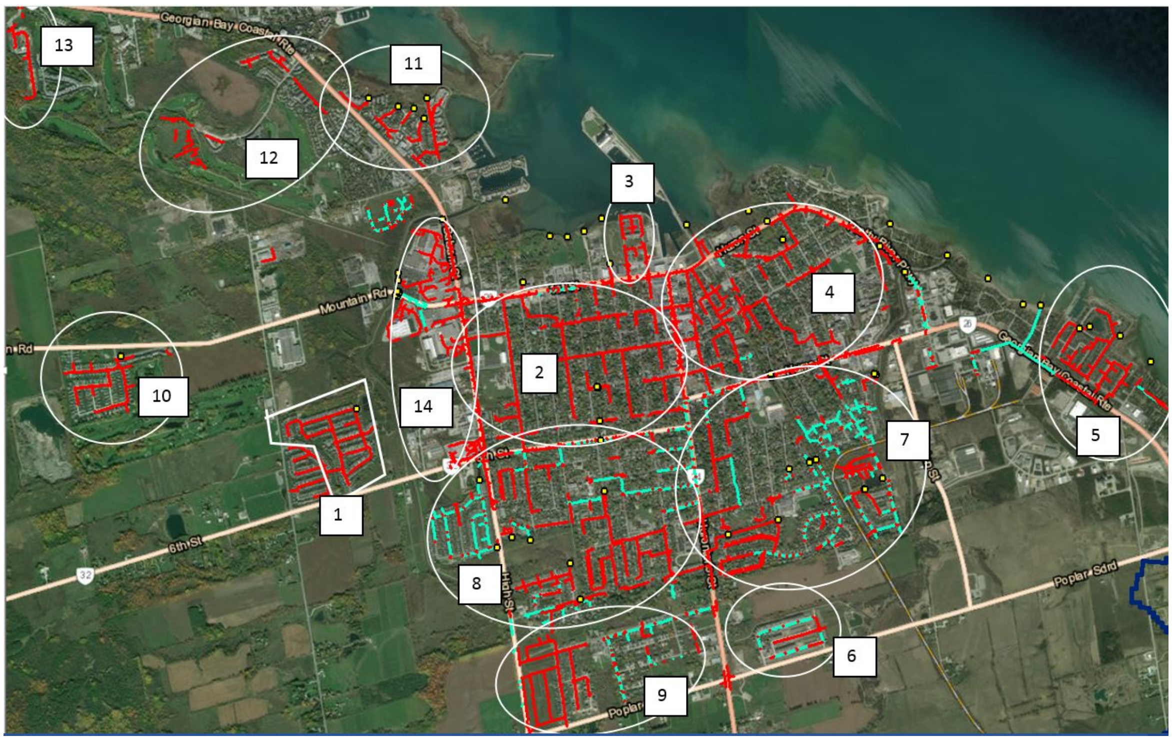


Figure A4- 2 Sectioning of the Town for Survey Completion

To aid in the update of the storm sewer inventory, the Town provided Greenland with all available As-Built drawings, including: recent construction projects, major roadways and local roads to help reduce the scope of surveying required. After entering the available data, a significant portion of the stormsewers had invert information, allowing the surveyor to progress faster.

The largest challenge in completing the storm sewer database update was the major roadways through the town: Hurontario Street, High Street, First Street (including Huron St), and Highway 26. Traffic control was not accounted for in the field survey budget, as it was expected that As-Built information for each of these streets would available. Through an intital search of the available records, the Town could not find complete information for any of the noted roadways. However, prior to an increase in scope of the required surveying, a more thorough look through some of the Town's archived records produced the missing information, which was then entered into the storm sewer database.

After the intial survey of manholes was complete, Better Measures Inc. was again retained to provide additional survey thorugh a small length of the Pretty River to confirm LiDAR elevations in a highly vegetated, steeply sloped environment; as well as at three (3) bridge crossings within the town for the development of hydraulic models. The location of survey points collected is presented in **Figure A4- 3**. In total, more than 700 elevation measurements were taken through the course of the field survey.

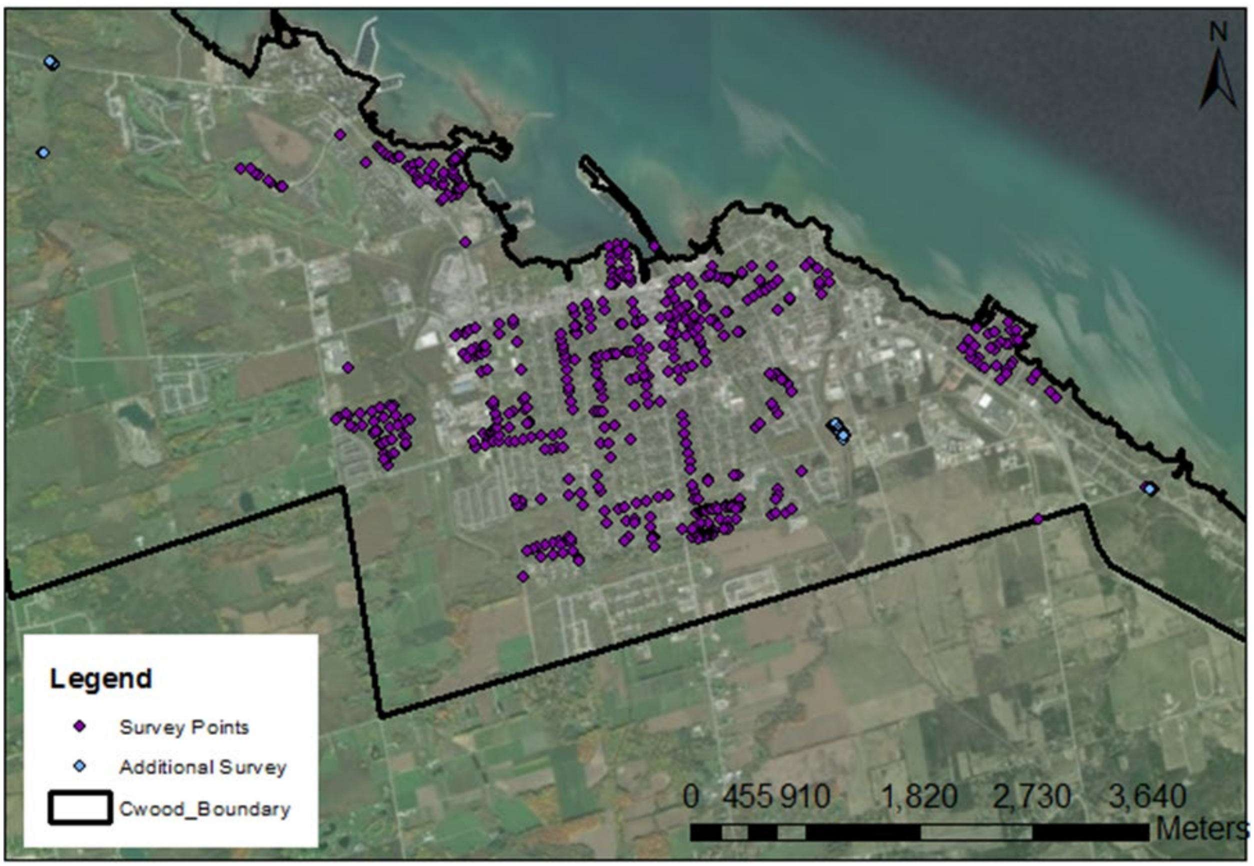


Figure A4- 3 Location of Survey Points Collected

3. Flow Monitoring

To calibrate the minor-major system built in PCSWMM, flow monitoring was undertaken at five locations (**Table A4- 1**) for a period of six months by Calder Engineering Ltd., from June 21, 2019 to December 17, 2019. Water level and velocity measurements were taken at five-minute intervals at each of these locations. Flow was then computed using the observed variables. Area of flow at the monitoring sites was computed using the cross-sectional properties of the culvert, which was either box, circular or arch shaped. The location of the monitoring stations is presented in **Figure A4- 4**.

Table A4- 1 provides a summary of the monitoring locations and the model ID used in PCSWMM for each location. These locations were chosen to encapsulate as much of the Town's major drainage areas as possible, to best calibrate the minor-major system model.

Table A4- 1 Flow Monitoring Stations

S.No	Monitoring Station	Catchment Area (Ha)	Station ID	Cross-section Type
1	Oak Street Canal	297.6	OSC_146	Box
2	Ste. Marie Street	95.54	SM_256	Pipe
3	Minnesota Street-1	82.8	MinS_204	Arch
4	Minnesota Street-2	82.8	MinS_205	Arch
5	Georgian Meadows	51.6	GM_58	Pipe

Figure A4- 4 Installed Flow Monitor Locations

As previously mentioned, flow monitor locations were chosen based on the drainage area of the sewer system. However, there were additional considerations that had to be taken into account: such as ability to install and land ownership. Initially, Monitor SM_256 was to be installed further north at the intersection of St. Paul and Huron Streets to capture the greatest portion of flow possible. However, the manhole cover could not be found in the field, thus a second choice at Ste. Marie Street and Huron Street was selected. Upon installation of the other four (4) monitors as part of this study, the Calder's field technician attempted to install Monitor SM_256, however due to high lake levels the manhole was completely full of water and silt, and the monitor could not be installed. Finally, the location on Ste. Marie Street, north of Ontario Street, was selected and the monitor was installed three (3) weeks after the others when the field technician returned to ensure that the installed monitors were functioning properly.

At the offset of the project, an additional monitor was also considered in the SWM pond inlet in the Blue Shores subdivision. However, the Town informed Greenland that this is private property, therefore a flow monitor could not be installed. A secondary location was considered in the Lakeside Pointe subdivision, however the drainage area of this point is relatively small and the benefits of this additional monitor were determined to be insufficient compared to the cost.

Monitors OSC_146, MinS_204, MinS_205 and GM_58 were installed on June 21, 2019 after approval of the locations of each monitor from the Town. Monitor SM_256 was installed on July 12, 2019. The monitors were installed for 6 months, with a data download occurring at three (3) months and six (6) months (upon removal). The installation photos of each Monitor are below (**Figure A4- 5- Figure A4- 9**).

In October 2019, after reviewing the collected climate data, it was confirmed that since installation of the monitors there had only been a single precipitation event greater than 10 mm. The lack of precipitation events, would cause difficulties in calibration of the minor system model, as only small events could be validated. At this time, the Town considered the possibility of extending the duration of monitoring through the winter to capture spring freshet events and expected large spring precipitation events. Therefore, Calder was contacted regarding the possibility of leaving the monitors in the sewers through the winter, or removing them as planned and reinstalling them in the spring, in hopes of capturing major spring storm events. Calder advised not leaving the monitors in through the winter due the risk of freezing and damage to the equipment, and the flow monitors were removed as planned in December 2019. The decision regarding further monitoring was delayed until the final three (3) months of data was collected, where it was determined only two (2) larger events were captured, both less than 30 mm. In February

2020, the Town made the decision to reinstall the flow monitors for an additional six (6) months of monitoring to complete the calibration of the minor-major system model.

Figure A4- 5 OSC_146 Monitor Installation

Figure A4- 6 SM_256 Monitor Installation

Figure A4- 7 MnS_204 Monitor Installation

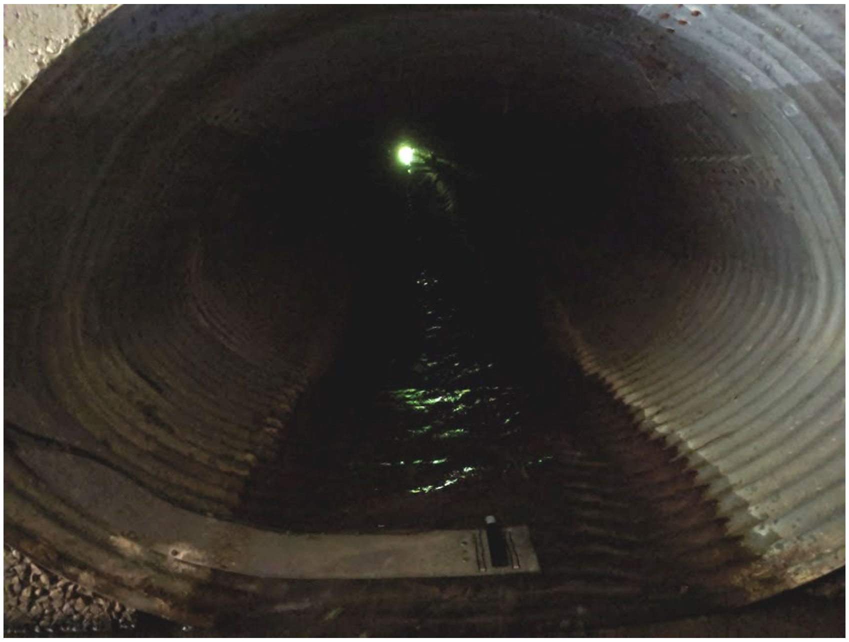


Figure A4- 8 MnS_205 Monitor Installation

Figure A4- 9 GM_58 Monitor Installation

4. Meteorological Data

The precipitation data required for the analysis was collected daily for every five-minute duration for the six (6) month period corresponding to the flow data collection from a private local weather station: https://www.wunderground.com/weather/ca/collingwood/44.50,-80.21, located in downtown Collingwood (ICOLLING16). Weather Underground (Wunderground) is a global collection of personal weather stations connecting data to create higher precision, local forecasts. The parameters measured at the Collingwood station include: time, temperature, dew point temperature, humidity, wind (speed, direction and gust speed), atmospheric pressure, and precipitation rate and accumulation. Greenland was primarily concerned with accumulated precipitation & precipitation rate for this study.

To quality check the data, the initial decision was made to compare daily climate summaries from Weather Underground against historical daily climate data from Environment Canada's Collingwood Station. In cases of high variation, preference would be given to the Environment Canada data. However, through the duration of this project, daily historical climate data from Environment Canada did not include precipitation data past mid-July. Therefore instead, daily Wunderground precipitation data was compared against precipitation data collected from the Collingwood (CLIM-MSC-WCO) station on the Ministry of Natural Resources' Surface Water Monitoring Centre (SWMC). The SWMC data was not used in this study, as data is collected at a 1-hour interval, which was not suitable for this study.

From early September 2019 to mid-November 2019, the Wunderground Station ICOLLING16 stopped recording precipitation data. The data was instead downloaded from nearby Wunderground stations, based on station data that most closely matched that of the SWMC Collingwood station. This allowed for the continued download of 5-minute time step data, while maintaining a high level of accuracy to Collingwood's weather patterns. The two nearest stations to Collingwood used for this analysis were located at the Blue Mountain Resort (ITHEBLUE5) and the Georgian Bay Club (ITHEBLUE6). **Figure A4- 10** displays the locations of the Wunderground stations used in the collection of precipitation data.

The data was used in conjunction with the flow monitoring in the storm sewers, to calibrate/ validate the minor-major system model and confirm sewer response to precipitation events. A summary of collected data is presented in **Figure A4- 11**.

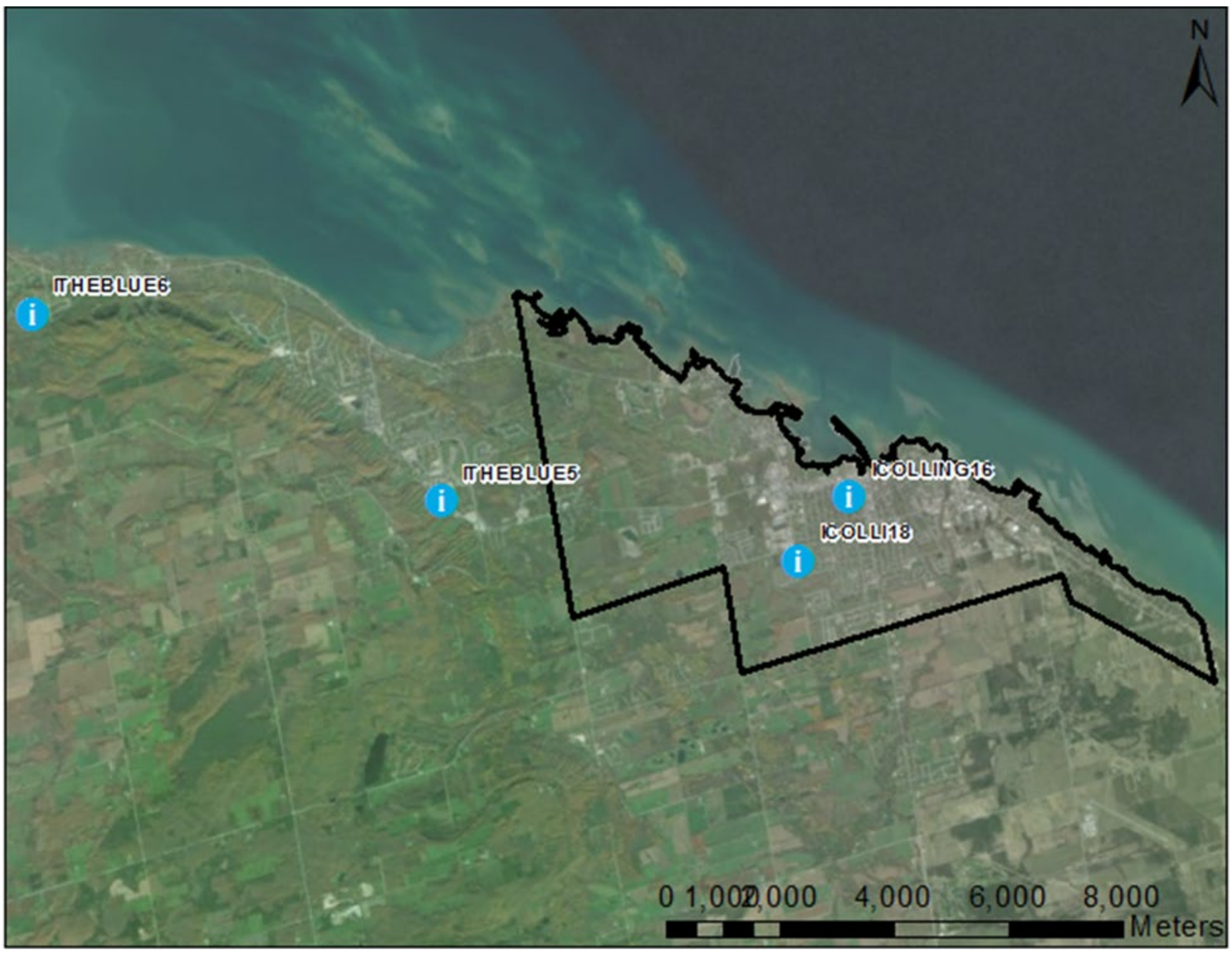


Figure A4- 10 Local Weather Underground Stations

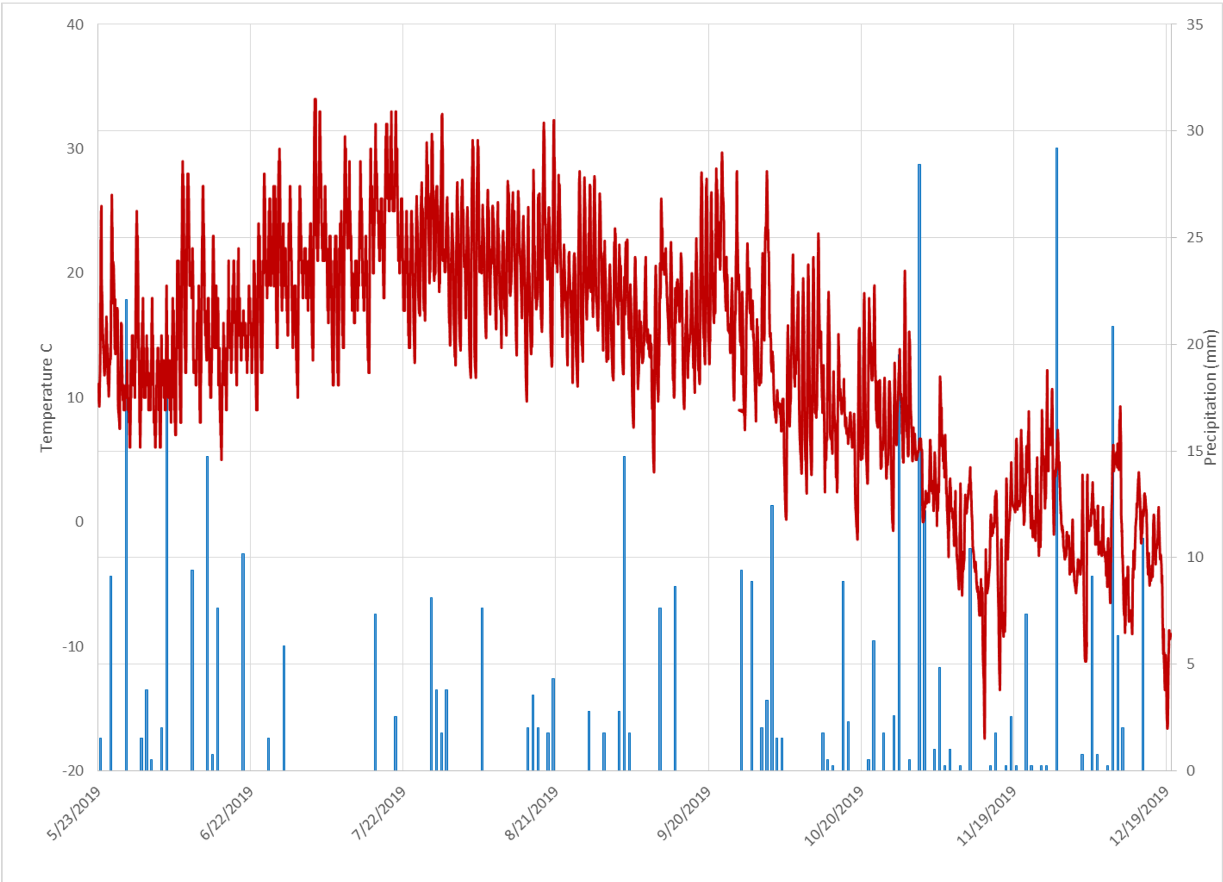


Figure A4- 11 Collected Precipitation and Temperature Data

Appendix 5

Hydrology Analysis

1. Pretty River

Table A5- 1 Pretty River Matched Flow and Adjusted Parameters – Original Catchment

Name	PCSWMM					VO5 Catchment	
	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)	NHYD	Peak Flow
0	17.42	281.0	620	0.7	1.36	0	1.363
1	340.69	3406.9	1000	1.2	10.09	1	10.289
2	312.2	2312.6	1350	0.8	6.32	2	6.351
3	443.02	4430.2	1000	1.2	11.86	3	11.976
4	78.12	1420.4	550	2	2.01	4	2.021
5	773.27	5523.4	1400	7	33.5	5	33.59
6	344.9	2155.6	1600	2.5	14.02	6	14.012
7	285.27	1901.8	1500	5.3	12.01	7	12.025
8	244.13	1436.1	1700	8	7.61	8	7.615
9	418.49	4184.9	1000	8.5	18.49	9	18.453
10	208.43	1736.9	1200	9	9.17	10	9.231
11	269.42	2449.3	1100	10	9.57	11	9.599
12	486.99	3746.1	1300	8	18.03	12	18.081
13	653.33	2916.7	2240	6	18.93	13	18.971
14	229.96	2420.6	950	11	11.6	14	11.698
15	58.94	1071.6	550	10	2.99	15	2.986
16	331.77	2764.8	1200	8	12.9	16	12.86
17	1274.02	6370.1	2000	5.5	40.15	17	40.152
Outlet	**6770.37**				**180.08**		**180.04**

Table A5- 2 Pretty River Updated Model Flow - (Timmins 84%)

Name	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)
0	3.45	94.5	365	0.7	0.3
DS1	19.1	218.5	874	1.0	0.79
DS2	5.71	119.4	478	0.5	0.34
1	328.3	3455.7	950	1.2	9.91
PRE/SC	262.7			0.8	6.59
3	407.5	4075.1	1000	1.2	10.91
4	77.06	1401.1	550	2	1.98
5	735.4	5252.6	1400	7	31.86
6	350.2	2188.4	1600	2.5	14.23
7	286.9	1912.6	1500	5.3	12.08
8	242.9	1428.9	1700	8	7.57
9	412.6	4125.6	1000	8.5	18.23
10	205.1	1709.1	1200	9	9.02
11	306.6	2786.9	1100	10	10.89
12	502.9	3725.2	1350	8	18.47
13	643.5	2872.7	2240	6	18.65
14	233.0	2453.0	950	11	11.75
15	61.9	1125.2	550	10	3.14
16	337.3	2811.2	1200	8	13.12
17	1309.7	6388.6	2050	5.5	40.87
Outlet	**6753.8**				**179.79**

2. Black Ash Creek

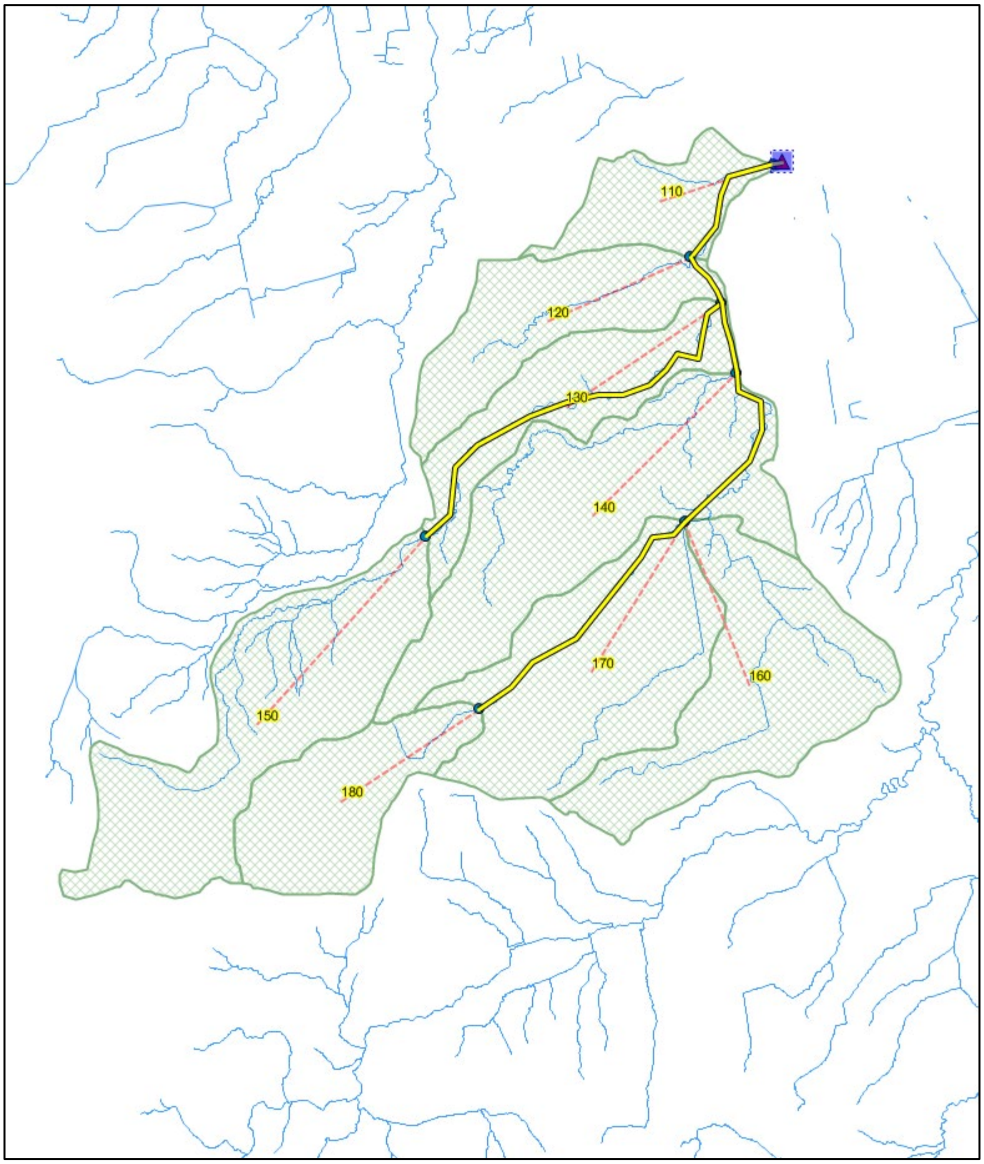


Figure A5- 1 Black Ash Creek PCSWMM Matched Model – Original Catchment

Table A5- 3 Black Ash Creek Matched Flow and Adjusted Parameters – Original Catchment

Name	PCSWMM					VO2 Catchment	
	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)	NHYD	Peak Flow
110	177	3540	500	2	1.26	110	1.221
120	305	4357	700	5	2.3	120	2.276
130	294	2450	1200	3	2.05	130	2.071
140	620	8857	700	8	5.49	140	5.465
150	574	4783	1200	5	5.29	150	5.43
160	490	4455	1100	7	2.92	160	2.989
170	515	8583	600	18	14.23	170	14.479
180	283	11891	238	18	5.12	180	5.534
Outlet					**31.103**	1	**29.69**

Table A5- 4 Black Ash Creek Updated Model Flow - (Timmins 90%)

Name	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)
110	46.9	1562.9	300	2	3.3
120	211.4	3356.1	630	5	8.6
130	233.6	2031.4	1150	3	9.04
140	569.3	8132.3	700	8	25.38
150	610.1	4960.2	1230	5	26.22
160	521.7	4576.0	1140	7	18.58
170	521.3	8687.7	600	18	40.97
180	65.8	4388.0	150	18	4.6
1102	31.7	989.4	320	1.5	3.31
1103	30.8	1231.5	250	2	1.53
1104	41.1	1643.1	250	2	3.6
1105	16.6	832.3	200	2	1.5
1202	8.8	551.4	160	2	3.36
1203	35.5	1184.5	300	1	2.61
GM	56.41			1	3.65
Harbor St	8.26			1	1.37
Outlet	**3065.4**				**129.29**

3. Silver Creek

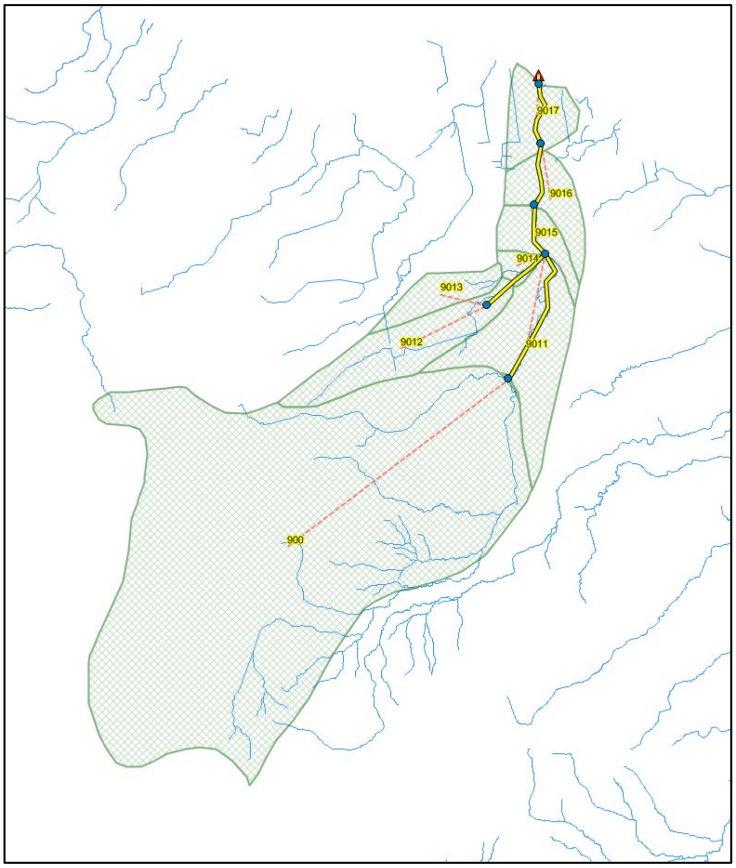


Figure A5- 2 Silver Creek PCSWMM Model –MacLaren Catchment

Table A5- 5 Silver Creek QUALHYMO Parameters

SubWatershed ID	SMAX	SMIN	API	SK	S*	CN condition I	CN condition II	Area
900	2100	61	27	0.11	165.6	60.5	78	2032
9011	881	22	27	0.11	66.1	79.4	90	227
9012	1202	30	27	0.11	90.1	73.8	87	165
9013	766	20	27	0.11	58.3	81.3	92	85
9014	1910	43	27	0.11	138.8	64.7	81	30
9015	2174	70	27	0.11	177.9	58.8	77	88
9016	3339	121	27	0.11	286.1	47.0	67	35.2
9017	2032	54	27	0.11	155.5	62.0	79	16
9018	3339	121	27	0.11	286.1	47.0	67	38
9019	2032	54	27	0.11	155.5	62.0	79	67

