Appendix C

Hydrologic Information

C-1. SWMHYMO Model Input & 2011-2012 Calibration and Verification Assessment

C-2. Additional 2013 Hydrologic Model Calibration & Verification Assessment

C-3. Beaver Pond Theoretical Storage Assessment

C-4. Sub-Surface Storage Attenuation Assessment within the Upper Kizell Drain

C-5. Upper Kizell Drain Hydrologic Model Verification Assessment - June 24, 2014 Storm Event

C-6. Design Event Peak Flows & Beaver Pond and Kizell Cell Performance Assessment

C-1. SWMHYMO Model Input & 2011-2012 Calibration and Verification Assessment

Table C-1-1
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SUMMARY OF KANATA LAKES GOLF COURSE DETENTION AREAS SCREENING

Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes: 1 . Drainage areas are only a rough estimation for screening purpose.

Detention Area ID	Location	Plan	Visible Pond Outline	Inlets to sewer or channel	CB Lead/Sewer Diameter (From Plan)	Inlet Info	Storage (m^3)	Drainage Area[1] (ha)	Outlet Catchment	Include in SWMHYMO?	What's involved in order to include the DA?
1	Longboat at Hodgson	plan1_DA1and 2.pdf	no	Channel	N/A	-	1056 @ 100.92m	-	-	No	-
2	Sherring at Knudson	plan1_DA1and 2.pdf	no	Sewer	200/675	200 @ 98.24m	-	-	-	No	-
3	Windeyer, north of Campeau	N/A	yes	Channel	N/A	-	3931 @ 97.92m (5507 @ 98.5m in P1)	-	P1	Yes	Do nothing (No update from P1)
4	Rosenfeld at Sherk	plan1_DA4_5_5a_6.pdf	yes	Sewer	3 plates (refer to field notes)/1050	750x200 @ 94.45m 1200x300 @ 94.80m 1200x200 @ 95.60m	36976 @ 97.69m (16418 @ 97.5m in P1)	-	P1	Yes	Update outflow rating curve
5a	Balding at Sherk	plan1_DA4_5_5a_6.pdf	no	Sewer	450/600	630x350 @ 99.59m 450 L/s restriction	8236 @ 102.14m (Spill to the neighborhood)	9.6	P1	Yes	Sub-divide Area 3A
5	Tanner at Sherk	plan1_DA4_5_5a_6.pdf	no	Sewer	300/525	300 @ 95.67m 400x150 plate should have been installed (drawing)	2577 @ 97.68m	1.9	P1	No	Sub-divide Area 3A
6A	East of Knudson at Sherk	plan1_DA4_5_5a_6.pdf	no	Sewer	250/1050	250 @ 94.15m	502 @ 94.99m	4.13	P1	No	Whether we include the DA or not, we need to adjust P1 outer boundary and add a new catchment
6B		nil			200/750	200 @ 97.12m	202 @ 98.82m	2.02	P1	No	Whether we include the DA or not, we need to adjust P1 outer boundary and add a new catchment
7	South of Beaverbrook at Westlock	p&p5_DA7.pdf	no	Sewer	300/600	300 @ 92.04	385 @ 94.06m	4.1	P1	No	Whether we include the DA or not, we need to adjust P1 outer boundary and add a new catchment
8	South of Zokol at Westlock	plan5_DA8.pdf	no	Sewer	250/2550	250 @ 91.84m	4650 @ 96.53m (2435 @ 96.00m in P1)	-	P1	Yes	Update outflow rating curve
9	North of Zokol at Westlock	p&p1_DA9.pdf	no	Sewer	300/2700	300 @ 92.82m	7609 @ 96.64m (6154 @ 96.5m in P1)	-	P1	Yes	Update outflow rating curve
10A	Walden at Slade	p&p4_DA10	no	Sewer	150	150 @ 98.15	1221 @ 100.96m	Insignificant	P1	No	-
10B					300	300 @ 98.24m	4473 @ 100.94m	4.85	P1	Yes	Sub-divide Area 4A, 6B and 7 to route through this DA
11	East of Westlock at Walden	plan11_DA11.pdf	no	Sewer	200/2700	200 @ 93.70m	2349 @ 95.53m	2.8	P1	Yes	Whether we include the DA or not, we need to adjust P1 outer boundary and add a new catchment

Table C-1-2
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SUMMARY OF KANATA LAKES GOLF COURSE DETENTION AREA 3, 4, 5a, 8, 9, 10B AND 11 STAGE-STORAGE-DISCHARGE ESTIMATES

Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes:
1. Storage volume for Detention Facility 3 calculated from DEM contours to a maximum elevation prior to overtopping the connecting channel.
2. Detention Pond/Area 3 discharge calculated based on capacity of open channel connection to Pond 4.
3. Storage volume for Detention Facilities 4, 5a, 8, 9, 10B and 11 calculated from DEM contours to a maximum elevation prior to encroaching onto adjacent residential property.
4. Outlet diameter for Detention Facilities 4, 5a, 8, 9, 10B and 11 obtained from field survey performed by City's staff.

Detention Pond 3

Elev. (m)	Storage Volume [1] (m^3)	Discharge [2] (m^3/s)
98	0	0
98.03	240	0
98.4	4127	0.9
98.45	4798	2.25
98.5	5507	4.16

Detention Pond 4

Elev. (m)	Storage Volume [3] (m^3)	Discharge [4] (m^3/s)	Diameter (mm)
95.5	1	1.47	3 rectangular plates: (750mmx200mm,
96	80	2.42	
96.5	650	3.09	
97	3459	3.63	
97.25	8899	3.86	
97.5	16418	4.09	
97.69	36976	4.25	

Detention Area 5a

Elev. (m)	Storage Volume [3] (m^3)	Discharge [4] (m^3/s)	Dimension (mm)
99.4	0	0.06	630x350
99.9	0	0.51	
100.4	40	0.65	
100.9	438	0.76	
101.4	1887	0.86	
101.9	5613	0.95	
102.1	8197	0.98	

Detention Area 8

Elev. (m)	Storage Volume [3] (m^3)	Discharge [4] (m^3/s)	Diameter (mm)
93	4	0.18	250
93.5	23	0.22	
94	92	0.25	
94.5	250	0.28	
95	580	0.30	
95.5	1272	0.33	
96	2435	0.35	

Detention Area 9

Elev. (m)	Storage Volume [3] (m^3)	Discharge [4] (m^3/s)	Diameter (mm)
94	0	0.25	300
94.5	39	0.31	
95	285	0.36	
95.5	901	0.40	
96	2499	0.44	
96.5	6154	0.47	
96.64	7609	0.48	

Detention Area 10B

Elev. (m)	Storage Volume [3] (m^3)	Discharge [4] (m^3/s)	Diameter (mm)
99.5	0	0.26	300
100	18	0.32	
100.25	93	0.34	
100.5	309	0.36	
100.75	1597	0.38	
100.94	3353	0.40	

Detention Area 11

Elev. (m)	Storage Volume [3] (m^3)	Discharge [4] (m^3/s)	Diameter (mm)
93.81	0	0.01	200
94	0	0.05	
94.5	19	0.09	
95	735	0.12	
95.5	2234	0.15	
95.53	2349	0.15	

TABLE C-1-3
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SWMHYMO INPUT PARAMETER COMPARISON - UPPER KIZELL DRAIN TO BEAVER POND OUTLET (PHASE 1 STUDY AREA)

Version: 1.0
Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes: 1. Phase 2 values compared to Shirley's Brook & Watt's Creek Phase 1 Stormwater Management Study (AECOM, 2012).
2. Values obtained from City of Ottawa Sewer Design Guidelines (November, 2004), Table 5.9
3. AMC II values used to compute design event peak flows.
4. AMC I condition used for model calibration / verification purposes.

Drainage Area ID	GIS ID	Drainage Area (ha)			HYD		XIMP			TIMP			Slope (%) (perv / imp)		MNP / MNI		Length (m) (perv / imp)		IA (mm) (perv / imp)		Curve Number [2] AMC II [3]			AMC I [4]		TP (hrs)			N		
		PHASE I	PHASE II	Difference	PHASE I	PHASE II	PHASE I	PHASE II	Difference	PHASE I	PHASE II	Difference	PHASE I	PHASE II	PHASE I	PHASE II	PHASE I	PHASE II	PHASE I	PHASE II	PHASE I	PHASE II	Difference	PHASE II	Difference	PHASE I	PHASE II	Difference	PHASE I	PHASE II	Difference
	1A	11.4	11.4	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	78	61	-22%	40	-49%	0.56	0.56	0.00	3	1.1	-1.90
	1B	9.3	9.3	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	80	61	-24%	40	-50%	0.81	0.81	0.00	3	1.1	-1.90
	1C	17.8	17.8	0.0	STANDHYD	STANDHYD	38	38	0	51	51	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	474	40 / 474	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	1D	15.8	15.8	0.0	STANDHYD	STANDHYD	41	41	0	55	55	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	915	40 / 915	1.5/0.8	4.67/1.57	80	65	-19%	44	-45%	-	-	-	-	-	-
	2A	29.3	29.3	0.0	STANDHYD	STANDHYD	34	34	0	45	45	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	858	40 / 858	1.5/0.8	4.67/1.57	80	60	-25%	39	-52%	-	-	-	-	-	-
	2B-1	13.0	13.0	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	80	66	-18%	45	-44%	0.44	0.44	0.00	3	1.1	-1.90
	2B-2	15.7	15.7	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	80	63	-21%	42	-48%	0.84	0.84	0.00	3	1.1	-1.90
	2C	13.8	13.8	0.0	STANDHYD	STANDHYD	39	39	0	52	52	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	498	40 / 498	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	3A-1	36.0	2.7	0.0	STANDHYD	STANDHYD	35	35	0	46	47	1	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	1760	40 / 242	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	3A-2		33.4			STANDHYD		31	-4		41	-5		2.0/0.2		0.250 / 0.025		40 / 1760		4.67/1.57		64	-20%	43	-47%		-	-		-	-
	3B	6.3	6.3	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	80	62	-23%	41	-49%	0.55	0.55	0.00	3	1.1	-1.90
	4	21.2	21.2	0.0	STANDHYD	STANDHYD	29	29	0	38	38	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	950	40 / 950	1.5/0.8	4.67/1.57	80	60	-25%	39	-52%	-	-	-	-	-	-
	4A	15.8	15.8	0.0	STANDHYD	STANDHYD	50	50	0	66	66	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	580	40 / 580	1.5/0.8	4.67/1.57	80	58	-28%	37	-54%	-	-	-	-	-	-
	4B	6.2	6.2	0.0	STANDHYD	STANDHYD	57	57	0	57	57	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	272	40 / 272	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	0	-	-
	4C	5.8	5.8	0.0	STANDHYD	STANDHYD	40	40	0	53	53	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	260	40 / 260	1.5/0.8	4.67/1.57	80	63	-21%	42	-48%	-	-	-	-	-	-
	5A	2.5	2.5	0.0	STANDHYD	STANDHYD	37	37	0	50	50	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	146	40 / 146	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	5B	9.5	9.5	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	80	62	-23%	41	-49%	0.67	0.67	0.00	3	1.1	-1.90
	5C	6.2	6.2	0.0	STANDHYD	STANDHYD	38	38	0	50	50	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	309	40 / 309	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	6A	4.1	4.1	0.0	STANDHYD	STANDHYD	39	39	0	52	52	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	238	40 / 238	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	6B	7.5	5.9	-1.7	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	80	61	-24%	40	-50%	0.87	0.87	0.00	3	1.1	-1.90
	6C	5.3	5.3	0.0	STANDHYD	STANDHYD	38	38	0	50	50	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	297	40 / 297	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	7	20.4	19.6	-0.8	STANDHYD	STANDHYD	35	33	-2	46	44	-2	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	800	40 / 778	1.5/0.8	4.67/1.57	80	60	-25%	39	-52%	-	-	-	-	-	-
	8	9.2	9.2	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	77	56	-27%	35	-55%	0.21	0.21	0.00	3	1.1	-1.90
	9	18.9	18.9	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	89	75	-16%	56	-37%	0.37	0.37	0.00	3	1.1	-1.90
	10-1	9.8	9.8	0.0	STANDHYD	STANDHYD	42	42	0	51	51	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	256	40 / 256	1.5/0.8	4.67/1.57	80	70	-13%	49	-38%	-	-	-	-	-	-
	10-2	18.6	18.6	0.0	STANDHYD	STANDHYD	38	38	0	51	51	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	354	40 / 354	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	10-3	4.3	4.3	0.0	STANDHYD	STANDHYD	41	41	0	55	55	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	161	40 / 161	1.5/0.8	4.67/1.57	80	78	-3%	60	-25%	-	-	-	-	-	-
	10-4	13.9	13.9	0.0	STANDHYD	STANDHYD	39	39	0	51	51	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	285	40 / 285	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	10A	9.9	9.9	0.0	STANDHYD	STANDHYD	33	33	0	44	44	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	246	40 / 246	1.5/0.8	4.67/1.57	80	65	-19%	44	-45%	-	-	-	-	-	-
	11	46.2	46.2	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	7.0	77	62	-20%	41	-47%	0.75	0.75	0.00	3	1.1	-1.90
	12	-	2.3	-	-	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	7.0	-	67	-	46	-	-	0.37	-	-	1.1	-
	13	-	2.9	-	-	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	7.0	-	67	-	46	-	-	0.64	-	-	1.1	-
	14	-	2.4	-	-	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	7.0	-	61	-	40	-	-	0.40	-	-	1.1	-
	15	-	2.5	-	-	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	7.0	-	50	-	30	-	-	0.20	-	-	1.1	-
	Goulbourn	1.6	1.6	0.0	STANDHYD	STANDHYD	71	71	0	71	71	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	358	40 / 358	1.5/0.8	4.67/1.57	80	65	-19%	44	-45%	-	-	-	-	-	-
	Kanata	2.8	2.8	0.0	STANDHYD	STANDHYD	32	32	0	32	32	0	2.0/0.2	2.0/0.2	0.25/0.013	0.250 / 0.025	370	40 / 370	1.5/0.8	4.67/1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	Total Area:	**408.0**	**415.6**	**7.6**																										

TABLE C-1-4
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SWMHYMO INPUT PARAMETER COMPARISON - WATT'S CREEK / KIZELL DRAIN (DOWNSTREAM OF BEAVER POND)

Version: 1.0
Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes: 1. Phase 2 values compared to Shirley's Brook & Watt's Creek Subwatershed Study (Dillon, 1999) QUALHYMO model parameters.
2. Values obtained from City of Ottawa Sewer Design Guidelines (November, 2004), Table 5.9
3. AMC II values used to compute design event peak flows.
4. AMC I condition used for model calibration / verification purposes.

Drainage Area ID	GIS ID	Watt's old ID	Drainage Area (ha)			HYD			XIMP			TIMP			Slope (%) (perv / imp)		MNP / MNI		Length (m) (perv / imp)		IA (mm) (perv / imp)		Curve Number [2] AMC II [3]					TP (hrs)			N	
																								AMC I [4]									
			Dillon	AECOM	Difference	Dillon	AECOM	Dillon	AECOM	Difference	Dillon	AECOM	Difference	Dillon	AECOM	Dillon	AECOM	Dillon	AECOM	Dillon	AECOM	Dillon	AECOM	AECOM[1]	Difference	AECOM[1]	Difference	Dillon	AECOM	Difference	Dillon	AECOM	Difference
	KD-2A-1	KD-2A	165.2	28.6	-43.1	NASHYD		-	-		-	-		-		-		-		-		7	66	57	-14%	36	-46%		0.91	-		1.1	-
	KD-2A-2			45.0		STANDHYD	STANDHYD	0.35	0.28	-0.07	0.35	0.28	-0.07	-	2.0 / 0.2	-	0.250 / 0.025	40 / 1195	40 / 2232	7.0 / 1.0	4.67 / 1.57		70	6%	49	-25%	-	-	-	-	-	-	-	-
	KD-2A-3			48.6		STANDHYD	STANDHYD		0.28	-0.07		0.31	-0.04		2.0 / 0.2		0.250 / 0.025		40 / 2074		4.67 / 1.57		74	12%	54	-18%		-	-		-	-
	KD-2B-1	KD-2B	134.7	134.9	126.2	STANDHYD	STANDHYD	0.61	0.40	-0.21	0.61	0.41	-0.20	-	2.0 / 0.2	-	0.250 / 0.025	40 / 974	40 / 3642	7.0 / 1.0	4.67 / 1.57	66	70	6%	49	-25%	-	-	-	-	-	-
	KD-2B-2			3.4		NASHYD			-	-		-	-				-		-		7		63	-5%	42	-37%		0.32	-		1.1	-
	KD-2B-3			7.4		NASHYD			-	-		-	-				-		-		7		65	-2%	44	-34%		0.49	-		1.1	-
	KD-2B-4			23.6		NASHYD			-	-		-	-				-		-		7		62	-6%	41	-38%		0.63	-		1.1	-
	KD-2B-5			4.7		STANDHYD	STANDHYD		0.50	-0.11		0.50	-0.11		2.0 / 0.2		0.250 / 0.025		40 / 498		4.67 / 1.57		79	20%	61	-7%		-	-		-	-
	KD-2B-6			7.7		STANDHYD	STANDHYD		0.61	0.00		0.61	0.00		2.0 / 0.2		0.250 / 0.025		40 / 1106		4.67 / 1.57		62	-6%	41	-38%		-	-		-	-
	KD-2B-7			20.1		NASHYD			-	-		-	-				-		-		7		63	-5%	42	-37%		1.50	-		1.1	-
	KD-2C			59.1		NASHYD			-	-		-	-				-		-		7		83	26%	67	2%		0.60	-		1.1	-
	KD-3A	KD-3	358.5	206.2	-40.3	STANDHYD	STANDHYD	0.2	0.30	0.10	0.2	0.34	0.14	-	2.0 / 0.2	-	0.250 / 0.025	40 / 2741	40 / 3876	7.0 / 1.0	4.67 / 1.57	71	78	10%	60	-16%	-	-	-	-	-	-
	KD-3B			112.1		NASHYD			-	-		-	-				-		-		7		66	-7%	45	-37%		1.20	-		1.1	-
	WC-1	W1A	500.4	403.5	-96.9	STANDHYD	STANDHYD	0.25	0.30	0.05	0.25	0.34	0.09	-	2.0 / 0.2	-	0.250 / 0.025	40 / 2138	40 / 5150	5.0 / 1.0	4.67 / 1.57	60	68	13%	47	-21%	-	-	-	-	-	-
	Kanata Town Centre-1	W1B	85.2	60.2	-25.0	STANDHYD	STANDHYD	0.65	0.34	-0.31	0.65	0.34	-0.31	-	2.0 / 0.2	-	0.250 / 0.025	40 / 364	40 / 2758	5.0 / 1.0	4.67 / 1.57	60	70	17%	49	-18%	-	-	-	-	-	-
	Kanata Town Centre-2A	W2	81	34.3	-25.9	STANDHYD	STANDHYD	0.4	0.36	-0.04	0.4	0.42	0.02	-	2.0 / 0.2	-	0.250 / 0.025	40 / 997	40 / 2152	5.0 / 1.0	4.67 / 1.57	74	75	1%	56	-25%	-	-	-	-	-	-
	Kanata Town Centre-2B			20.8		STANDHYD	STANDHYD		0.23	-0.17		0.24	-0.16		2.0 / 0.2		0.250 / 0.025		40 / 1900		4.67 / 1.57		69	-7%	48	-35%		-	-		-	-
	WC-3	W3	138.1	204.1	66.0	STANDHYD	NASHYD	0.07	-	-	0.07	-	-	-	-	-	-	40 / 1519	-	5.0 / 1.0	7	57	66	16%	45	-21%	-	1.28	-	-	1.1	-
	WC-4A	W4	276.5	126.3	-4.9	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	5	7	70	82	17%	66	-6%	2	2.30	0.30	3	1.1	-1.90
	WC-4B			145.3		NASHYD	NASHYD		-	-		-	-		-		-		-		7		73	4%	53	-24%		1.22	-0.78		1.1	-1.90
	WC-5A	W5	388.2	59.5	50.9	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	5	7	73	73	0%	53	-27%	3.2	0.79	-2.41	3	1.1	-1.90
	WC-5B			379.6		NASHYD	NASHYD		-	-		-	-		-		-		-		7		73	0%	53	-27%		3.28	0.08		1.1	-1.90
	Total Area:		**2127.8**	**2134.8**	**7.0**																											

Table C-1-5
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SUMMARY OF WATT'S CREEK SWMHYMO MODEL STAGE-STORAGE-DISCHARGE ESTIMATES

Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes:
1. Stage-storage-discharge obtained from detailed engineering drawing (plan2.pdf in plan2.pdf IN 13616-Richardson Side_Eagleson) provided by the City.
2. Stage-storage-discharge was estimated assuming 5-year level control.
3. Storage volume estimated based on grading information from available engineering drawings.
4. Outlet diameter obtained from available engineering drawings.
5. Stage-discharge obtained from R-1563.
6. Stage-discharge obtained from R-1564.