Table A5- 6 Silver Creek Matched Flow and Adjusted Parameters (Timmins 94%)

Name	PCSWMM					QUALHYMO	
	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)	ISER	Peak Flow
900	2032	6773	3000	5	77.24	900	77.206
9011	227	1335	1700	1.5	10.58	9011	10.732
9012	165	1833	900	15	13.69	9012	13.284
9013	85	1063	800	15	7.79	9013	7.616
9014	30	545	550	2	1.84	9014	1.779
9015	88	880	1000	1	3.69	9015	3.595
9016	35.2	352	1000	0.5	1.01	9016	0.921
9017	16	457	350	1	0.98	9017	0.921
Outlet	**2678.2**				**105.75**	**97**	**110.26**

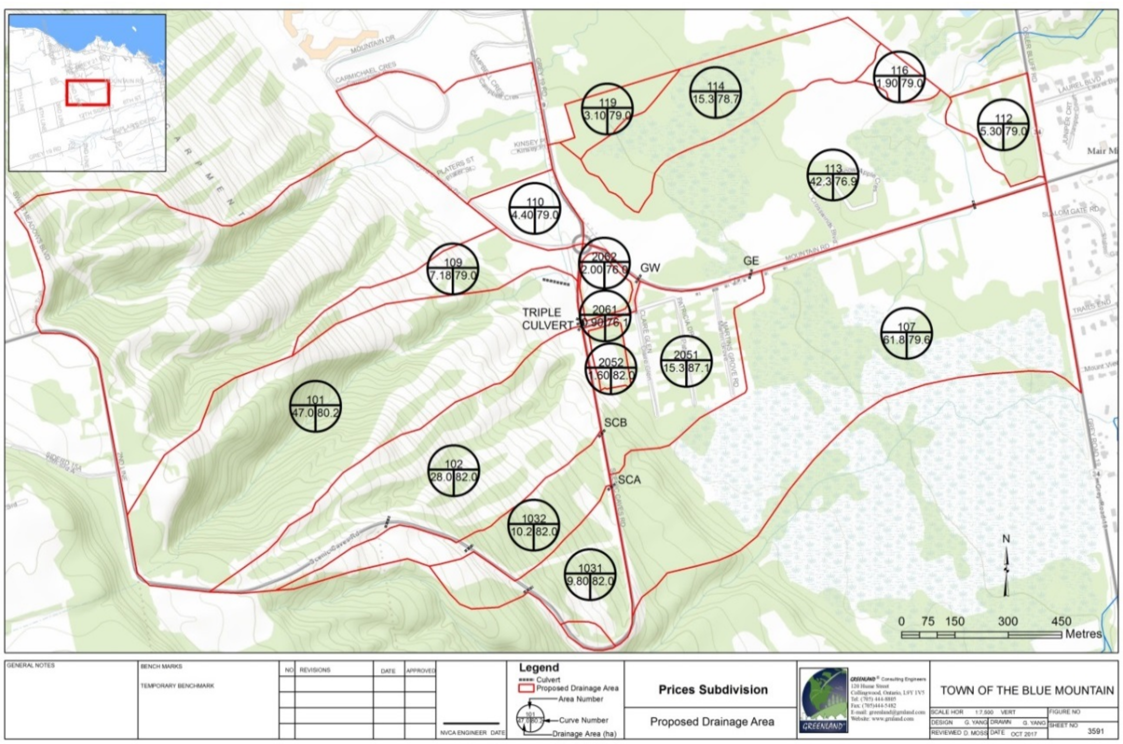


Figure A5- 3 Windfall Catchment - Original Catchment

Table A5- 7 Windfall Matched Flow and Adjusted Parameters - Original Catchment (100yr 24 SCS)

Name	PCSWMM					VO2 Catchment	
	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)	NHYD	Peak Flow
101_Prc	47	1469	320	18	3.91	101	3.847
102_Prc	28	933	300	18	2.86	102	2.866
1031_Prc	9.8	576	170	18	1.36	1031	1.358
1032_Prc	10.2	408	250	18	1.16	1032	1.093
105_Prc	16.9	845	200	5	1.95	105	1.919
107_Prc	61.8	1236	500	10	2.68	107	2.666
112_Prc	5.3	353	150	5	0.41	112	0.396
113_Prc	42.3	1410	300	7	1.87	113	1.823
2061_Prc	0.9	150	60	2	0.09	2061	0.087
2062_Prc	2	200	100	3	0.47	2062	0.45
Outlet	**224.2**				**11.75**		**11.53**

Table A5- 8 Silver Creek Updated Model Flow - (Timmins 90%)

Name	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)
101_Prc	43.90	1372.0	320	18	3.85
102_Prc	28.03	934.5	300	18	2.55
1031_Prc	9.85	579.1	170	18	0.93
1032_Prc	10.16	406.6	250	18	0.94
105_Prc	16.87	843.7	200	5	1.61
107_Prc	61.86	1237.1	500	10	4.68
112_Prc	5.26	350.6	150	5	0.46
113_Prc	42.30	1410.0	300	7	3.28
2061_Prc	0.98	163.6	60	2	0.08
2062_Prc	2.00	199.7	100	3	0.21
900	2018.6	6728.6	3000	5	71.25
9011	136.84	1052.6	1350	1.5	6.57
9014	81.48	905.3	900	2	3.88
9015	84.08	934.3	900	1	3.41
9016	39.9	399.0	1000	0.5	1.04
9017	42.02	700.3	600	1	1.96
Outlet	**2624.1**				**93.49**

4. Batteaux Creek

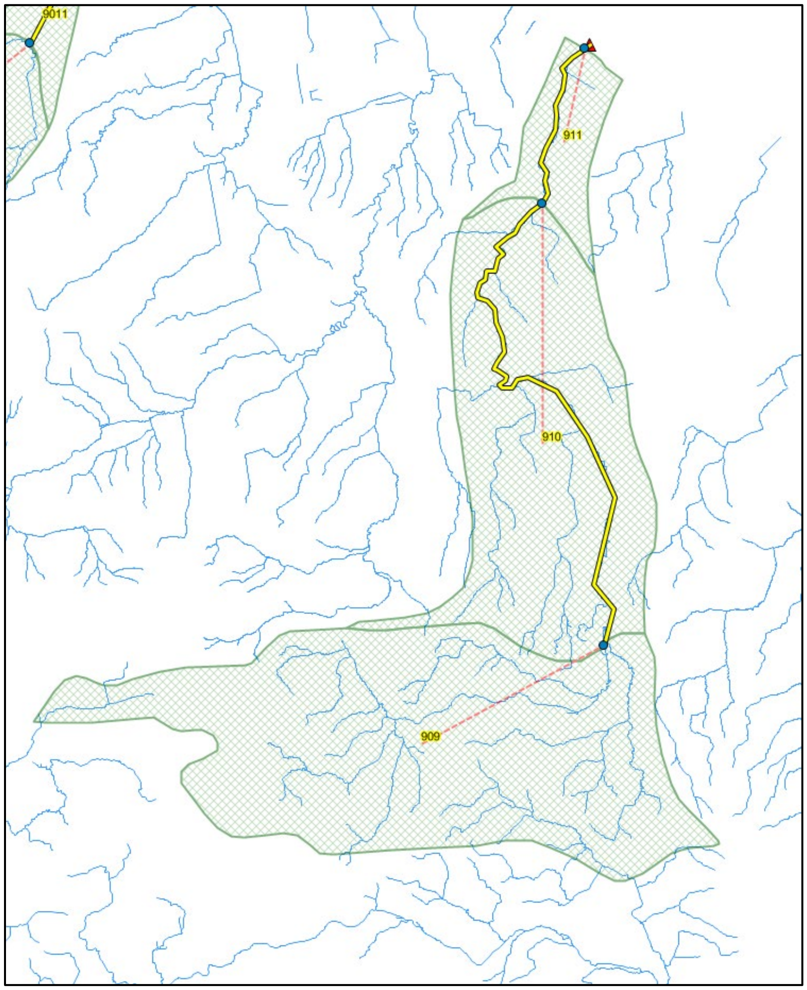


Figure A5- 4 Batteaux Creek PCSWMM Model – MacLaren's Catchment

Table A5- 9 Batteaux Creek QUALHYMO Parameters

SubWatershed ID	SMAX	SMIN	API	SK	S*	CN condition I	CN condition II	Area
909	1735	43.4	27	0.11	130.2	66.1	82	3021
910	1735	43.4	27	0.11	130.2	66.1	82	2118
911	1344	33.7	27	0.11	100.9	71.6	86	372

Table A5- 10 Batteaux Creek Matched Flow and Adjusted Parameters – Original Catchment (Timmins 87%)

Name	PCSWMM					QUALHYMO	
	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)	ISER	Peak Flow
909	3021	7746	3900	7	105.14	909	105.481
910	2118	5724	3700	4	65.62	910	65.155
911	372	2067	1800	1.5	14.63	911	14.451
Outlet	5511				176.46		178.837

Table A5- 11 Batteaux Creek Updated Model Flow - (Timmins 84%)

Name	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)
909	2249.3	6615.5	3400	7	78.66
910	2696.1	7286.8	3700	4	78.51
911	274.8	1772.9	1550	1.5	10.86
Outlet	**5220.2**				**160.31**

5. Townline Creek

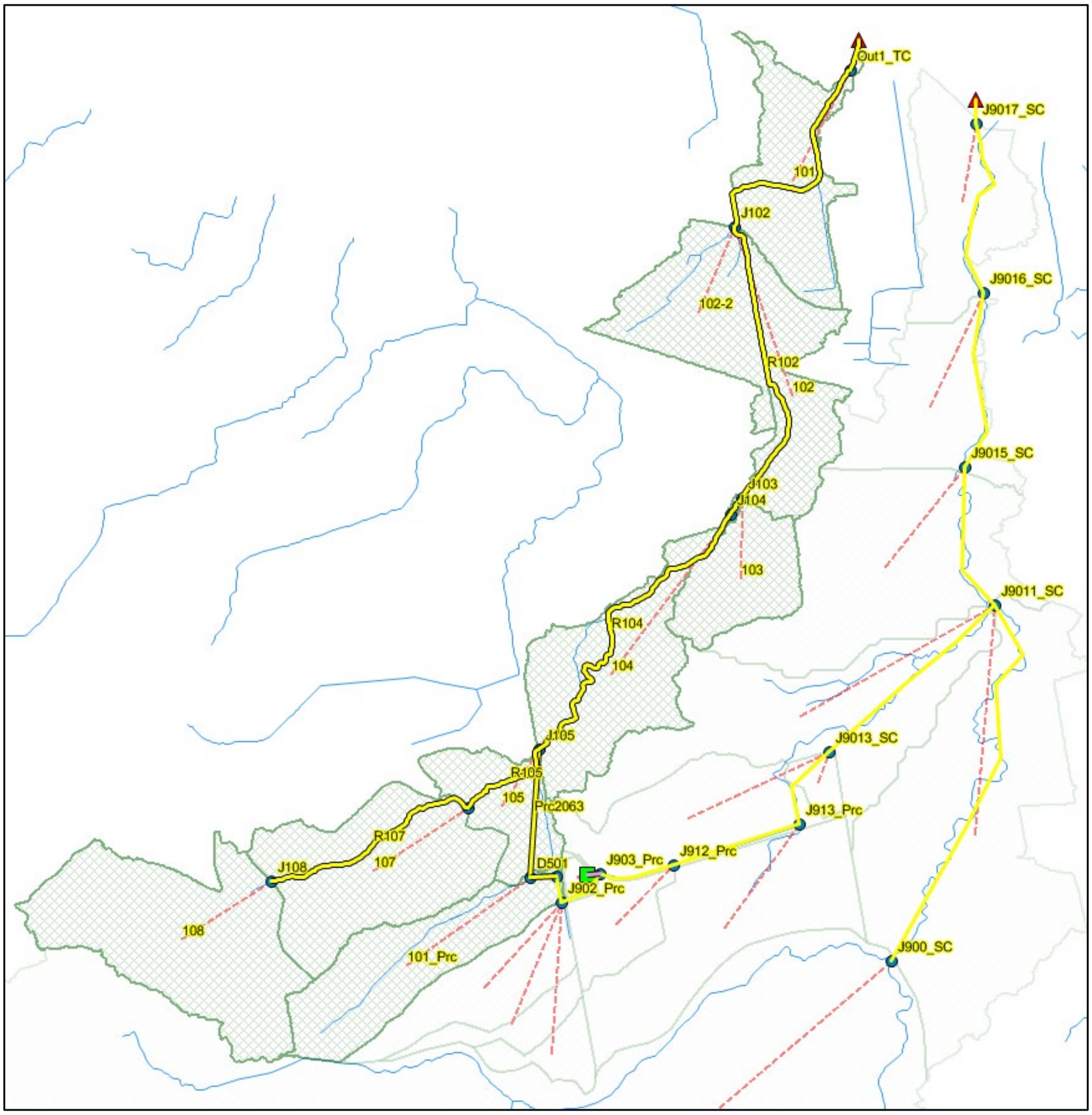


Figure A5- 5 Townline Creek PCSWMM Matched Model

Table A5- 12 Townline Creek Matched Flow and Adjusted Parameters – Original Catchment (Timmins)

Name	PCSWMM					HEC-HMS	
	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)	ID	Peak Flow
101	39.93	399	1000	0.56	1.6	101	1.61
102	33.95	340	1000	0.8	1.56	102	1.52
102-2	36.50	961	380	0.94	1.93	102-2	2.12
103	25.74	257	1000	1	0.72	103	0.16
104	45.60	456	1000	2.42	2.08	104	1.96
105	22.89	286	800	6.25	2.47	105	2.17
101_Prc	43.94	439	1000	15.36	3.11	106	2.73
107	59.65	746	800	19.59	4.9	107	4.76
108	73.38	611	1200	8.26	4.78	108	4.73
Outlet	**381.6**				**17.24**	1	**18.42**

Table A5- 13 Townline Creek Updated Model Flow - (Timmins)

Name	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Peak Runoff (m^3/s)
101	39.93	399	1000	0.56	1.6
102	34.20	340	1000	0.8	1.57
102-2	36.50	961	380	0.94	1.93
103	25.98	257	1000	1	0.72
104	52.90	456	1000	2.42	2.41
105	22.50	286	800	6.25	2.42
101_Prc	43.90	439	1000	15.36	2.59
107	59.75	746	800	19.59	4.91
108	75.17	611	1200	8.26	4.89
Outlet	**390.84**				**17.14**

Appendix 6

Minor System Modelling Details

Contents

1. Urban Area – Total

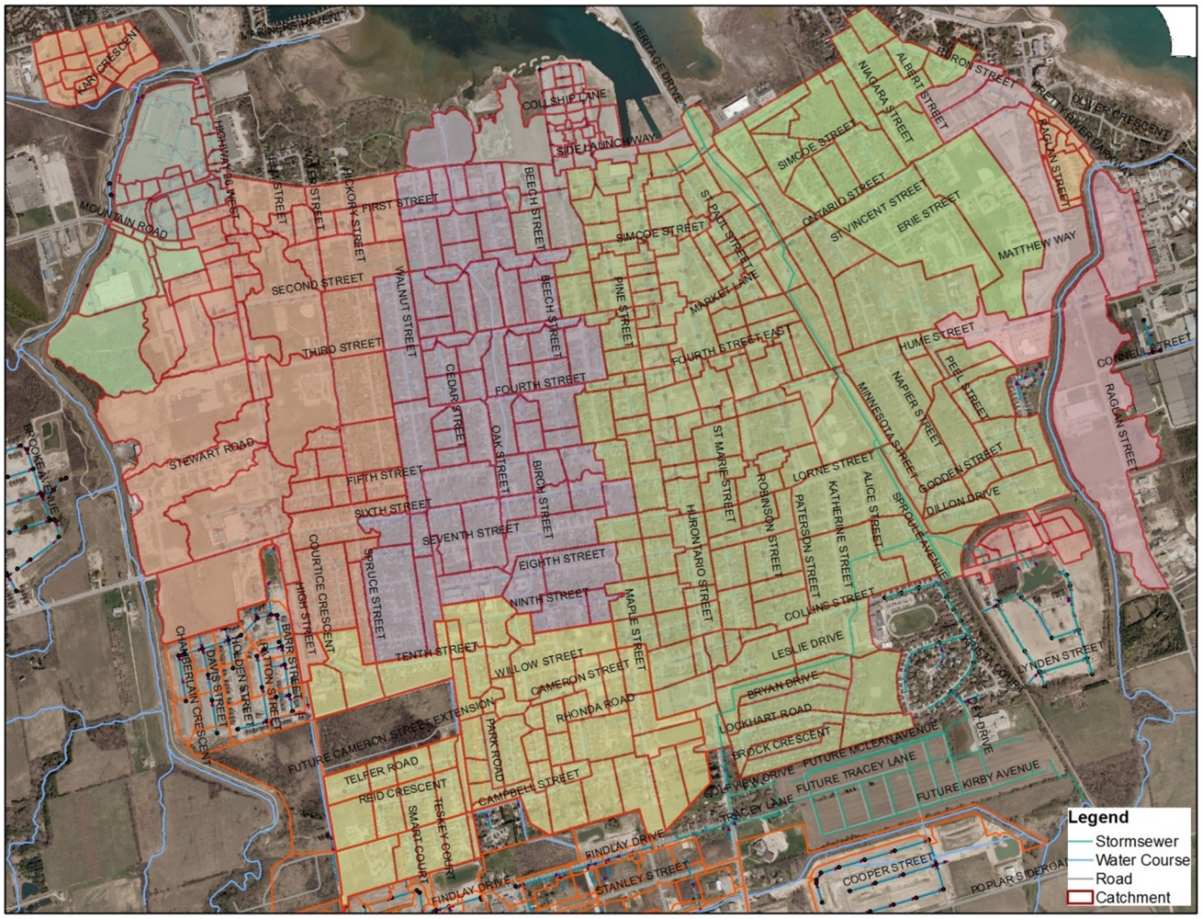


Fig. A6- 1 Collingwood Urban Area Catchments

Fig. A6- 2 Collingwood Urban Area Major Catchment Slopes

Table A6- 1: Urban Area Catchment Slope

Name	Description	Length	Slope
Down_A-III	Area-III	1500	0.64
Mid_A-III	Area-III	470	1.17
Up_A-III	Area-III	1500	0.79
15_A-VII	Area-VII	1300	0.77
1_CF	Cambridge & First	500	0.61
Ext_CF	Cambridge & First	500	2.09
Down_Minnesota	Minnesota St	1400	0.646
Mid_Minnesota	Minnesota St	1500	0.46
Up_Minnesota	Minnesota St	1500	0.57
203F1_MC_Plus	Mountaincroft_Plus	620	1.68
203F2_MC_Plus	Mountaincroft_Plus	600	1.28
203F3_MC_Plus	Mountaincroft_Plus	1100	0.53
Down_OSC	Oak St Drainage	1300	0.53
Mid_OSC	Oak St Drainage	1100	0.58
Up_OSC	Oak St Drainage	1200	0.62
DS1	Pretty River	1100	0.86
DS2	Pretty River	650	0.71
Ext_RR	River Run	420	0.79
23_RS	Riverside	500	0.57
6_SY	Ship Yard	800	0.66
7U1_WH	Walker Heights	850	1.147
100_WC	Western Commercial	520	0.73

Table A6- 2: Curve Numbers for Various Land Uses and Soil Groups

CN HID

Soil Gr.	Crops	Pasture	Forest	Lawn	MID	Commercial	Road	Water
A	62	49	32	39	57	57	77	50
AB	68	59	46	50	65	65	81	50
B	74	69	60	61	72	72	85	50
BC	78	74	67	68	77	77	88	50
C	82	79	73	74	81	81	90	50
CD	84	82	76	77	84	84	91	50
D	86	84	79	80	86	86	92	50
Muck	74	69	60	61	72	72	85	50

Table A6- 3: XIMP and TIMP parameters for various land uses

	XIMP	TIMP
Crops	0	0
Pasture	0	0
Forest	0	0
Lawn	0	0
MID	0.2	0.35
Commercial	0.9	0.9
Road	0.35	0.65
Water	0	0

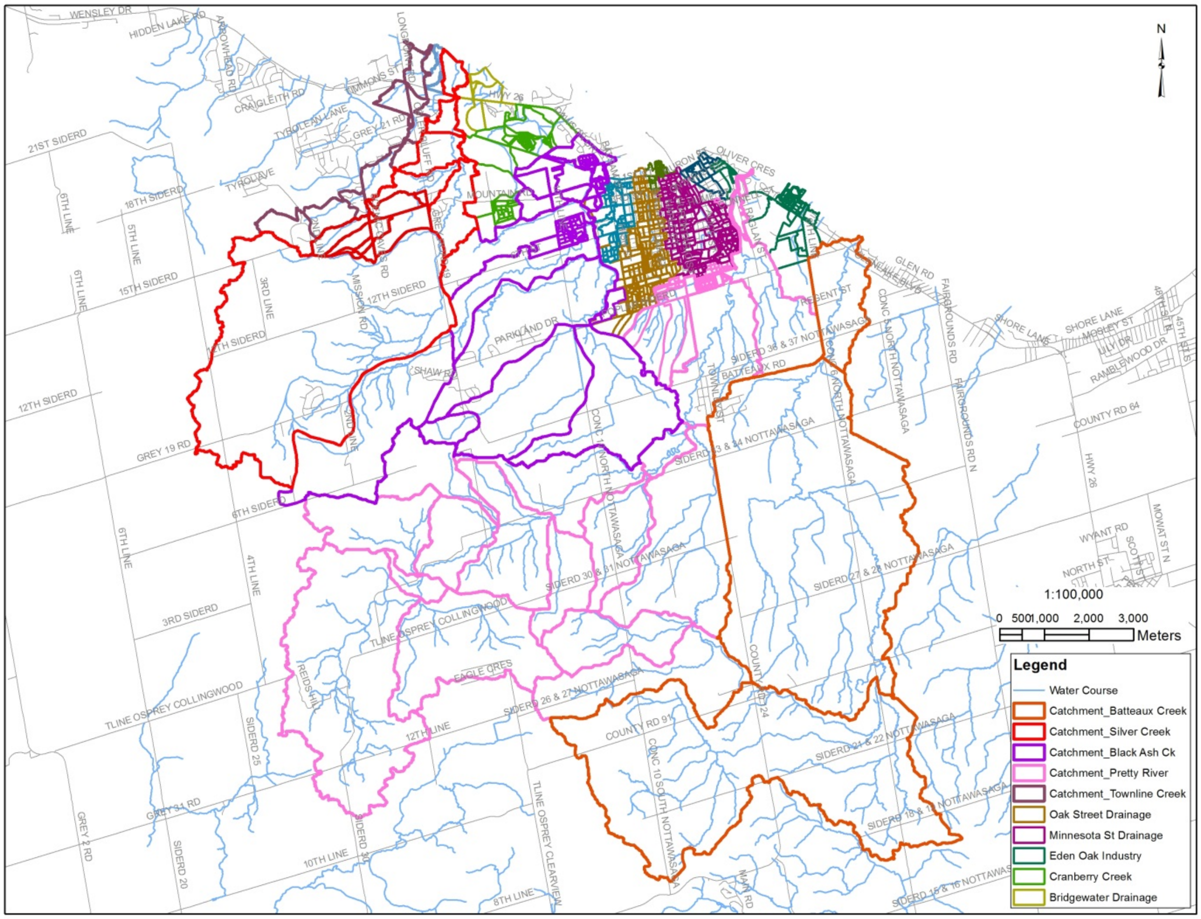


Fig. A6- 3 Final Updated Catchments

Table A6- 4: Outlet Rating Curve Calculation

PCSWMM Catchments					**Outlet**					
Name	**Outlet**	**CB**	**DCB**		**Name**	**Inlet Node**	**Outlet Node**	**Curve Name**	**CB**	**DCB**
204_PRE	Pond_PRE	0	0		1584MH10-IC	1584MH10-S	1584MH10	2_CB	2	0
207_PRE	Pond_PRE	0	0		1584MH11-IC	1584MH11-S	1584MH11	2_CB	2	0
A_PRE	1584MH1-S	2	0		1584MH12-IC	1584MH12-S	1584MH12	2_CB	2	0
B_PRE	1584MH3-S	0	2		1584MH13-IC	1584MH13-S	1584MH13	2_CB	2	0
C_PRE	1584MH5-S	2	0		1584MH14-IC	1584MH14-S	1584MH14	2_CB	2	0
D_PRE	1584MH6-S	2	0		1584MH15-IC	1584MH15-S	1584MH15	2_CB	2	0
E_PRE	1584MH7-S	2	0		1584MH16-IC	1584MH16-S	1584MH16	2_CB	2	0
EX_PRE	1584Outfall	0	0		1584MH17-IC	1584MH17-S	1584MH17	2_CB	2	0
F_PRE	1584MH8-S	2	0		1584MH1-IC	1584MH1-S	1584MH1	2_CB	2	0
G_PRE	1584MH9-S	1	0		1584MH2-IC	1584MH2-S	1584MH2	0_CB	0	0
H_PRE	1584MH15-S	2	0		1584MH3-IC	1584MH3-S	1584MH3	2_DCB	0	2
I_PRE	1584MH16-S	2	0		1584MH4-IC	1584MH4-S	1584MH4	0_CB	0	0
J_PRE	1584MH17-S	2	0		1584MH5-IC	1584MH5-S	1584MH5	2_CB	2	0
K_PRE	1584MH9-S	0	2		1584MH6-IC	1584MH6-S	1584MH6	2_CB	2	0
L_PRE	1584MH10-S	2	0		1584MH7-IC	1584MH7-S	1584MH7	2_CB	2	0
M_PRE	1584MH11-S	2	0		1584MH8-IC	1584MH8-S	1584MH8	2_CB	2	0
N_PRE	1584MH12-S	2	0		1584MH9-IC	1584MH9-S	1584MH9	2_CB+2_DCB	2	2
O_PRE	1584MH13-S	2	0							
P_PRE	1584MH14-S	2	0							
Q_PRE	1584MH9-S	1	0							
R_PRE	1584Outfall	0	0							
Z_PRE	1584Outfall	0	0							

2. Pretty River Sub-catchments

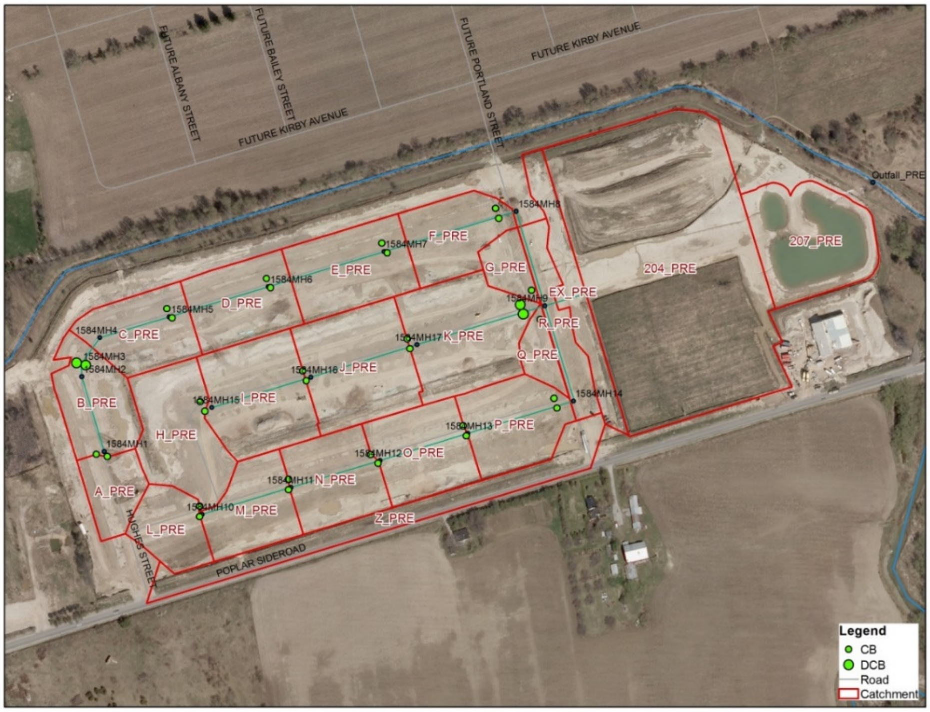


Fig. A6- 4 Pretty River Estates Catchments and Catch Basins

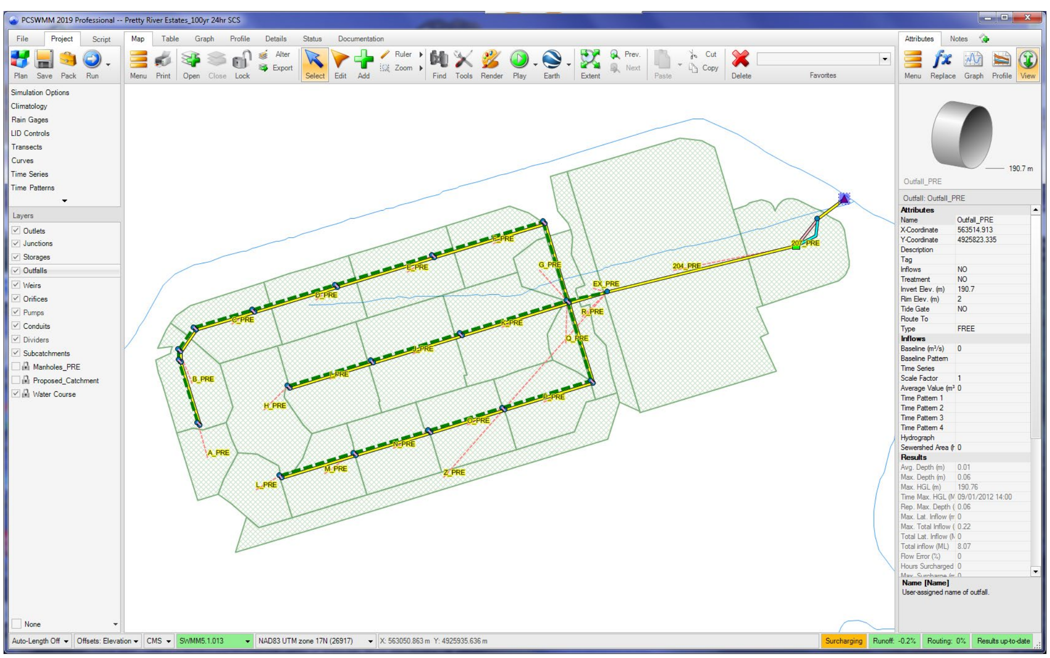


Fig. A6- 5 Pretty River Estates PCSWMM Schematics

3. Georgian Meadows Sub-catchments

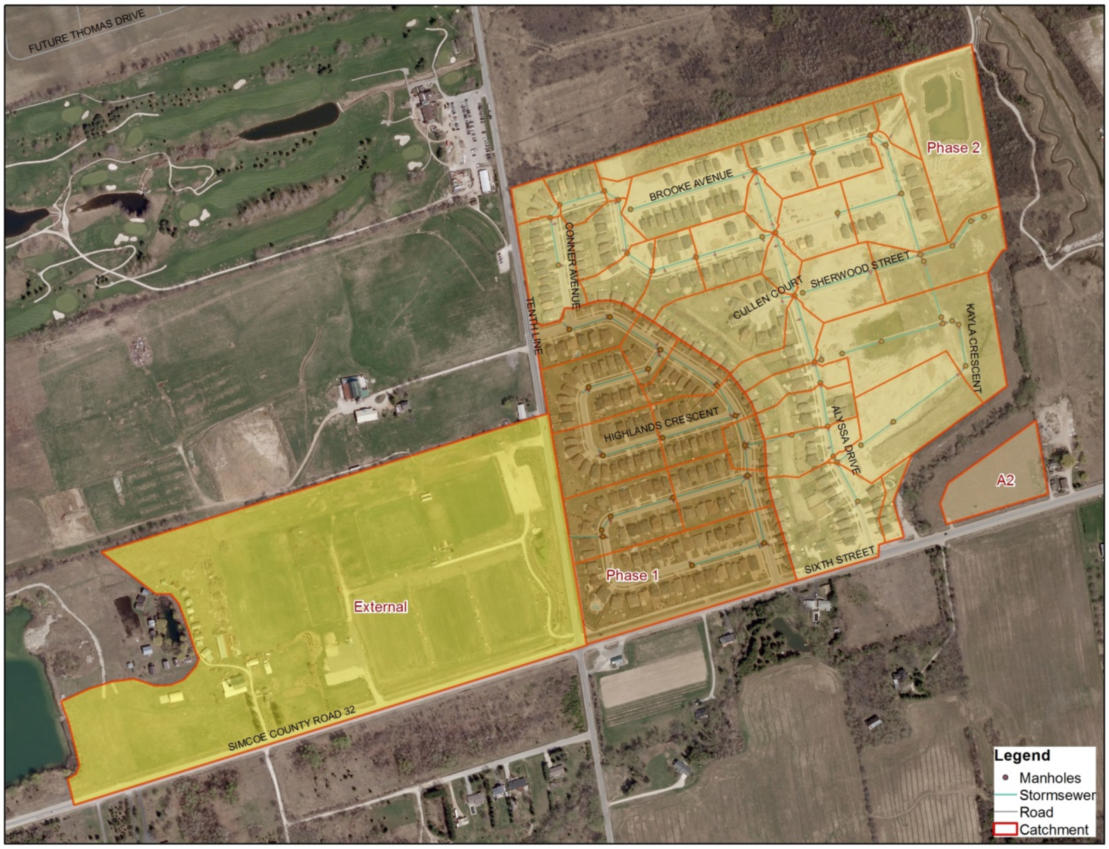


Fig. A6- 6 Georgian Meadows Catchments

Table A6- 5: Georgian Meadows Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
Phase 1	11.6	43.78	18.43	2.52	74	0.8	1.5
Phase 2	23.8	36.61	16.39	0.97	71	0.8	1.5
Ext	19.22	0	0		67		2.5
A2	1.0	0	0		67		2.5

4. Mair Mills

Fig. A6- 7 Mair Mills Catchments

Table A6- 6: Mair Mills Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
200	5.47				71		
201	6.35				71		
202	14.29	40	20	0.5/2.0	65.2	1.5	5
203	1.69	50	25	0.5/2.0	65.2	1.5	5
204	2.90				66.6		
205	1.15	20	20	0.5/2.0	65.2	1.5	5
206	0.84	50	25	0.5/2.0	65.7	1.5	5
207	0.81				65.7		

5. Mountain Croft

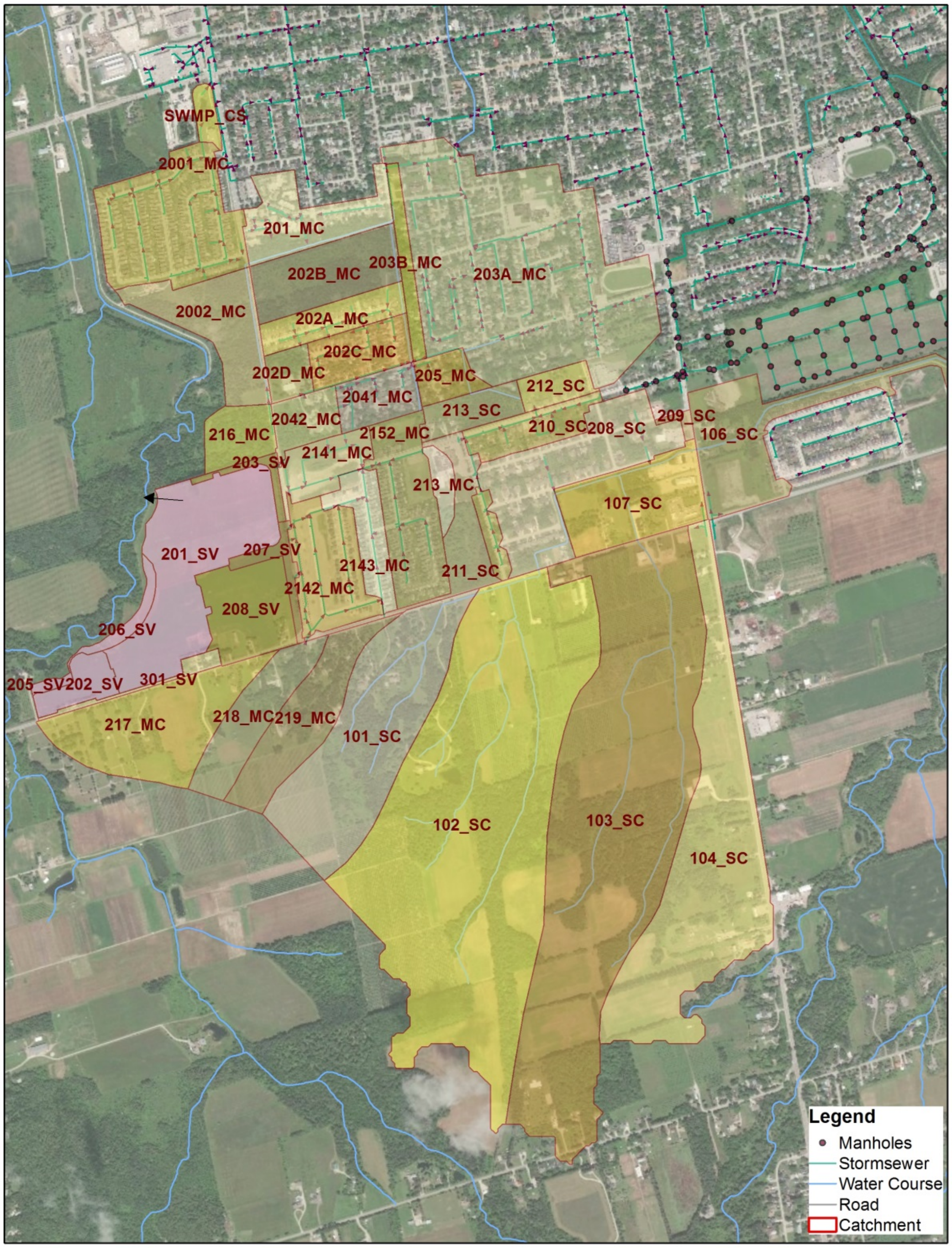


Fig. A6- 8 Mountaincroft Catchments

Table A6 7: Mountaincroft Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
2002	8.23	0	0	0.4	82.2	2	6.95
2001	5.31	0	0	0.4	82.2	2	6.95
219	10.23	0	0	1.4	49.5	2	6.95
218	7.89	0	0	1.5	49.5	2	6.95
217	15.42	0	0	1.4	49.5	2	6.95
216	9.95	0	0	1.5	51.8	2	6.95
213	1.69	30	30	1.0	54.0	2	6.95
205	2.85	30	15	5.0	71.3	2	5.5
2042	3.08	22	10	2.0	59.2	2	7.1
2041	3.84	32	15	2.0	68.7	2	5.4
202A	5.65	45.5	25	1.0	78.8	2	4.73
202B	8.74	0	0	0.3	72.3	2	10.0
202C	5.41	54	33	2.0	90.3	2	4.3
202D	1.93	20	10	1.0	79.8	2	7.5
2141	4.68	60	30	1.0		2	6.95
2142	8.34	60	30	1.0		2	6.95
2143	4.31	60	30	1.0		2	6.95
103A	45.93	50	15	0.5			
103B	3.07	30	15	2			
101	7.88	60	30		82.2		

6. South Collingwood

Table A6- 8: South Collingwood Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
101 (220_MC)	24.8	1.0	0	1.26	57.3	2	8.22
102 (221_MC)	72.7	1.1	0	1.2	57.3	2	8.23
103 (222_MC)	60.2	1.0	0	1.22	59.0	2	8.31
104 (223_MC)	29.4	0.1	0	1.16	61.9	2	8.03
105 (224_MC)	34.3	1.0	0	1.12	60.6	2	8.37
106 (208_MC)	31.5	0	0	0.35	61.7	2	8.0
107 (209_MC)	10.2	5.0	0	0.49	63.0	2	8.16
208 (207_MC)	16	40	20	0.5/2.0	72.1	1	5.9
209 (EO)	4.5	35	16	0.5/2.0	71.1	1	5.9
210 (211_MC)	7.5	40	16	0.5/2.0	74.9	1	5.6
211 (212_MC)	5.4	0	0	0.55	60.4		7.90
212 (206_MC)	1.9	84	16	0.5/2.0	64.1	1	5.6
213 (206_MC)	2.7	0	0	1.05	62.3		7.98

Table A6- 9: Summitview Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
201	18.69	55	27	1.0/2.0	49.5	1	5
202	2.83	55	27	1.0/2.0	49.5	1	5
203	0.92	41	3	1.0/2.0	49.5	1	5
205	0.45	40	0	8	69.4	1	3.8
206	1.5	40	0	4	69.4	1	3.8
207	1.51	41	2	1.0/2.0	49.5	1	5
208	8.01	55	27	1.0/2.0	49.5	1	6.84
301	1.72	12	0	3	55.1		4.64

7. Eden Oak and Riverside

Fig. A6- 9 Eden Oak and Riverside Catchments

Table A6- 10: Eden Oak Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
500	7.55	51	22	2.0/2.0	68.0	0.8	5
505	0.54	50	50	2.0/2.0	68.0	0.8	5
501	4.64	50	23	2.0/2.0	68.0	0.8	5
502	6.56	50	22	2.0/2.0	68.0	0.8	5
503	1.27	20	20		68.0		7
504	1.07	50	50	2.0/2.0	68.0	0.8	5
511	0.11	20	20		68.0		7
506	0.24	57	57	2.0/2.0	68.0	0.8	5
507	1.42	48	6				
508	0.17	49	7				
509	0.03	20	20		68.0		7
510	0.11	20	20		68.0		7
512	1.68	47	6		68.0		7

Table A6- 11: Riverside Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
100 ext	1.4			0.28	69.93		8.19
200	7.04	42	23		78.39		7
600	1.81	64	48		88.29		5.06
300	7.85	51	33		80.70		9.11
500	3.71	61	43		86.76		5.81
400	2.08			0.28	57.5		14.08
700	1.03	51	32	2.0	81.44		8.68
800	1.68			0.28	58.02		13.78

8. Blue Shores

Fig. A6- 10 Blue Shores Catchments

9. Tanglewood

Fig. A6- 11 Tanglewood Catchments

Table A6- 12: Tanglewood Parameters (Existing 2007)

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
1200	103.0	1	1	2.74	65	2	7.5
1201	63.0	0	0	1.43	63	2	9.4
1202	21.0	0	0	0.4	65	2	7.4
1300	16.7	0	0	1.25	64.8	2	7.8
1400	17.7	0	0	2.80	62.1	2	9.6
1401	22.3	0	0	0.5	66.6	2	5.5
1500	4.4	0	0	0.29	73.4	2	6.82
1600	8.5	12	6	0.29	76.2	2	7.6
1700	40.0	2	1	0.09	55	2	13.8
1800	27.7	17	9	0.31	71.7	2	5.2
1801	11.7	5	3	0.38	67	2	10.4

Table A6- 13: Tanglewood Parameters (Ultimate)

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
1200	103.0	35	21	2.74	58	2	5.7
1201	63.0	35	21	1.43	64.7	2	6.6
1202	21.0	10	6	0.4	68	2	7.1
1300	16.7	25	15	1.25	65.4	2	7.1
1400	17.7	35	21	2.80	65	2	7.6
1401	22.3	11	7	0.5	70	2	4.9
1500	4.4	30	15	0.29	73	2	6.32
1600	8.5	32	18	0.29	73	2	5.7
1700	40.0	4	2	0.09	58	2	13.5
1800	27.7	21	12	0.31	66	5.3	5.2
1801	11.7	25	15	0.38	66	2	9.6

Table A6- 14: Tanglewood Parameters (Existing 2019)

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
1200	103.0	1	1	2.74	65	2	7.5
1201	63.0	0	0	1.43	63	2	9.4
1202	21.0	0	0	0.4	65	2	7.4
1300	16.7	0	0	1.25	64.8	2	7.8
1400	17.7	0	0	2.80	62.1	2	9.6
1401	22.3	5	0	0.5	66.6	2	5.5
1500	4.4	0	0	0.29	73.4	2	6.82
1600	8.5	12	6	0.29	76.2	2	7.6
1700	40.0	2	1	0.09	55	2	13.8
1800	27.7	21	12	0.31	66	5.3	5.2
1801	11.7	25	15	0.38	66	2	9.6

Table A6- 15: Cranberry Tanglewood Parameters

Catchment	Area (ha)	TIMP (%)
1	0.71	70
2	0.35	70
3	0.64	70
4	0.50	70

10. Blue Fairways

Fig. A6- 12 Blue Fairways Catchments

Table A6- 16: Blue Fairways Block 1 Parameters

Catchment		Area (ha)	TIMP (%)		XIMP (%)	Slope (%)	C	CN	IA (mm)	
									Imp	Perv
A1	100	0.35	60.6	71	46.4	0.5/2.0	0.75	69	2	5
	101	0.23		45			0.54	69	2	5
	102	0.19		71			0.75	69	2	5
	103	0.20		71			0.75	69	2	5
	104	0.12		0			0.25	69	2	5
A2	105	0.52	48.7	20	34.1	0.5/2.0	0.54	69	2	5
	106	0.1		45			0.54	69	2	5
	107	0.04		71			0.75	69	2	5
	108	0.25		71			0.75	69	2	5
	109	0.14		71			0.75	69	2	5
	110	0.22		45			0.54	69	2	5
	111	0.10		71			0.75	69	2	5
	112	0.25		71			0.75	69	2	5
A3	113	0.49	64.5	71	49.7	0.5/2.0	0.75	69	2	5
	114	0.25		71			0.75	69	2	5
	115	0.17		71			0.75	69	2	5
	116	0.39		45			0.45	69	2	5
	118	0.15		71			0.75	69	2	5
A4	119	0.33	77.4	71		0.5/2.0	0.75	69	2	5
	120	0.15		71			0.75	69	2	5
	121	0.17		71			0.75	69	2	5
	122	0.05		71			0.75	69	2	5
	123	0.08		71			0.75	69	2	5
E5		5.81	0		0	0.5	0.25	67	2	7.13
E6		1.51	0		0	0.5	0.32	71.7	2	5.81
E7		0.38	50.3		50.3	1.0/2.0		69	2	5
E8		1.72	0		0	0.5	0.3	70.5	2	5.74
E9		3.88	54.1		44.0	0.5/2.0		69	2	5

Table A6- 17: Blue Fairways Block 2 Parameters

Catchment	Area (ha)	TIMP (%)	C
101	0.13	71	0.84
102	0.25	71	0.74
103	0.28	71	0.82
104	0.08	71	0.78
105	0.08	0	0.19
106	0.41	30	0.39
107	0.48	71	0.68

11. Bridgewater

Fig. A6- 13 Bridgewater Catchments

12. Eden Oak Industry

Fig. A6- 14 Eden Oak Industry Catchments

Table A6- 18: Eden Oak Industry Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	Slope (%)	CN	IA (mm)	
						Imp	Perv
100	252.7			0.72	64.6	1	8.45
101	21.4			2.37	64.51	1	7.93
102	1.2			3.68	64.6	1	7.49
200	59.3			0.75	51.61	1	8.26
201	32.1			1.60	58.4	1	7.95
2010	8.0	70.8	70.8	1.60	90.0	1	2.9
202	2.9			2.00	52.3	1	9.3
2020	8.1	68.3	66.6	1.20	88	1	2.9
203	8.8	51	49	1.43	94	1	4.9
204	95.8	65	65	1.90	89	1	3.3
2040	13.2	71	71	1.90	93	1	2.9
205	3.7	54	31	1.90	94.7	1	3.4
DS	6.9	30	15		80	1	5.0

13. River Run

Fig. A6- 15 River Run Catchments

Table A6- 19: River Run Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	CN	IA (mm)	
					Imp	Perv
203	0.241	50	25	80	2	5
204	0.272	50	25	80	2	5
205	0.471	50	25	80	2	5
206	0.462	30	15	80	2	5
207	0.416	40	15	80	2	5
Ext	5.726	80	80	80	2	5

14. Western Commercial

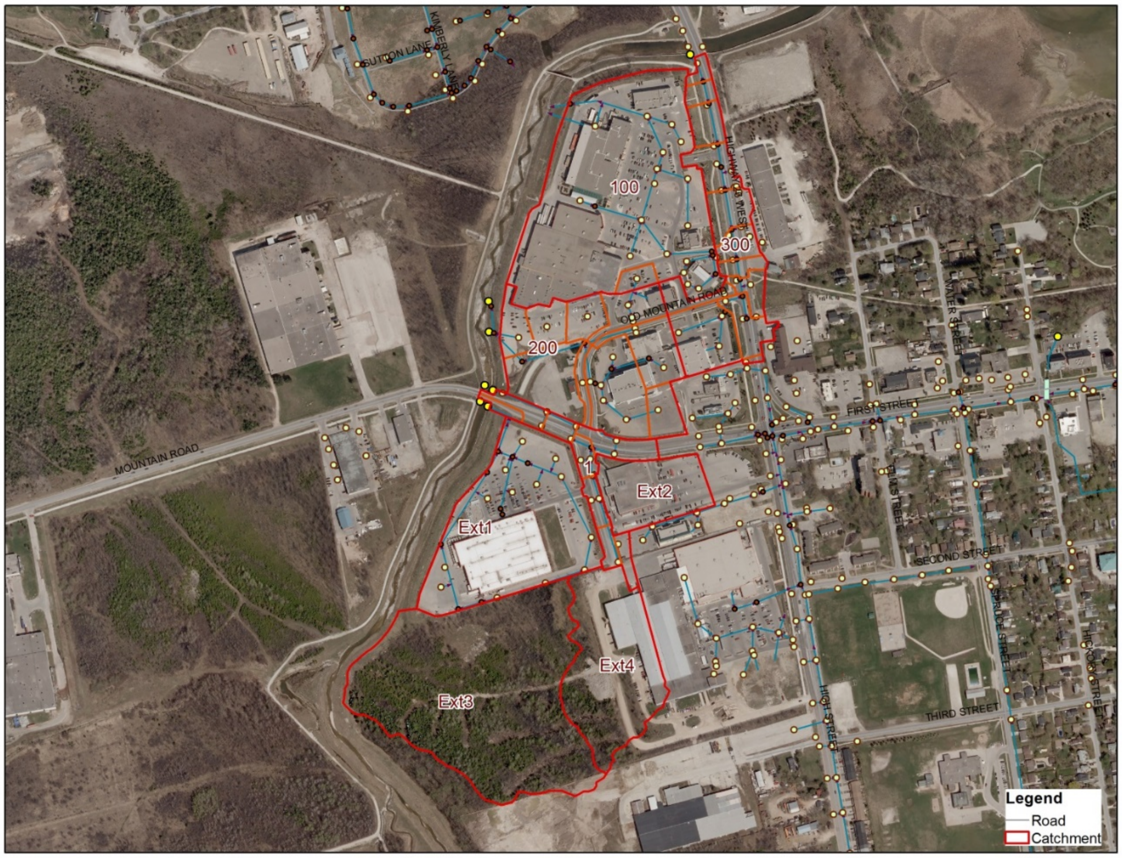


Fig. A6- 16 Western Commercial Catchments

Table A6- 20: Western Commercial Parameters

Catchment	Area (ha)	TIMP (%)	XIMP (%)	CN	IA (mm)	
					Imp	Perv
1	1.34	90	90	80	2	5
Ext1	4.45	90	90	80	2	5
Ext2	1.40	90	90	80	2	5
Ext3	7.49	0	0	80	2	5
Ext4	2.96	50	50	80	2	5
100	7.27	90	90	80	2	5
200	4.56	90	90	80	2	5

300	3.30	90	90	80	2	5

Appendix 7

Stormwater Management Ponds

Table A7- 1 Pond Locations and Outlets to be added to Hydrologic Model

SWM No.	Pond Name	Location	Outlet
SWM #1	Georgian Meadows	53 Brooke Ave	Black Ash Creek
SWM #2	Mair Mills	57 Kells Crescent	Storm Sewer along Mountain Road
SWM #3	Creekside	1 Chamberlain Crescent	Storm Sewer along High Street
SWM #4	Telfer	49 Telfer Road	Existing Ditch
SWM #5	Mountaincroft	171 Findlay Drive	Existing ditch to Campbell St culvert to Oak Street Canal
SWM #6	South Collingwood	109 Findlay Drive	Open channel
SWM #7	Riverside	19 Williams Street	Ditch along Train Trail to Minnesota Drain
SWM #8	River Run	27 River Run	Hume Street Storm Sewer or Pretty River
SWM #9	Shannon Court	36 Raglan Street	Existing ditch along Pretty River Parkway
SWM #10	Industrial	155 Sanford Fleming Drive	Existing ditch along old rail line
SWM #11	Lakeside Pointe	40 Silver Crescent	Georgian Bay
SWM #12	Cranberry Trail West	23 Sundial Court	Drainage ditch along Highway 26
SWM #13	Pretty River Estates	7400 Poplar SdRd	Pretty River
SWM #14	Eden Oak East	TBD	Pretty River
SWM #15	Eden Oak West	TBD	Storm Sewer along Hurontario Street
SWM #16	Van Dolder's	185 Mountain Road	Black Ash Creek
SWM #17	Summitview	TBD	Black Ash Creek

Table A7- 2 Stage-Storage-Discharge Curve for SWM #1 at Georgian Meadows

Stage	Depth	Area	Pipe Outfl
186.4	0	5828	0
186.67	0.27	6272	0
187.61	1.21	7037	0.075
187.76	1.36	7280	0.075

Table A7- 3 Stage-Storage-Discharge Curve for SWM#2 at Mair Mills

MAIR MILLS

POND STAGE-STORAGE-DISCHARGE DATA

Side Slope	3 :1
Bottom Length	30.00 m
Bottom Width	3.00 m
Bottom Elev.	199.00 m
Static Water	200.20 m
Stage	0.10 m

Orifice	1	2
diameter(mm	100.00	300.00
invert(m)	200.20	200.80
Weir	Manhole	Overflow
length(m)	0.00	1.20
sill(m)	0.00	202.00

Outlet is a hickenbottom type with a 450mm dia. outlet pipe connected to double ditch inlet overflow structure.

	Orifice		Weir			
	1	2	manhole	overflow	Total	Volume	
Water Level	Discharge	Discharge	Discharge	Discharge	Discharge	Dead	Live
(m)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3)	(m^3)
199.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.00
199.60	0.0000	0.0000	0.0000	0.0000	0.0000	1041.30	0.00
200.20	0.0000	0.0000	0.0000	0.0000	0.0000	2568.30	0.00
200.30	0.0047	0.0000	0.0000	0.0000	0.0047		321.72
200.40	0.0081	0.0000	0.0000	0.0000	0.0081		664.30
200.50	0.0104	0.0000	0.0000	0.0000	0.0104		1027.72
200.60	0.0123	0.0000	0.0000	0.0000	0.0123		1412.00
200.70	0.0140	0.0000	0.0000	0.0000	0.0140		1817.12
200.80	0.0155	0.0000	0.0000	0.0000	0.0155		2243.10
200.90	0.0168	0.0000	0.0000	0.0000	0.0168		2685.77
201.00	0.0181	0.0420	0.0000	0.0000	0.0601		3141.00
201.10	0.0192	0.0727	0.0000	0.0000	0.0920		3608.77
201.20	0.0203	0.0939	0.0000	0.0000	0.1142		4089.10
201.30	0.0214	0.1111	0.0000	0.0000	0.1325		4581.97
201.40	0.0224	0.1260	0.0000	0.0000	0.1483		5087.40
201.50	0.0000	0.1500	0.0000	0.0000	0.1500		5605.37
201.60	0.0000	0.1500	0.0000	0.0000	0.1500		6135.90
201.70	0.0000	0.1500	0.0000	0.0000	0.1500		6678.97
201.80	0.0000	0.1500	0.0000	0.0000	0.1500		7234.60
201.90	0.0000	0.1500	0.0000	0.0000	0.1500		7802.77
202.00	0.0000	0.1500	0.0000	0.0000	0.1500		8383.50
202.10	0.0000	0.1500	0.0000	0.1148	0.2648		9034.17
202.20	0.0000	0.1500	0.0000	0.4723	0.6223		10362.17
202.30	0.0000	0.1500	0.0000	1.1387	1.2887		11716.83
202.40	1.0000	1.1500	0.0000	0.0000	2.1500		13098.17
202.50	2.0000	2.1500	0.0000	0.0000	4.1500		14506.17

Table A7- 4 Mair Mills Stage-Storage-Discharge Curve, with Calculated Depth-Area Relationship

	Orifice		Weir						
	1	2	Manhole	Overflow	Total	Volume		Depth	Area
Water Lev	Discharge	Discharge	Discharge	Discharge	Discharge	Dead	Live		
(m)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3/s)	(m3)	(m3)	(m)	(m2)
199	0	0	0	0	0	0	0		
199.6	0	0	0	0	0	1041.3	0		
200.2	0	0	0	0	0	2568.3	0	0	3100
200.3	0.0047	0	0	0	0.0047		321.72	0.1	3334.4
200.4	0.0081	0	0	0	0.0081		664.3	0.2	3517.2
200.5	0.0104	0	0	0	0.0104		1027.72	0.3	3751.2
200.6	0.0123	0	0	0	0.0123		1412	0.4	3934.4
200.7	0.014	0	0	0	0.014		1817.12	0.5	4168
200.8	0.0155	0	0	0	0.0155		2243.1	0.6	4351.6
200.9	0.0168	0	0	0	0.0168		2685.77	0.7	4501.8
201	0.0181	0.042	0	0	0.0601		3141	0.8	4602.8
201.1	0.0192	0.0727	0	0	0.092		3608.77	0.9	4752.6
201.2	0.0203	0.0939	0	0	0.1142		4089.1	1	4854
201.3	0.0214	0.1111	0	0	0.1325		4581.97	1.1	5003.4
201.4	0.0224	0.126	0	0	0.1483		5087.4	1.2	5105.2
201.5	0	0.15	0	0	0.15		5605.37	1.3	5254.2
201.6	0	0.15	0	0	0.15		6135.9	1.4	5356.4
201.7	0	0.15	0	0	0.15		6678.97	1.5	5505
201.8	0	0.15	0	0	0.15		7234.6	1.6	5607.6
201.9	0	0.15	0	0	0.15		7802.77	1.7	5755.8
202	0	0.15	0	0	0.15		8383.5	1.8	5858.8
202.1	0	0.15	0	0.1148	0.2648		9034.17	1.9	7154.6
202.2	0	0.15	0	0.4723	0.6223		10362.2	2	10500
202.3	0	0.15	0	1.1387	1.2887		11716.8	2.1	11000
202.4	1	1.15	0	0	2.15		13098.2	2.2	11500
202.5	2	2.15	0	0	4.15		14506.2	2.3	12000

Table A7- 5 Stage-Storage Curve for SWM#5 at Mountaincroft

Pond Volume Table

Wet Cell		Forebay	
Side Slope	5	Side Slope	5 :1
Bottom Length	85.00	Bottom Length	37.00 m
Bottom Width	25.00	Bottom Width	18.00 m
Bottom Elev.	192.90	Bottom Elev.	192.70
Water Level	194.20	Water Level	194.20
Stage	0.1	Stage	0.1 m

Elev. (m)	Depth (m)	Area (m^2)	Avg. Area (m^2)	Volume: Dead (m^3)	Accum. Dead (m^3)	Live (m^3)	Accum. Live (m^3)	Accum. Total
192.70	0.00	**480.00**	480.00	0.00	0.00	0.00	0.00	0.00
192.80	0.10	**502.16**	491.08	49.11	49.11	0.00	0.00	49.11
192.90	0.20	**2840.00**	1671.08	167.11	216.22	0.00	0.00	216.22
193.00	0.30	2943.85	2891.92	289.19	505.41	0.00	0.00	505.41
193.10	0.40	3047.69	2995.77	299.58	804.99	0.00	0.00	804.99
193.20	0.50	3151.54	3099.62	309.96	1114.95	0.00	0.00	1114.95
193.30	0.60	3255.38	3203.46	320.35	1435.29	0.00	0.00	1435.29
193.40	0.70	3359.23	3307.31	330.73	1766.02	0.00	0.00	1766.02
193.50	0.80	3463.08	3411.15	341.12	2107.14	0.00	0.00	2107.14
193.60	0.90	3566.92	3515.00	351.50	2458.64	0.00	0.00	2458.64
193.70	1.00	3670.77	3618.85	361.88	2820.52	0.00	0.00	2820.52
193.80	1.10	3774.62	3722.69	372.27	3192.79	0.00	0.00	3192.79
193.90	1.20	3878.46	3826.54	382.65	3575.45	0.00	0.00	3575.45
194.00	1.30	3982.31	3930.38	393.04	3968.49	0.00	0.00	3968.49
194.10	1.40	4086.15	4034.23	403.42	4371.91	0.00	0.00	4371.91
194.20	1.50	**4190.00**	4138.08	413.81	4785.72	0.00	0.00	4785.72
194.30	1.60	4437.06	4313.53		4785.72	431.35	431.35	5217.07
194.40	1.70	4684.11	4560.58		4785.72	456.06	887.41	5673.13
194.50	1.80	4931.17	4807.64		4785.72	480.76	1368.17	6153.89
194.60	1.90	5178.22	5054.69		4785.72	505.47	1873.64	6659.36
194.70	2.00	5425.28	5301.75		4785.72	530.17	2403.82	7189.54
194.80	2.10	5672.33	5548.81		4785.72	554.88	2958.70	7744.42
194.90	2.20	5919.39	5795.86		4785.72	579.59	3538.29	8324.00
195.00	2.30	6166.44	6042.92		4785.72	604.29	4142.58	8928.29
195.10	2.40	6413.50	6289.97		4785.72	629.00	4771.57	9557.29
195.20	2.50	6660.56	6537.03		4785.72	653.70	5425.28	10210.99
195.30	2.60	6907.61	6784.08		4785.72	678.41	6103.69	10889.40
195.40	2.70	7154.67	7031.14		4785.72	703.11	6806.80	11592.52
195.50	2.80	7401.72	7278.19		4785.72	727.82	7534.62	12320.34
195.60	2.90	7648.78	7525.25		4785.72	752.52	8287.14	13072.86
195.70	3.00	7895.83	7772.31		4785.72	777.23	9064.37	13850.09
195.80	3.10	8142.89	8019.36		4785.72	801.94	9866.31	14652.03
195.90	3.20	8389.94	8266.42		4785.72	826.64	10692.95	15478.67
196.00	3.30	**8637.00**	8513.47		4785.72	851.35	11544.30	16330.02
196.10	3.40	8808.67	8722.83		4785.72	872.28	12416.58	17202.30
196.20	3.50	8980.33	8894.50		4785.72	889.45	13306.03	18091.75
196.30	3.60	9152.00	9066.17		4785.72	906.62	14212.65	18998.37
196.40	3.70	9323.67	9237.83		4785.72	923.78	15136.43	19922.15
196.50	3.80	9495.33	9409.50		4785.72	940.95	16077.38	20863.10
196.60	3.90	**9667.00**	9581.17		4785.72	958.12	17035.50	21821.22

Table A7- 6 Stage-Storage-Discharge Curve for SWM#5 at Mountaincroft

Mountainview Subdivision - SWM Pond
POND STAGE-STORAGE-DISCHARGE DATA

	Wet Cell	Forebay
Avg. Side Slope	5 :1	5 :1
Bottom Length	85.00 m	37.00 m
Bottom Width	25.00 m	18.00 m
Bottom Elev.	192.90 m	192.70 m
Static Water	194.20 m	194.20 m
Stage	0.10 m	0.10 m