Unnamed Pond in KD-2B-5		
Elev. (m)	Storage Volume [1] (m^3)	Discharge [1] (m^3/s)
-	0	0
83.18	128	0.15
83.84	388	0.15

Unnamed Pond in KD-2B-6		
Elev. (m)	Storage Volume [2] (m^3)	Discharge [2] (m^3/s)
-	0	0.00
-	95	0.41

Private Pond 2 in Golf Course			
Elev. (m)	Storage Volume [3] (m^3)	Discharge [4] (m^3/s)	Diameter (mm)
74.45	0	0	341
75.12	15695	0.23	
75.22	18191	0.25	
75.65	29421	0.33	

Private Pond 3 in Golf Course			
Elev. (m)	Storage Volume [3] (m^3)	Discharge [4] (m^3/s)	Diameter (mm)
73.65	0	0	417
74.47	6160	0.26	
74.58	7115	0.28	
75.16	12301	0.37	

SWF-1206		
Elev. (m)	Storage Volume [3] (m^3)	Discharge [5] (m^3/s)
89.90	0	0.00
90.20	2854	0.96
93.20	40592	1.44

SWF-1205		
Elev. (m)	Storage Volume [3] (m^3)	Discharge [6] (m^3/s)
89.00	0	0.00
90.20	6939	0.79
91.00	14350	4.70

TABLE C-1-6
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SWMHYMO INPUT PARAMETER COMPARISON - SHIRLEY'S BROOK

Version: 1.0
Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes: 1. SBWC Phase 2 SWM values compared to Novatech SWMHYMO Model (Novatech, 2006).
2. Values obtained from City of Ottawa Sewer Design Guidelines (November, 2004), Table 5.9
3. AMC II values used to compute design event peak flows.
4. AMC I condition used for model calibration / verification purposes.

Drainage Area ID	GIS ID	Drainage Area (ha)			HYD		XIMP			TIMP			Slope (%) (perv / imp)		MNP / MNI		Length (m) (perv / imp)		IA (mm) (perv / imp)		Curve Number [2] AMC II [3]			AMC I [4]		TP (hrs)			N		
		Novatech	AECOM	Difference	Novatech	AECOM	Novatech	AECOM	Difference	Novatech	AECOM	Difference	Novatech	AECOM	Novatech	AECOM	Novatech	AECOM	Novatech	AECOM	Novatech	AECOM[1]	Difference	AECOM[1]	Difference	Novatech	AECOM	Difference	Novatech	AECOM	Difference
Morgan's Grant Phase 10A	MG10A-1	15.2	42.2	27.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	42	9	80	63	-21%	42	-48%	0.27	1.27	1.00	3	1.1	-1.9
	MG10A-2	5.2	5.2	0.0	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	9	80	66	-18%	45	-44%	0.27	0.17	-0.10	3	1.1	-1.9
	MG10A-3A	5.71	6.6	0.9	STANDHYD	STANDHYD	0.51	0.38	-0.13	0.62	0.48	-0.14	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 502	40 / 1410	1.5 / 0.8	4.67 / 1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	MG10A-3B	0.45	1.0	0.5	STANDHYD	STANDHYD	0.07	0.49	0.42	0.39	0.65	0.26	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 97	40 / 242	1.5 / 0.8	4.67 / 1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	MG10A-3C	1.21	2.2	1.0	STANDHYD	STANDHYD	0.1	0.44	0.34	0.36	0.58	0.22	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	20 / 76	40 / 432	1.5 / 0.8	4.67 / 1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	MG10A-3D	0.27	3.4	3.1	STANDHYD	STANDHYD	0.67	0.44	-0.23	0.67	0.55	-0.12	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	20 / 52	40 / 452	1.5 / 0.8	4.67 / 1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	MG10A-4	10.04	9.6	-0.4	STANDHYD	STANDHYD	0.63	0.33	-0.30	0.64	0.40	-0.24	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	20 / 495	40 / 1112	1.5 / 0.8	4.67 / 1.57	80	61	-24%	40	-50%	-	-	-	-	-	-
	MG10A-5A	7.6	3.8	1.5	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	9	80	66	-18%	45	-44%	0.57	0.27	-0.30	3	1.1	-1.9
	MG10A-5B		3.3			STANDHYD		-	-		-	-		-		-		-		9		67	-16%	46	-42%		0.23	-0.34		1.1	-1.9
	MG10A-5C		2.0			NASHYD		-	-		-	-		-		-		-		9		61	-24%	40	-50%		0.17	-0.40		1.1	-1.9
	MG10A-6	5.66	6.3	0.6	STANDHYD	STANDHYD	0.28	0.37	0.09	0.37	0.46	0.09	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 194	40 / 758	1.5 / 0.8	4.67 / 1.57	80	74	-8%	54	-32%	-	-	-	-	-	-
	MG10A-7	3.53	7.0	3.5	STANDHYD	STANDHYD	0.63	0.35	-0.28	0.63	0.35	-0.28	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	20 / 1300	40 / 1580	1.5 / 0.8	4.67 / 1.57	80	62	-23%	41	-49%	-	-	-	-	-	-
	MG10A-8	3.65	3.8	0.1	STANDHYD	STANDHYD	0.58	0.50	-0.08	0.58	0.50	-0.08	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	20 / 900	40 / 846	1.5 / 0.8	4.67 / 1.57	80	68	-15%	47	-41%	-	-	-	-	-	-
	MG10A-9	3.7	29.9	26.2	STANDHYD	NASHYD	0.28	-	-	0.37	-	-	2.0 / 0.2	-	0.25 / 0.013	-	20 / 360	-	1.5 / 0.8	9	80	58	-28%	37	-54%	-	1.84	-	-	1.1	-
	Total Area:	**62.2**	**126.3**	**64.1**																										
Northtech Campus	Northtech-8a	222	378.5	156.5	WILHYD	WILHYD	-	-	-	-	-	-	-	-	-	-	-	-	9	28	52.2	65	25%	44	-16%	1.6	2.91	1.31	-	-	-
	Northtech-719	5.3	61.9	56.6	STANDHYD	NASHYD	0.33	-	-	0.45	-	-	0.6 / 0.6	-	0.25 / 0.013	-	150 / 150	-	4.17 / 1.58	9	-	66	-	45	-	-	0.96	-	-	1.1	-
	Northtech-726	66	36.2	-29.8	WILHYD	WILHYD	-	-	-	-	-	-	-	-	-	-	-	-	4.7	9	72	60	-17%	39	-46%	0.44	0.42	-0.02	-	-	-
	Northtech-862-1	12.9	6.1	3.9	STANDHYD	NASHYD	0.34	-	-	0.45	-	-	0.61 / 0.61	-	0.25 / 0.015	-	222.51 / 222.51	-	2.54 / 2.54	9	-	63	-	42	-	-	0.41	-	-	1.1	-
	Northtech-862-2		10.7			STANDHYD		0.66	0.32		0.66	0.21		2.0 / 0.2		0.250 / 0.025		40 / 728		4.67 / 1.57		69	-	48	-		-	-		-	-
	Northtech-402-1	60.6	27.2	-0.4	STANDHYD	NASHYD	0.8	-	-	0.8	-	-	1	-	-	-	-	-	-	9	70	77	10%	58	-17%	-	0.58	-	-	1.1	-
	Northtech-402-2		33.0			STANDHYD		0.55	-0.25		0.55	-0.25		2.0 / 0.2		0.250 / 0.025		40 / 1710		4.67 / 1.57		80	14%	63	-10%		-	-		-	-
	Total Area:	**366.8**	**553.6**	**186.8**																										
KRP	KRP-1A	19.9	13.6	1.0	STANDHYD	STANDHYD	0.57	0.73	0.16	0.71	0.73	0.02	1.1 / 1.1	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	450 / 450	40 / 996	4.67 / 1.57	4.67 / 1.57	80	69	-14%	48	-40%	-	-	-	-	-	-
	KRP-1B		7.2			STANDHYD		0.50	-0.07		0.50	-0.21		2.0 / 0.2		0.250 / 0.025		40 / 1000		4.67 / 1.57		61	-24%	40	-50%		-	-		-	-
	KRP-2	4.2	4.2	0.0	STANDHYD	STANDHYD	0.75	0.63	-0.12	0.75	0.63	-0.12	0.5 / 0.5	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	200 / 200	40 / 566	4.67 / 1.57	4.67 / 1.57	80	80	0%	63	-22%	-	-	-	-	-	-
	KRP-3	32	34.2	2.2	WILHYD	WILHYD	-	-	-	-	-	-	-	-	-	-	-	-	4.67	9	67.4	73	8%	53	-21%	0.31	0.88	0.57	-	-	-
	KRP-4	5.4	4.9	-0.5	STANDHYD	STANDHYD	0.7	0.91	0.21	0.8	0.91	0.11	0.5 / 0.5	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	50 / 200	40 / 584	4.67 / 1.57	4.67 / 1.57	80	39	-51%	21	-74%	-	-	-	-	-	-
	Total Area:	**61.5**	**64.1**	**2.6**																										
South March Community	SMC-850-1	22.9	10.7	-0.1	STANDHYD	STANDHYD	0.34	0.37	0.03	0.45	0.42	-0.03	0.68 / 0.68	2.0 / 0.2	0.25 / 0.015	0.250 / 0.025	548.6 / 548.6	40 / 1016	4.67 / 1.57	4.67 / 1.57	-	60	-	39	-	-	-	-	-	-	-
	SMC-850-2		12.1			STANDHYD		0.38	0.04		0.46	0.01		2.0 / 0.2		0.250 / 0.025		40 / 1272		4.67 / 1.57		61	-	40	-		-	-		-	-
	SMC-841	7.6	6.9	-0.7	STANDHYD	STANDHYD	0.34	0.41	0.07	0.45	0.49	0.04	1.20 / 1.20	2.0 / 0.2	0.25 / 0.015	0.250 / 0.025	317 / 317	40 / 1060	4.67 / 1.57	4.67 / 1.57	-	61	-	40	-	-	-	-	-	-	-
	SMC-860	6.3	4.6	-1.7	STANDHYD	STANDHYD	0.34	0.43	0.09	0.45	0.51	0.06	1.26 / 1.26	2.0 / 0.2	0.25 / 0.015	0.250 / 0.025	610 / 610	40 / 650	4.67 / 1.57	4.67 / 1.57	-	72	-	52	-	-	-	-	-	-	-
	SMC-861	21.1	20.5	-0.6	STANDHYD	STANDHYD	0.34	0.32	-0.02	0.45	0.39	-0.06	1.26 / 1.26	2.0 / 0.2	0.25 / 0.015	0.250 / 0.025	610 / 610	40 / 1198	4.67 / 1.57	4.67 / 1.57	-	66	-	45	-	-	-	-	-	-	-
	SMC-701A	38.2	25.2	-7.0	STANDHYD	STANDHYD	0.3	0.45	0.15	0.3	0.48	0.18	0.49 / 0.49	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	600 / 600	40 / 1466	4.67 / 1.57	4.67 / 1.57	-	64	-	43	-	-	-	-	-	-	-
	SMC-701B		1.2			STANDHYD		0.60	0.30		0.80	0.50		2.0 / 0.2		0.250 / 0.025		40 / 224		4.67 / 1.57		80	-	63	-		-	-		-	-
	SMC-701C		4.4			STANDHYD		0.39	0.09		0.45	0.15		2.0 / 0.2		0.250 / 0.025		40 / 983		4.67 / 1.57		46	-	26	-		-	-		-	-
	SMC-701D		0.4			STANDHYD		0.28	-0.02		0.28	-0.02		2.0 / 0.2		0.250 / 0.025		40 / 204		4.67 / 1.57		47	-	27	-		-	-		-	-
	SMC-5	11.5	11.1	-0.4	STANDHYD	STANDHYD	0.34	0.46	0.12	0.45	0.52	0.07	1.26 / 1.26	2.0 / 0.2	0.25 / 0.015	0.250 / 0.025	500 / 500	40 / 788	4.67 / 1.57	4.67 / 1.57	-	72	-	52	-	-	-	-	-	-	-
	SMC-805	3.7	5.7	2.0	STANDHYD	STANDHYD	0.9	0.64	-0.26	0.9	0.66	-0.24	0.50 / 0.50	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	575 / 575	40 / 1275	4.67 / 1.57	4.67 / 1.57	80	78	-3%	60	-25%	-	-	-	-	-	-
	Total Area:	**111.3**	**102.7**	**-8.6**																										
Shirley's Brook Northwest	SB-1	427.9	444.6	16.7	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	9	9	63	69	10%	48	-23%	1.4	3.28	1.88	2	1.1	-0.9
	SB-2A	237.8	204.2	-33.6	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	9	9	51	67	31%	46	-10%	0.8	1.55	0.75	2	1.1	-0.9
	SB-2B	194.3	81.4	-112.9	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	9	13	51	63	24%	42	-18%	1.4	0.74	-0.66	1.1	1.1	0.0
	Total Area:	**860.0**	**730.2**	**-129.8**																										
Morgan's Grant	MG-1A	2	5.1	3.1	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	9	85	60	-29%	39	-55%	0.25	0.39	0.14	3	1.1	-1.9
	MG-1B	16.6	11.0	-5.6	STANDHYD	STANDHYD	0.12	0.32	0.20	0.25	0.40	0.15	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 570	40 / 884	1.5 / 0.8	4.67 / 1.57	85	61	-28%	40	-53%	-	-	-	-	-	-
	MG-2	13.8	13.8	0.0	STANDHYD	STANDHYD	0.14	0.32	0.18	0.27	0.39	0.12	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 540	40 / 966	1.5 / 0.8	4.67 / 1.57	85	61	-28%	40	-53%	-	-	-	-	-	-
	MG-3	14.4	14.1	-0.3	STANDHYD	STANDHYD	0.22	0.43	0.21	0.36	0.52	0.16	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 765	40 / 944	1.5 / 0.8	4.67 / 1.57	85	61	-28%	40	-53%	-	-	-	-	-	-
	MG-4	7.1	7.3	0.2	STANDHYD	STANDHYD	0.25	0.48	0.23	0.4	0.57	0.17	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 590	40 / 632	1.5 / 0.8	4.67 / 1.57	85	61	-28%	40	-53%	-	-	-	-	-	-
	MG-5	3.5	3.4	-0.1	STANDHYD	STANDHYD	0.25	0.46	0.21	0.4	0.53	0.13	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 390	40 / 544	1.5 / 0.8	4.67 / 1.57	85	61	-28%	40	-53%	-	-	-	-	-	-
	MG-6A	5.2	4.1	0.2	STANDHYD	STANDHYD	0.22	0.46	0.24	0.36	0.55	0.19	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	-	40 / 614	1.5 / 0.8	4.67 / 1.57	85	61	-28%	40	-53%	-	-	-	-	-	-
	MG-6B		1.3			STANDHYD		0.62	0.40		0.70	0.34		2.0 / 0.2		0.250 / 0.025		40 / 288		4.67 / 1.57		61	-28%	40	-53%		-	-		-	-
	MG-8A	3	2.8	-0.2	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	1.5	9	85	75	-12%	56	-34%	0.28	0.25	-0.03	3	1.1	-1.9
	MG-8B	5.8	6.0	0.2	STANDHYD	NASHYD	0.09	-	-	0.2	-	-	2.0 / 0.2	-	0.25 / 0.013	-	40 / 270	-	1.5 / 0.8	9	85	65	-24%	44	-48%	-	0.34	-	-	1.1	-
	MG-9	12.7	13.0	0.3	STANDHYD	STANDHYD	0.18	0.35	0.17	0.33	0.42	0.09	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 570	40 / 1078	1.5 / 0.8	4.67 / 1.57	85	63	-26%	42	-51%	-	-	-	-	-	-
	MG-10	11.8	10.8	-1.0	STANDHYD	STANDHYD	0.22	0.46	0.24	0.36	0.53	0.17	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 630	40 / 1088	1.5 / 0.8	4.67 / 1.57	85	62	-27%	41	-52%	-	-	-	-	-	-
	MG-11	6.4	5.9	-0.5	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	4.67	9	75	77	3%	58	-22%	0.2	0.22	0.02	2	1.1	-0.9
	MG-13	6.9	7.3	0.4	STANDHYD	STANDHYD	0.48	0.45	-0.03	0.6	0.54	-0.06	2.0 / 0.2	2.0 / 0.2	0.25 / 0.013	0.250 / 0.025	40 / 160	40 / 656	1.5 / 0.8	4.67 / 1.57	85	73	-14%	53	-37%	-	-	-	-	-	-
	Total Area:	**109.2**	**106.0**	**-3.2**																										
Klondike & Adjacent Lands																														
March Road (40m ROW + road widening)	Klondike-A-MR1	5.83	2.5	-3.4	STANDHYD	STANDHYD	0.7	0.76	0.06	0.8	0.77	-0.03	0.4	2.0 / 0.2	-	0.250 / 0.025	-	40 / 555	-	4.67 / 1.57	65	80	23%	63	-4%	-	-	-	-	-	-
Commercial / Residential	Klondike-A-400	4.52	5.3	0.8	STANDHYD	STANDHYD	0.58	0.75	0.17	0.68	0.75	0.07	1	2.0 / 0.2	-	0.250 / 0.025	-	40 / 982	-	4.67 / 1.57	65	79	22%	61	-6%	-	-	-	-	-	-
Commercial / Residential	Klondike-A-500	1.52	1.1	-0.4	STANDHYD	NASHYD	0.58	-	-	0.68	-	-	1	-	-	-	-	-	-	9	65	80	23%	63	-4%	-	0.66	-	-	1.1	-
Future Development (Mixed)	Klondike-C-300A	7.48	6.1	0.0	STANDHYD	NASHYD	0.3	-	-	0.37	-	-	1	-	-	-	-	-	-	9	65	58	-11%	37	-44%	-	0.17	-	-	1.1	-
	Klondike-C-300B		1.4			STANDHYD		0.23	-0.07		0.25	-0.12		2.0 / 0.2		0.250 / 0.025		40 / 452		4.67 / 1.57		39	-40%	21	-67%		-	-		-	-
Medium Density Residential	Klondike-C-201	1.96	2.0	0.0	STANDHYD	NASHYD	0.57	-	-	0.65	-	-	1.5	-	-	-	-	-	-	9	65	58	-11%	37	-44%	-	0.17	-	-	1.1	-
Medium Density Residential	Klondike-C-202	3.07	3.1	0.0	STANDHYD	NASHYD	0.57	-	-	0.65	-	-	1	-	-	-	-	-	-	9	65	49	-25%	29	-56%	-	0.17	-	-	1.1	-
Park	Klondike-C-203	1.9	1.9	0.0	STANDHYD	NASHYD	0.24	-	-	0.3	-	-	1	-	-	-	-	-	-	9	65	71	9%	51	-22%	-	0.17	-	-	1.1	-
Medium Density Residential	Klondike-C-204	5.2	5.1	-0.1	STANDHYD	STANDHYD	0.57	0.39	-0.18	0.65	0.50	-0.15	1	2.0 / 0.2	-	0.250 / 0.025	-	40 / 712	-	4.67 / 1.57	65	71	9%	51	-22%	-	-	-	-	-	-
Klondike Road R.O.W. U/S OCR	Klondike-C-205	2.22	2.3	0.1	STANDHYD	STANDHYD	0.7	0.43	-0.27	0.8	0.46	-0.34	1	2.0 / 0.2	-	0.250 / 0.025	-	40 / 523	-	4.67 / 1.57	65	63	-3%	42	-36%	-	-	-	-	-	-
Industrial	Klondike-C-101	3.16	3.2	0.0	STANDHYD	NASHYD	0.7	-	-	0.7	-	-	0.6	-	-	-	-	-	-	9	65	62	-5%	41	-37%	-	0.54	-	-	1.1	-
SWMF 'C'	Klondike-C-102	0.9	1.3	0.4	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	9	80	87	9%	74	-8%	0.17	0.18	0.01	-	1.1	-
Klondike Road R.O.W. D/S OCR	Klondike-C-103	1.2	1.0	-0.2	STANDHYD	STANDHYD	0.7	0.30	-0.40	0.8	0.30	-0.50	1	2.0 / 0.2	-	0.250 / 0.025	-	40 / 223	-	4.67 / 1.57	65	73	12%	53	-18%	-	-	-	-	-	-
Low Density Residential	Klondike-D-101	6.7	6.6	-0.1	STANDHYD	STANDHYD	0.3	0.38	0.08	0.37	0.47	0.10	1	2.0 / 0.2	-	0.250 / 0.025	-	40 / 634	-	4.67 / 1.57	65	66	2%	45	-31%	-	-	-	-	-	-
Medium Density Residential	Klondike-D-102	7.7	8.0	0.3	STANDHYD	STANDHYD	0.57	0.34	-0.23	0.65	0.42	-0.23	1	2.0 / 0.2	-	0.250 / 0.025	-	40 / 748	-	4.67 / 1.57	65	70	8%	49	-24%	-	-	-	-	-	-
Low/Med Density Residential	Klondike-D-201	9.64	9.3	-0.3	STANDHYD	STANDHYD	0.4	0.40	0.00	0.5	0.50	0.00	1	2.0 / 0.2	-	0.250 / 0.025	-	40 / 1170	-	4.67 / 1.57	65	73	12%	53	-18%	-	-	-	-	-	-
Klondike Woods	Klondike-D-301	2.09	1.7	-0.4	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	9	55	63	15%	42	-24%	0.17	0.33	0.16	-	1.1	-
Industrial	Klondike-D-302	2.15	2.2	0.1	STANDHYD	NASHYD	0.7	-	-	0.7	-	-	0.6	-	-	-	-	-	-	9	65	63	-3%	42	-36%	-	0.92	-	-	1.1	-
SWMF 'D' & Inlet Channel	Klondike-D-303	1.4	1.6	0.2	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	9	80	62	-23%	41	-49%	0.17	0.17	0.00	-	1.1	-
Shirley's Brook U/S of Klondike Rd	Klondike-S-100	1.65	2.2	0.5	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	80	-	63	-	-	0.28	-	-	1.1	-
Shirley's Brook U/S of Marconi Ave	Klondike-S-101	8.4	8.1	-0.3	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	9	80	76	-5%	57	-29%	0.17	0.55	0.38	-	1.1	-
Shirley's Brook U/S of OCR	Klondike-S-102	3.49	3.7	0.3	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	75	-	56	-	-	0.28	-	-	1.1	-
Shirley's Brook U/S of March Valley Road	Klondike-S-200	5.67	4.8	-0.8	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	-	9	80	73	-9%	53	-34%	0.17	1.14	0.97	-	1.1	-
	Total Area:	**87.9**	**84.5**	**-3.4**																										

Drainage Area ID	GIS ID	Drainage Area (ha)			HYD		XIMP[2]			TIMP[1]			Slope (%) (perv / imp)		MNP / MNI		Length (m) (perv / imp)		IA (mm) (perv / imp)		Curve Number [2] AMC II			AMC I		TP (hrs)			N		
		Dillon	AECOM	Difference	Dillon	AECOM	Dillon	AECOM	Difference	Dillon	AECOM	Difference	Dillon	AECOM	Dillon	AECOM	Dillon	AECOM	Dillon	AECOM	Dillon	AECOM[1]	Difference	AECOM[1]	Difference	Dillon	AECOM	Difference	Dillon	AECOM	Difference
Remaining Shirley's Brook Area	SB-5A	690.2	134.0	348.7	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	9	9	68	76	12%	57	-16%	1	2.05	1.05	1.1	1.1	0.00
(Dillon's Model)	SB-5B		904.9			NASHYD		-	-		-	-		-		-		-		9		69	1%	48	-29%		3.38	2.38		1.1	0.00
	SB-6A	124.3	56.3	-68.0	NASHYD	STANDHYD	-	0.37	-	-	0.44	-	-	2.0 / 0.2	-	0.250 / 0.025	-	40 / 2840	9	4.67 / 1.57	72	59	-18%	38	-48%	0.9	-	-	1.1	-	-
	SB-6B		80.1			NASHYD		-	-		-	-		-		-		-		9		67	-7%	46	-36%		3.40	2.50		1.1	0.00
	SB-7	163.3	100.8	-62.5	NASHYD	NASHYD	-	-	-	-	-	-	-	-	-	-	-	-	9	9	74	84	14%	69	-7%	0.7	2.21	1.51	1.1	1.1	0.00
	Total Area:	**977.8**	**1276.1**	**298.3**																										

Table C-1-7
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SUMMARY OF SHIRLEY'S BROOK SWMHYMO MODEL STAGE-STORAGE-DISCHARGE ESTIMATES

Project No.: 60264539
Date: 02/06/15
Design: GAF/OC

Notes:

1. Stage-storage-discharge obtained from report R-1425-B.
2. Storage volume obtained from available engineering drawings.
3. Outlet diameter obtained from available engineering drawings.
4. Storage volume was estimated assuming 1m deep, V-shaped ditch with a side slope of 3:1 and a measured length from available plan and profile drawings.
5. Discharge control type obtained from available plan and profile drawings.
6. Stage-storage-discharge was estimated assuming 5-year level control.
7. Storage volume estimated based on grading information from available engineering drawing.
8. Stage-storage-discharge obtained from project CP-09-270 by Mcintosh Perry.
9. Stage-discharge estimated with HEC-RAS analysis.
10. Stage-storage-discharge from previous SWMHYMO model (Novatech 2007) was assumed due to the lack of information.
11. Stage-storage-discharge obtained from report R-1502-B.
12. Stage-storage-discharge obtained from report R-1502-A.
13. Stage-storage-discharge obtained from report R-1588.
14. Stage-storage-discharge obtained from report R-1589.
15. Stage-storage-discharge obtained from report R-0093.

Morgan's Grant 10A

SWF-1228 West Cell		
Elev. (m)	Storage Volume [1] (m^3)	Discharge [1] (m^3/s)
-	0	0
-	400	0.02
-	800	0.08
-	1250	0.18
-	1650	0.29
-	2100	0.43
-	2550	0.58
-	2900	0.74

SWF-1228 East Cell		
Elev. (m)	Storage Volume [1] (m^3)	Discharge [1] (m^3/s)
-	0	0
-	400	0.05
-	800	0.12
-	1200	0.2
-	1600	0.27
-	1900	0.33
-	2300	0.39
-	2700	0.44
-	3200	0.5
-	3600	0.55

Ponding Area 2 & 3			
Elev. (m)	Storage Volume [2] (m^3)	Discharge [3] (m^3/s)	Diameter (mm)
-	0	0	300
-	1688	0.07	

Ponding Area 4, 5A & 5B			
Elev. (m)	Storage Volume [2] (m^3)	Discharge [3] (m^3/s)	Diameter (mm)
-	0	0	375
-	3800	0.10	

Ponding Area 1A & 1B			
Elev. (m)	Storage Volume [2] (m^3)	Discharge [3] (m^3/s)	Diameter (mm)
-	0	0	200
-	984	0.03	

North Ditch along TFR			
Elev. (m)	Storage Volume [4] (m^3)	Discharge [5] (m^3/s)	Outlet Control Type
-	0	0	D
-	660	0.09	

South Ditch along TFR			
Elev. (m)	Storage Volume [4] (m^3)	Discharge [5] (m^3/s)	Outlet Control Type
-	0	0	D
-	900	0.09	

Northtech Campus

Representative Pond in 402-2		
Elev. (m)	Storage Volume [6] (m^3)	Discharge [6] (m^3/s)
-	0	0
-	19000	0.40

Representative Pond in 862-2		
Elev. (m)	Storage Volume [6] (m^3)	Discharge [6] (m^3/s)
-	0	0
-	6200	0.11

Kanata Research Park

Private Pond in Golf Course		
Elev. (m)	Storage Volume [6] (m^3)	Discharge [6] (m^3/s)
-	0	0
-	520	0.36

Golf Course SWMF #1			
Elev. (m)	Storage Volume [7] (m^3)	Discharge [3] (m^3/s)	Diameter (mm)
72.00	0	0	546
74.50	2441	1.24	
75.00	7593	1.37	
75.50	13286	1.49	

Unnamed Pond in KRP-2		
Elev. (m)	Storage Volume [6] (m^3)	Discharge [6] (m^3/s)
-	0	0
-	1800	0.16

South March Community

Unnamed Pond in 701D		
Elev. (m)	Storage Volume [8] (m^3)	Discharge [8] (m^3/s)
74.78	0	0
74.87	40	0.04
75.05	128	0.05

Unnamed Pond in 701B		
Elev. (m)	Storage Volume [6] (m^3)	Discharge [6] (m^3/s)
-	0	0
-	410	0.07

SWF-1215		
Elev. (m)	Storage Volume [7] (m^3)	Discharge [9] (m^3/s)
72.80	0	0.00
73.00	787	0.18
73.50	3396	1.50
74.00	6941	7.40
74.80	14614	48.3

Morgan's Grant

Bidgood Pond		
Elev. (m)	Storage Volume [10] (m^3)	Discharge [10] (m^3/s)
-	0	0
-	110	0.83
-	1120	0.88

SWF-1227 Forebay		
Elev. (m)	Storage Volume [11] (m^3)	Discharge [11] (m^3/s)
-	0	0
-	1165	1.10
-	1890	3.50
-	2500	7.00

SWF-1227 Wet Cell		
Elev. (m)	Storage Volume [11] (m^3)	Discharge [11] (m^3/s)
-	0	0
-	6100	1.80
-	8600	3.00
-	13200	5.50

Klondike

SWF-1236		
Elev. (m)	Storage Volume [12] (m^3)	Discharge [12] (m^3/s)
-	0	0
-	714	0.02
-	4900	0.14
-	7300	0.45
-	7600	1.40

SWF-1234		
Elev. (m)	Storage Volume [13] (m^3)	Discharge [13] (m^3/s)
-	0	0
-	1060	0.02
-	1900	0.04
-	4010	0.33
-	5630	0.38
-	7350	0.43
-	9170	9.71

SWF-1235		
Elev. (m)	Storage Volume [14] (m^3)	Discharge [14] (m^3/s)
-	0	0
-	1900	0.02
-	2200	0.04
-	3940	0.32
-	5480	0.37
-	7090	0.42
-	8800	7.69

Shirley's Brook Northeast

SWF-1213		
Elev. (m)	Storage Volume [15] (m^3)	Discharge [15] (m^3/s)
-	0	0
-	5000	0.20
-	14000	1.20
-	23000	1.80
-	32500	2.36
-	42000	9.20
-	51500	24.7

TABLE C-1-8
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
2011 & 2012 CALIBRATION EVENT RAINFALL DATA
Version: 1
Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

SWMHYMO Storm Files

	Event 2011-1	Event 2011-2	Event 2011-3	Event 2012-1	Event 2012-2
	2	2	2	2	2
	Event 2011-1	Event 2011-2	Event 2011-3	Event 2012-1	Event 2012-2
Event	15	15	15	15	15
Details	144	115	38	179	65
0:00	0.8	8.0	1.6	0.8	0.8
0:15	1.6	20.0	7.2	0.8	0.0
0:30	0.8	0.8	10.4	0.8	0.0
0:45	0.0	0.0	9.6	1.6	0.0
1:00	0.8	0.0	3.2	0.8	0.0
1:15	5.6	0.0	2.4	0.8	1.6
1:30	0.0	0.0	0.0	0.8	5.6
1:45	0.8	0.0	0.0	1.6	0.0
2:00	0.8	0.0	0.8	3.2	0.0
2:15	0.0	0.0	24.8	2.4	0.0
2:30	0.8	0.0	32.8	2.4	0.0
2:45	0.8	0.0	11.2	3.2	0.0
3:00	0.0	0.8	5.6	4.8	0.0
3:15	0.0	0.0	11.2	2.4	0.0
3:30	0.8	0.8	1.6	3.2	0.0
3:45	0.0	8.8	1.6	3.2	0.0
4:00	0.0	35.2	1.6	3.2	0.0
4:15	0.8	5.6	0.8	0.8	0.0
4:30	0.0	4.8	0.0	0.8	0.0
4:45	0.0	2.4	0.0	0.0	0.8
5:00	0.0	2.4	0.8	0.0	6.4
5:15	0.8	0.0	0.0	0.8	8.0
5:30	0.0	0.8	0.0	0.0	0.8
5:45	0.0	1.6	0.0	0.8	0.8
6:00	0.0	1.6	0.0	2.4	0.0
6:15	0.8	1.6	0.0	3.2	0.0
6:30	0.0	1.6	0.0	4.8	0.0
6:45	0.0	0.0	0.0	4.8	0.0
7:00	0.0	0.0	0.0	4.0	0.0
7:15	0.0	0.0	0.0	3.2	0.0
7:30	0.0	0.0	0.0	2.4	0.0
7:45	0.0	0.0	0.0	0.0	0.8
8:00	0.8	0.0	1.6	0.8	0.8
8:15	0.0	0.0	0.8	0.8	0.0
8:30	0.0	0.0	28.8	0.8	0.0
8:45	0.8	0.0	11.2	0.0	0.0
9:00	0.0	0.0	5.6	0.8	0.0
9:15	0.0	0.0	0.8	0.0	0.0
9:30	0.0	0.0	-1.0	1.6	0.0
9:45	0.0	0.0		0.8	0.0
10:00	0.0	0.0		0.0	0.0
10:15	0.0	0.0		0.8	0.0
10:30	0.0	0.0		0.0	0.8
10:45	0.0	0.0		1.6	19.2
11:00	2.4	0.0		0.0	57.6
11:15	4.8	0.0		0.0	6.4
11:30	1.6	4.8		0.0	0.0
11:45	1.6	0.0		0.0	0.8
12:00	2.4	0.0		0.8	22.4
12:15	4.0	0.0		0.8	5.6
12:30	11.2	0.0		0.8	0.0
12:45	3.2	0.0		0.8	0.8
13:00	2.4	0.0		0.0	5.6
13:15	1.6	0.0		0.0	20.8
13:30	1.6	0.0		0.8	2.4
13:45	0.8	0.0		0.0	0.8
14:00	1.6	0.0		0.0	4.0
14:15	0.8	0.0		0.0	10.4
14:30	0.8	0.0		0.8	4.8
14:45	1.6	0.0		0.8	2.4
15:00	1.6	0.0		2.4	4.8
15:15	1.6	0.0		1.6	20.0
15:30	1.6	0.0		0.0	28.8
15:45	1.6	0.0		0.0	24.8
16:00	1.6	0.0		0.0	6.4
16:15	1.6	0.0		0.0	-1.0
16:30	1.6	0.0		0.0	
16:45	1.6	0.8		0.0	
17:00	1.6	0.0		0.0	
17:15	1.6	0.0		0.0	
17:30	0.8	0.0		0.0	
17:45	1.6	0.0		0.0	
18:00	1.6	0.0		0.0	
18:15	1.6	0.0		1.6	
18:30	0.8	0.0		4.8	
18:45	1.6	0.0		2.4	
19:00	1.6	0.0		0.8	
19:15	0.0	2.4		0.8	
19:30	1.6	0.0		0.0	
19:45	0.0	7.2		1.6	
20:00	1.6	0.0		1.6	
20:15	0.8	0.0		1.6	
20:30	1.6	4.0		1.6	
20:45	3.2	0.0		0.8	
21:00	2.4	0.0		1.6	

21:15	2.4	0.0		0.0	
21:30	0.8	0.0		0.8	
21:45	0.8	0.0		0.0	
22:00	0.8	1.6		0.0	
22:15	1.6	3.2		0.0	
22:30	0.8	0.0		0.0	
22:45	0.0	0.0		0.0	
23:00	0.0	0.0		0.0	
23:15	0.0	16.8		0.8	
23:30	0.8	5.6		0.0	
23:45	0.0	0.8		0.0	
0:00	0.0	0.8		0.0	
0:15	0.0	12.8		0.0	
0:30	0.8	0.0		0.0	
0:45	0.0	0.8		0.0	
1:00	0.0	2.4		0.0	
1:15	1.6	32.0		0.0	
1:30	0.8	32.0		0.0	
1:45	0.8	3.2		0.0	
2:00	2.4	4.8		0.0	
2:15	0.8	4.0		0.0	
2:30	0.8	0.0		0.0	
2:45	1.6	3.2		0.8	
3:00	1.6	0.0		0.0	
3:15	0.8	0.0		0.0	
3:30	0.8	2.4		0.0	
3:45	0.0	4.0		0.0	
4:00	0.8	3.2		1.6	
4:15	0.8	3.2		0.8	
4:30	1.6	0.8		0.0	
4:45	0.0	-1		0.8	
5:00	0.8			0.0	
5:15	0.8			0.0	
5:30	0.8			0.0	
5:45	0.0			0.0	
6:00	0.0			0.0	
6:15	0.0			0.0	
6:30	0.8			0.0	
6:45	0.0			0.0	
7:00	0.8			0.0	
7:15	0.0			0.0	
7:30	0.0			0.0	
7:45	0.8			0.0	
8:00	0.0			0.0	
8:15	0.0			0.0	
8:30	0.8			0.0	
8:45	0.8			0.0	
9:00	0.0			0.0	
9:15	0.0			0.8	
9:30	0.0			0.0	
9:45	0.0			0.0	
10:00	0.8			1.6	
10:15	0.0			0.8	
10:30	0.8			0.0	
10:45	0.8			1.6	
11:00	0.0			0.0	
11:15	0.0			0.0	
11:30	0.0			1.6	
11:45	0.8			0.0	
12:00	-1			2.4	
12:15				0.0	
12:30				0.0	
12:45				0.0	
13:00				1.6	
13:15				0.0	
13:30				0.8	
13:45				2.4	
14:00				0.0	
14:15				0.0	
14:30				0.8	
14:45				0.0	
15:00				0.0	
15:15				0.0	
15:30				0.0	
15:45				0.0	
16:00				0.0	
16:15				0.0	
16:30				0.0	
16:45				0.0	
17:00				0.0	
17:15				0.0	
17:30				2.4	
17:45				0.0	
18:00				0.0	
18:15				0.0	
18:30				0.0	
18:45				0.8	
19:00				0.0	
19:15				0.0	
19:30				0.0	
19:45				0.8	
20:00				0.0	
20:15				0.0	
20:30				0.8	
20:45				-1.0	
Total (mm)	**32.6**	**63.4**	**44.0**	**31.4**	**69.0**

TABLE C-1-9
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
CALIBRATION & VERIFICATION STORM EVENT IDF COMPARISON

Version: 1.0
Project No.: 60164823
Date: 2/6/2015
Design: GAF/OC
Notes:

1. Rainfall intensities calculated from IDF equations extracted from Section 5.3.2 of City of Ottawa Sewer Design Guidelines
2. Based on the highest among the available rain gauges

Coeff	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
A	732.951	998.071	1174.184	1402.884	1569.58	1735.688
B	0.81	0.814	0.816	0.819	0.82	0.82
C	6.199	6.053	6.014	6.018	6.014	6.014