Orifice	1	2
diameter(mm	200.00	600.00
invert(m)	194.20	194.20
Weir		Overflow
length(m)		8.00
sill(m)		196.00

Outlet reverse slope pipe w 200 mm dia. orifice and 600mm dia. outlet pipe

	Orifice		Weir			Volume		
	1	Outlet Pipe	manhole	overflow	Total			
Water Level (m)	Discharge (m^3/s)	Discharge (m^3/s)	Discharge (m^3/s)	Discharge (m^3/s)	Discharge (m^3/s)	Dead (m^3)	Live (m^3)	Total (m^3)
194.20	0.0000	0.0000	0.0000	0.0000	0.0000	4786	0	4786
194.30	0.0000	0.0000	0.0000	0.0000	0.0000	4786	431	5217
194.40	0.0264	0.0000	0.0000	0.0000	0.0264	4786	887	5673
194.50	0.0373	0.0000	0.0000	0.0000	0.0373	4786	1368	6154
194.60	0.0457	0.0000	0.0000	0.0000	0.0457	4786	1874	6659
194.70	0.0528	0.0000	0.0000	0.0000	0.0528	4786	2404	7190
194.80	0.0590	0.0000	0.0000	0.0000	0.0590	4786	2959	7744
194.90	0.0646	0.0000	0.0000	0.0000	0.0646	4786	3538	8324
195.00	0.0698	0.0000	0.0000	0.0000	0.0698	4786	4143	8928
195.10	0.0746	0.7125	0.0569	0.0000	0.1316	4786	4772	9557
195.20	0.0792	0.7511	0.1610	0.0000	0.2402	4786	5425	10211
195.30	0.0835	0.7877	0.2958	0.0000	0.3792	4786	6104	10889
195.40	0.0875	0.8227	0.4554	0.0000	0.5429	4786	6807	11593
195.50	0.0914	0.8563	0.6364	0.0000	0.7278	4786	7535	12320
195.60	0.0951	0.8887	0.8366	0.0000	0.8366	4786	8287	13073
195.70	0.0987	0.9199	1.0542	0.0000	0.9199	4786	9064	13850
195.80	0.1022	0.9500	1.2880	0.0000	0.9500	4786	9866	14652
195.90	0.1056	0.9793	1.5369	0.0000	0.9793	4786	10693	15479
196.00	0.1088	1.0076	1.8000	0.0000	1.0076	4786	11544	16330
196.10	0.1120	1.0353	2.0766	0.4331	1.4683	4786	12417	17202
196.20	0.1150	1.0622	2.3662	1.2692	2.3313	4786	13306	18092
196.30	0.1180	1.0884	2.6680	2.4130	3.5014	4786	14213	18998
196.40	0.1209	1.1140	2.9817	3.8403	4.9543	4786	15136	19922
196.50	0.1238	1.1390	3.3068	5.5419	6.6810	4786	16077	20863
196.60	0.1266	1.1635	3.6429	7.5151	8.6787	4786	17035	21821

Table A7- 7 Stage-Storage Curve for SWM#6 at South Collingwood

	South Collingwood									
	Pond Stage-Storage-Discharge Data									
Avg. Side Slope		5 : 1			Orifice	Orifice				
Bottom Length		78		diameter(mm	100	400				
Bottom Width				invert(m)	192.6	192.6				
Bottom Elev.		191.4		Weir	Manhole	Overflow				
Static Water		192.6		length(m)	1.2	6				
				sill(m)	192.9	194				
		Orifice 1	Head on	Orifice 2	Weir	Weir	Total	Volume		Cal
Depth	Water Lev	Discharge	orifice (m	Discharge	Discharge	Discharge	Discharge	Live		Area
	(m)	(cum/sec)		(invert 190.7			(cum/sec)	(m3)		
0	191.4			in cum/sec)		0	0			1150
1.2	192.6	0				0	0		0	2650
0.1	192.7	0.0047	0	0	0	0	0.0047	274.74	0.1	2845
0.2	192.8	0.0081	0	0	0	0	0.0081	584.55	0.2	3351
0.3	192.9	0.0104	0	0	0	0	0.0104	929.44	0.3	3546
0.4	193	0.0123	0	0	0.0694	0	0.0818	1309.4	0.4	4053
0.6	193.2	0.0155	0	0	0.3608	0	0.2100	2145.39	0.6	4307
0.7	193.3	0.0168	0.1	0.236	0.5555	0	0.2529	2640.44	0.7	5594
0.8	193.4	0.0181	0.2	0.2586	0.7764	0	0.2766	3174.51	0.8	5650
0.9	193.5	0.0192	0.3	0.2793	1.0206	0	0.2985	3747.6	0.9	5800
1	193.6	0.0203	0.4	0.2986	1.2861	0	0.3189	4364.59	1	6000
1.4	194	0.0242	0.8	0.3657	2.5335	0	0.3899	7320.35	1.4	8813
1.9	194.5	0.0284	1.3	0.4352	4.4444	5.2503	5.6303	12136.6	1.9	10452

Table A7- 8 Stage-Storage Curve for SWM#7 at Riverside

Depth	Elevation	Discharge	Live Volur	Total Volume			AREA (sq.r
	(m)		(m3)	(m3)			
0	185	0		0	185	0	4438.7
0.2	185.2	0		932	185.2	0.2	4945.9
0.4	185.4	0		1956	185.4	0.4	5453.0
0.8	185.8	0		4278	185.8	0.8	6467.4
1.1	186.1	0		6304	186.1	1.1	7228.1
0.3	186.4	0.0194	2302	8606	186.4	1.4	8021.3
0.5	186.6	0.0474	3961	10265	186.5	1.5	8285.7
0.6	186.7	0.055	4817	11121	186.6	1.6	8520.6
0.7	186.8	0.1489	5724	12028	186.7	1.7	8755.6
0.8	186.9	0.1598	6631	12935	186.8	1.8	8990.5
0.9	187		7583	13887	186.9	1.9	9225.5
1	187.1	0.1836	8535	14839	187	2	9460.4
1.1	187.2		9579	15883	187.1	2.1	9695.4
1.2	187.3		10523	16827	187.2	2.2	9930.3
1.3	187.4	0.2143	11551	17855	187.3	2.3	10165.3
1.4	187.5	2.0806			187.4	2.4	10400.2
1.6	187.7	2.3699	14829	21133	187.7	2.7	11719
1.9	188				188	3	13837.9

Table A7- 9 Stage-Storage Curve for SWM#12 at Cranberry Marsh

CRANBERRY MARSH STAGE-STORAGE-DISCHARGE CHARACTERISTICS

Cranberry Marsh Stage-Storage Table

Elevation (m)	Area (ha)	Storage (m3)	Storage (ha-m)
178.80	**0.0**	**0**	**0.0**
178.85	1.3	328	0.0
178.90	2.6	1,313	0.1
178.95	3.9	2,953	0.3
179.00	5.3	5,250	0.5
179.05	6.6	8,203	0.8
179.10	7.9	11,813	1.2
179.15	9.2	16,078	1.6
179.20	**10.5**	**21,000**	**2.1**
179.25	13.0	26,863	2.7
179.30	**15.4**	**33,950**	**3.4**
179.35	17.8	42,250	4.2
179.40	20.2	51,750	5.2
179.45	22.6	62,450	6.2
179.50	25.0	74,350	7.4
179.55	27.4	87,450	8.7
179.60	**29.8**	**101,750**	**10.2**
179.65	31.8	117,144	11.7
179.70	33.8	133,525	13.4
179.75	35.7	150,894	15.1
179.80	**37.7**	**169,250**	**16.9**

Marsh Outlet Hydraulic Rating Curves from HEC-RAS

EXISTING		*ULTIMATE*	
Flow (m^3/s)	W.S. Elev (m)	Flow (m^3/s)	W.S. Elev (m)
0.00	178.80	0.00	178.80
0.45	179.01	0.45	178.99
0.61	179.05	0.61	179.01
1.19	179.21	1.19	179.11
1.57	179.30	1.57	179.18
1.90	179.36	1.90	179.24
2.17	179.41	2.17	179.29
2.51	179.46	2.51	179.35
9.10	179.86	9.10	179.89

Table A7- 10 Stage-Storage Curve for SWM#14 at Eden Oak East

	East SWM Pond Characteristics												
	Stage-Storage-Discharge Relationship												
	ELEVATION	DEPTH (m	AREA (sq.m	STORAGE (cu.m.)	STORAGE	ICDType 'C'		ICDType '(	Head on	Orifice	Weir	Total	
					(Ha-m)	Discharge Rate		Discharge	orifice (m	Discharge	Discharge	Discharge	
					(lps)			(cum/sec)		(invert 190.7		(cum/sec)	(Ha-m)
	189.6	0	1080.56	0	0		FOREBAY			in cum/sec)			
	189.9	0.3	1266.73	123.77	0.0124	0		0	0	0	-	0	
	190	0.4	1333.95	312.66	0.0313	0		0	0	0	0	0	
	190.2	0.6	1471.19	370.17	0.037	0		0	0	0	0	0	
	190.3	0.7	1541.2	801.25	0.0801	0		0	0	0	0	0	
	190.4	0.8	3240.68	966.26	0.0966	0	PERMANE	0	0	0	0	0	
	190.5	0.9	3420.18	1459.47	0.1459	0		0	0	0	0	0	
	190.6	1	3551.17	1808.04	0.1808	0		0	0	0	0	0	0
0.1	190.7	0.8	3741.96	367.91	0.0368	11	ACTIVE ST	0.011	0	0	0	0.011	0.0368
0.2	190.8	0.9	2876.5	748.83	0.0749	16		0.016	0	0	0	0.016	0.0749
0.3	190.9	1	4019.66	1143.64	0.1144	19		0.019	0	0	0	0.019	0.1144
0.4	191	1.1	4144.23	1551.83	0.1552	22		0.022	0	0	0	0.022	0.1552
0.5	191.1	1.2	4270.48	1972.57	0.1973	24.5		0.0245	0	0	0	0.0245	0.2406
0.6	191.2	1.3	4398.41	2406.01	0.2406	26.5		0.0265	0	0	0	0.0265	0.2852
0.7	191.3	1.4	4528.01	2852.33	0.2852	28.5		0.0285	0	0	0	0.0285	0.1973
0.8	191.4	1.5	4659.3	3311.7	0.3312	30		0.03	0	0	0	0.03	0.3312
0.9	191.5	1.6	4792.26	3784.28	0.3784	31.5		0.0315	0	0	0	0.0315	0.3784
1	191.6	1.7	4926.89	4270.24	0.427	33		0.033	0	0	0	0.033	0.427
1.1	191.7	1.8	5063.21	4769.74	0.477	34.5		0.0345	0	0	0	0.0345	0.477
1.2	191.8	1.9	5201.2	5282.96	0.5283	36.5		0.0365	0	0	0	0.0365	0.5283
1.3	191.9	2	5340.87	5810.06	0.581	38		0.038	0	0	0	0.038	0.581
1.4	192	2.1	5482.22	6351.22	0.6351	39.5		0.0395	0	0	0	0.0395	0.6351
1.5	192.1	2.2	5626.49	6906.65	0.6907	41		0.041	0	0	0	0.041	0.6907
1.6	192.2	2.3	5773	7476.64	0.7477	42.5		0.0425	0	0	0	0.0425	0.7477
1.7	192.3	2.4	5922.29	8061.42	0.8061	44		0.044	0	0	0	0.044	0.8061
1.8	192.4	2.5	6073.48	8661.21	0.8661	45.5		0.0455	0.25	0.3564	0	0.4019	0.8661
1.9	192.5	2.6	6226.85	9276.23	0.9276	47		0.047	0.35	0.4217	0	0.4687	0.9276
2	192.6	2.7	6382.42	9906.69	0.9907	47.33		0.0473	0.45	0.4782	0	0.5255	0.9907
2.1	192.7	2.8	6541.59	10552.89	1.0553	47.67		0.0477	0.55	0.5286	0	0.5763	1.0553
2.2	192.8	2.9	6705.95	11215.27	1.1215	48		0.048	0.65	0.5747	0	0.6227	1.1215
2.3	192.9	3	6874.6	11894.3	1.1894	48.33		0.0483	0.75	0.6173	0	0.6656	1.1894
2.4	193	3.1	7047.55	12590.4	1.259	48.67		0.0487	0.85	0.6572	0	0.7058	1.259
2.5	193.1	3.2	7248.97	13305.23	1.3305	49		0.049	0.95	0.6948	0.1613	0.905	1.3305
2.6	193.2	3.3	7429.63	14039.16	1.4039	49.33		0.0493	1.05	0.7304	0.4562	1.2359	1.4039
2.7	193.3	3.4	7592.43	14790.26	1.479	49.67		0.0497	1.15	0.7644	0.838	1.6521	1.479
2.8	193.4	3.5	7781.22	15558.95	1.5559	50		0.05	1.25	0.7969	1.2902	2.1372	1.5559
2.9	193.5	3.6	7975.04	16346.76	1.6347	50.33		0.0503	1.35	0.8282	1.8031	2.6817	1.6347

Table A7 11 Stage-Storage Curve for SWM#15 at Eden Oak West

East SWM Pond Characteristics												
Stage-Storag	Relationship											
ELEVATION	DEPTH (m	AREA (sq.m	STORAGE (cu.m.)	STORAGE	ICDType 'A'		ICDType '/	Head on	Orifice	Weir	Total	
				(Ha-m)	Discharge	Rate	Discharge	orifice (m	Discharge	Discharge	Discharge	
							(cum/sec)		(invert 190.7		(cum/sec)	(Ha-m)
190.65	0	200.77	0	0	0	FOREBAY			in cum/sec)			
190.9	0.25	304.98	62.76	0.0063	0							
191.35	0.7	533.3	249.19	0.0249	0							
191.35	0.7	1404.22	249.19	0.0249	0	PERMANENT						
191.5	0.85	1581.68	472.91	0.0473	0							
191.65	1	1781.63	724.55	0.0725	0							
191.7	1.05	1863.07	92.03	0.0092	6	ACTIVE STOI	0.006	0	0	0	0.006	0.0092
191.8	1.15	1958.97	283.14	0.0283	6.8		0.0068	0	0	0	0.0068	0.0283
191.9	1.25	2056.83	483.93	0.0484	7.6		0.0076	0	0	0	0.0076	0.0484
192	1.35	2156.67	694.6	0.0695	8.4		0.0084	0	0	0	0.0084	0.0695
192.1	1.45	2258.5	915.36	0.0915	9.2		0.0092	0	0	0	0.0092	0.0915
192.2	1.55	3362.32	1146.4	0.1146	10		0.01	0.13	0.0227	0	0.0327	0.1146
192.3	1.65	2468.11	1387.92	0.1388	10.8		0.0108	0.23	0.0304	0	0.0412	0.1388
192.4	1.75	2575.88	1640.12	0.164	11.6		0.0116	0.33	0.0366	0	0.0482	0.164
192.5	1.85	2685.63	1903.2	0.1903	12.4		0.0124	0.43	0.0418	0	0.0542	0.1903
192.6	1.95	2797.37	2177.35	0.2177	13.2		0.0132	0.53	0.0465	0	0.0597	0.2177
192.7	2.05	2911.09	2462.77	0.2463	14		0.014	0.63	0.0507	0	0.0847	0.2463
192.8	2.15	3026.8	2759.66	0.276	14.8		0.0148	0.73	0.0546	0	0.0694	0.276
192.9	2.25	3144.49	3068.23	0.3068	15.6		0.0156	0.83	0.0583	0	0.0739	0.3068
193	2.35	3264.18	3388.66	0.3389	16.4		0.0164	0.93	0.0617	0	0.0781	0.3389
193.1	2.45	3385.85	3721.16	0.3721	17.2		0.0172	1.03	0.0649	0	0.0821	0.3721
193.2	2.55	3509.51	4065.93	0.4066	18		0.018	1.13	0.068	0.1129	0.1989	0.4066
193.3	2.65	3635.15	4423.16	0.4423	18.8		0.0188	1.23	0.071	0.3193	0.4091	0.4423
193.37	2.72	3726.56	4680.82	0.4681	19.36		0.0194	1.3	0.073	0.5009	0.5932	0.4681
193.4	2.75	3762.73	4793.06	0.4793	19.6		0.0196	1.33	0.0738	0.5866	0.6801	0.4793
193.5	2.85	3940.98	5178.24	0.5178	22		0.022	1.43	0.0766	0.9031	1.0017	0.5178

Figure A7- 1 SWM Ponds added to PCSWMM not from Major Subdivisions

Appendix 8

Model Calibration Report

September 30, 2020

Collingwood Stormwater Management Master Model

Urban Centre Model Calibration Report – DRAFT

Prepared for the Town of Collingwood

Authored by:

Greenland
International Consulting Ltd.

URBAN CENTRE MODEL CALIBRATION REPORT
TOWN OF COLLINGWOOD

Table of Contents

1 INTRODUCTION

The following report has been prepared to describe the calibration process used for the development of the models to represent the storm sewer and overland flow systems in the Town of Collingwood. This process includes the following:

- A review of the quality of the measured information available for flow and rainfall. This includes a description of the source and quality of information collected;
- A description of model construction and the applicability of using default parameters commonly directed by municipal and local conservation authorities; and,
- The methodology used to adjust the timing and variability of soil moisture conditions due to seasonal changes.

The urban centre model calibration report has been updated from the original draft report to include the results from an additional flow monitoring season. The 2019 flow monitoring season did not include any significant rainfall events whereas there have been several in the 2020 season. The calibration and validation efforts for both seasons will be outlined in the document.

1.1 Background

The PCSWMM software was used to describe the drainage system of the Town of Collingwood. It was selected based on its flexibility to describe both the pipe network and the overland flow system but also describe the key river and creek systems that are linked to these municipal drainage systems. PCSWMM has been used extensively to model urban drainage systems and recently has added more accurate means to describe rural catchments. This enabled the PCSWMM software to use information prepared from other software for the various river systems to be linked to the municipal drainage network. The calibration process is described in this document.

Figure 1 shows the location of the local urban centre drainage catchments.

1.2 Project Scope

The urban model development followed the steps that were outlined in the overall study report. The key steps are included as follows:

- Prepare a storm sewer infrastructure PCSWMM model based on the Town sewer network information for pipe and manholes augmented by field survey to fill data gaps;
- Update drainage infrastructure (ditches and culverts) linked to the sewer network;
- Introduce the storm water management facilities constructed to the infrastructure model and confirm the facilities operational response;
- Import the hydraulic model information for Oak Street Canal and Minnesota Drain as irregular conduits linked to culvert crossings and connect to sewer infrastructure 1D model;
- Add overland road sections described by conduits linked to the manhole nodes;
- Complete the calibration with monitored data;
- Adjust the infrastructure model to connect with a mesh created by the digital elevation model to produce a 2D model;
- Link the 2D mesh with the conduits for the Oak Street Canal and Minnesota Drain; and,
- Plot the flow spread within the mesh for various storm events.

The following report identifies the key work done in completing the calibration with monitored data.

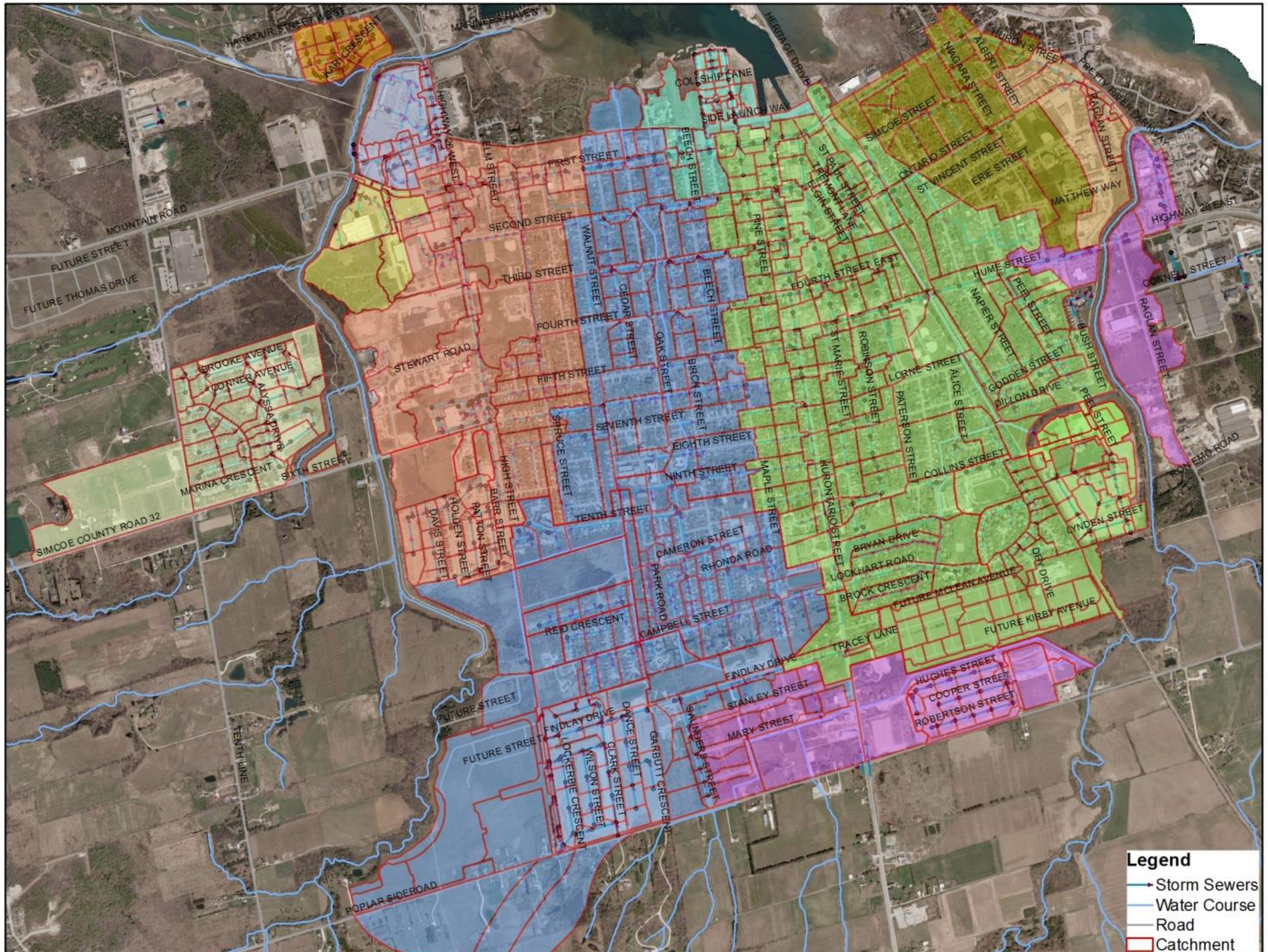


Figure 1 Major Urban Sewer Catchments

2 PHYSICAL DATA

The following section provides details of the physical data that was collected during the study to be used in calibrating the urban centre model. The data included five flow monitoring stations and local rain gauge information.

2.1 Observed Flow Data

The original workplan included the installation of 5 flow monitors for a six month period in 2019. During this time period, there were no significant rainfall events. The criteria to be considered a significant event was based on a rainfall volume greater than 30 mm in a 24 hour period. The events that occurred in 2019 were used to establish the timing of flows in a catchment and the threshold response from soil moisture conditions. The decision was made to collect additional flow information in 2020 to better calibrate the model that was developed.

To calibrate the minor-major system built in PCSWMM, flow monitoring was undertaken at five locations for a period of six months undertaken by Calder Engineering Ltd. and provided to Greenland Consulting Engineers. Water level and velocity measurements were taken at every five-minute interval at each of these locations. Flow was then computed using the observed variables. Area of flow at the monitoring sites was computed using the cross-sectional properties of the culvert, which was either box, circular or arch shaped.

Table 1 provides a summary of the monitoring locations and the model ID used in PCSWMM for each location.

Table 1 Flow Monitoring Stations

Monitoring Station	Catchment Area (Ha)	Station ID	Cross-section Type
Oak Street Canal	297.6	OSC_146	Box
St. Marie Street	95.54	SM_256	Pipe
Minnesota Street-1	82.8	MinS_204	Arch
Minnesota Street-2	82.8	MinS_205	Arch
Georgian Meadows	51.6	GM_58	Pipe

The location of the monitoring stations is presented in **Figure 2**.

2.1.1 2019 Flow Monitoring Season

- There were no major rainfall events (>30 mm volume) observed during the monitoring period, therefore the resulting recorded flows are very low with the maximum recorded flow being ~ 0.6 m3/s;

2.1.2 2020 Flow Monitoring Season

The 2020 flow monitoring season commenced on 3/27/2020 and over the six month period there were several events that produced measurable results. The initial data collection occurred on 7/21/2020. The flow gauges were operational until 9/30/2020.

Figure 2 Flow Monitoring Stations

2.2 Observed Rainfall Data

The precipitation data required for the analysis was collected for every five-minute duration for the period corresponding to the flow data from a local private weather station:

https://www.wunderground.com/weather/ca/collingwood/44.50,-80.21.

2.2.1 2019 Monitoring Season

Ten rainfall events were recorded during the time the flow monitors were installed in 2019. The significant events were recorded at the end of the season when two of the flow monitors had to be removed prior to these events. **Table 2** provides a summary of the events.

Table 2 2019 Monitored Events

Event	Precipitation (mm)
6/28/2019	5.84
7/16/2019	7.37
7/28/2019	11.8
9/03/2019	14.73
9/13/2019	8.64
9/26/2019	9.4
10/27/2019	19.51
10/31-11/1/2019	40.94
11/27/2019	29.21
12/08/2019	20.83

The data available for the time period from 21-June 2019 to 18-Sep 2019 was adopted to complete the model calibration. The data for the time period 18-Sep 2019 to 17-Dec 2019 was used for the model validation period.

2.2.2 2020 Monitoring Season

The 2020 season has contained more larger events than the previous year. Eight events had a rainfall volume greater than 20 mm with four events greater than 30 mm which were deemed significant. The 06/23/2020 event can be considered a 10 year event over the greatest 6 hours. **Table 3** summarizes the events.

Table 3 2020 Monitored Events

Event	Precipitation (mm)
3/29/2020	41.7
4/30/2020	23.4
5/24/2020	24.6
6/10/2020	31.0
6/23/2020	62.2
7/10/2020	32.3
7/16/2020	28.2
7/19/2020	20.3

The monitoring and rainfall data are provided in **Attachment 1**.

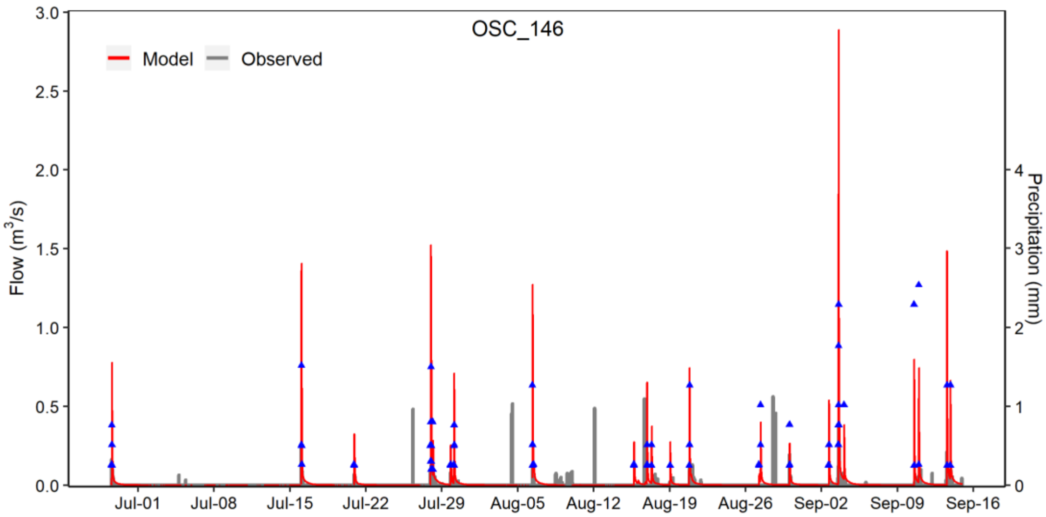
3 MODEL CALIBRATION PROCESS

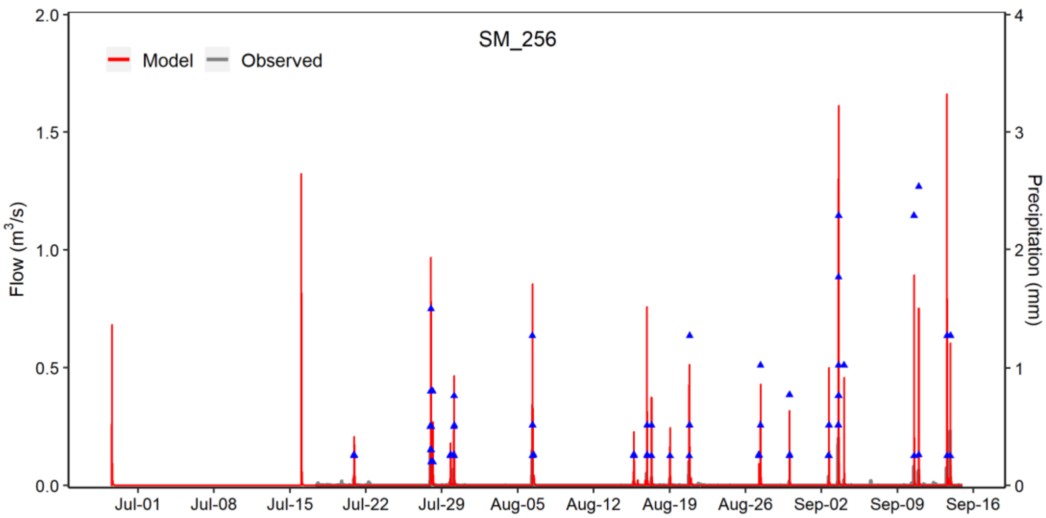
The urban centre model calibration process followed several steps. Once the main sewer infrastructure, overland flow system, SWM ponds, and individual drainage catchments were set up in PCSWMM, the calibration process followed these steps which included:

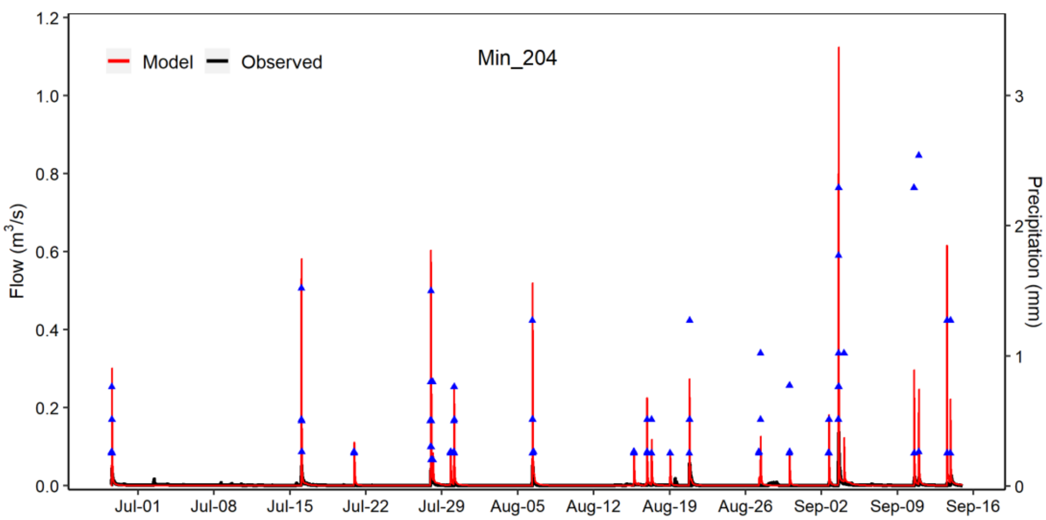
- Set default parameters from PCSWMM as the starting point in each catchment;
- Adjust the parameters based on land use and soil conditions to reflect the standard ranges in the Town Standards and NVCA guidelines;
- Isolate the individual events during the monitoring period and develop the actual rain storm information for input;
- Adjust the key parameters that affect the timing of flows;
- Adjust the key parameters that affect the volume of runoff and the peak flow response;
- Test the consistency of the parameter adjustments with other events;
- Review the range of sensitivity that the model can be adjusted and compare with the peak, timing and volume responses at the flow gauges. Determine whether there are other factors not being accounted for in the model that may be seasonal inputs (ie; groundwater influence);
- Document the results.

3.1 Default Model Parameters

The PCSWMM model was first simulated using typical default parameters. These parameters have been established by calibrated models previously developed through Ontario and documented in the provincial and conservation authority manuals. **Figure 4** presents the time-series plots during the calibration period at various monitoring stations.


OSC_146
Model
Observed
Flow (m³/s)
Precipitation (mm)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
4
3
2
1
0
Jul-01
Jul-08
Jul-15
Jul-22
Jul-29
Aug-05
Aug-12
Aug-19
Aug-26
Sep-02
Sep-09
Sep-16


SM_256
Model
Observed
Flow (m³/s)
Precipitation (mm)
2.0
1.5
1.0
0.5
0.0
4
3
2
1
0
Jul-01
Jul-08
Jul-15
Jul-22
Jul-29
Aug-05
Aug-12
Aug-19
Aug-26
Sep-02
Sep-09
Sep-16


Min_204
Model
Observed
Flow (m³/s)
Precipitation (mm)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3
2
1
0
Jul-01
Jul-08
Jul-15
Jul-22
Jul-29
Aug-05
Aug-12
Aug-19
Aug-26
Sep-02
Sep-09
Sep-16

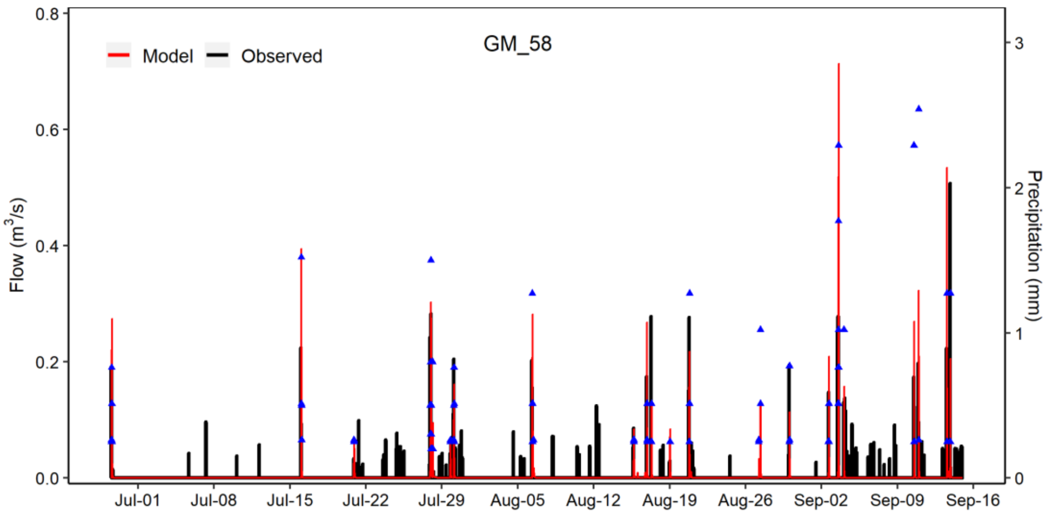


Figure 3 Comparison of Observed / Simulated Flows – Default Parameters

The following observations can be made from these plots comparing the observed and simulated flows for the model setup with default parameters:

- Simulated peak flows are higher than the observed peaks;
- Model is responding to rainfall events, while some of the observed peaks (say on 07-July, 26-July, 04-Aug, 12-Aug, 28-Aug etc.) do not correspond to any rainfall event;
- Timing of the simulated peaks accurately reflects the observed timing;
- Recorded flows are very low at all the monitoring stations; and,
- A very low range baseflow is recorded in St. Marie Street and Minnesota Street monitoring stations.

In order to build an acceptable model that mimics the watershed hydrology, further calibration of model parameters was carried out. Since the purpose of model is to simulate the conditions to be expected during a flooding scenario, the parameters would not be adjusted to replicate the extreme low flows being measured at the gauges. During the calibration process, the parameters affecting the peak flow would only be tweaked for the larger recorded events, in order to adjust the peak response of the catchment, both in terms of quantity and timing.

4 2019 MODEL VALIDATION PROCESS

In order to improve the model performance for simulating peak flows during the larger recorded events, some of the model parameters were adjusted using the slide controls in PCSWMM. Several parameters were adjusted to determine which ones were sensitive to change. A sensitivity analysis was completed on these parameters. In the default model run the simulated peak flows were found to be higher than the observed flows while the timing of peaks was accurately representing measured results. Therefore, the parameters that were sensitive to runoff volume and peak flow were adjusted. These modifications were tested to simulate a reduction in peak modelled flows.

The model calibration was attempted in various stages. After modifying parameters at each stage, the observed flow was compared with the simulated flow. Results corresponding to default and final parameter sets are presented in this document. **Table 5** presents the PCSWMM parameters that are calibrated and their corresponding default and adjusted values.

Table 4 Model parameters

Parameter	Parameter definition	Default Value	2019 Value
CN	Curve Number	80	Varies (Avg. = 77.8%)
L/W	Length to width Ratio	2	4
TIMP	% impervious area	Varies (Avg. = 57%)	Varies (Avg. = 49%)
% Routed	% impervious area	0%	60%
MID	Medium Intensity Development	50%	35%
AMC	Antecedent moisture condition	2.0	1.5
DryTime	Drying time	7 days	3 days

4.1 Continuous versus Event Based Model Calibration

The model was attempted to be calibrated using the continuous simulation mode. There are limitations to this method with the CN method being applied for soil moisture conditions. The PCSWMM software does not adjust the CN value continuously through the calibration period but attempts to maintaining the soil moisture accounting with the initial abstraction Ia parameter. The parameter is tracked and adjusted based on the drying time after a rainfall event. The Ia parameter is not as sensitive as the CN parameter or the TIMP previously discussed.

There is a tendency to start to overestimate peak flows when running the CN method in continuous mode. Therefore, a series of individual storm events were simulated and compared with the same event within a continuous model run. The model is therefore, independently simulated for two peak flow events during July 2019. The event based model simulation results are compared with the results from the continuous simulation, as presented in **Figure 5**. The plots indicate that the event-based runs generate lower peaks than the continuous simulation runs. The possible reason for this difference could be because of the way the initial abstraction is accounted for in the model.

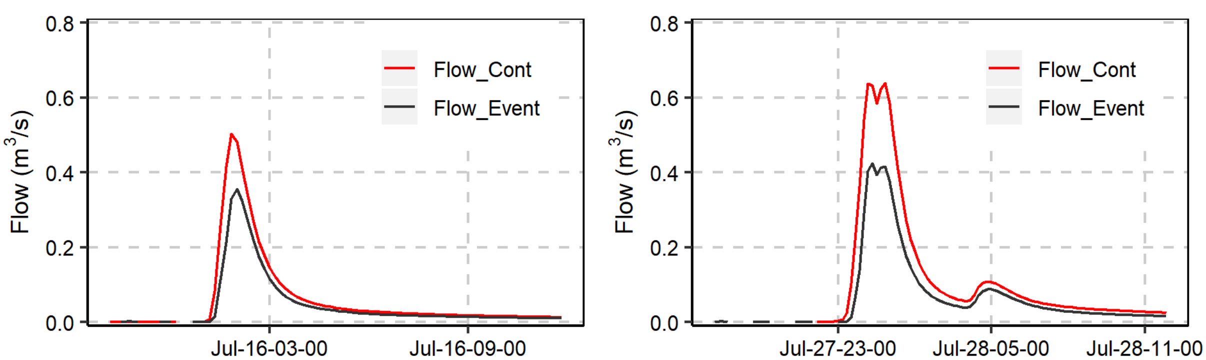


Figure 4 Effect of Continuous Vs Event-Based Simulation

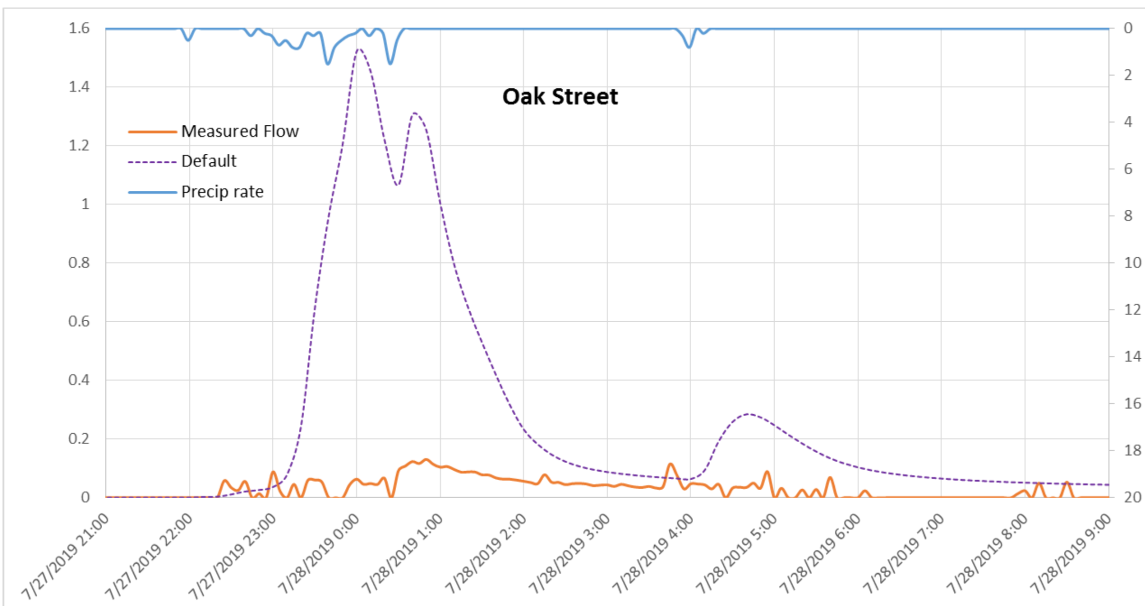
The recommendation was made to determine the urban centre model calibration using only individual events and not to run the models in continuous mode.

4.2 Initial Model Calibration Adjustments

The initial model calibration adjustments were completed with a series of small rainfall events that occurred between 06/28/2019 and 09/13/2019. These events had rainfall volumes that ranged from 5.85 mm to 14.73 mm. All comparisons are provided in **Attachment 2**.

4.2.1 Oak Street Gauge

Figure 6 and **Figure** 7 show the comparison of modelled and measured flow conditions with the default parameters and the adjusted parameters for the two larger events during the 2019 calibration period.



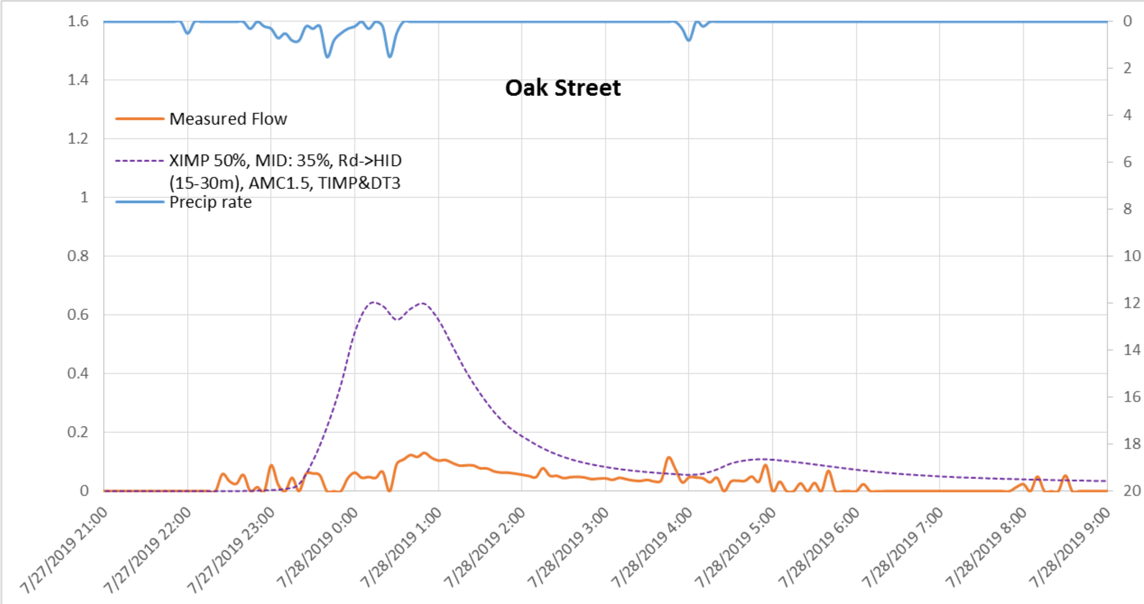
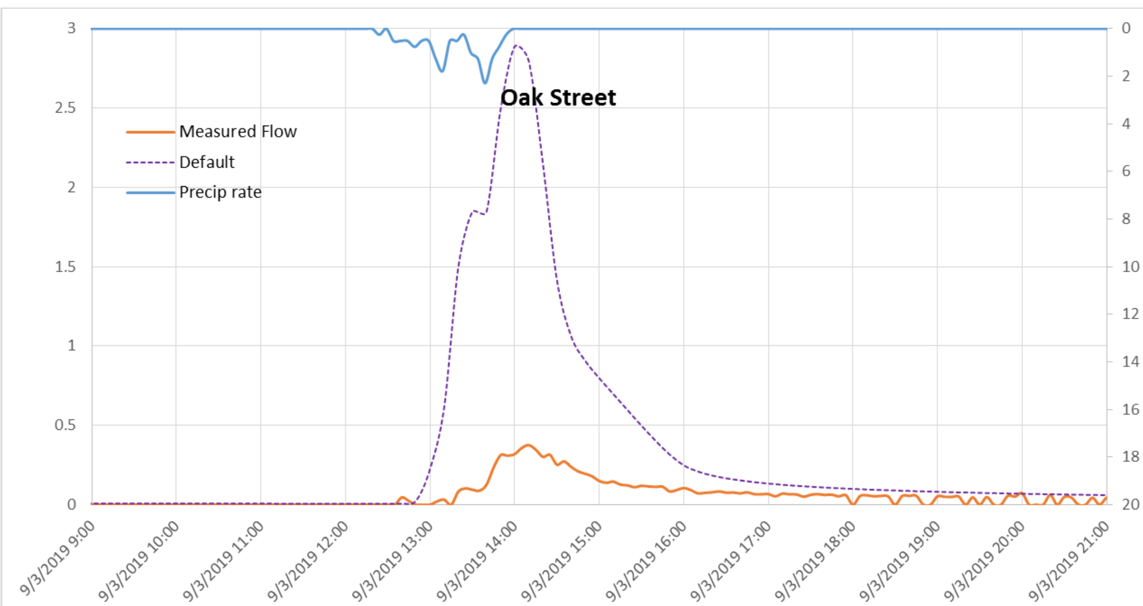


Figure 5 July 28, 2019 Event

The key observation is that the model adjustments show a response by representing the peak after the heavy rain occurs. The timing of this response was also screened with the smaller events. The model does predict more volume than occurs during the summer event. This required additional events to understand the physical processes that were impacting the results.



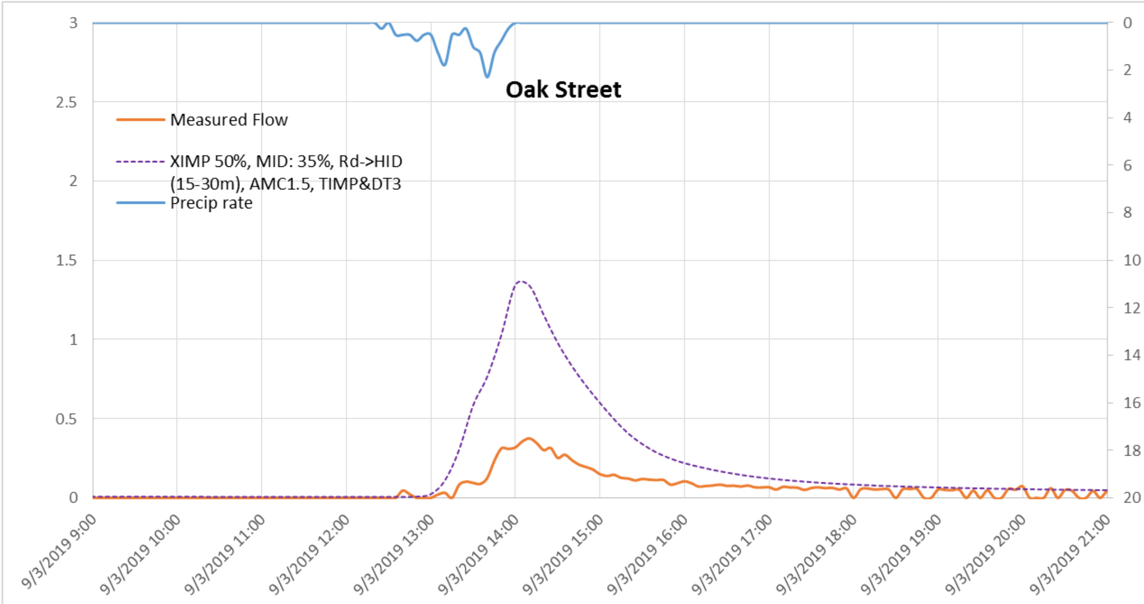
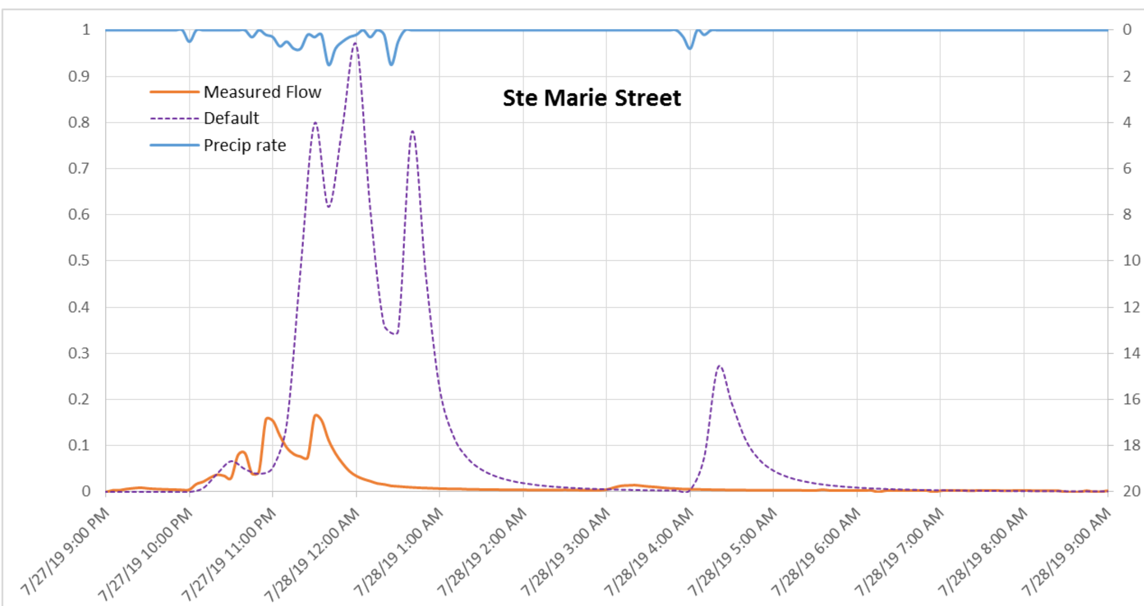


Figure 6 Sep 03, 2019 Event

4.2.2 Ste Marie Street

Figure 8 and **Figure 9** show the comparison of modelled and measured flow conditions with the default parameters and the adjusted parameters for the two larger events during the 2019 calibration period.



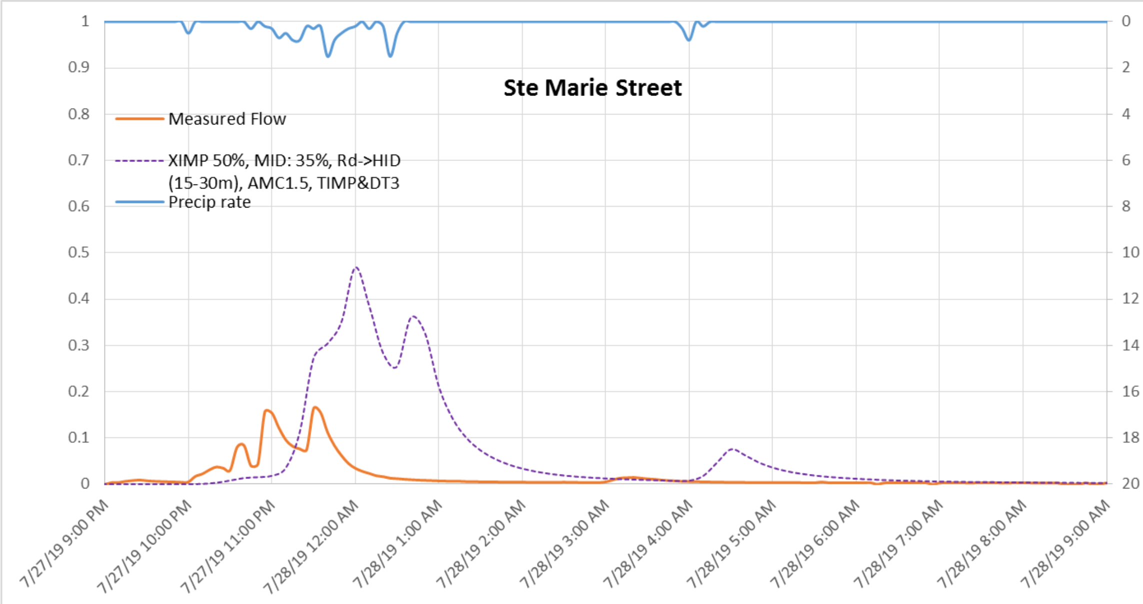
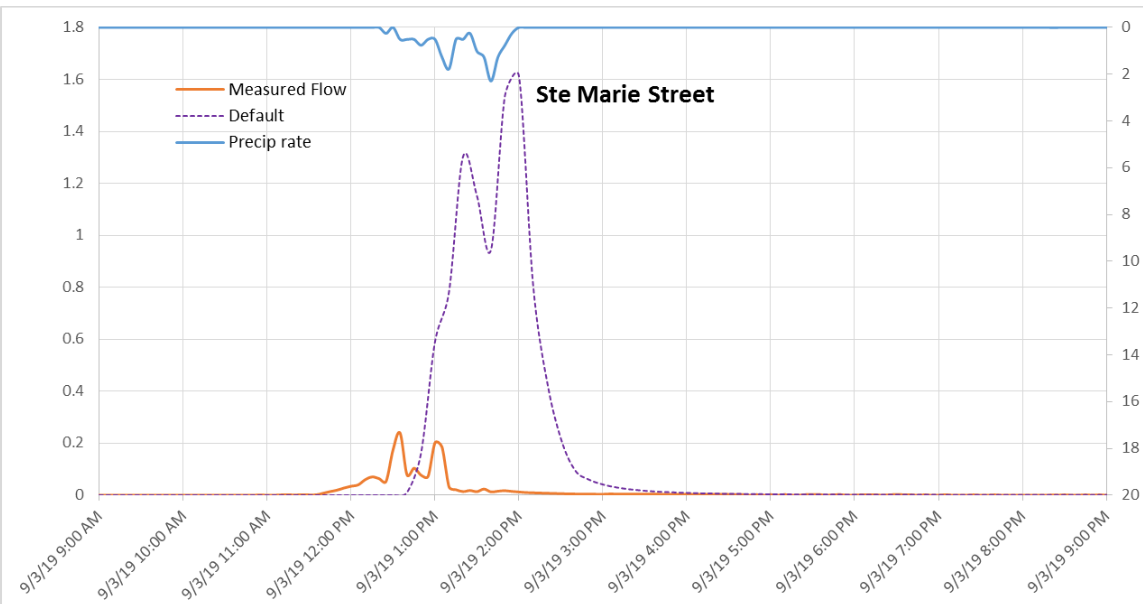


Figure 7 July 28, 2019 Event



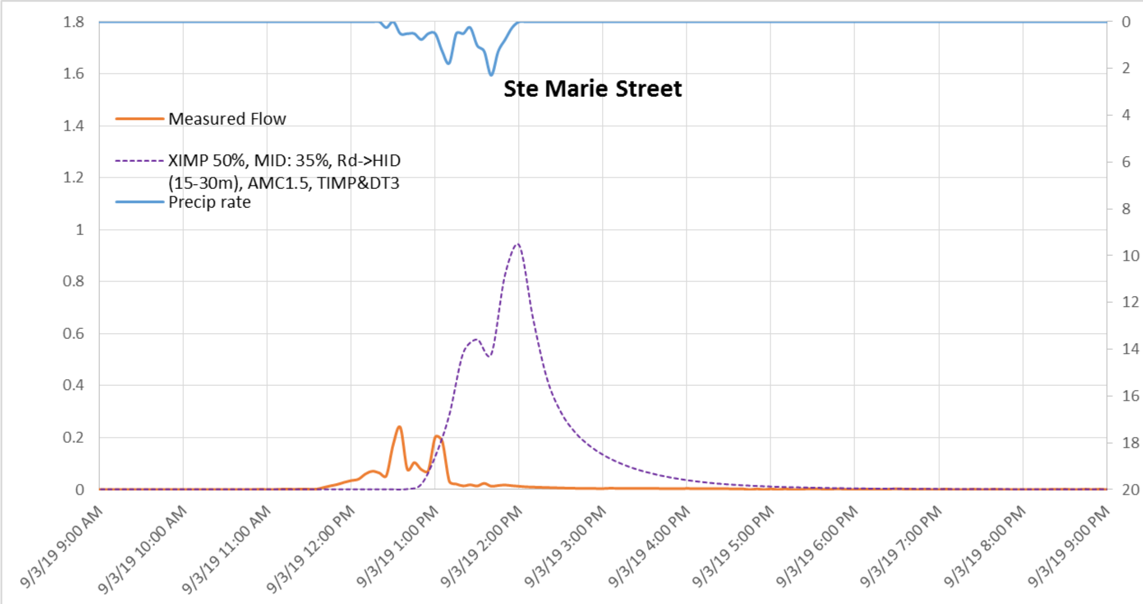
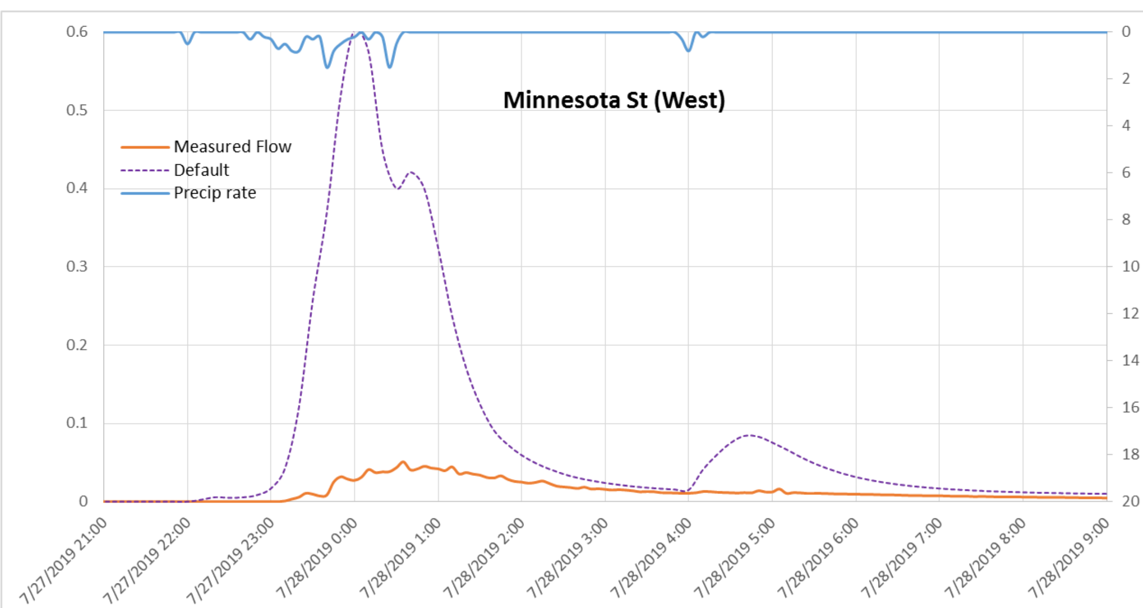


Figure 8 Sep 03, 2019 Event

Similar to the Oak Street gauge, there is additional volume being generated by the model. This required additional events to understand the physical processes that were impacting the results.

4.2.3 Minnesota Street (West)

Figure 10 and **Figure 11** show the comparison of modelled and measured flow conditions with the default parameters and the adjusted parameters for the two larger events during the 2019 calibration period.