Time (min)	City of Ottawa IDF Curves						2013 Storm Event IDF Curves [2]				
	2 Year (mm/hr)	5 Year (mm/hr)	10 Year (mm/hr)	25 Year (mm/hr)	50 Year (mm/hr)	100 Year (mm/hr)	May 10 - 11 2013-1	May 21 - 24 2013-2	Jun 1 - 2 2013-3	Jun 6 - 8 2013-4	Jun 10 - 12 2013-5
5	103.6	141.2	165.8	196.6	219.5	242.7	19.2	38.4	76.8	7.2	9.6
10	76.8	104.2	122.1	144.7	161.5	178.6	13.2	34.8	61.2	6.0	8.4
15	61.8	83.6	97.9	115.8	129.2	142.9	10.4	28.8	56.0	4.8	8.0
30	40.0	53.9	63.0	74.5	83.1	91.9	6.8	20.8	41.2	4.8	6.0
60	24.6	32.9	38.5	45.4	50.5	55.9	5.4	16.0	23.0	3.4	5.0
120	14.6	19.5	22.7	26.7	29.7	32.9	4.0	10.1	11.7	2.8	4.0
360	6.1	8.2	9.5	11.2	12.4	13.7	2.4	3.4	3.9	2.2	2.8
720	3.5	4.7	5.4	6.4	7.1	7.8	1.9	1.7	2.0	1.9	2.0
1440	2.0	2.7	3.1	3.6	4.0	4.4	1.0	1.0	1.1	1.3	1.3

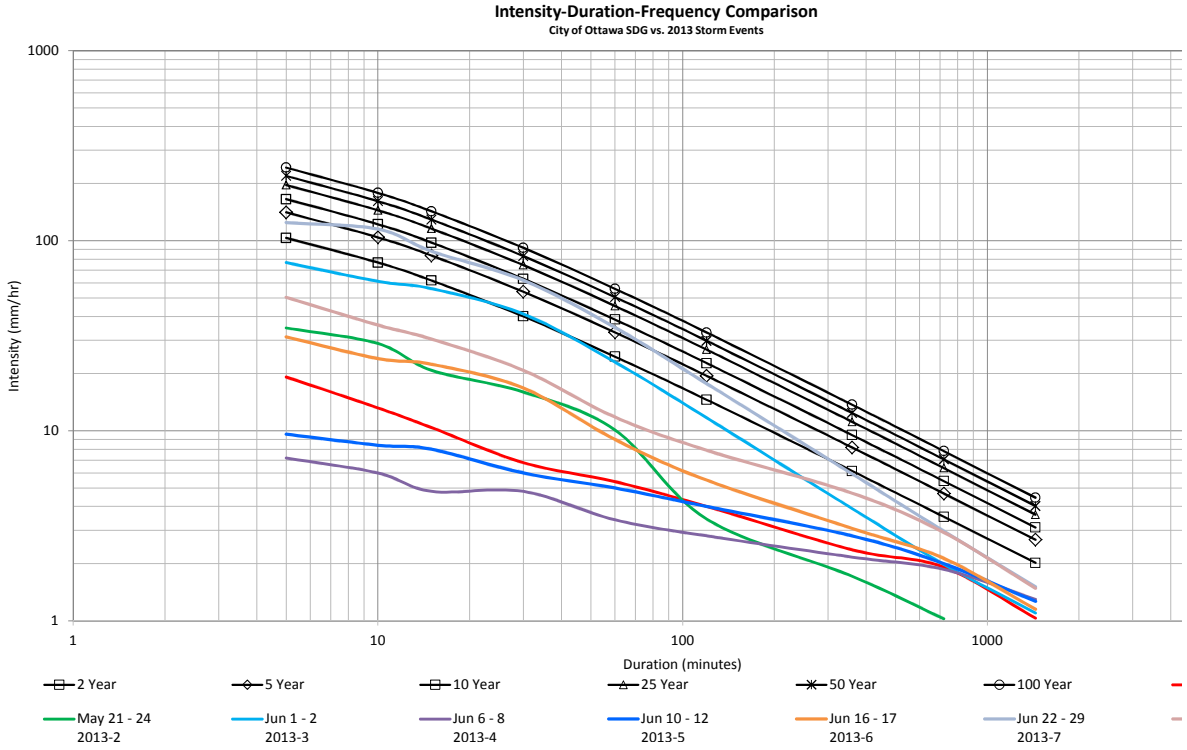


TABLE C-1-10

CITY OF OTTAWA

SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY

SUMMARY OF XPSWMM BEAVER POND / KIZELL CELL INITIAL WATER LEVELS

Version: 1
Project No.: 60264539
Date: 2/6/2015
Design: GAF/SN

Notes:

1 Beaver Pond outlet invert elevation is 87.63m

2. Invert of Beaver Pond outlet structure is 90.42 m.

Event Description	Water Levels (m)	
	Initial Depth (m)	Initial Elevation (m)[1]
2011-1	2.89	90.52
2011-2	3.06	90.69
2011-3	2.79	90.42
2012-1	2.93	90.56
2012-2	2.86	90.49
Design Events	2.79	90.42

TABLE C-1-11
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
HYDROLOGIC MODEL (SWMHYMO) CALIBRATION & VERIFICATION ASSESSMENT

Version: 2
Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Contributing Stream Gauge Areas (obtained from GIS data used in SWMHYMO model)

Beaver Pond =	416 ha
Shirley's Brook =	1767 ha
Watt' Creek =	2171 ha

Notes:

1 *Rainfall duration may include multiple storm cells occurring within no greater than 24 hour inter-event time.*
2 *Total depth represents depth over entire event duration.*
3 *Antecedent Moisture Conditions (AMC) prior to start of storm event (<*
4 *Surface runoff calculated using simplified linear baseflow separation.*
5 *Estimated Initial Abstraction (Ia) measured from start of rainfall event to runoff response for first storm cell only. Approx. avg. of 7 mm & 9 mm for Watts Creek /Kizell Drain and Shirley's Brook respectively assumed in SWMHYMO model calibration.*
6 *Represents maximum Peak Flow (PF) over rainfall event.*
7 *Estimated Runoff Lag Time (RLT) assessed from start of runoff response to peak runoff response for each storm cell. Where recorded flows exceed City's rating curve, RLT estimates are based on water depth data where available.*
8 *Rainfall Volume (RFV) calculated using total rainfall depth / contributing Drainage Area (DA). Runoff Volume (ROV) calculated from start of runoff response to end of response and includes entire rainfall event.*
9 *"n/a" - data not available / cannot be calculated.*
10 *Missing data / comparison not calculated.*
11 *+ -data considered suspect.*

Event No.	Rainfall Event Details (Point Rainfall)												
	Rainfall Duration [1]		Total Hours (hr)	Total Depth [2] (mm)	Rainfall Volume (RFV - ha.m) [8]			AMC Conditions [3]		Initial Abstraction (Ia - mm) [5]			
	From (mm/dd/yy/hh:mm)	To (mm/dd/yy/hh:mm)			Upper Kizell (Beaver Pond)	Shirley's Brook	Watt's Creek	3-Day (mm)	5-day (mm)	Upper Kizell (Beaver Pond)	Shirley's Brook	Watt's Creek
2011-1	5/13/11 9:15 PM	5/15/11 9:00 AM	35.75	32.6	13.56	57.60	70.77	0.0	0.0	13	8	14
2011-2	6/23/11 5:45 PM	6/24/11 10:15 PM	28.50	63.4	26.37	112.03	137.64	5.2	5.2	7	7	7
2011-3	10/20/11 12:15 AM	10/20/11 9:30 AM	9.25	44.0	18.30	77.75	95.52	2.0	8.2		9	22 +
2012-1	4/23/12 1:00 AM	4/24/12 9:30 PM	44.50	31.4	13.06	55.48	68.17	12.8	15.0	7	10	9
2012-2	9/7/12 8:45 PM	9/8/12 12:45 PM	16.00	69.0	28.70	121.92	149.80	2.8	12.6	7		7

Event No.	Peak Flow (PF - m^3/s) [6]											
	Upper Kizell (Beaver Pond)				Shirley's Brook				Watt's Creek			
	Recorded	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-)%	Recorded	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-)%	Recorded	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-)%
2011-1					0.4	0.9	0.7	103%/71%	0.4	2.0	1.8	454%/401%
2011-2	0.37	0.63	0.96	71%/160%		5.4	6.0					
2011-3					1.3	3.5	1.9	169%/45%		6.0	4.2	
2012-1	0.09	0.27	0.17	202%/93%		0.87	0.60		0.36	1.68	1.03	367%/186%
2012-2	0.20	0.75	0.65	267%/218%						14.0	10.8	

Event No.	Est. Runoff Lag Time (RLT - hr) [7]											
	Upper Kizell (Beaver Pond)				Shirley's Brook				Watt's Creek			
	Recorded	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-) hrs	Recorded	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-) hrs	Recorded	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-) hrs
2011-1					24.25	21.25	21.00	-3.0/-3.25	10.00	11.25	11.25	1.25/1.25
2011-2	32.50	29.75	30.50	-2.75/-2.0		27.00	27.00					
2011-3					6.75	4.25	4.25	-2.5/-2.5		5.50	5.50	
2012-1	35.75				20.00				18.75	9.50	10.50	-9.25/-8.25
2012-2	18.50	17.50	17.00	-1.0/-1.5						15.25	15.25	

Event No.	Runoff Volume (ROV - ha.m) [8]														
	Upper Kizell (Beaver Pond)					Shirley's Brook					Watt's Creek				
	Recorded	% RFV	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-)%	Recorded	% RFV	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-)%	Recorded	% RFV	Simulated (Point Rainfall)	Simulated (Distributed Rainfall)	Increase / Decrease (+/-)%
2011-1						4.64	8%	8.59	6.98	85%/51%	2.13	3%	17.56	15.55	724%/630%
2011-2	8.08	31%	9.36	22.90	16%/183%			25.86	28.92						
2011-3						5.82	7%	13.99	6.97	140%/20%			26.54	18.34	
2012-1	1.89	14%	3.68	2.53	95%/34%						3.24	5%	16.74	10.69	420%/230%
2012-2	5.27	18%	9.93	7.23	88%/37%								50.90	38.74	

Location	Rainfall Event Comparison vs. Radar Data (Distributed Rainfall)				
	Rainfall Depth (mm)				
	2011-1	2011-2	2011-3	2012-1	2012-2
March Road RG (measured)	32.6	63.4	44.0	31.4	69.1
March Road RG (radar)	31	123	34	21	57
St. Gabriel RG (measured)	-	-	-	35.0	85.0
St. Gabriel RG (radar)	30	114	26	23	56
Upper Kizell [1]	30	125	28	23	55
Watt's Creek [1]	31	113	35	22	58
Shirley's Brook [1]	29	67	29	24	73

Notes: 1. Weighted rainfall depth calculated using inverse-distance method.

TABLE C-1-12
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
CREST GAUGE COMPARISON TO SWMHYMO PEAK FLOWS

Version: 1
Project No.: 60264539
Date: 2/6/2015
Design: GAF/SN/CL

Notes: *1. Drainage area at crest gauge WC-1 is 819 ha vs. downstream flow point 849 ha.*
2. Shaded area comparison between crest gauges and SWMHYMO results.

Location	Peak Flow (cms)					
	2012-1			2012-2		
	AMC I	AMC II	Crest	AMC I	AMC II	Crest
SB-1	0.06	0.14	n/a	0.71	1.38	2.53
SB-2	0.63	0.67	n/a	4.49	5.90	2.43
SB-3	0.08	0.11	n/a	1.71	3.28	1.30
KD-1	0.67	0.73	n/a	4.12	5.20	1.19
KD-2	0.32	0.36	n/a	1.36	1.69	0.60
WC-1[1]	0.71	0.80	n/a	6.68	8.97	5.65

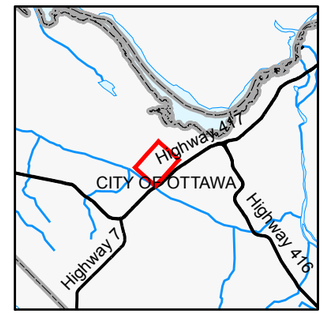
Legend

- Stream and River
- Urban Area with Site Level SWM
- Urban Area with No Identified SWM/ / No Available SWM Information
- Subcatchments

Available SWMF Information

- DETAILED
- PARTIAL
- NONE
- Storm Sewer
- Minor System Outlet
- Major System Flow Direction

Ottawa



Basemapping and orthophotography provided by the City of Ottawa.

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Shirley s Brook & Watt s Creek Phase 2 SWM Study

Existing Conditions SWMHYMO Model - Kizell Drain Urban Area

February 2015
60264539

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Figure C-1-1

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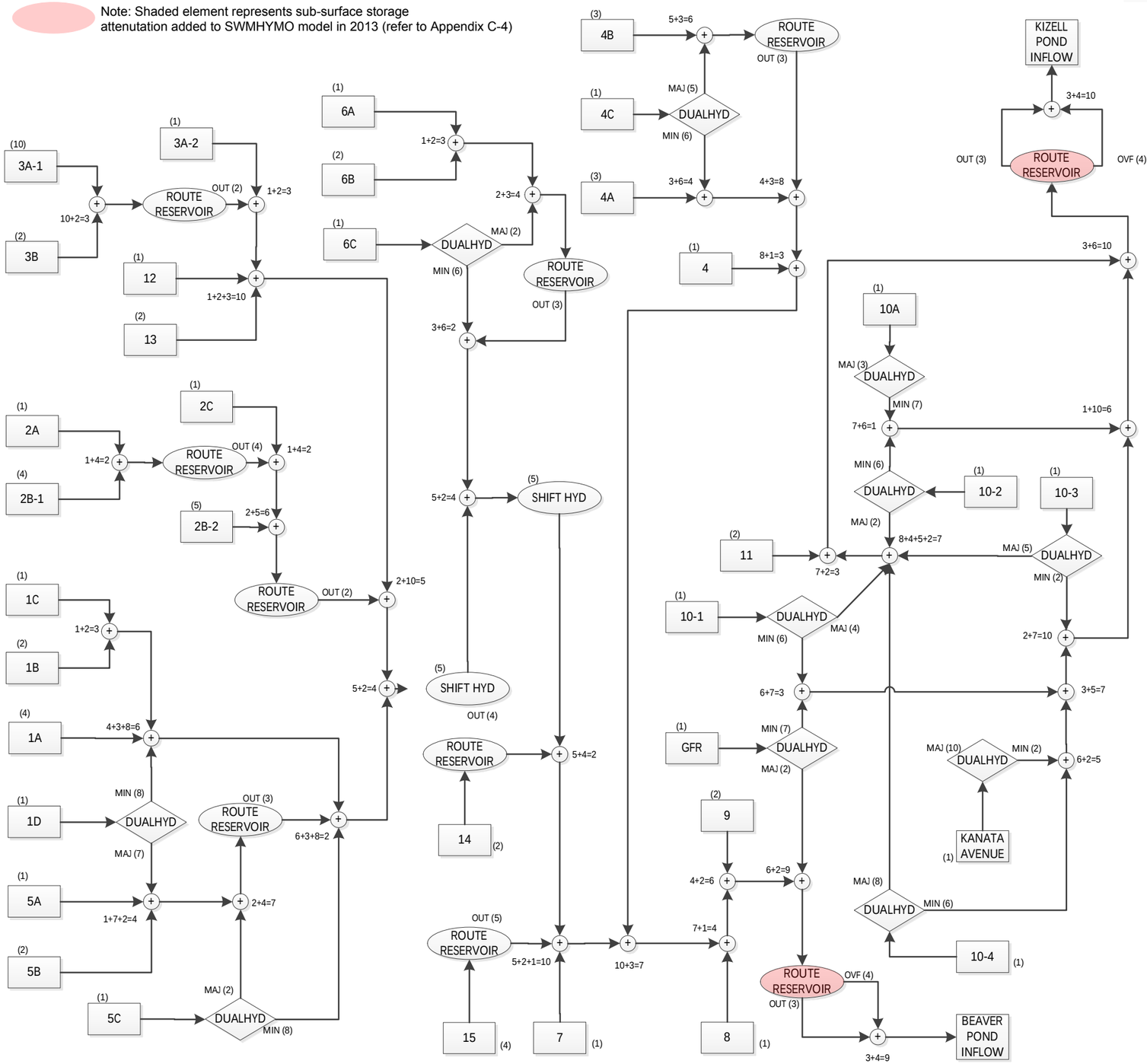
Watt's Creek/Upper Kizell SWMHYMO Model Schematics

Upper Kizell

Note: Shaded element represents sub-surface storage attenuation added to SWMHYMO model in 2013 (refer to Appendix C-4)



Watt's Creek

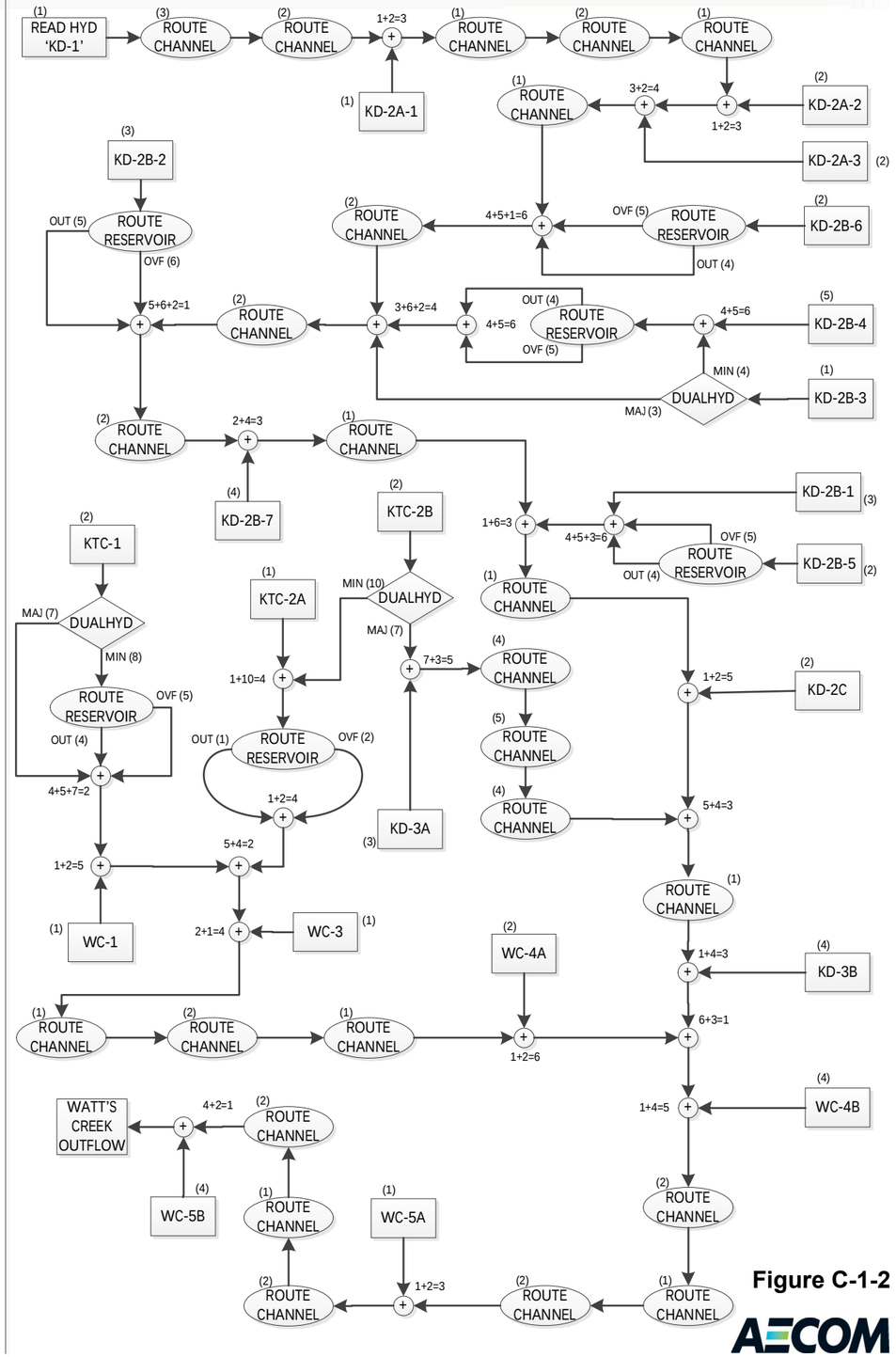
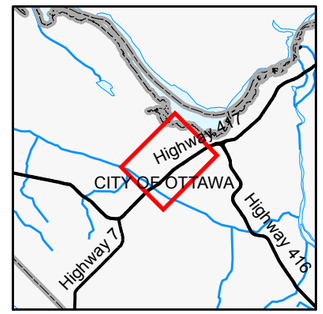