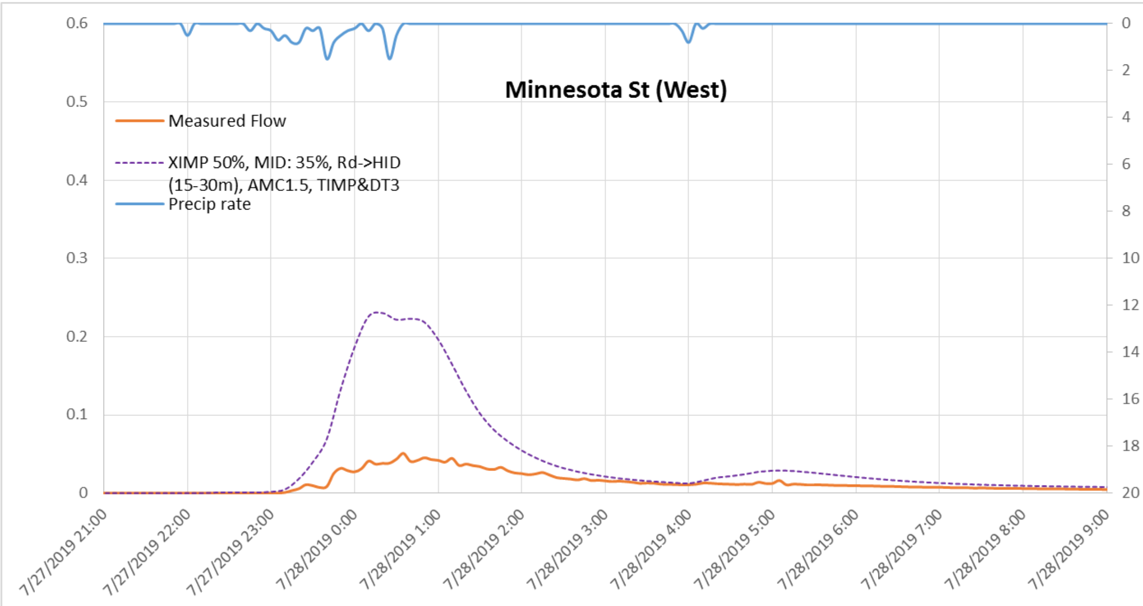
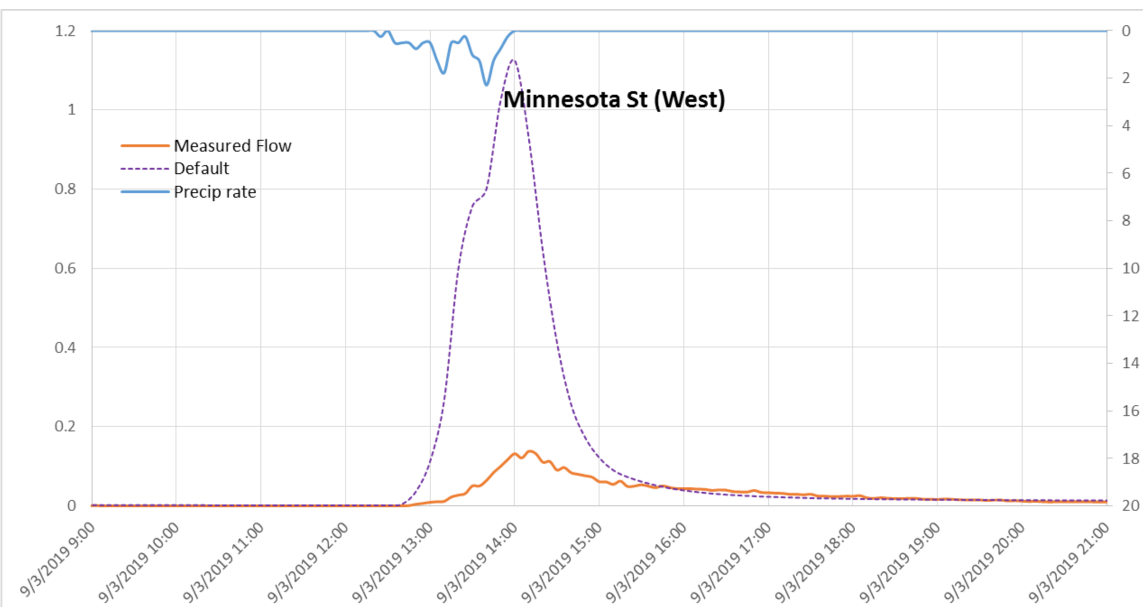


Figure 9 July 28, 2019 Event



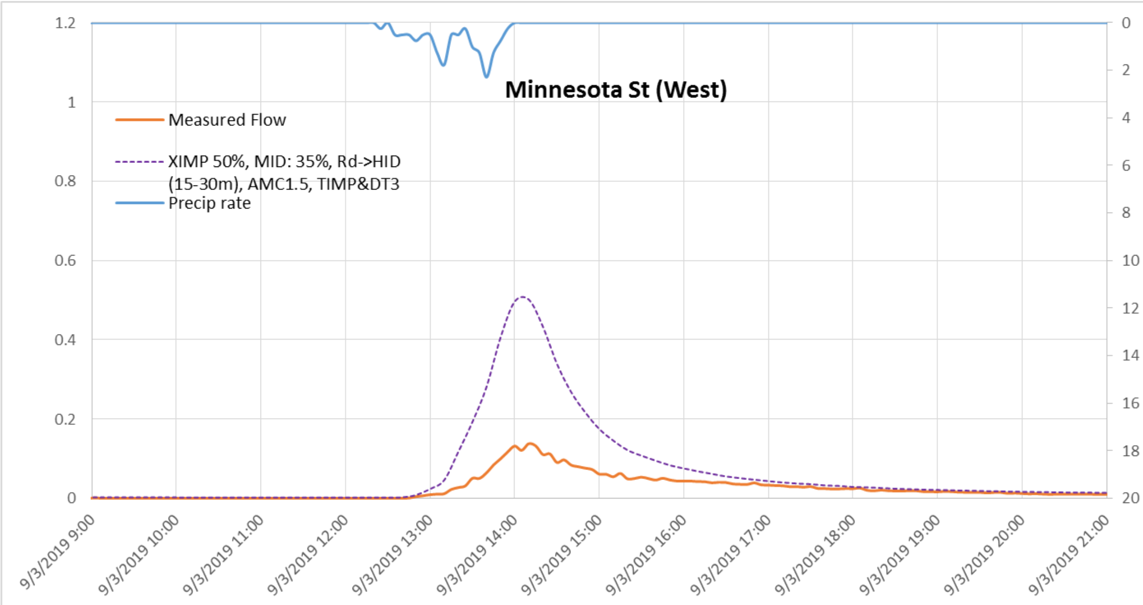
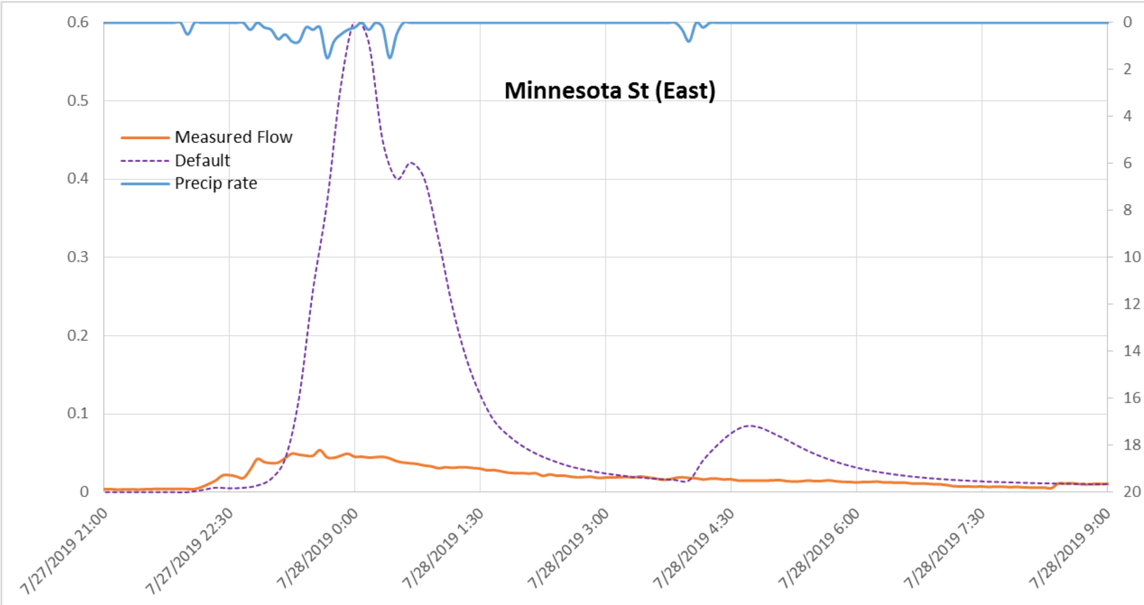


Figure 10 Sep 03, 2019 Event

Similar to the Oak Street gauge, there is additional volume being generated by the model. This required additional events to understand the physical processes that were impacting the results.

4.2.4 Minnesota Street (East)

Figure 12 and **Figure 13** show the comparison of modelled and measured flow conditions with the default parameters and the adjusted parameters for the two larger events during the 2019 calibration period.



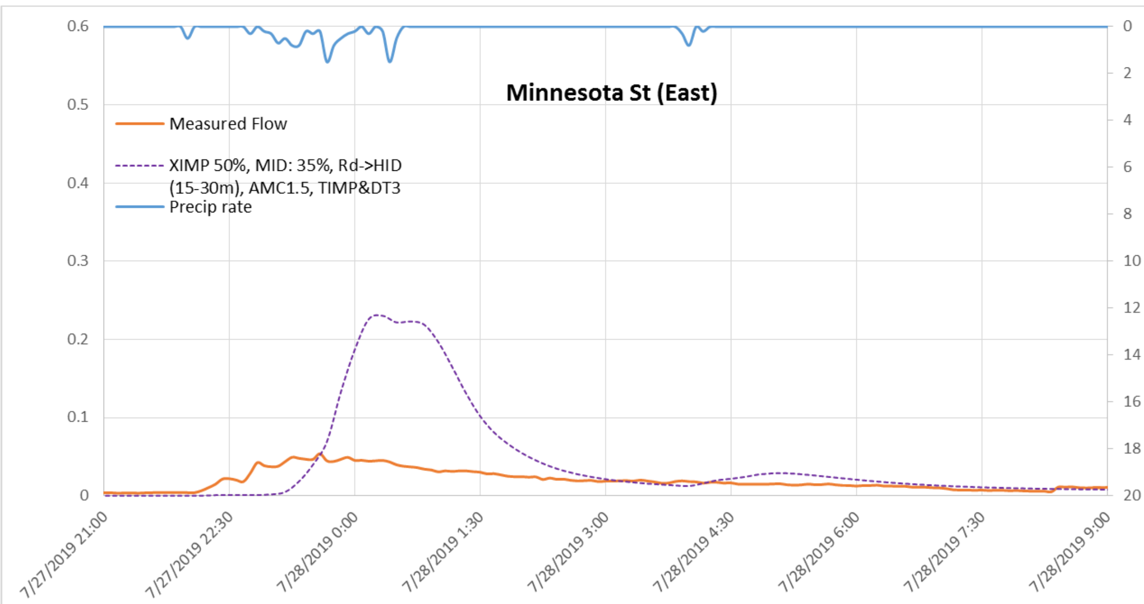
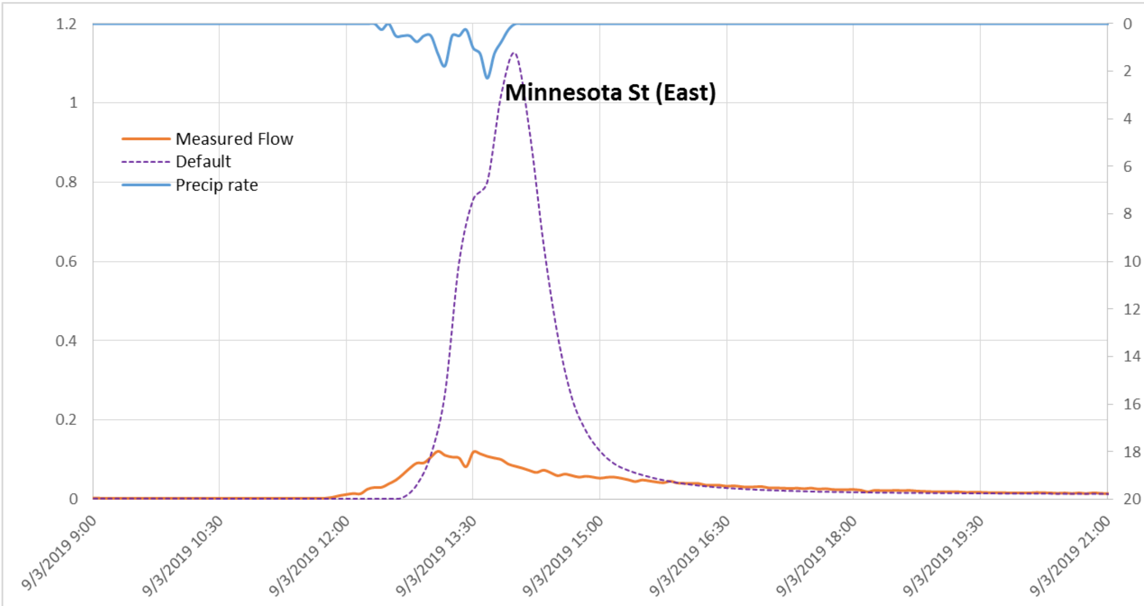


Figure 11 July 28, 2019 Event



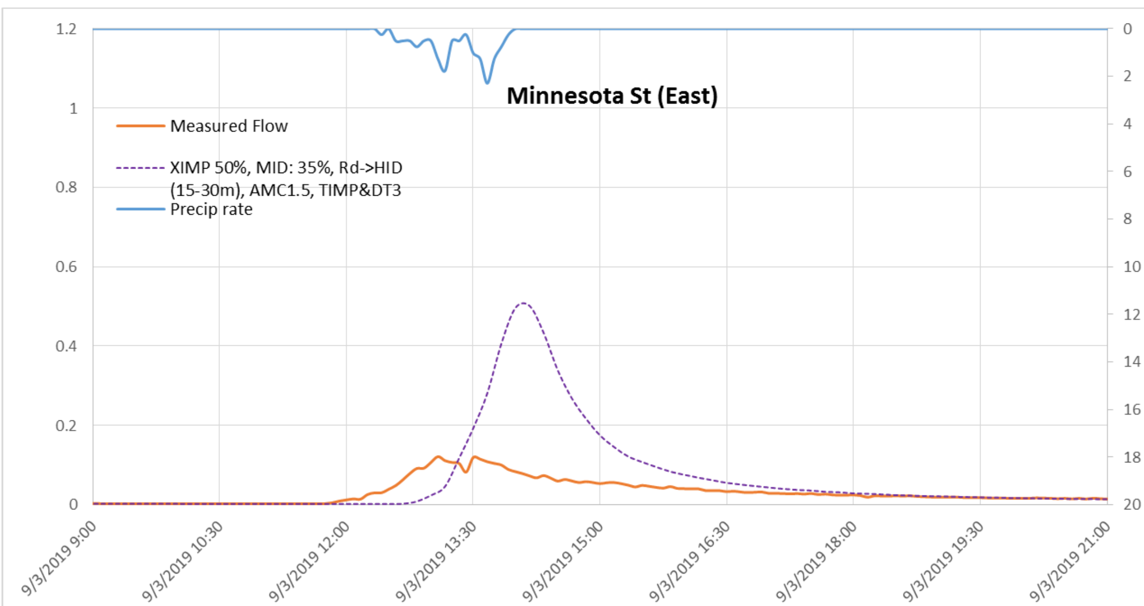
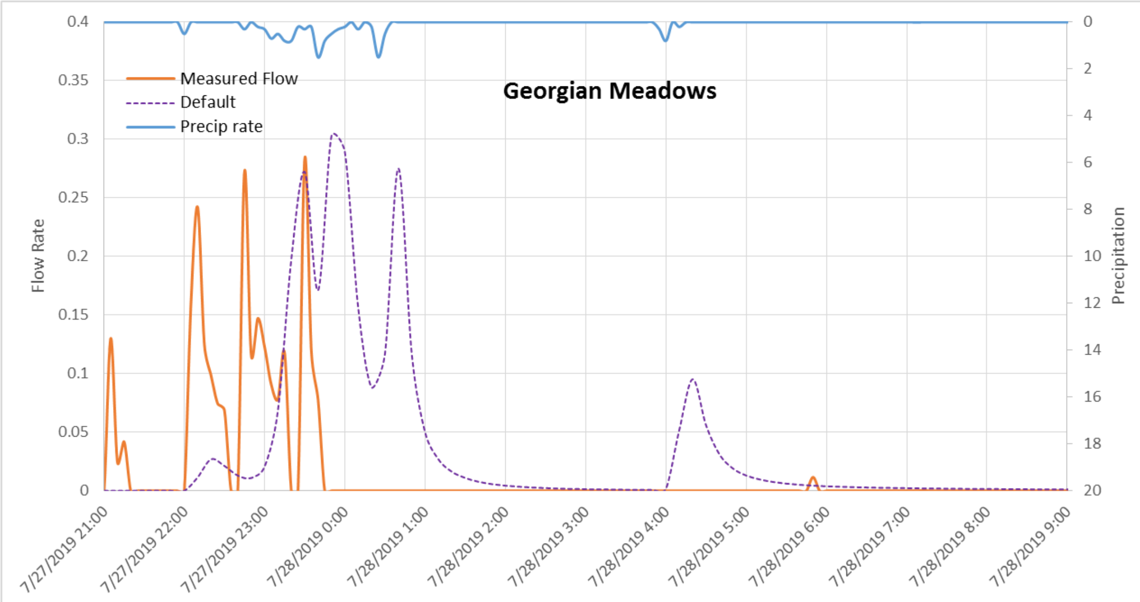


Figure 12 Sep 03, 2019 Event

Similar to the Oak Street gauge, there is additional volume being generated by the model. This required additional events to understand the physical processes that were impacting the results.

4.2.5 Georgian Meadows

Figure 14 and **Figure 15** show the comparison of modelled and measured flow conditions with the default parameters and the adjusted parameters for the two larger events during the 2019 calibration period.



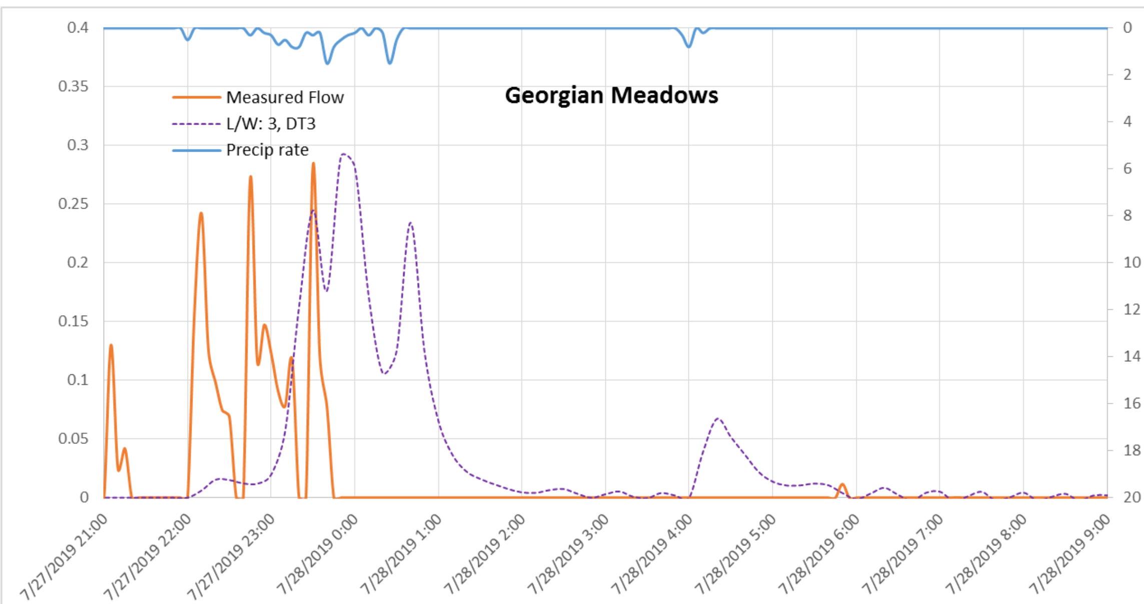
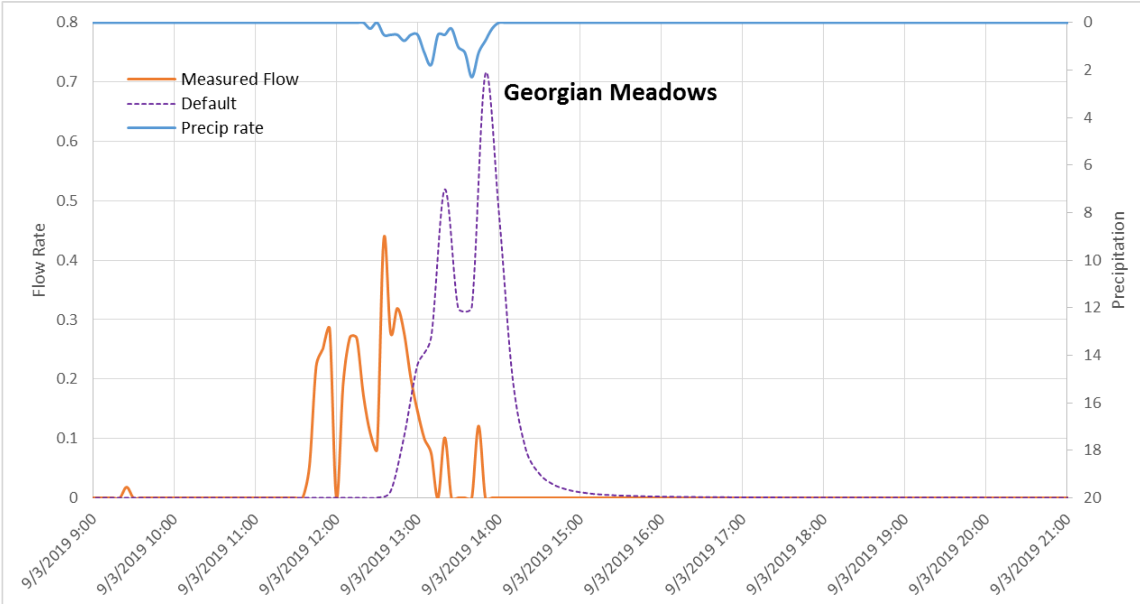


Figure 13 July 28, 2019 Event



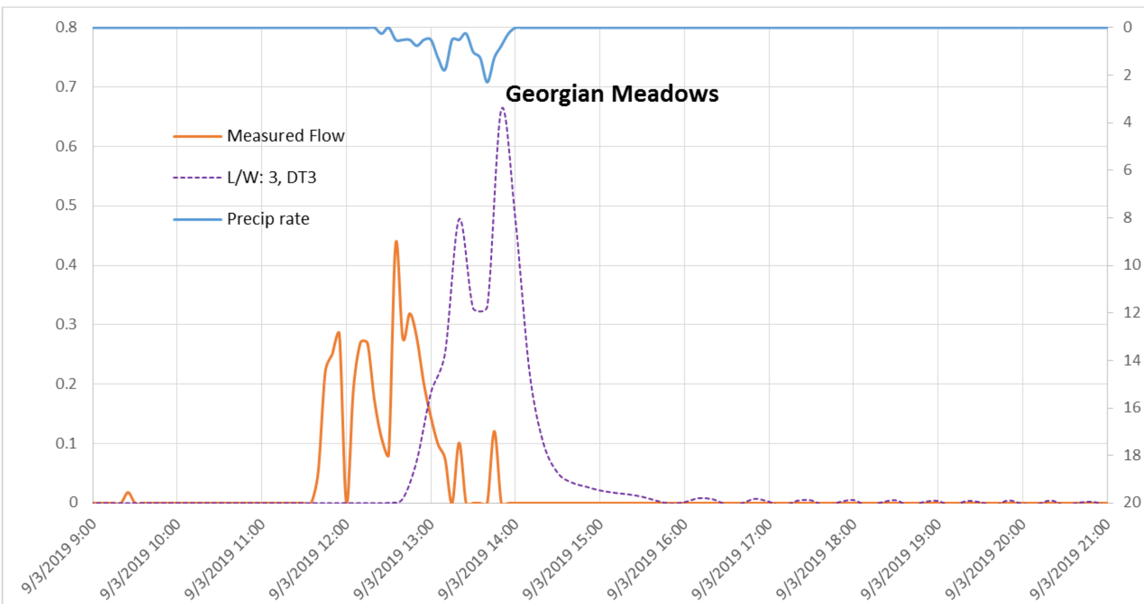


Figure 14 Sep 03, 2019 Event

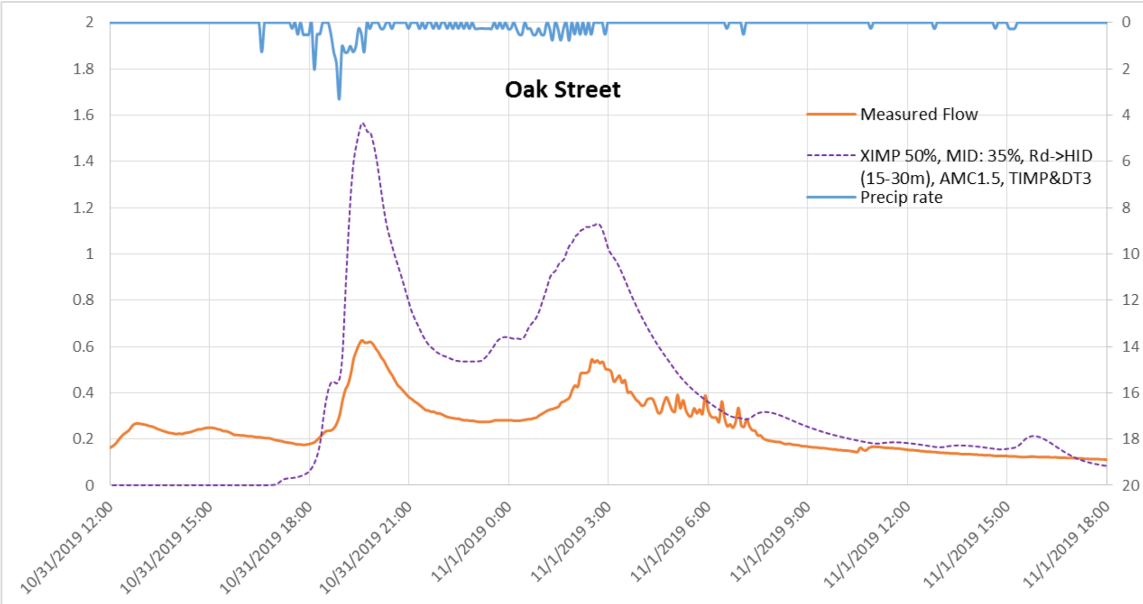
There seemed to be a shift in the response between the model and the information collected at the flow monitor. This may be attributed to an error in the start date/time in the gauge during installation.

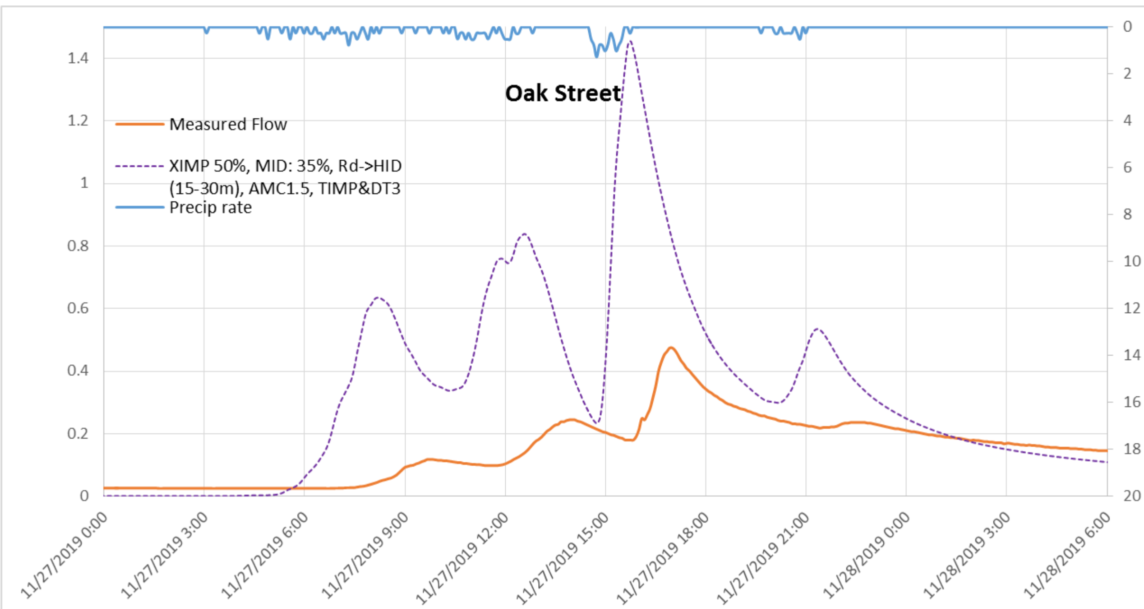
4.3 Initial Validation Process

The three monitors that were still operational for the late 2019 season had three events that were more significant. However, the storm events are characterized by low intense rainfall spread over several hours. The initial calibration model was run for these events and compared with flows at the gauge locations.

4.3.1 Oak Street

Figure 16 shows the three main events recorded during the 2019 validation period.


Oak Street
Measured Flow
XIMP 50%, MID: 35%, Rd->HID (15-30m), AMC1.5, TIMP&DT3
Precip rate
10/31/2019 12:00
10/31/2019 15:00
10/31/2019 18:00
10/31/2019 21:00
11/1/2019 0:00
11/1/2019 3:00
11/1/2019 6:00
11/1/2019 9:00
11/1/2019 12:00
11/1/2019 15:00
11/1/2019 18:00


Oak Street
Measured Flow
XIMP 50%, MID: 35%, Rd->HID (15-30m), AMC1.5, TIMP&DT3
Precip rate
11/27/2019 0:00
11/27/2019 3:00
11/27/2019 6:00
11/27/2019 9:00
11/27/2019 12:00
11/27/2019 15:00
11/27/2019 18:00
11/27/2019 21:00
11/28/2019 0:00
11/28/2019 3:00
11/28/2019 6:00

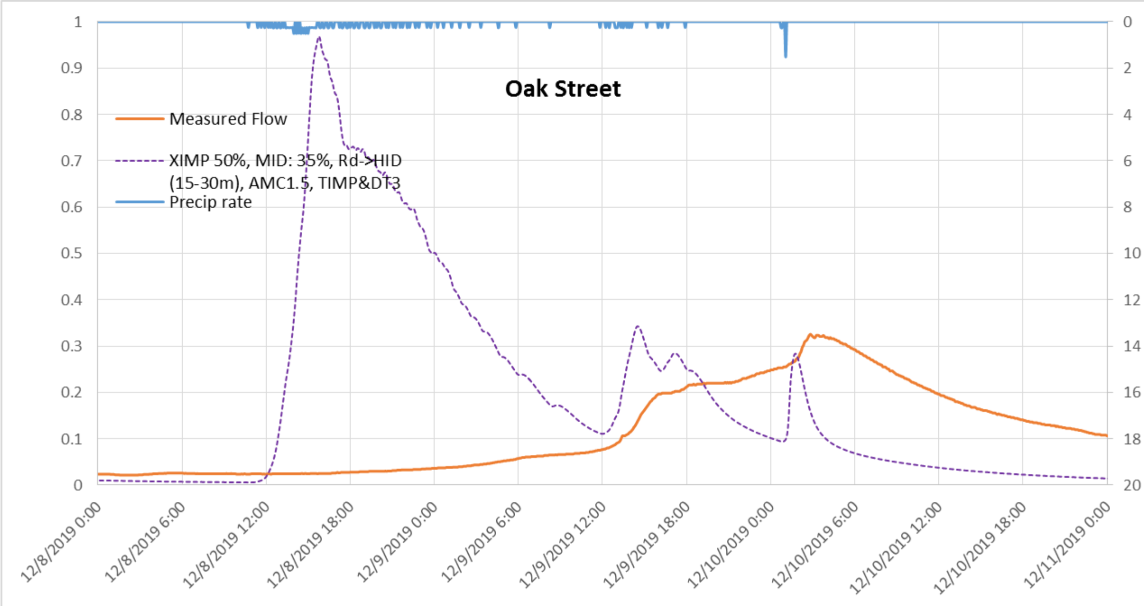
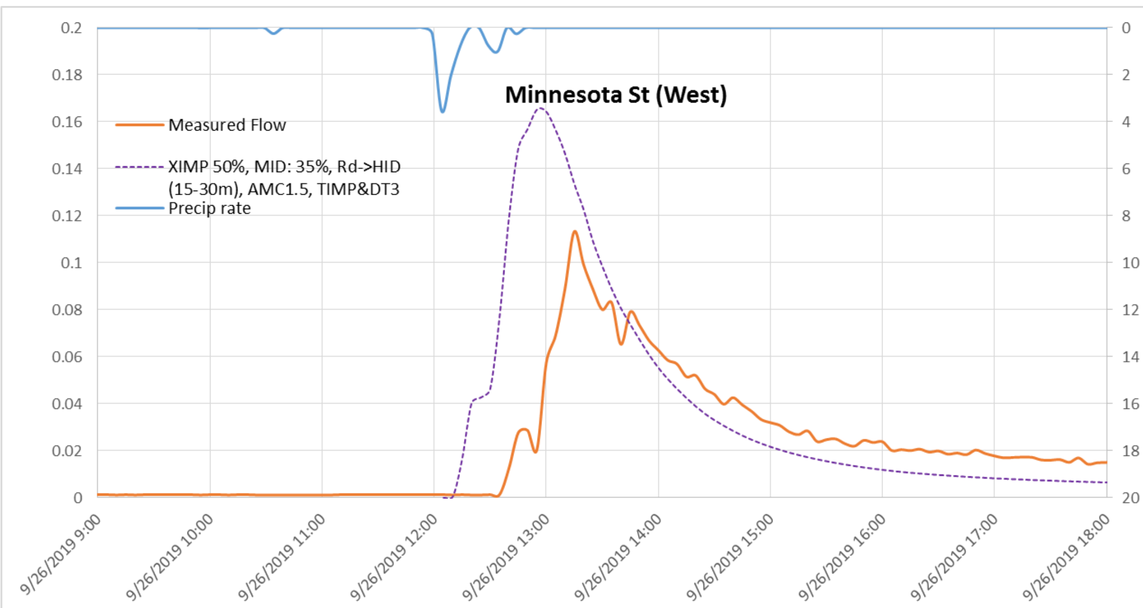
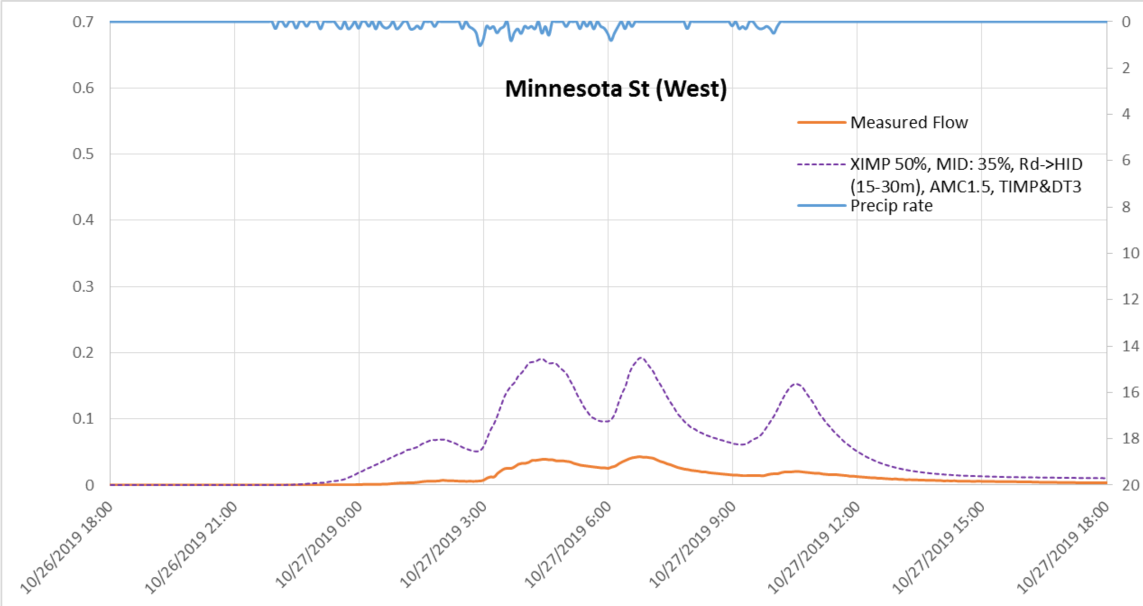


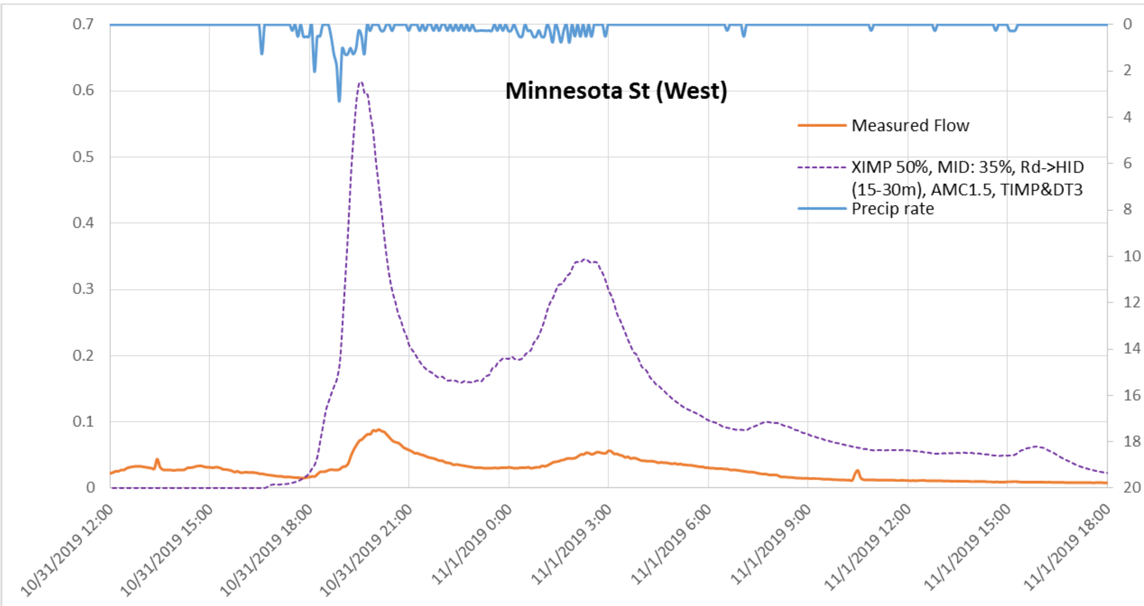
Figure 15 Three Fall 2019 Validation Events

4.3.2 Minnesota Street (West)

Figure 17 shows all five events recorded during the 2019 validation period.