Figure C-1-2

Legend

- Stream and River
- Urban Area with Site Level SWM
- Urban Area with No Identified SWM/ No Available SWM Information
- Subcatchments



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Shirley s Brook & Watt s Creek Phase 2 SWM Study

Existing Conditions SWMHYMO Model - Watt's Creek

February 2015
60264539

AECOM

Figure C-1-3

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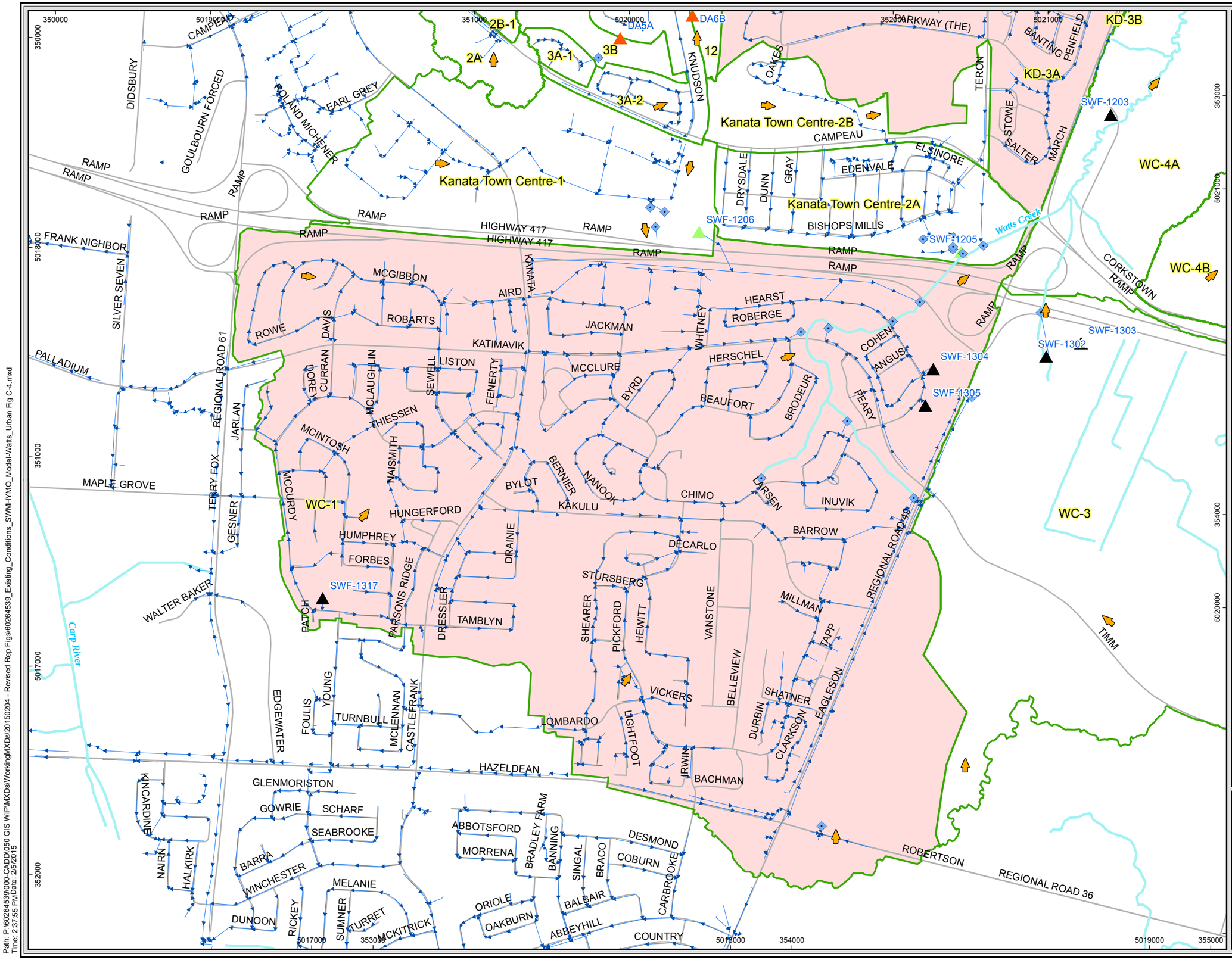
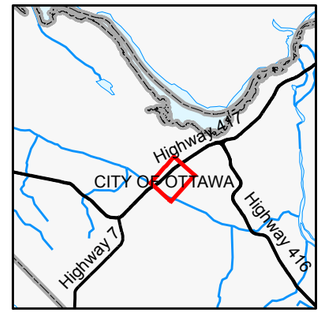


Legend

- Stream and River
- Urban Area with Site Level SWM
- Urban Area with No Identified SWM/ No Available SWM Information
- Subcatchments

Available SWMF Information

- DETAILED
- PARTIAL
- NONE
- Storm Sewer
- Minor System Outlet
- Major System Flow Direction



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Shirley s Brook & Watt s Creek Phase 2 SWM Study

Existing Conditions SWMHYMO Model - Watt's Creek Urban Area

February 2015
60264539

AECOM

Figure C-1-4

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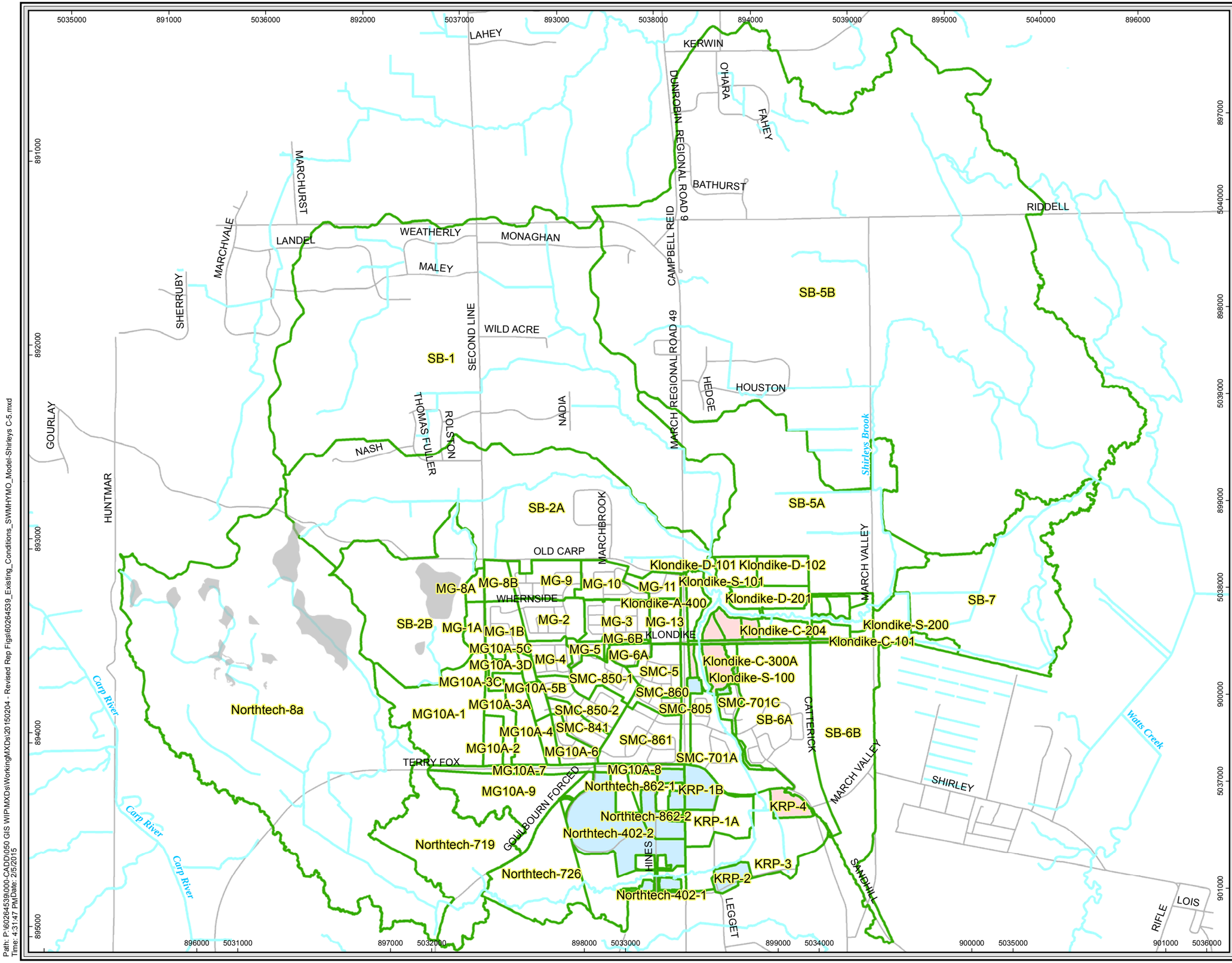
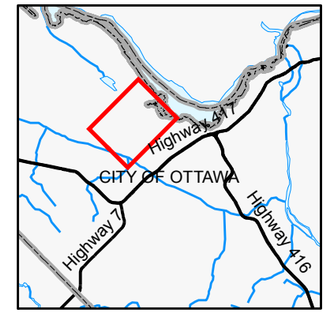


Legend

- Stream and River
- Urban Area with Site Level SWM
- Urban Area with No Identified SWM / No Available SWM Information
- Subcatchments
- Catchments with Depressional Topography (Increased Ia)



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Shirley s Brook & Watt s Creek Phase 2 SWM Study

Existing Conditions SWMHYMO Model - Shirley's Brook

February 2015
60264539

AECOM

Figure C-1-5

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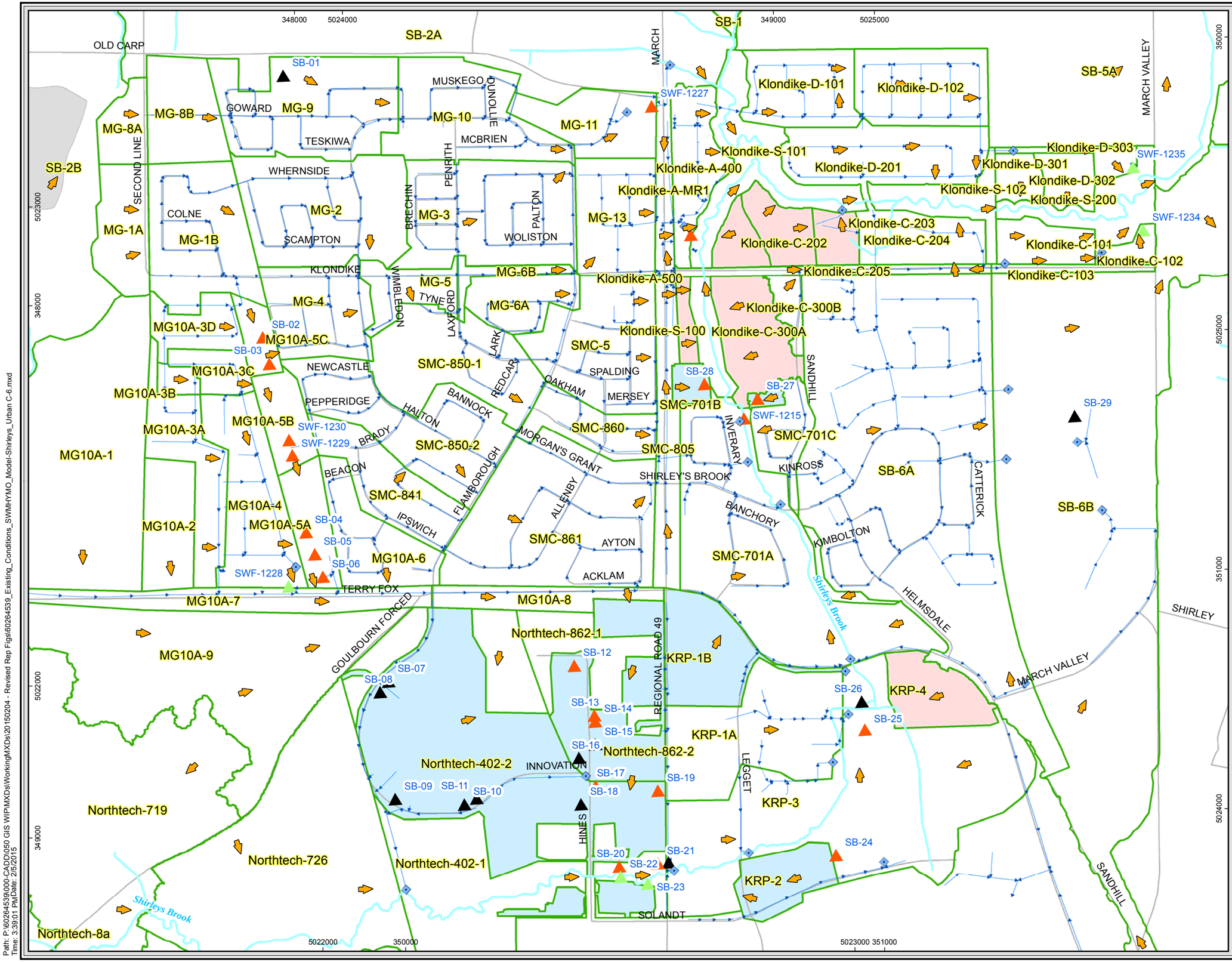


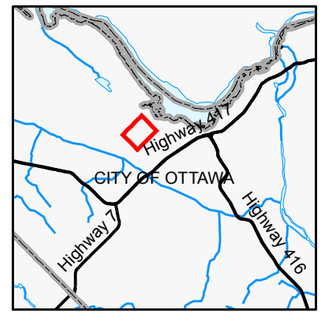
Legend

- Stream and River
- Urban Area with Site Level SWM
- Urban Area with No Identified SWM/ No Available SWM Information
- Subcatchments

Available SWMF Information

- DETAILED
- PARTIAL
- NONE
- Storm Sewer
- Minor System Outlet
- cutfill_poly

Major System Flow Direction



Basemapping and orthophotography provided by the City of Ottawa.

m
0 50 100 200 300 400
1:10,000
NAD 83, MTM 9

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Shirley s Brook & Watt s Creek Phase 2 SWM Study

Existing Conditions SWMHYMO Model - Shirley's Brook Urban Area

February 2015
60264539

AECOM

Figure C-1-6

Path: P:\60264539\000-CADD\050 GIS WIP\MXDs\Working\MXDs\20150204 - Revised Rep Figs\60264539_Existing_Conditions_SWMHYMO_Model-Shirleys_Urban C-6.mxd
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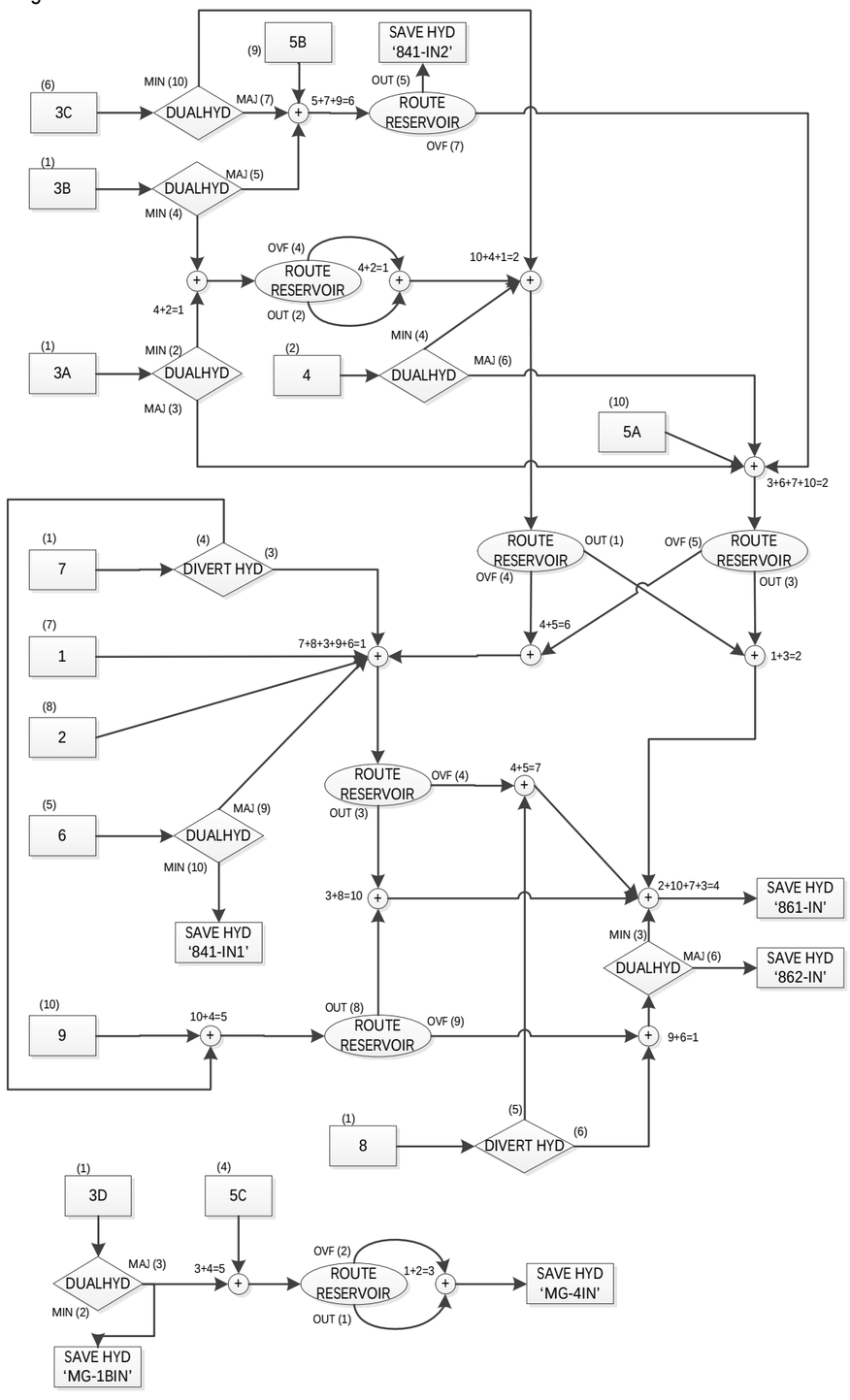
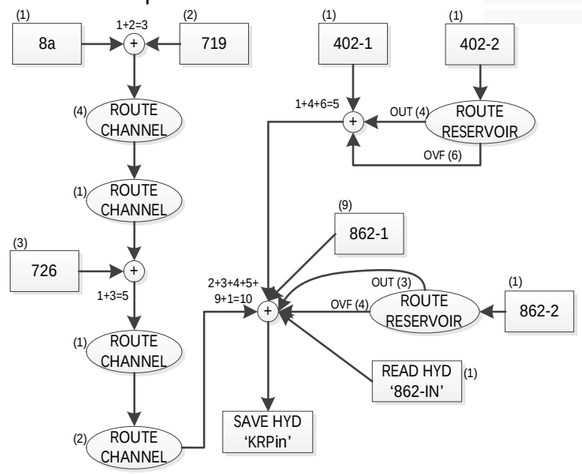
Shirley's Brook SWMHYMO Schematics