Minnesota St (West)
Measured Flow
XIMP 50%, MID: 35%, Rd->HID (15-30m), AMC1.5, TIMP&DT3
Precip rate
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
14
16
18
20
10/26/2019 18:00
10/26/2019 21:00
10/27/2019 0:00
10/27/2019 3:00
10/27/2019 6:00
10/27/2019 9:00
10/27/2019 12:00
10/27/2019 15:00
10/27/2019 18:00


Minnesota St (West)
Measured Flow
XIMP 50%, MID: 35%, Rd->HID (15-30m), AMC1.5, TIMP&DT3
Precip rate
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
14
16
18
20
10/31/2019 12:00
10/31/2019 15:00
10/31/2019 18:00
10/31/2019 21:00
11/1/2019 0:00
11/1/2019 3:00
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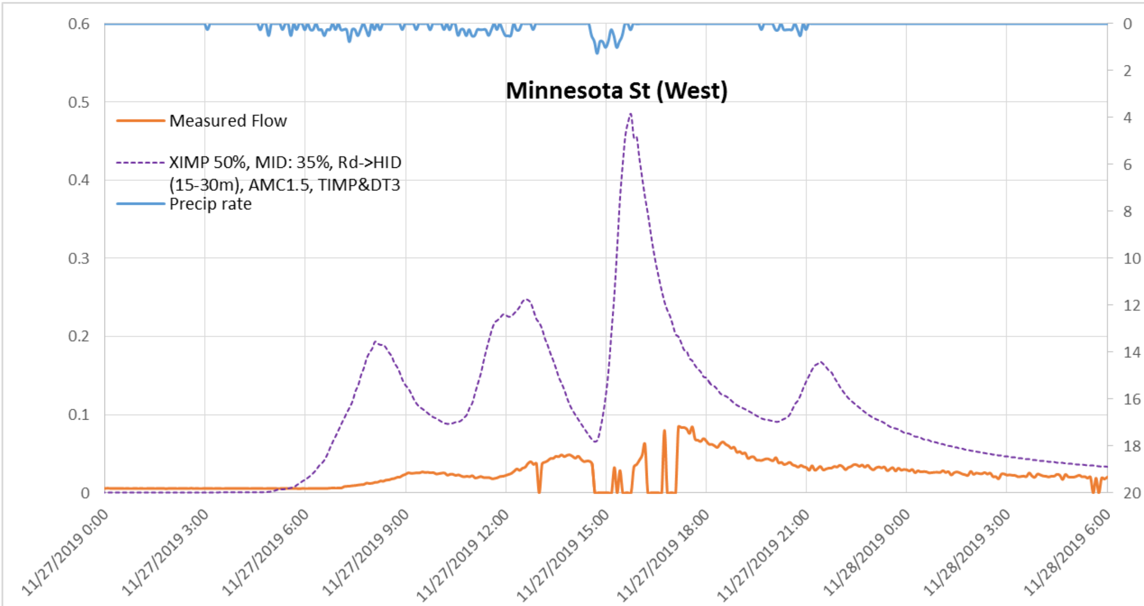
11/1/2019 15:00
11/1/2019 18:00



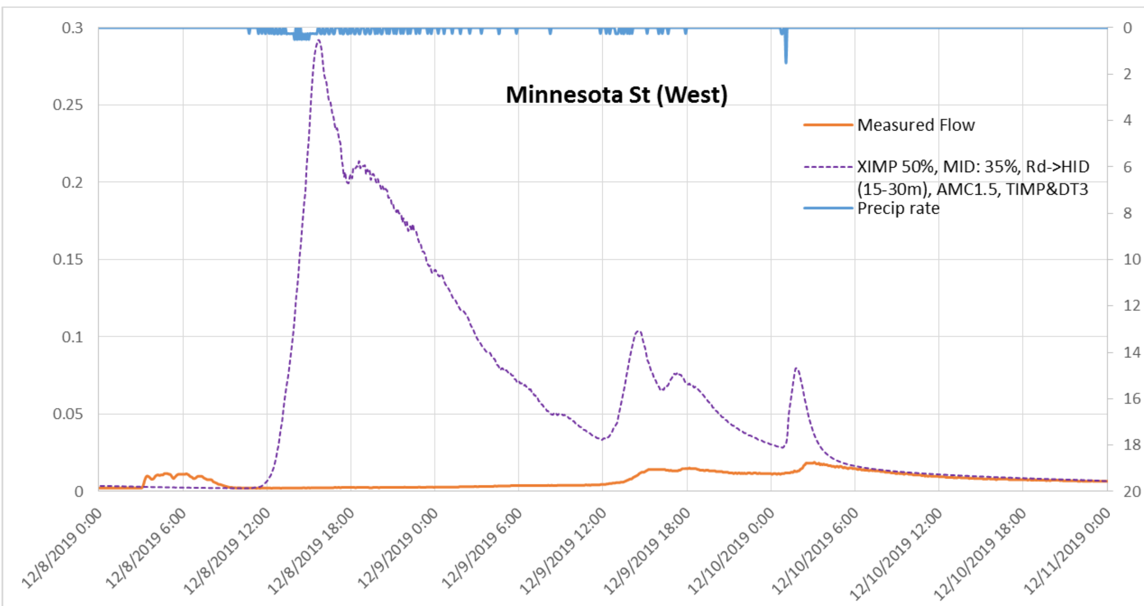
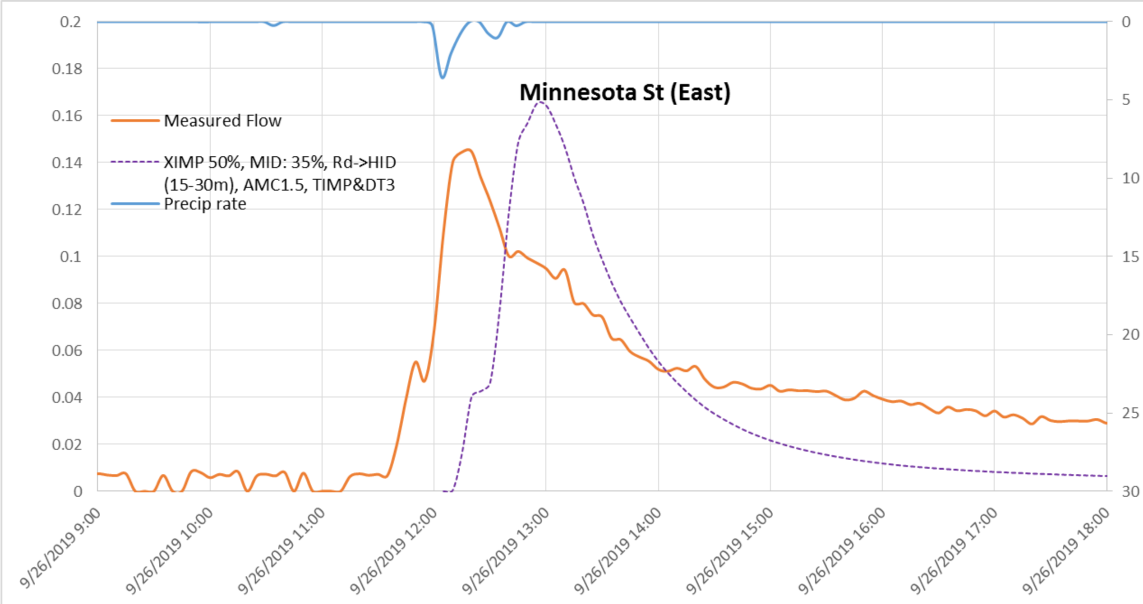


Figure 16 Five Fall 2019 Validation Events

The model as calibrated with the 2019 data generates higher peaks and runoff volumes than recorded.

4.3.3 Minnesota Street (East)

Figure 18 shows all five events recorded during the 2019 validation period.


Minnesota St (East)
Measured Flow
XIMP 50%, MID: 35%, Rd->HID (15-30m), AMC1.5, TIMP&DT3
Precip rate
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
5
10
15
20
25
30
9/26/2019 9:00
9/26/2019 10:00
9/26/2019 11:00
9/26/2019 12:00
9/26/2019 13:00
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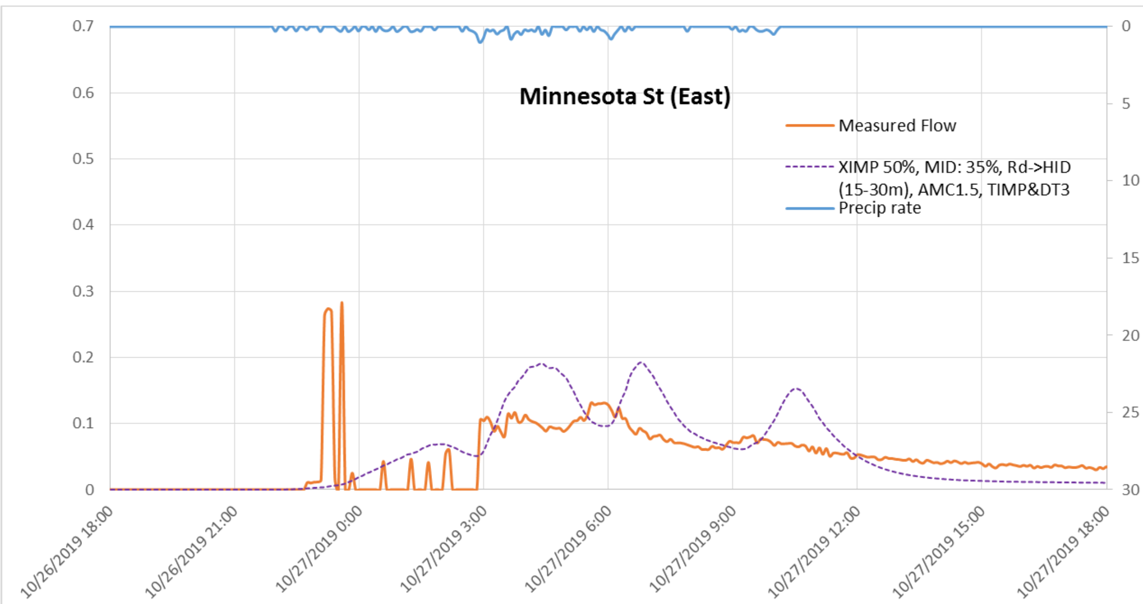
9/26/2019 15:00
9/26/2019 16:00
9/26/2019 17:00
9/26/2019 18:00


Minnesota St (East)
Measured Flow
XIMP 50%, MID: 35%, Rd->HID (15-30m), AMC1.5, TIMP&DT3
Precip rate
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
30
10/26/2019 18:00
10/26/2019 21:00
10/27/2019 0:00
10/27/2019 3:00
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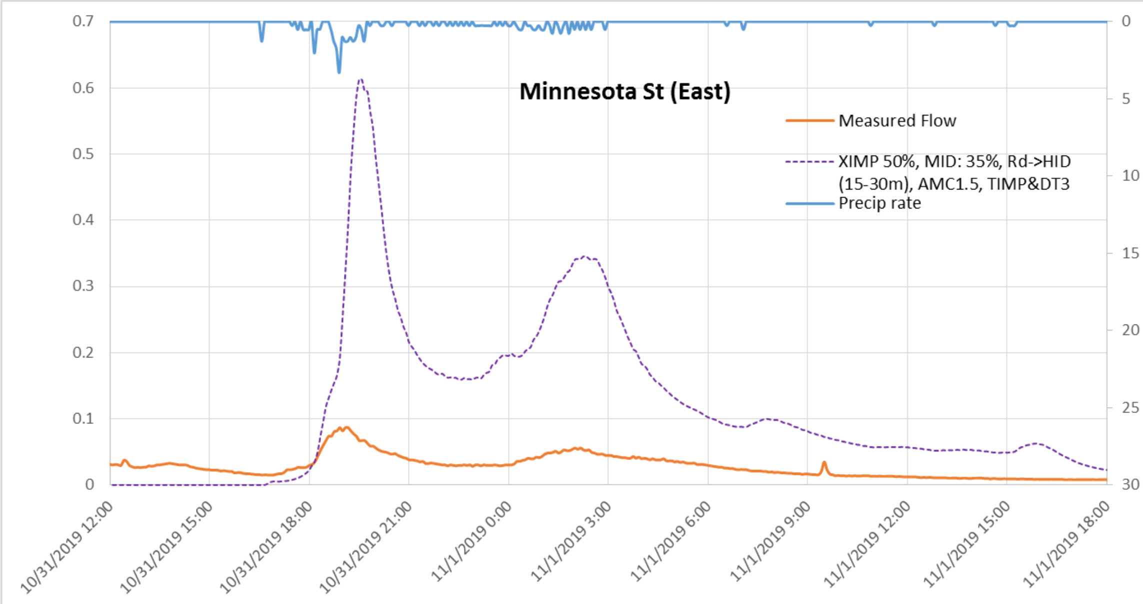
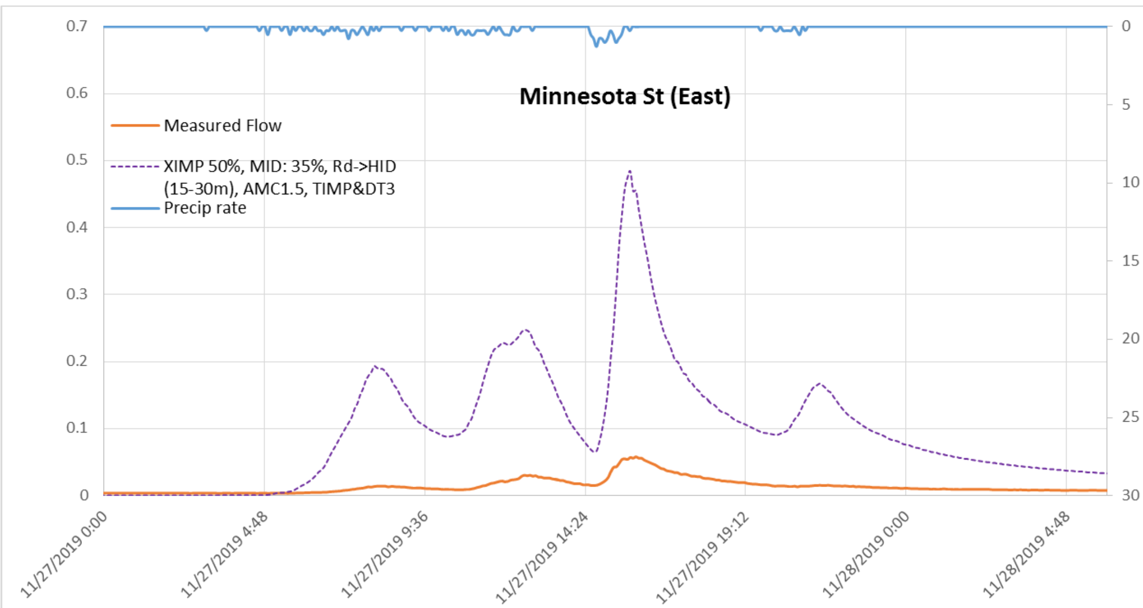
10/27/2019 9:00
10/27/2019 12:00
10/27/2019 15:00
10/27/2019 18:00


Minnesota St (East)
Measured Flow
XIMP 50%, MID: 35%, Rd->HID (15-30m), AMC1.5, TIMP&DT3
Precip rate
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
30
10/31/2019 12:00
10/31/2019 15:00
10/31/2019 18:00
10/31/2019 21:00
11/1/2019 0:00
11/1/2019 3:00
11/1/2019 6:00
11/1/2019 9:00
11/1/2019 12:00
11/1/2019 15:00
11/1/2019 18:00


Minnesota St (East)
Measured Flow
XIMP 50%, MID: 35%, Rd->HID (15-30m), AMC1.5, TIMP&DT3
Precip rate
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
30
11/27/2019 0:00
11/27/2019 4:48
11/27/2019 9:36
11/27/2019 14:24
11/27/2019 19:12
11/28/2019 0:00
11/28/2019 4:48

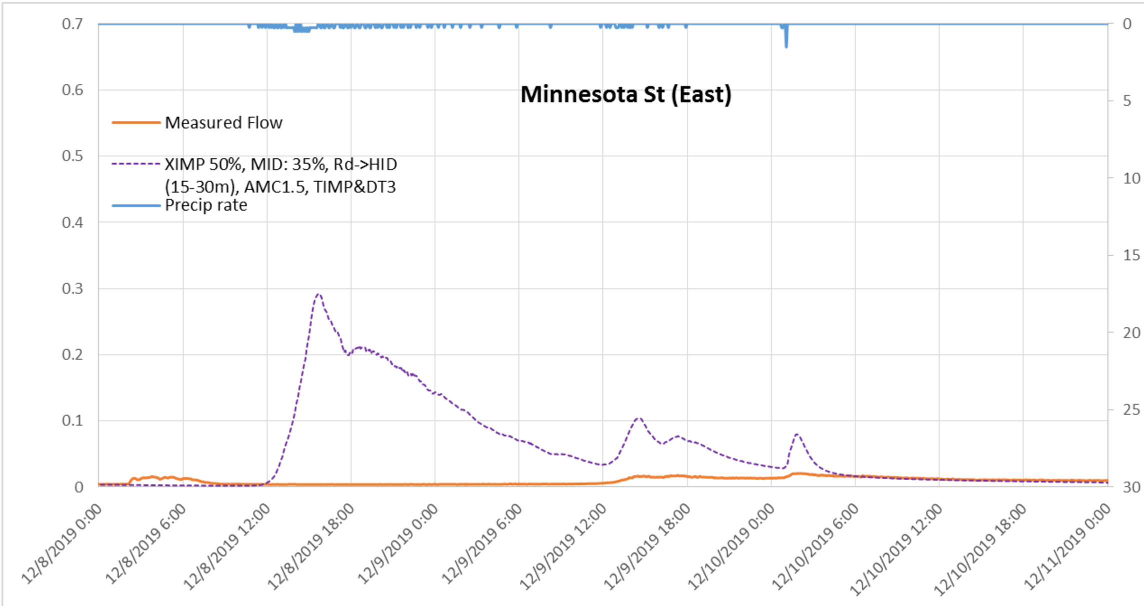


Figure 17 Five Fall 2019 Validation Events

The model as calibrated with the 2019 data generates higher peaks and runoff volumes than recorded. It was determined upon review that additional monitoring would be required to determine whether other physical processes were involved in the determination of flows. These gauge locations monitor significant areas where there are ditch systems or disjointed sewer networks constructed from old driveway culvert systems that may either cause flows to be added or leave through the groundwater table.

The second observation is that for shorter more intense storms, the modelled and monitored results are more comparable. The additional monitoring would hopefully collect some more significant storm events to further qualify this phenomenon.

5 2020 MODEL VALIDATION PROCESS

The urban centre model validation process in 2020 involved running the calibrated model from 2019 with the new storm events and compare with the flow conditions at the gauge locations (**Section 5.1**). This resulted in a further adjustment of the key parameters and the isolation of other physical processes that are occurring in some of the older neighbourhoods (**Section 5.2**). Examples of the comparisons are shown in the report. All model events are provided in **Attachment 3.**

5.1 Model Results

The following section outlines the comparison of modelled and monitored results using the 2020 data with the 2019 calibrated model. In most cases the timing of the response has been simulated, however depending on the location and event, the modelled peak is overestimated using the model parameters from the 2019 calibration attempt. This phenomenon was more pronounced in older neighbourhoods and with the larger mid-summer storm events.

5.1.1 Apr 30, 2020

This event occurred during seasonal high water table as indicated with base flow conditions and sump pump activity. **Figure 19** to **Figure 23** show the comparison of the modelled conditions with the measured conditions using the parameters calibrated with the 2019 data.

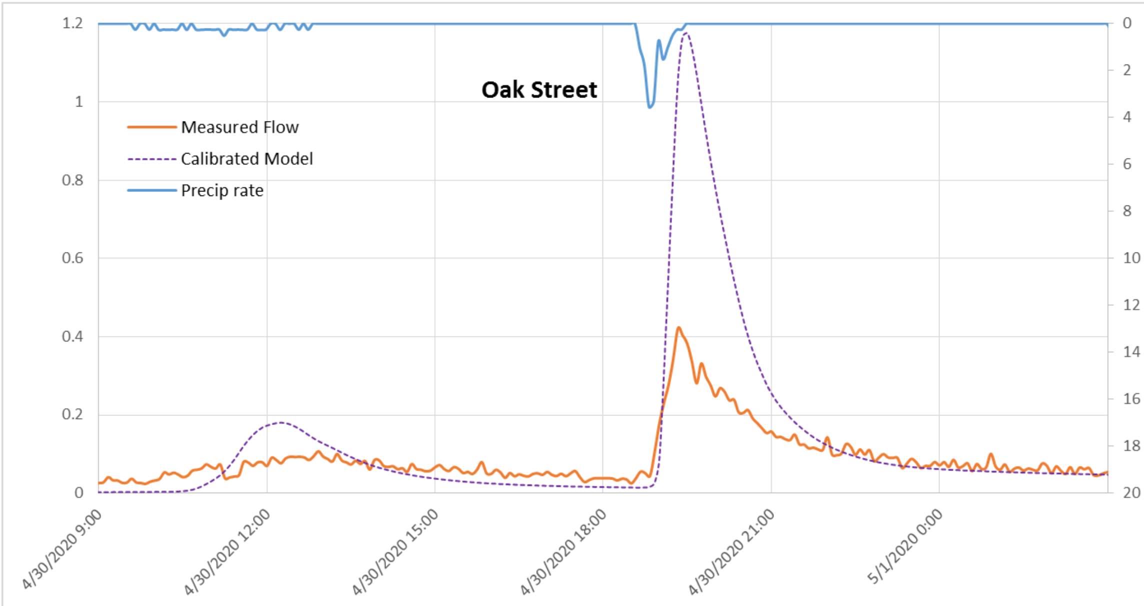


Figure 18 Oak Street (Site 1)

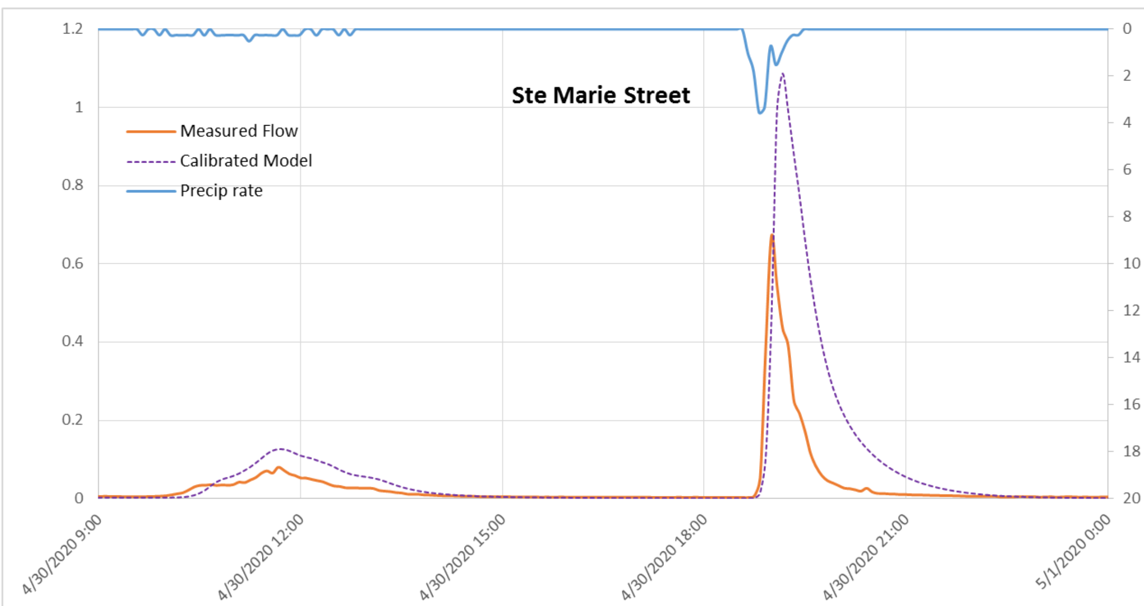


Figure 19 Ste Marie Street (Site 2)

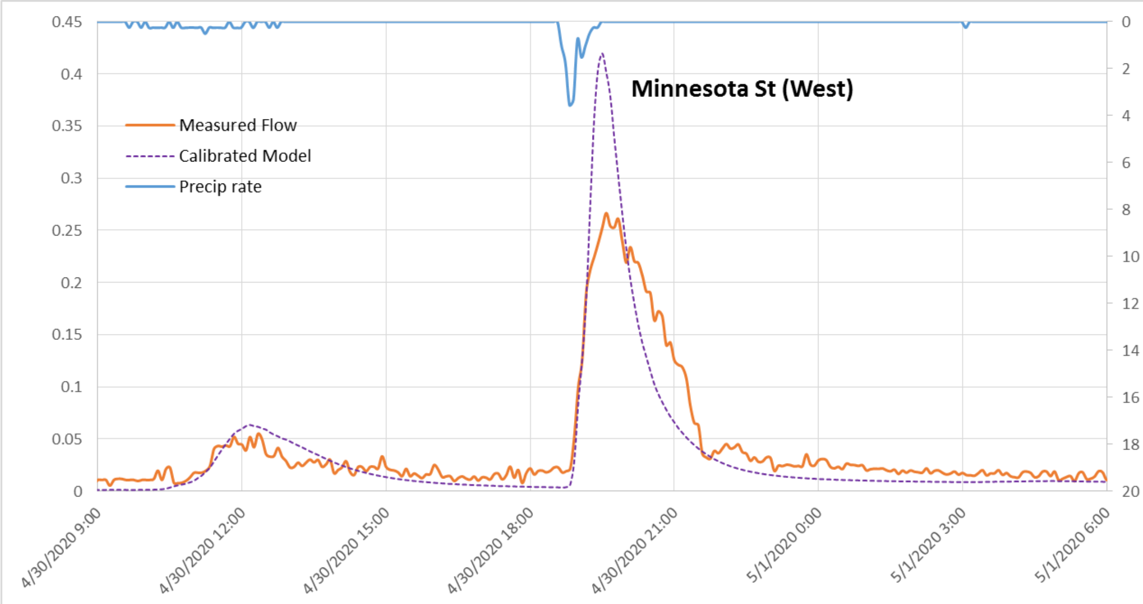


Figure 20 Minnesota Street West (Site 3 West)

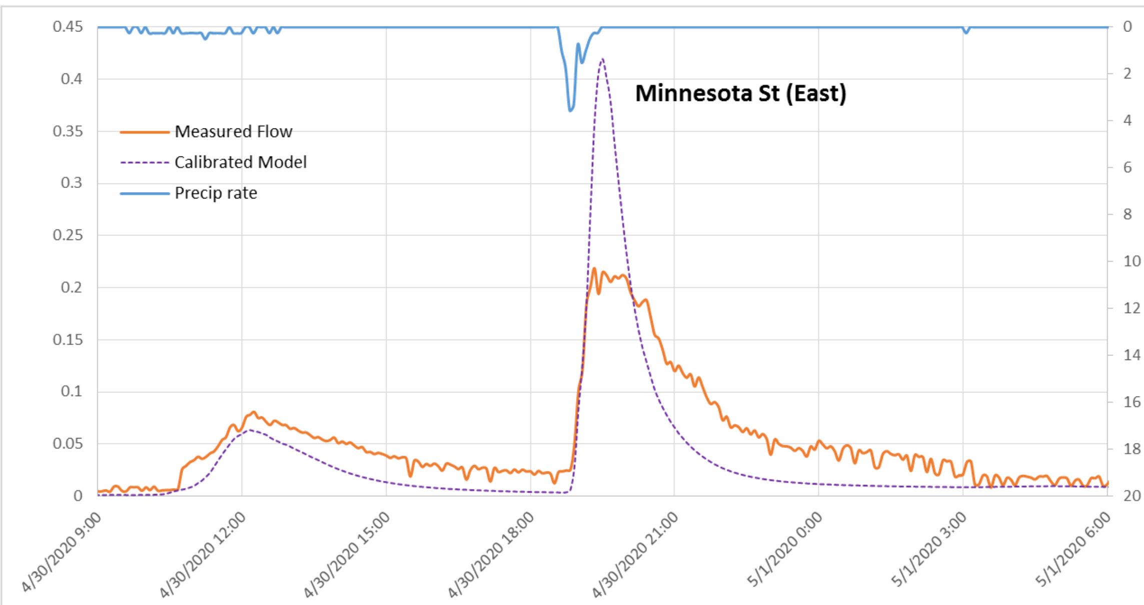


Figure 21 Minnesota Street East (Site 3 East)

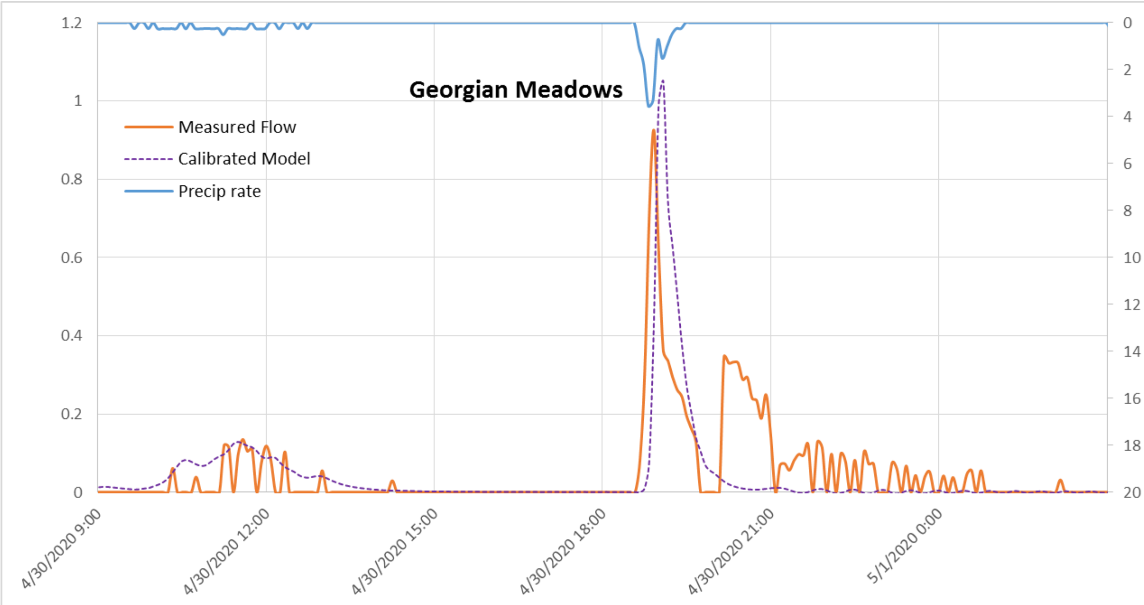


Figure 22 Georgian Meadows (Site 4)

5.1.2 Jun 10, 2020

The June 10, 2020 rainfall event consisted in two significant pulses within a three hour period comprising 43.2 mm in total volume for the event. The soil conditions were dryer representing early summer conditions. **Figure 24** to **Figure 27** show examples of the modelled and measured conditions.