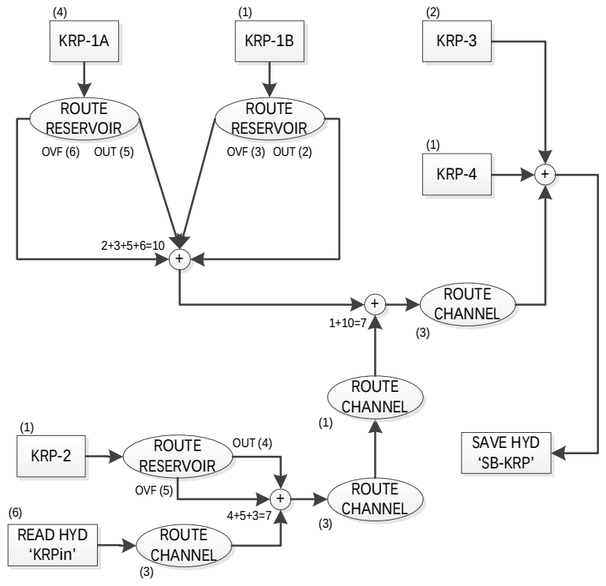
Morgan's Grant 10A



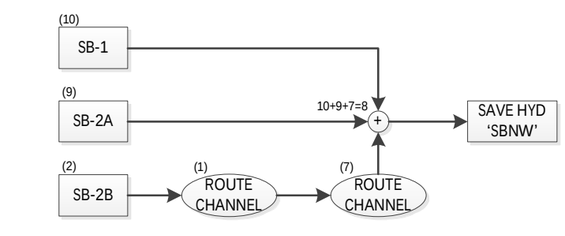
Northtech Campus



KRP



Shirley's Brook Northwest Branch



South March Community

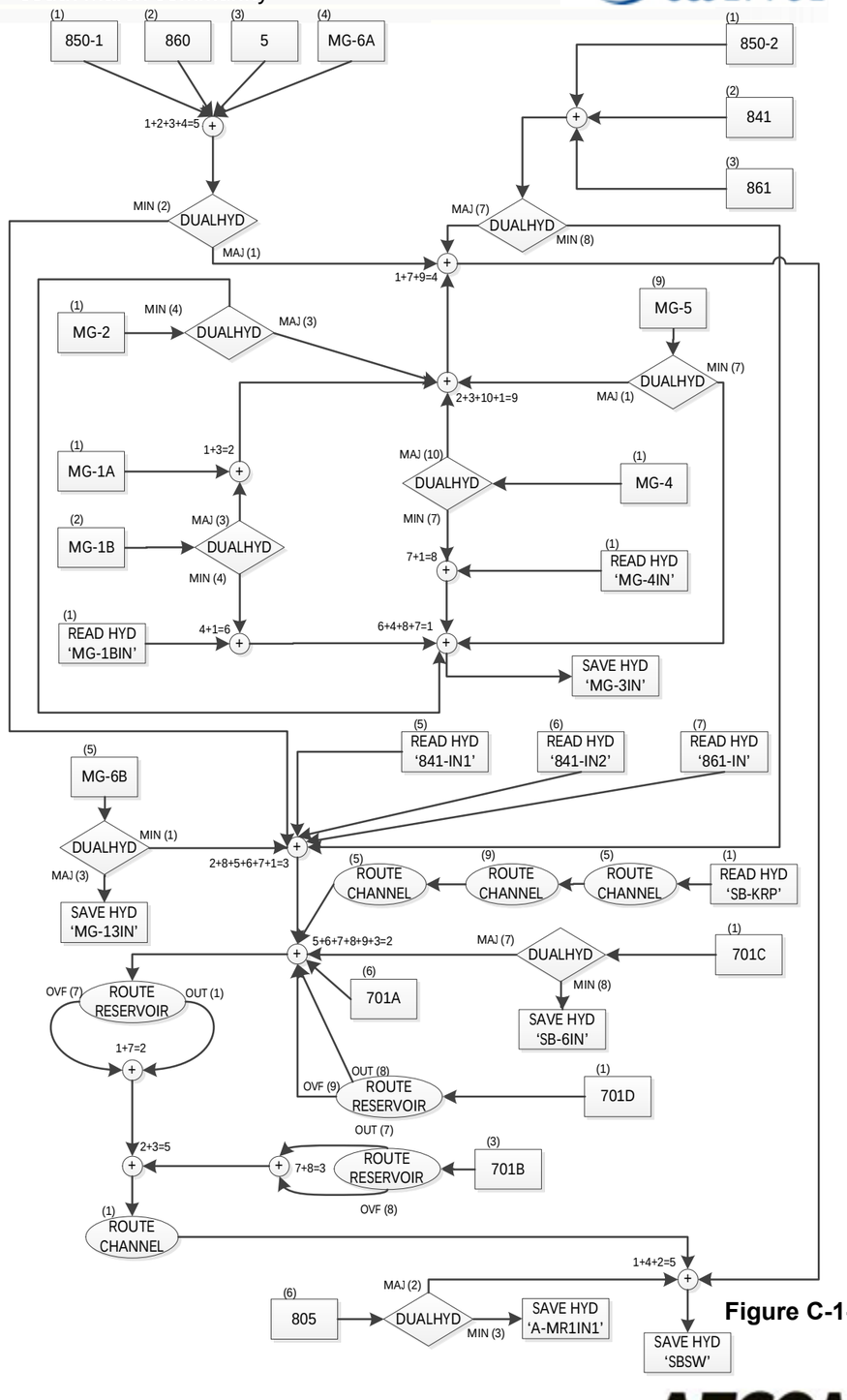
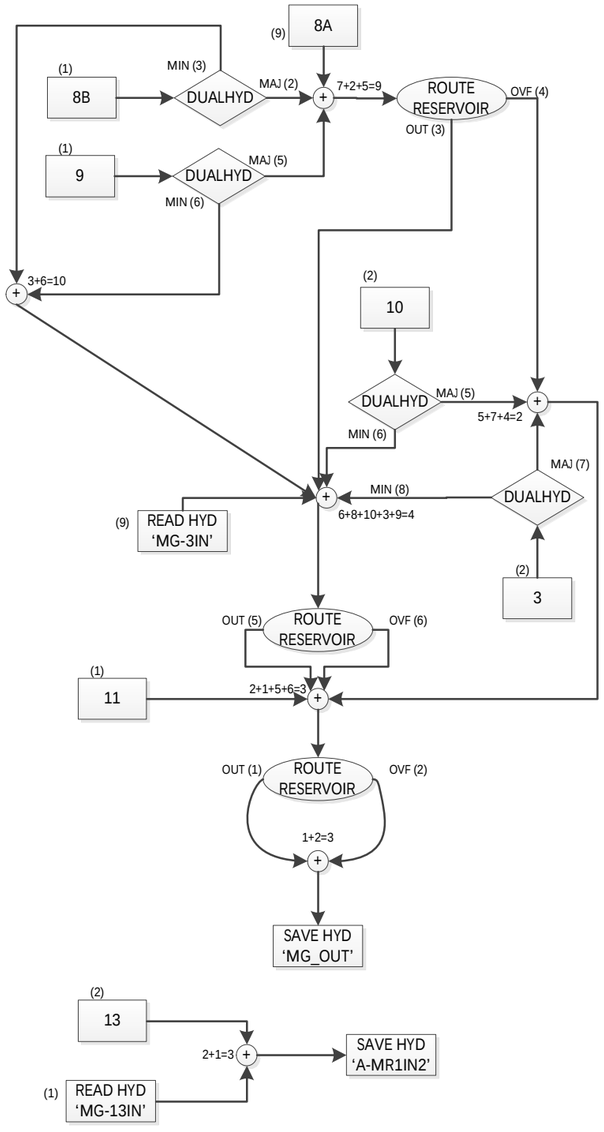


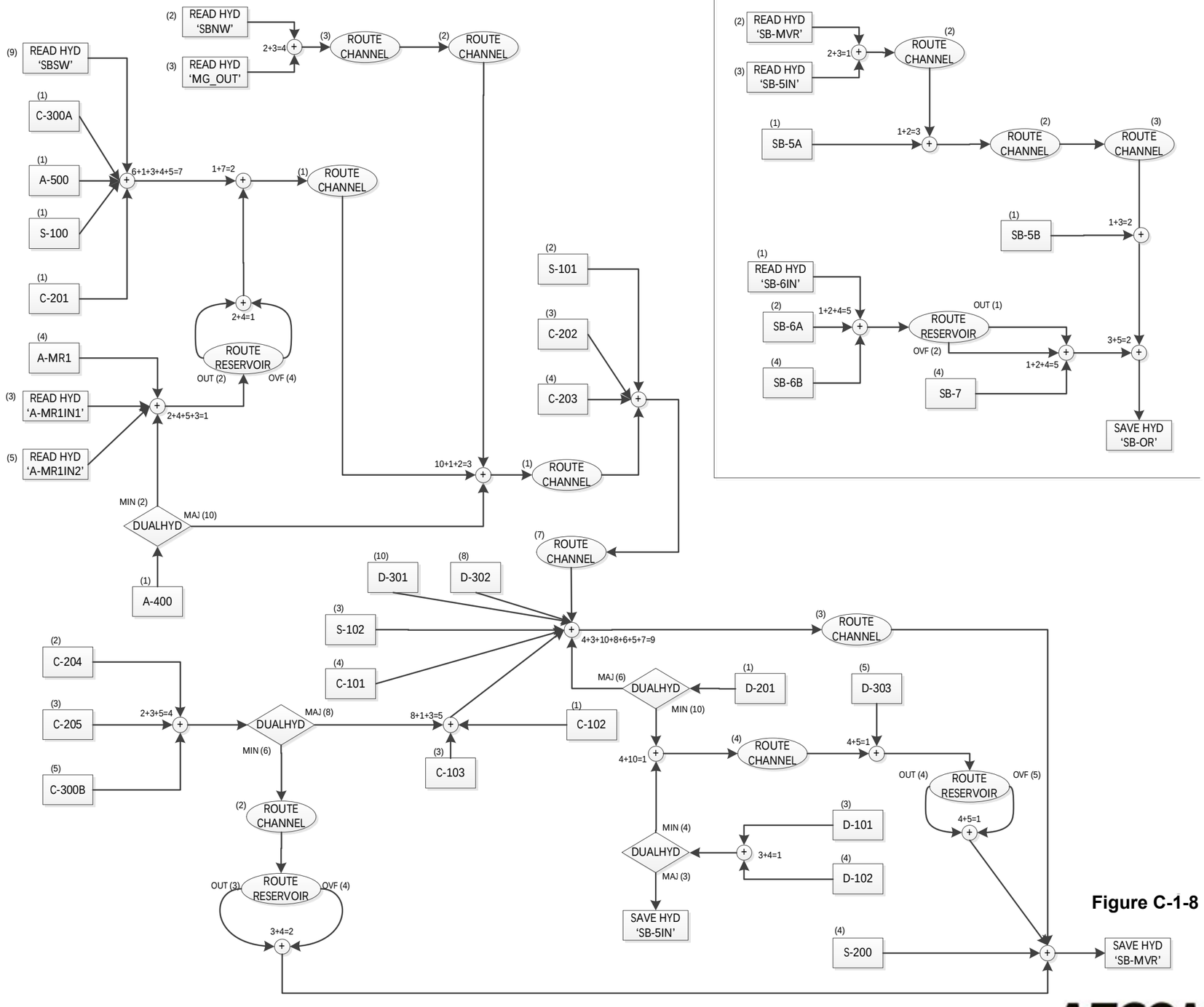
Figure C-1-7

Shirley's Brook SWMHYMO Schematics

Morgan's Grant



Klondike Road Subdivision



Shirley's Brook Northeast

Figure C-1-8

Rainfall & Streamflow Monitoring Data

2011

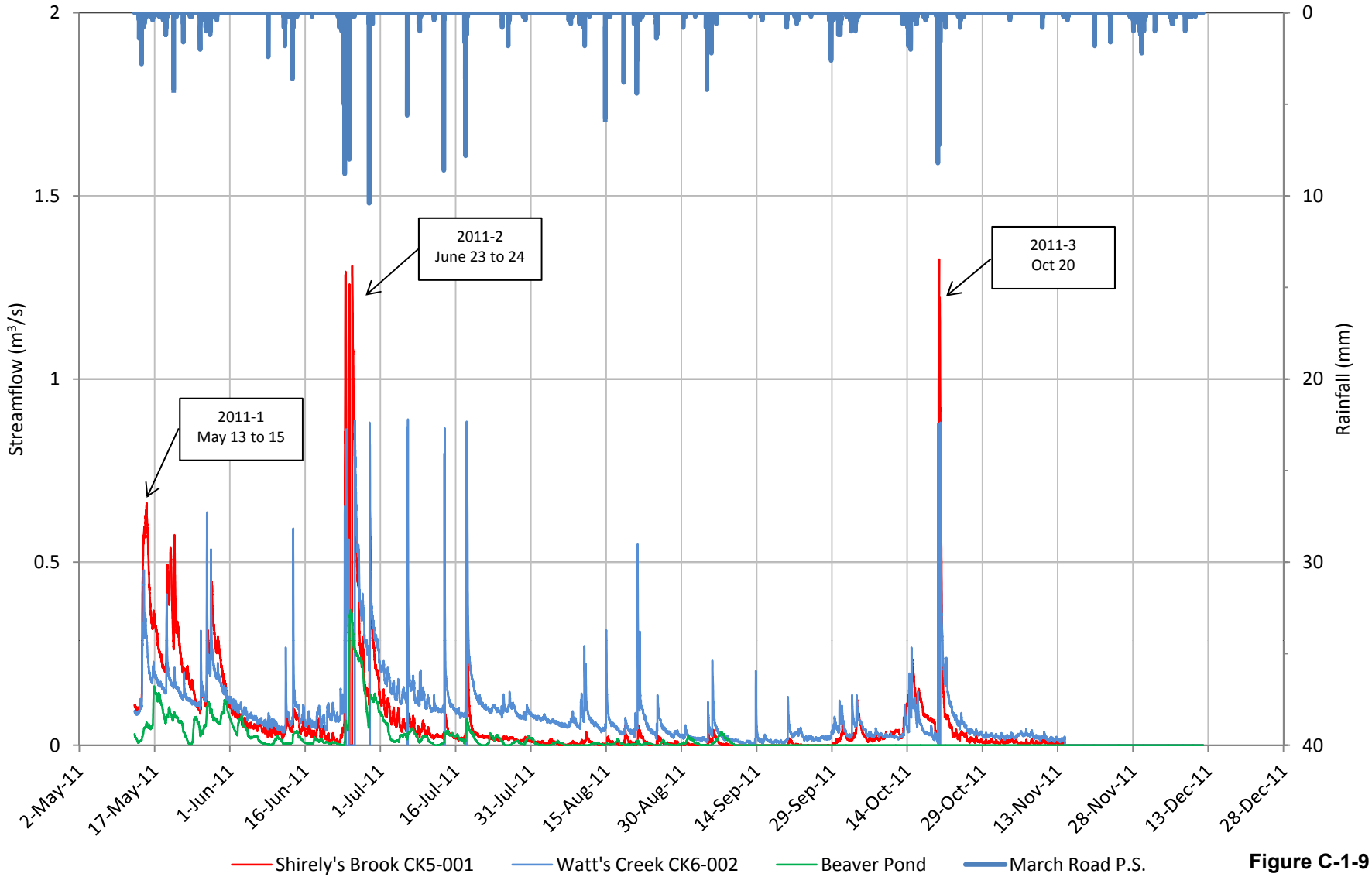


Figure C-1-9

Note: Monitoring data to end of April suspect due to potential snowmelt / frozen ground conditions

Rainfall & Streamflow Monitoring Data

2012

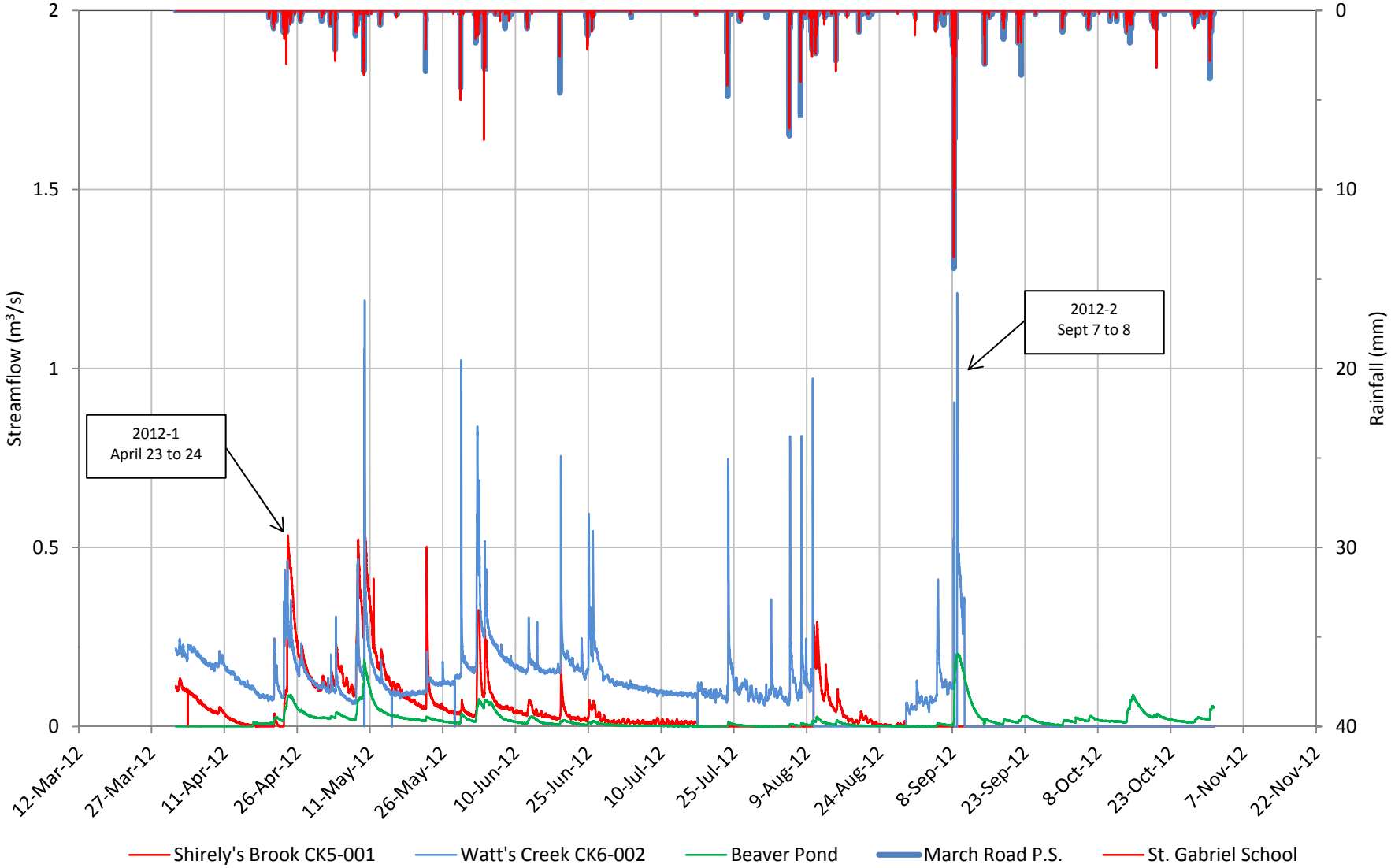


Figure C-1-10

Note: Monitoring data to mid-April suspect due to potential snowmelt / frozen ground conditions

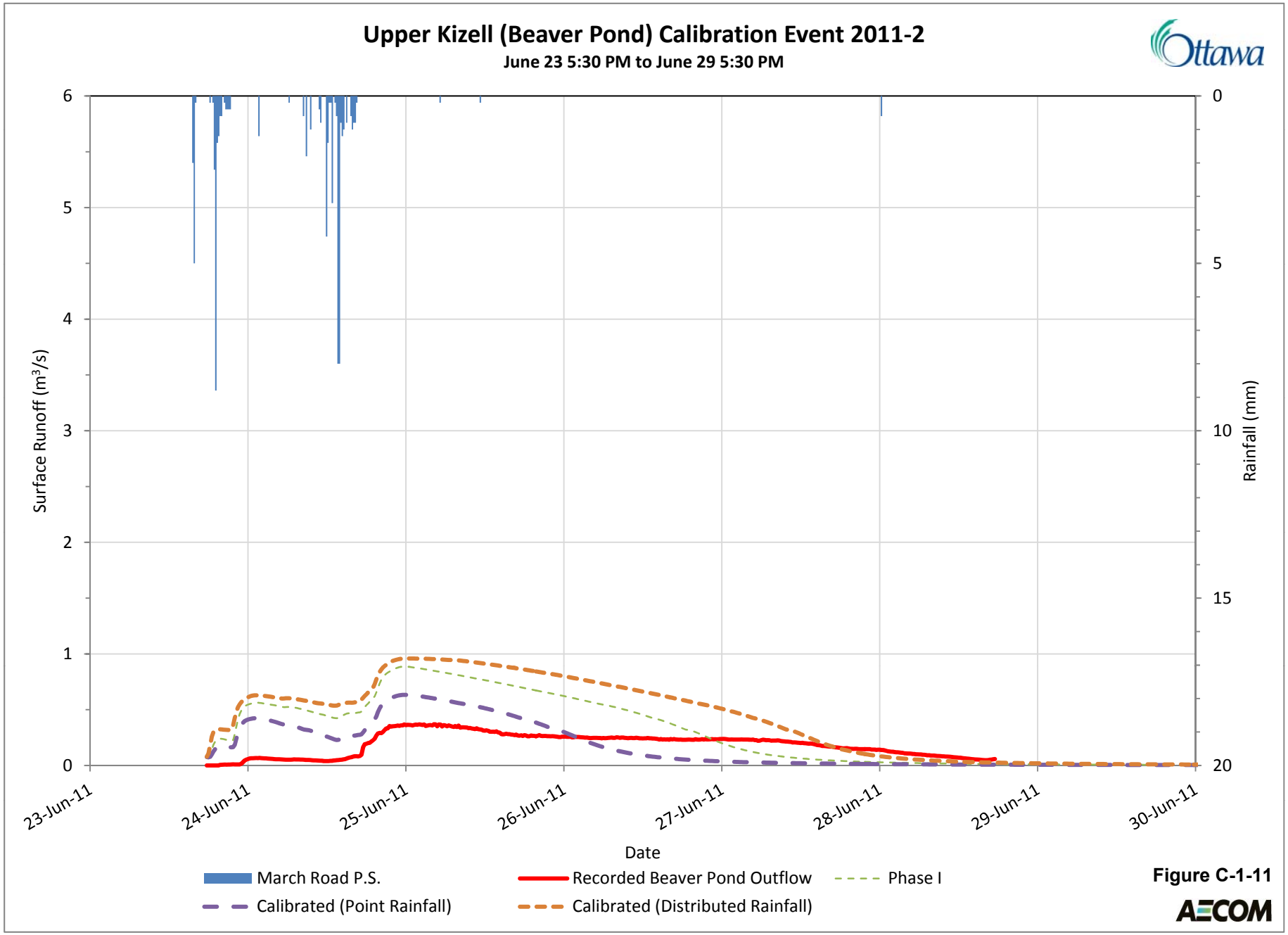
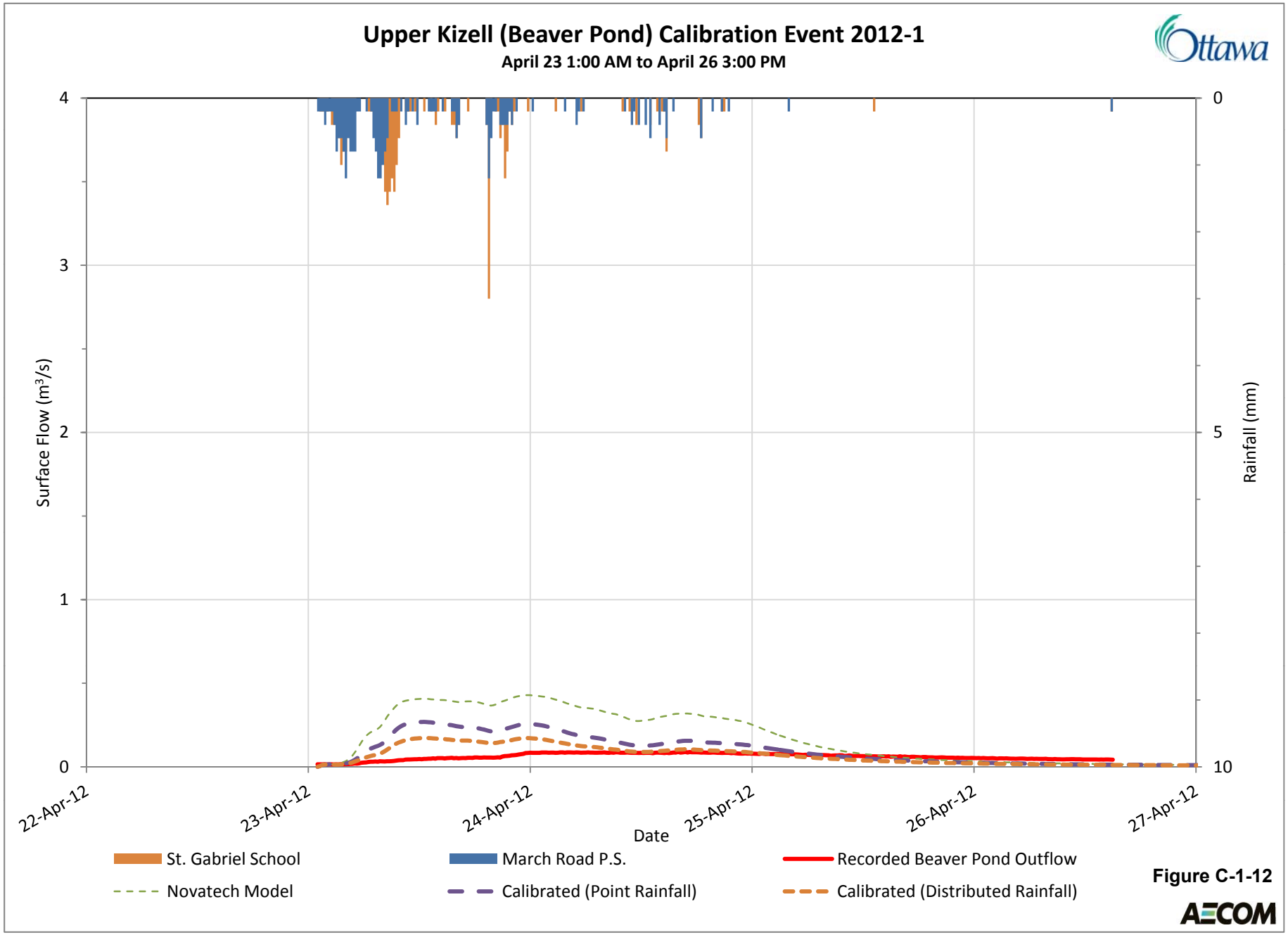

Upper Kizell (Beaver Pond) Calibration Event 2011-2
June 23 5:30 PM to June 29 5:30 PM
Surface Runoff (m³/s)
Rainfall (mm)
0
1
2
3
4
5
6
0
5
10
15
20
23-Jun-11
24-Jun-11
25-Jun-11
26-Jun-11
27-Jun-11
28-Jun-11
29-Jun-11
30-Jun-11
Date
March Road P.S.
Recorded Beaver Pond Outflow
Phase I
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)

Figure C-1-11


Upper Kizell (Beaver Pond) Calibration Event 2012-1
April 23 1:00 AM to April 26 3:00 PM
Ottawa
Surface Flow (m3/s)
Rainfall (mm)
4
3
2
1
0
0
5
10
22-Apr-12
23-Apr-12
24-Apr-12
25-Apr-12
26-Apr-12
27-Apr-12
Date
St. Gabriel School
March Road P.S.
Recorded Beaver Pond Outflow
Novatech Model
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)
Figure C-1-12
AECOM

Upper Kizell (Beaver Pond) Verification Event 2012-2

September 7 8:45 AM to September 14 2:15 PM

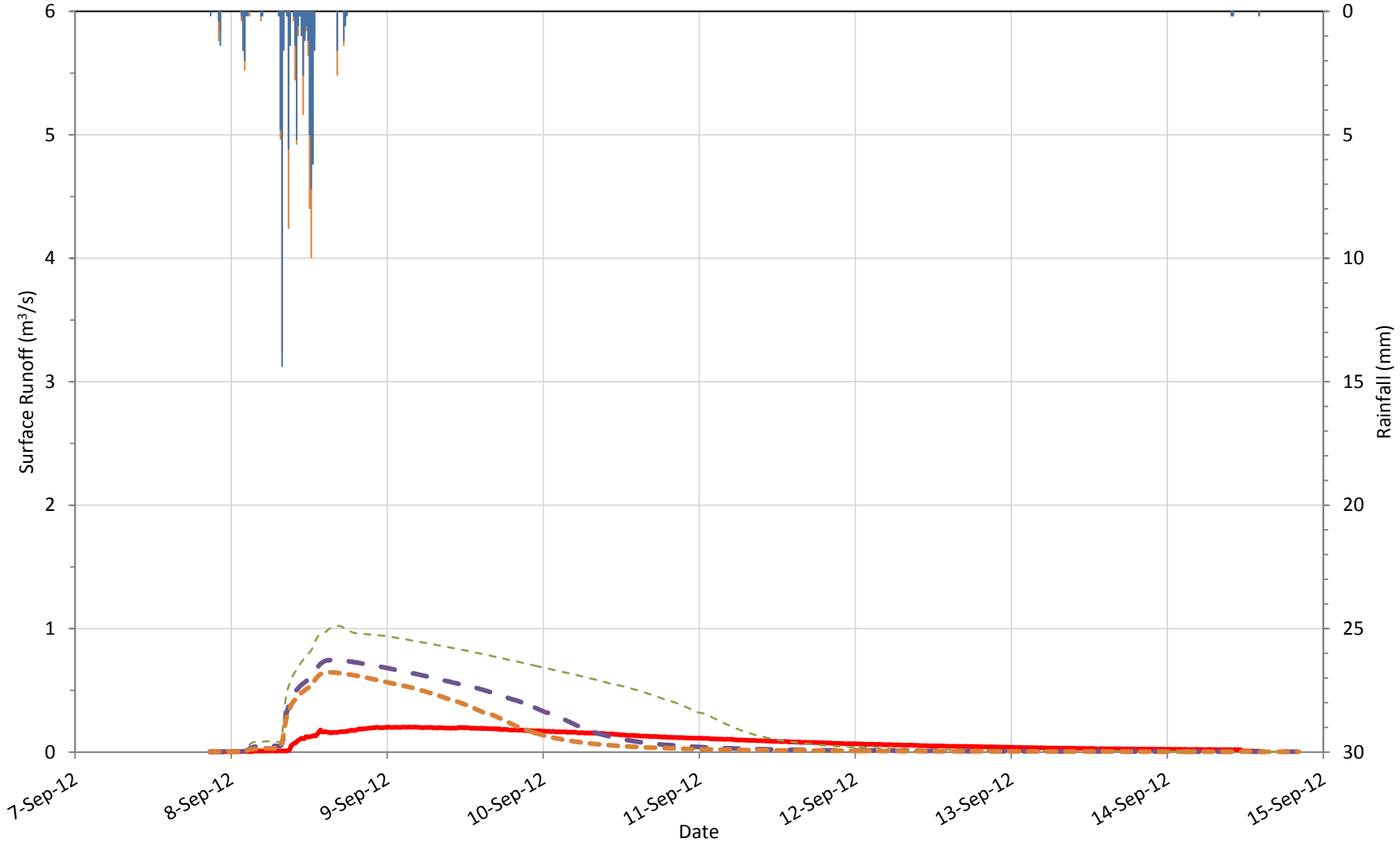


Figure C-1-13

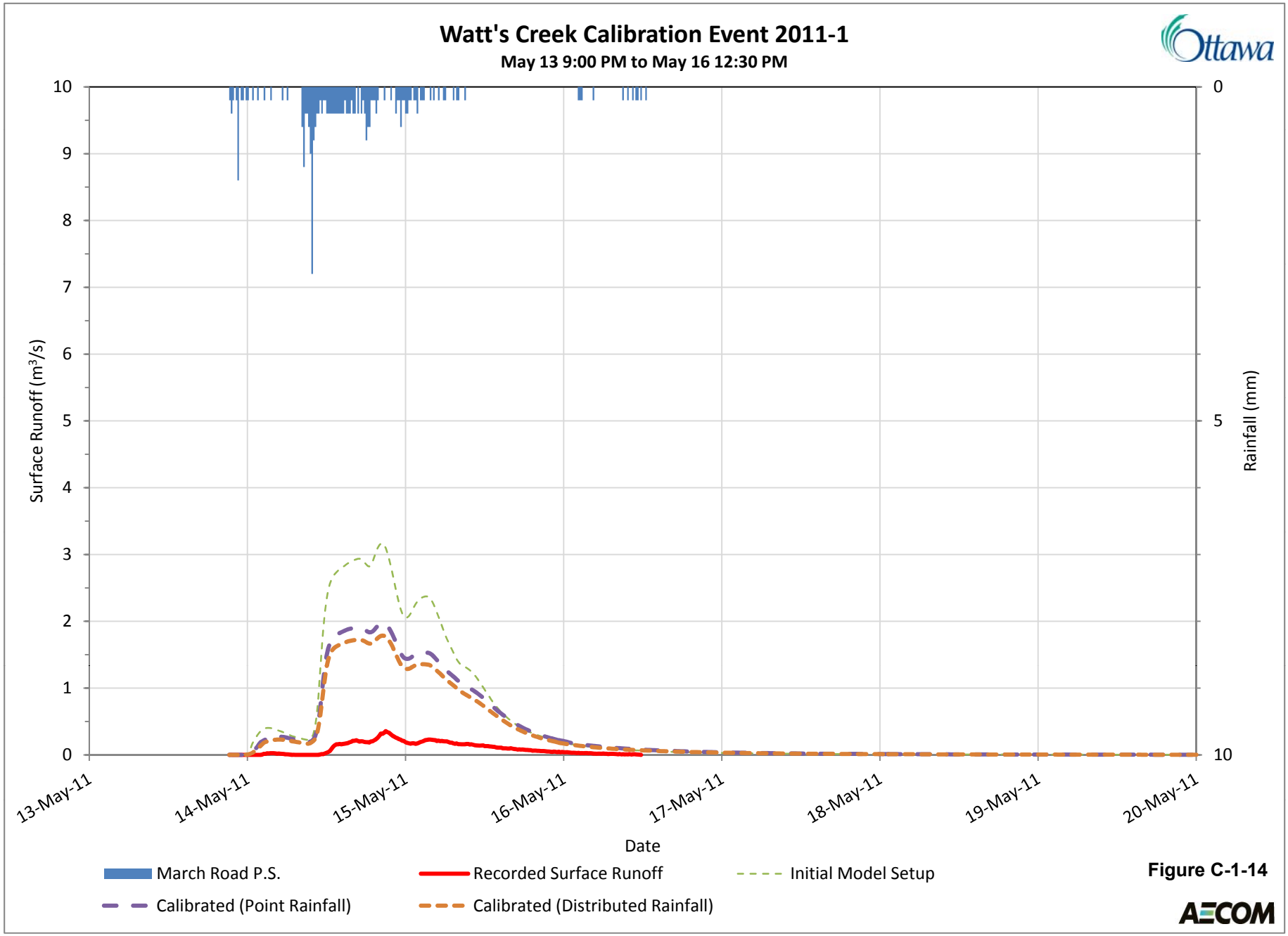

Watt's Creek Calibration Event 2011-1
May 13 9:00 PM to May 16 12:30 PM
Surface Runoff (m³/s)
Rainfall (mm)
0
1
2
3
4
5
6
7
8
9
10
0
5
10
13-May-11
14-May-11
15-May-11
16-May-11
17-May-11
18-May-11
19-May-11
20-May-11
Date
March Road P.S.
Recorded Surface Runoff
Initial Model Setup
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)