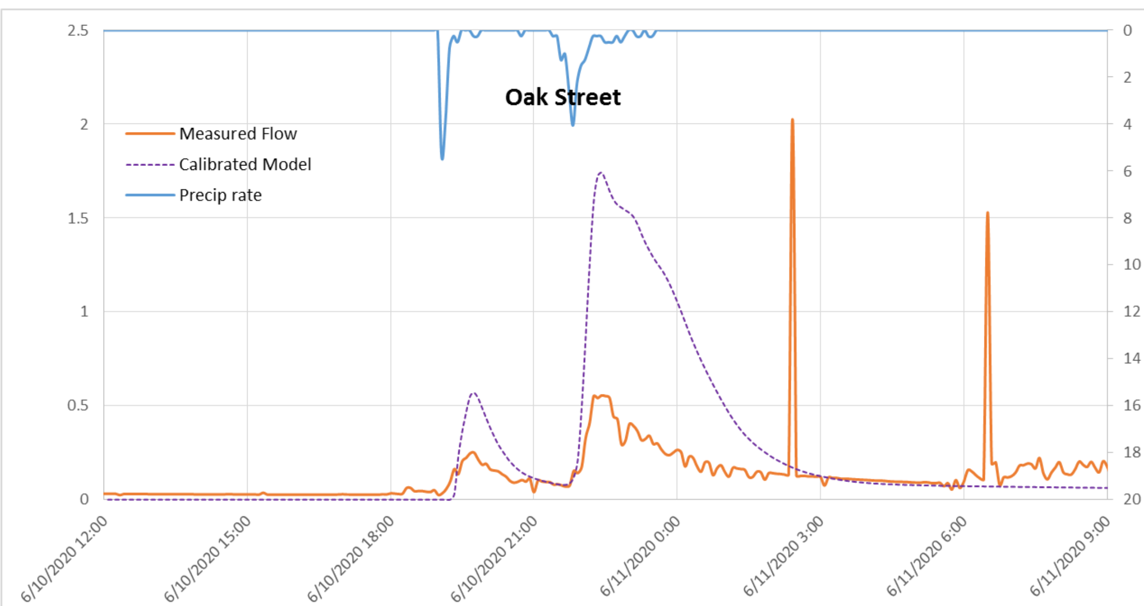


Figure 23 Oak Street (Site 1)

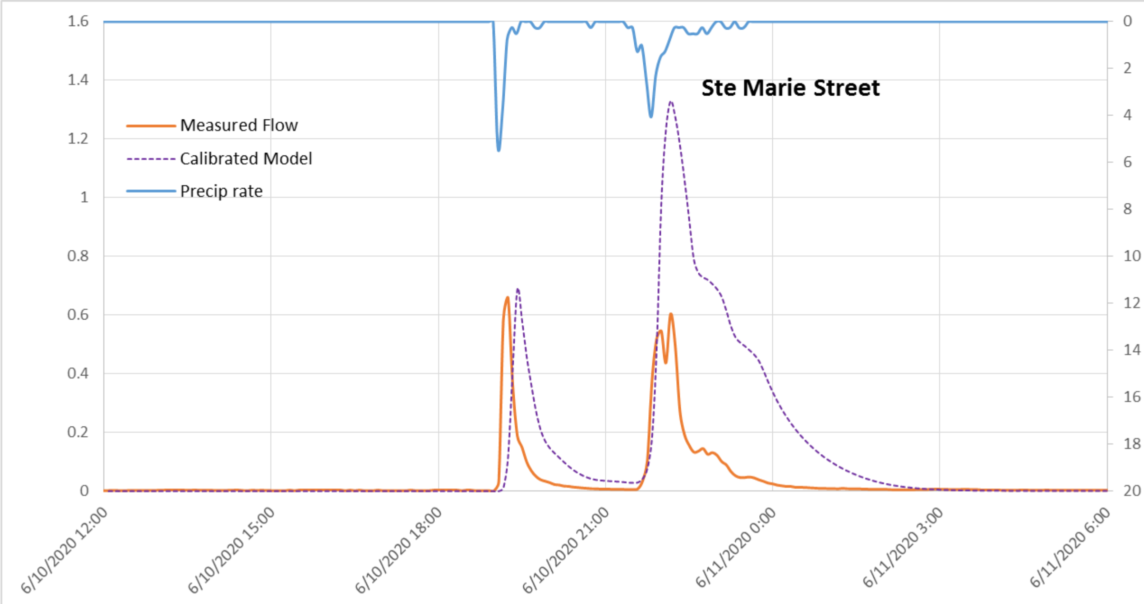


Figure 24 Ste Marie Street (Site 2)

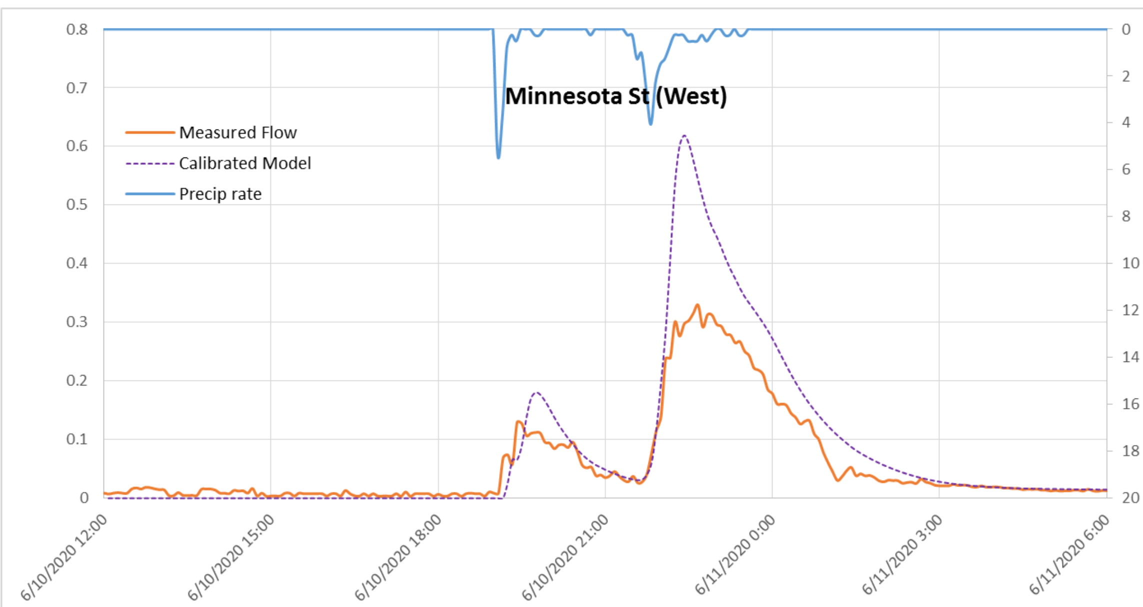


Figure 25 Minnesota Street West (Site 3 West)

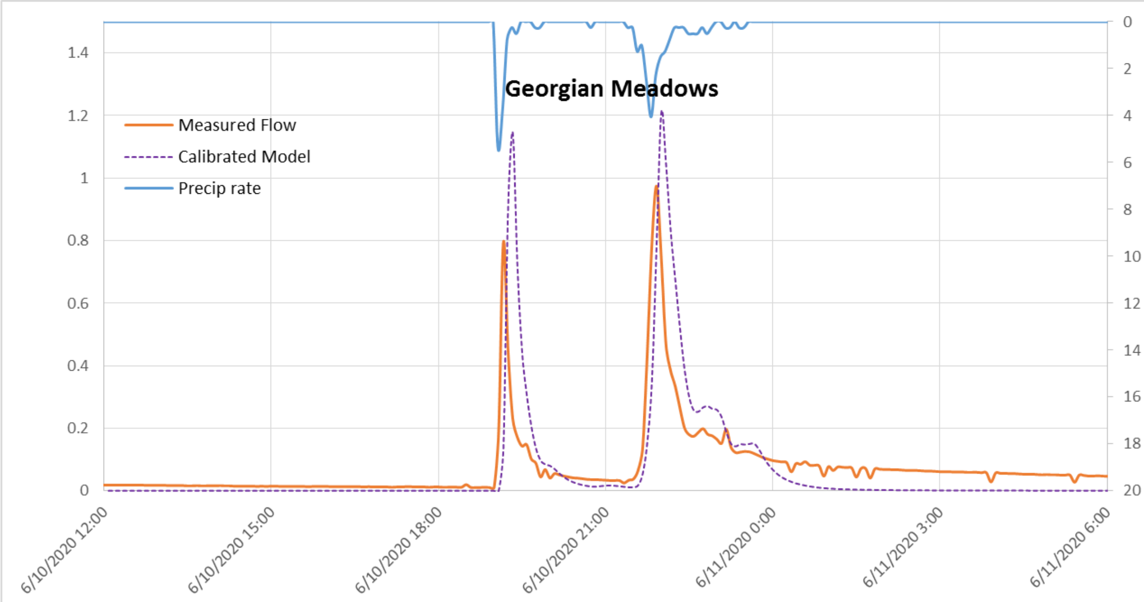


Figure 26 Georgian Meadows (Site 4)

The comparison of peak response and volume being modelled using the 2019 calibrated data became more pronounced with the mid summer events in late June and July. Further adjustments to the modelled parameters were done.

5.2 Updated Parameters

Several model parameter adjustments were considered with the additional events tested in 2020. These adjustments included:

- Remove the road sags;
- Length to width ratio is set at 4;
- 80% impervious area drains to pervious area;
- Ia-perv changed to 8 mm; and,
- N-perviousness is changed to 0.25.

Table 6 shows the changes in peak flow and runoff volume with the adjustments from the 2019 calibration to new updated model with additional 2020 storms.

Table 5 Peak Flow and Runoff Volume Comparison

Site 1	Peak Flow			Volume		
Oak Street	Modelled 2019	Modelled Adjusted	Measured	Modelled 2019	Modelled Adjusted	Measured
	m^3/s	m^3/s	m^3/s	m^3	m^3	m^3
4/30/2020	1.18	0.59	0.42	7884	4370	4979
5/24/2020	1.80	0.88	1.08	11369	7414	8349
6/10/2020	1.74	1.09	0.56	18404	13661	9965
Site 2	**Peak Flow**			**Volume**		
Ste Marie St	Modelled 2019	Modelled Adjusted	Measured	Modelled 2019	Modelled Adjusted	Measured
	m^3/s	m^3/s	m^3/s	m^3	m^3	m^3

4/30/2020	1.09	0.58	0.67	3993	2511	1927
5/24/2020	1.39	0.78	1.65	4834	3249	2727
6/10/2020	1.33	0.80	0.66	8001	6093	2546
6/23/2020	2.12	1.73	1.17	23910	21362	5461
7/10/2020	0.89	0.63	0.41	9218	7340	2911
7/16/2020	1.33	0.65	1.14	7799	5985	2594
7/19/2020	1.57	0.77	1.27	4024	2525	2107
Site 3 West	**Peak Flow**			**Volume**		
Minnesota St (West)	Modelled 2019	Modelled Adjusted	Measured	Modelled 2019	Modelled Adjusted	Measured
	m^3/s	m^3/s	m^3/s	m^3	m^3	m^3
4/30/2020	0.42	0.18	0.27	2469	1367	2683
5/24/2020	0.65	0.26	0.49	3208	1884	4384
6/10/2020	0.62	0.32	0.33	5365	3675	3869
6/23/2020	1.26	0.94	0.64	19197	16569	10695
Site 3 East	**Peak Flow**			**Volume**		
Minnesota St (East)	Modelled 2019	Modelled Adjusted	Measured	Modelled 2019	Modelled Adjusted	Measured
	m^3/s	m^3/s	m^3/s	m^3	m^3	m^3
3/29/2020	0.73	0.56	0.33	9844	7962	8457
4/30/2020	0.42	0.18	0.22	2469	1367	3324
5/24/2020	0.65	0.26	0.32	3208	1884	3211
Site 4	**Peak Flow**			**Volume**		
Georgian Meadows	Modelled 2019	Modelled Adjusted	Measured	Modelled 2019	Modelled Adjusted	Measured
	m^3/s	m^3/s	m^3/s	m^3	m^3	m^3
4/30/2020	1.05	0.92	0.93	2833	2510	2339
5/24/2020	1.29	1.13	1.24	3110	2628	3385
6/10/2020	1.21	0.97	0.97	4400	3548	4301
6/23/2020	1.58	1.36	1.06	13172	11149	11181
7/10/2020	0.53	0.42	0.26	4770	3741	3461
7/16/2020	1.93	1.36	0.81	4112	3177	3393
7/19/2020	2.29	1.72	1.39	2637	2266	3005

It is important to note that for some of the larger events (eg. 06/23/2020), there is a considerable difference in the runoff volume being generated by the model and the measured volume at the gauge. This is the most pronounced for the Ste Marie Street gauge. For a 62.4 mm rainfall volume, less than 12 mm of runoff is being measured at the gauge. The model is simulating around 45 mm of runoff volume which is representative of the area, soil type, etc.

The model matches much more closely with newer urban catchments that are characterized by curb and gutter systems. Some of the older areas of town have hybrid drainage systems that are a combination of ditches, and area drains linked to shallow sewer systems.

The drainage area for the Ste Marie gauge includes a portion of the downtown core, some updated urban roads with curb and gutter, and some older areas with a hybrid of ditches and shallow sewers. The soils are well drained sands on shallow bedrock with locations where groundwater will pass through fissures in the bedrock. Based on the runoff volumes measured at the flow gauge, there is significant evidence that runoff during major storm events is getting lost through the soil and fissures in the bedrock.

In order to simulate the runoff volumes measured at the gauge, the downtown core would have to be modelled at 42 to 44% impervious and the remainder of the fully urbanized catchment as 3 to 4% impervious. This would not represent the runoff being generated at the surface. Using the updated parameters described at the beginning of this section, the peak flows are more closely matched and the runoff volumes represent those that would be anticipated from normal subsurface drainage conditions. **Figure 28** shows the relationship of the modelled and measured volume differences based on the size of storm.

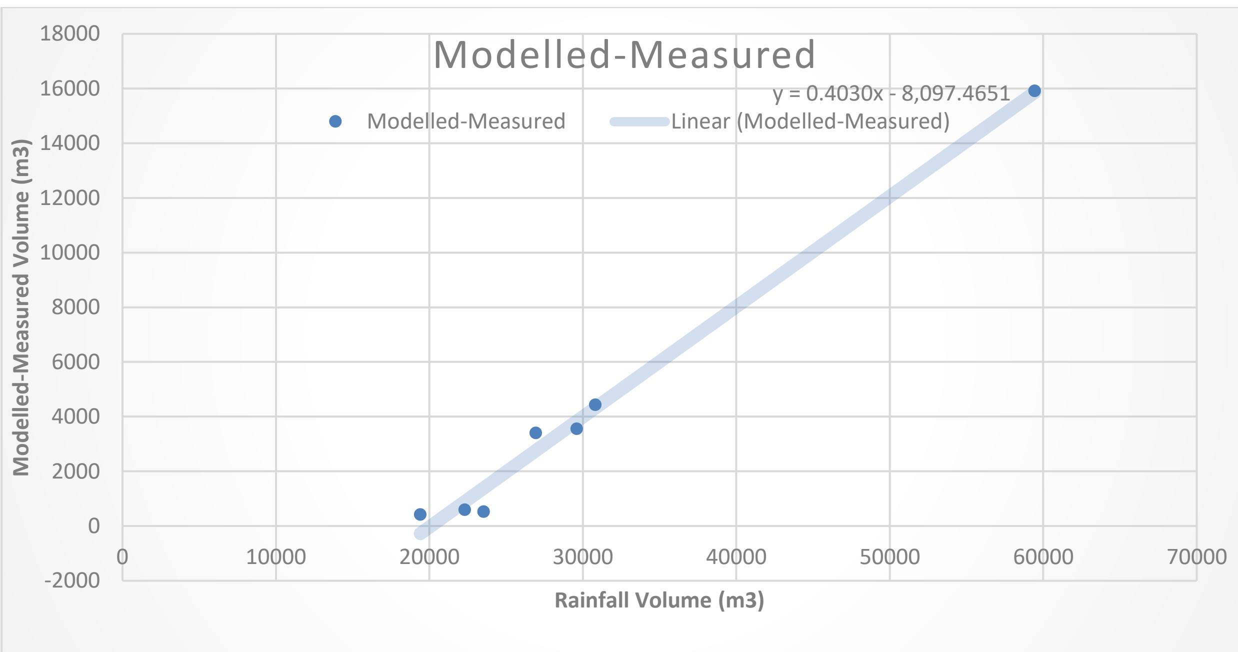


Figure 27 Comparison of Modelled vs Measured Volume Difference

For rainfall events up to 25 mm in volume there is less than 500 m^3 difference in the modelled and measured runoff volumes at the gauge. With larger rainfall events, this difference begins to increase. This is stormwater that is leaving the drainage network through subsurface means. To adjust the model to simulate these losses would risk underestimating the flow conditions for events that can potentially occur (ie late winter early spring conditions, high groundwater table conditions).

5.2.1 Apr 30, 2020

Figure 29 to **Figure 33** show the updated model comparison with measured flows for the April 30, 202 rainfall event.

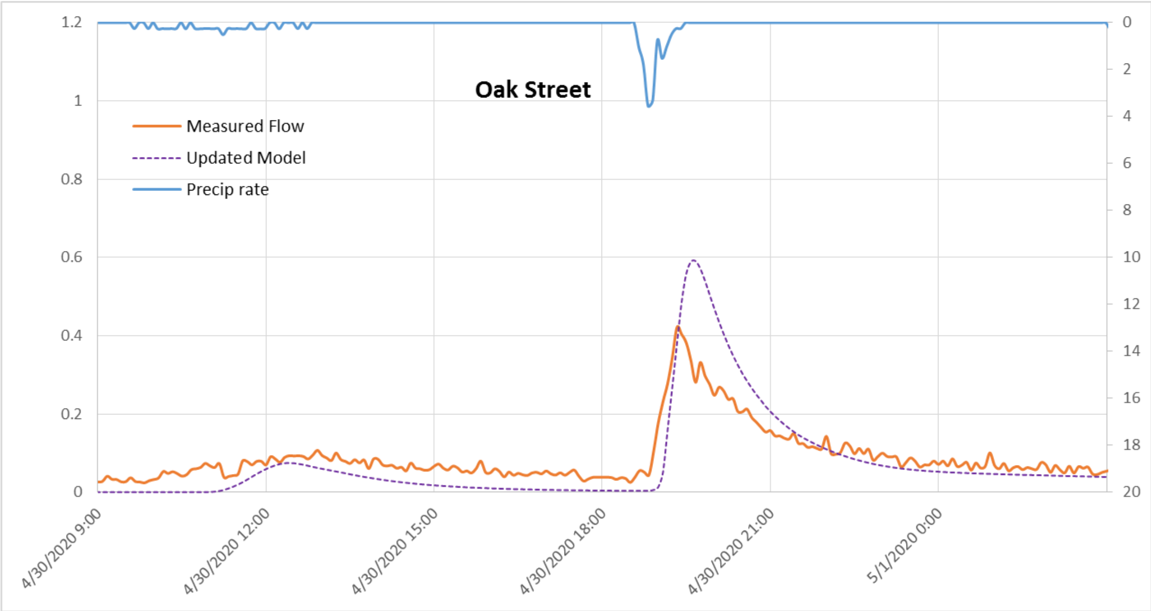


Figure 28 Oak Street (Site 1)

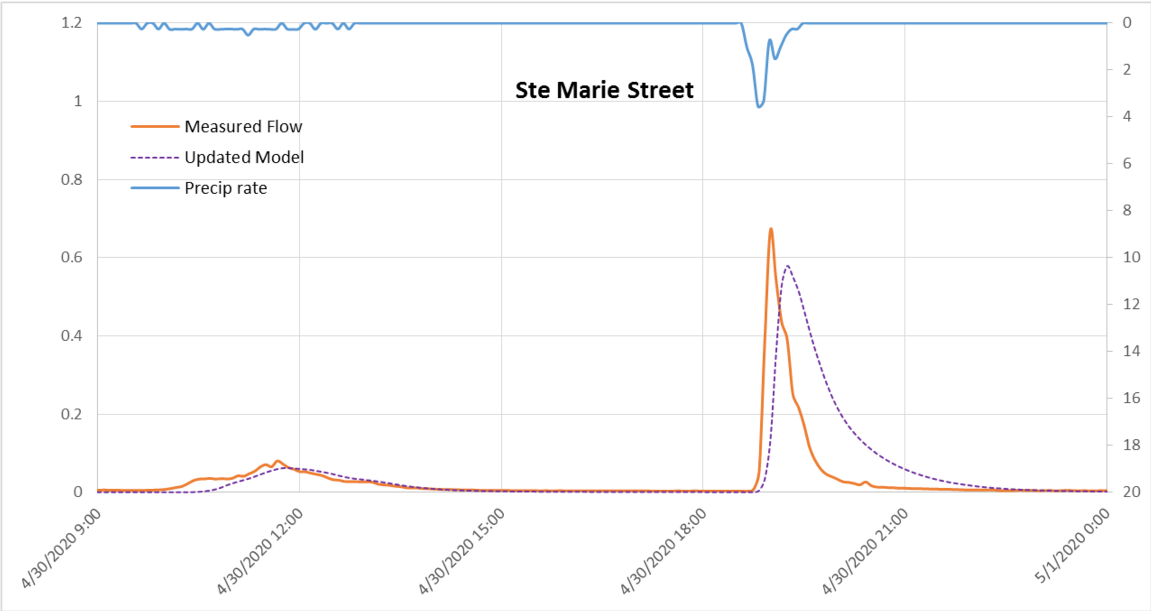


Figure 29 Ste Marie Street (Site 2)

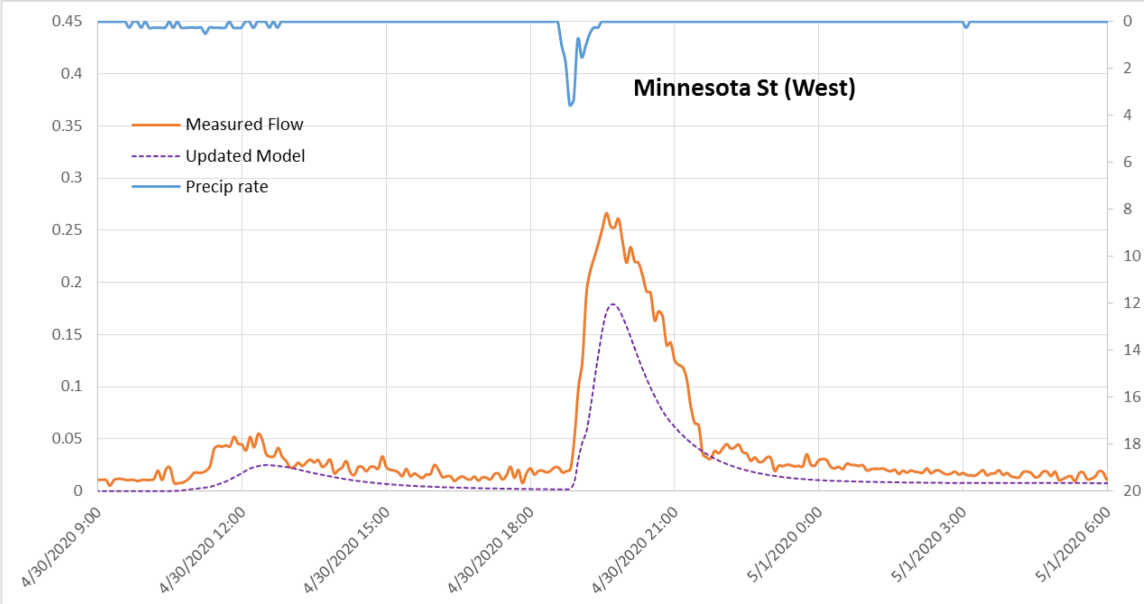


Figure 30 Minnesota Street West (Site 3 West)

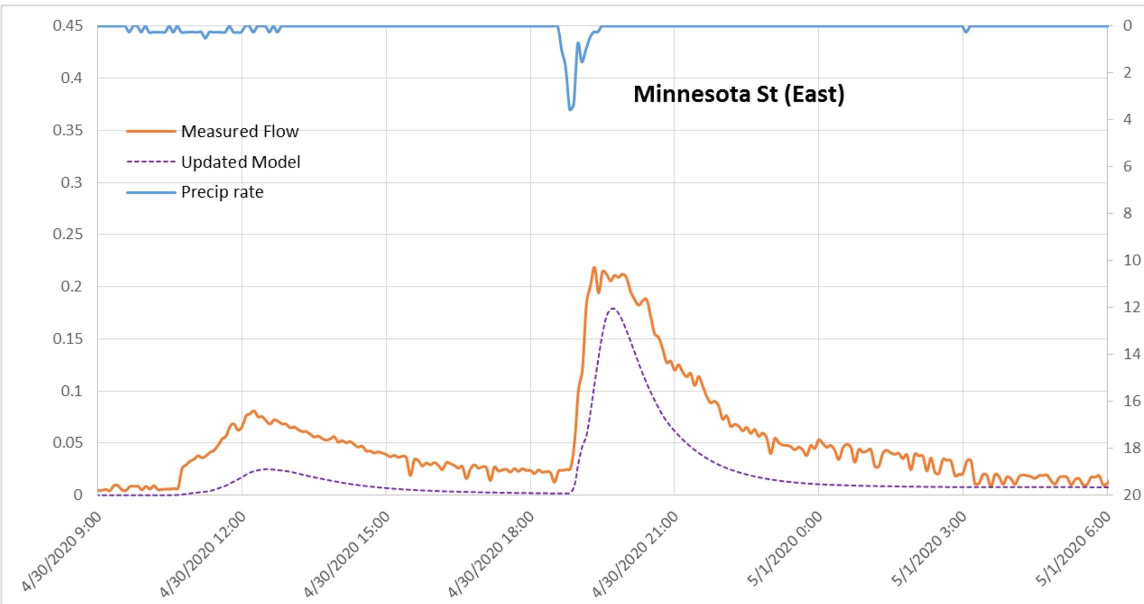


Figure 31 Minnesota Street East (Site 3 East)

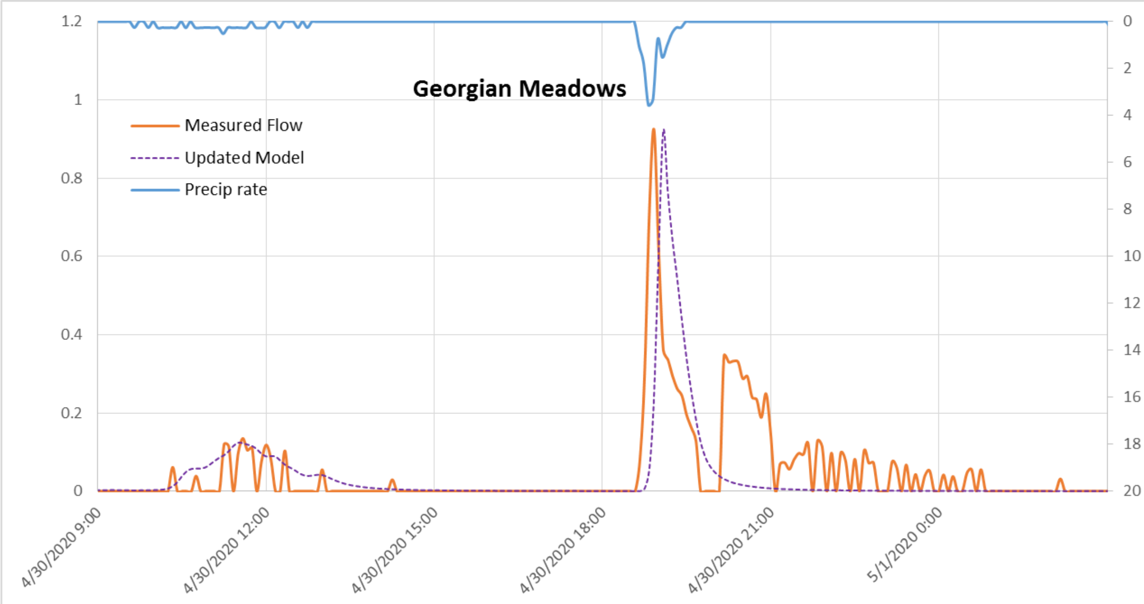


Figure 32 Georgian Meadows (Site 4)

Other model comparisons with the updated parameters are included in **Attachment 3**.

6 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations can be made from the calibration and validation exercises with the development of the urban centre model for the Town of Collingwood:

- although there were limited rainfall events in 2019 to test the model for the effectiveness of the drainage infrastructure, the parameter adjustments set the appropriate timing of flow response;
- there were several larger rainfall events in 202 that were used to qualify the calibration effort with some minor adjustments and to validate the model;
- the urban centre model simulates the drainage response from a curb and gutter network. The drainage catchments with ditch systems or municipal drains have evidence of interaction with the groundwater table. The evidence is shown with base flow during high water table conditions and significant loss of flows during low water table conditions; and,
- the updated urban centre model accounts for drainage conditions that would occur during early spring or late fall conditions with either partially frozen ground or high water table conditions.