Figure C-1-14

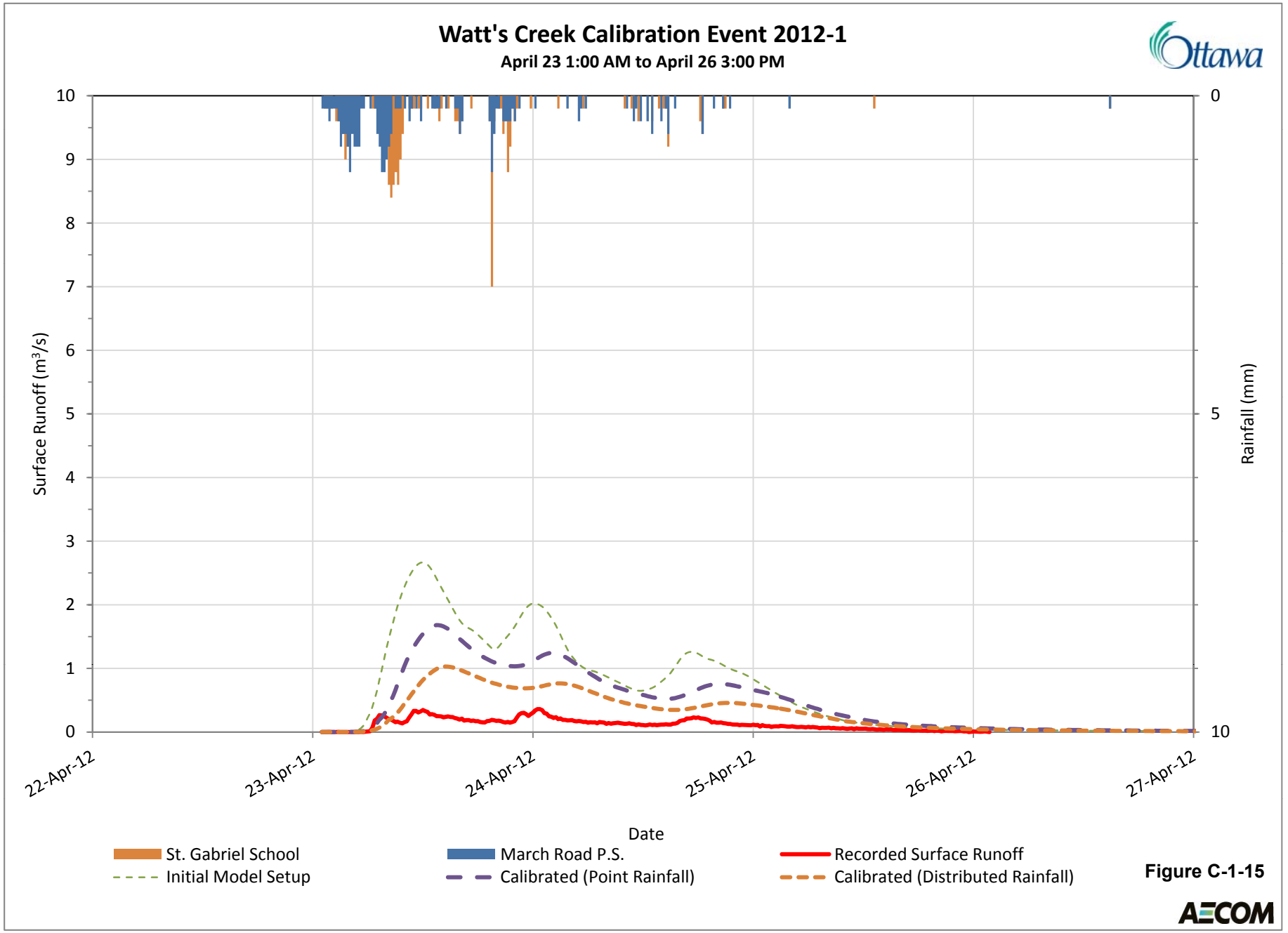


Figure C-1-15

AECOM

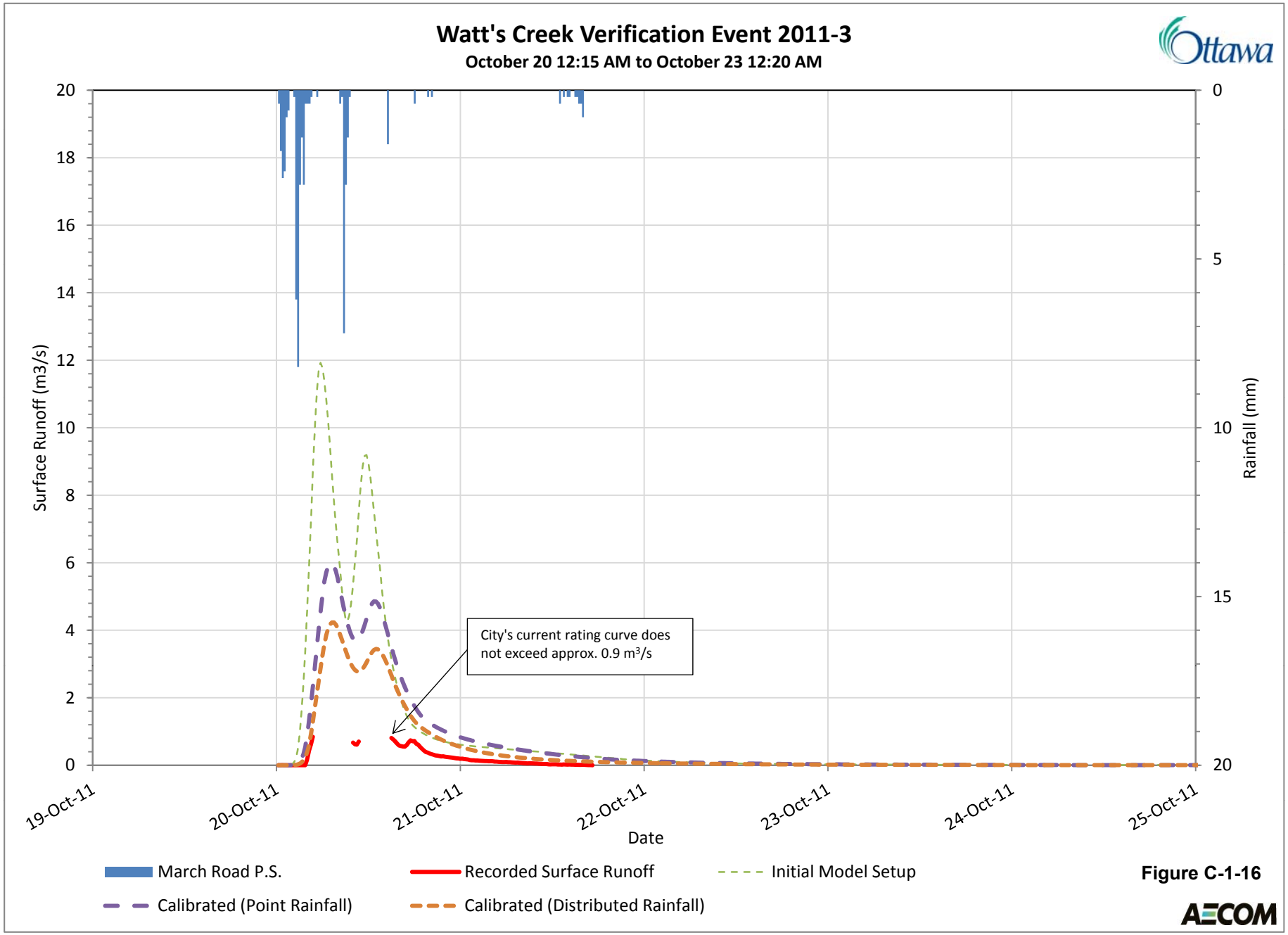

Watt's Creek Verification Event 2011-3
October 20 12:15 AM to October 23 12:20 AM
Ottawa
Surface Runoff (m3/s)
Rainfall (mm)
Date
19-Oct-11
20-Oct-11
21-Oct-11
22-Oct-11
23-Oct-11
24-Oct-11
25-Oct-11
City's current rating curve does not exceed approx. 0.9 m³/s
March Road P.S.
Recorded Surface Runoff
Initial Model Setup
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)
AECOM

Figure C-1-16

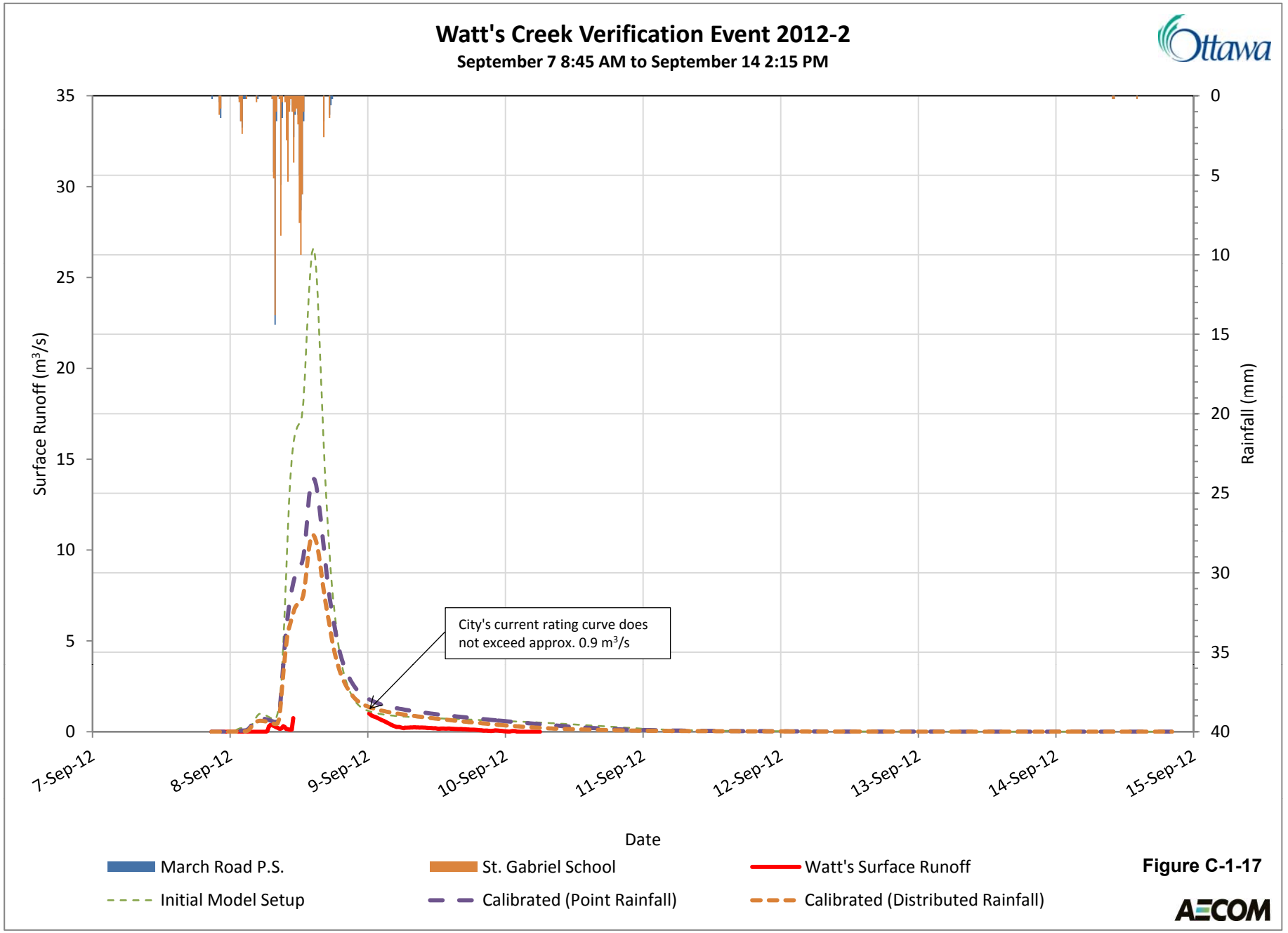

Watt's Creek Verification Event 2012-2
September 7 8:45 AM to September 14 2:15 PM
Ottawa
Surface Runoff (m³/s)
Rainfall (mm)
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40
7-Sep-12
8-Sep-12
9-Sep-12
10-Sep-12
11-Sep-12
12-Sep-12
13-Sep-12
14-Sep-12
15-Sep-12
Date
City's current rating curve does not exceed approx. 0.9 m³/s
March Road P.S.
St. Gabriel School
Watt's Surface Runoff
Initial Model Setup
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)
AECOM

Figure C-1-17

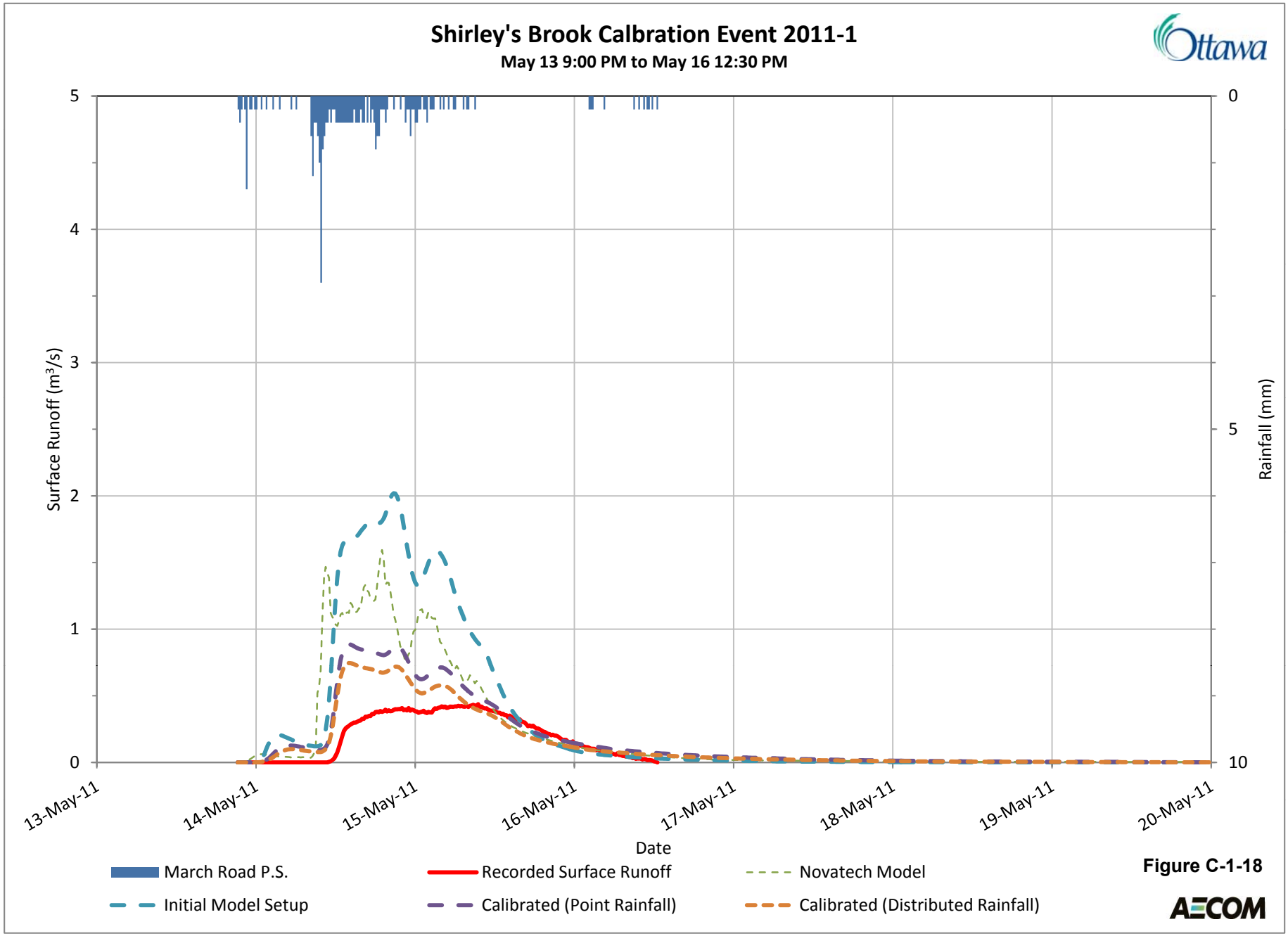

Shirley's Brook Calbration Event 2011-1
May 13 9:00 PM to May 16 12:30 PM
Ottawa
Surface Runoff (m³/s)
Rainfall (mm)
0
1
2
3
4
5
0
5
10
13-May-11
14-May-11
15-May-11
16-May-11
17-May-11
18-May-11
19-May-11
20-May-11
Date
March Road P.S.
Recorded Surface Runoff
Novatech Model
Initial Model Setup
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)
AECOM

Figure C-1-18

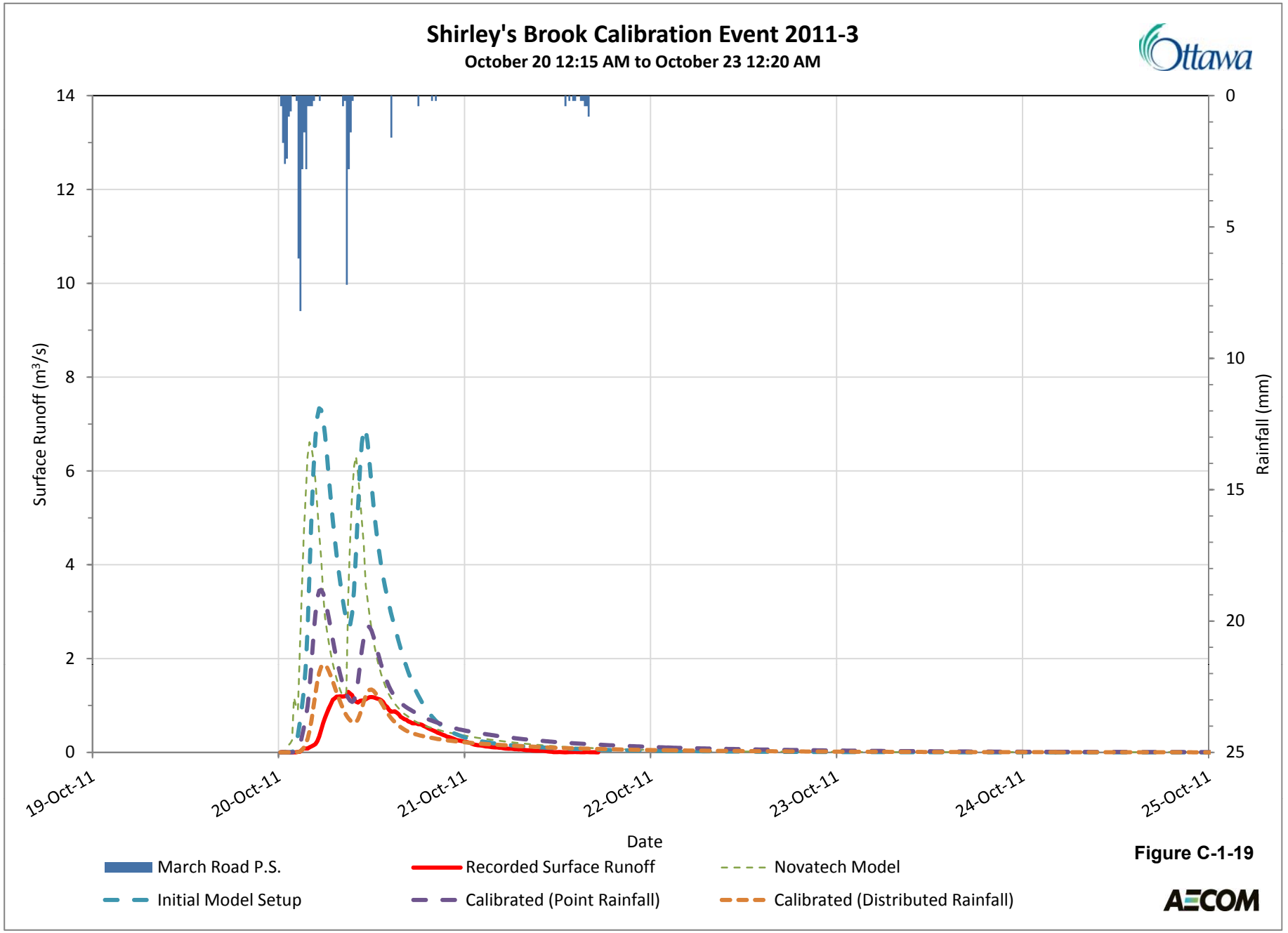

Shirley's Brook Calibration Event 2011-3
October 20 12:15 AM to October 23 12:20 AM
Surface Runoff (m³/s)
Rainfall (mm)
0
2
4
6
8
10
12
14
0
5
10
15
20
25
19-Oct-11
20-Oct-11
21-Oct-11
22-Oct-11
23-Oct-11
24-Oct-11
25-Oct-11
Date
March Road P.S.
Recorded Surface Runoff
Novatech Model
Initial Model Setup
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)

Figure C-1-19

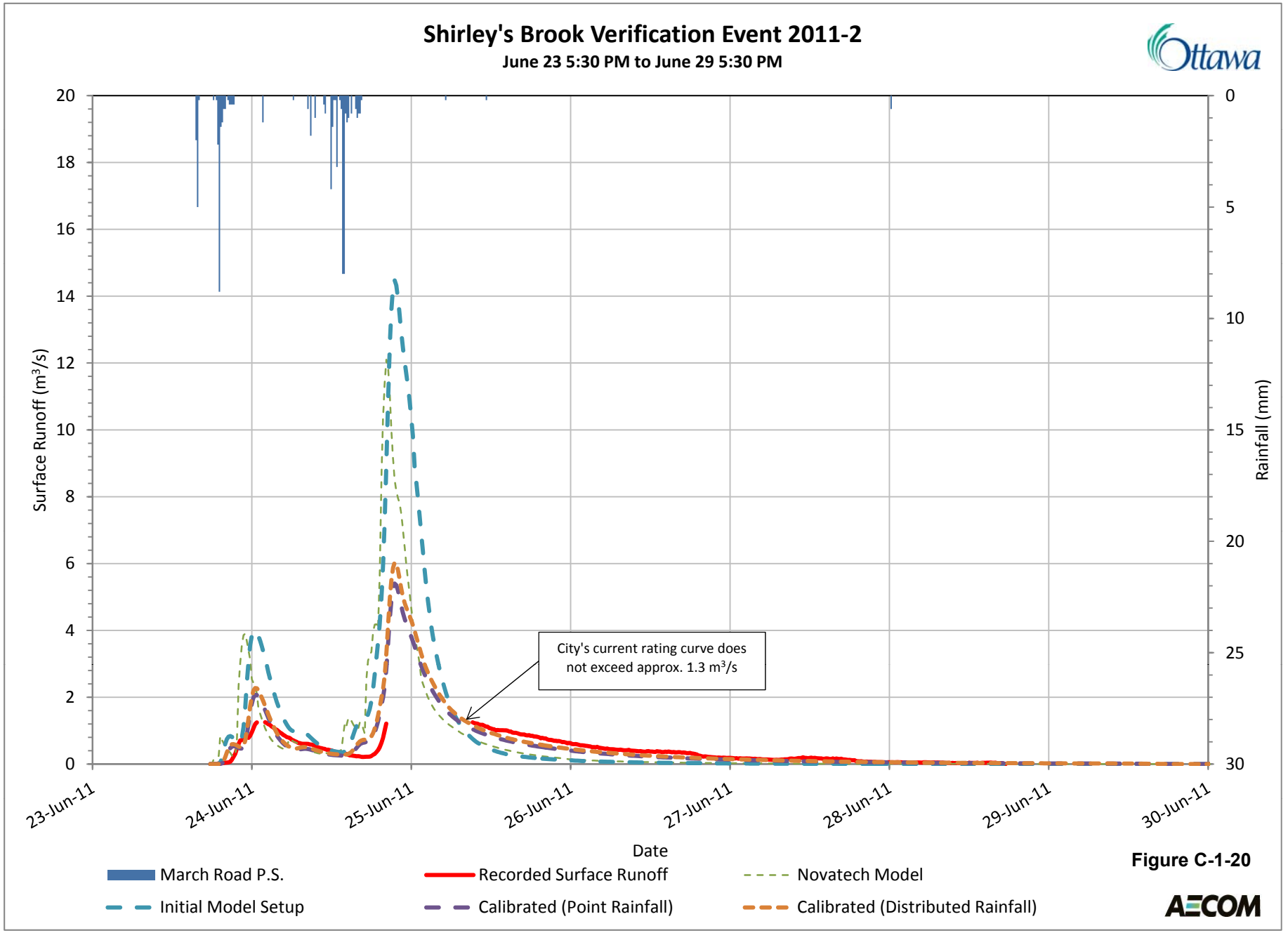

Shirley's Brook Verification Event 2011-2
June 23 5:30 PM to June 29 5:30 PM
Surface Runoff (m³/s)
Rainfall (mm)
Date
23-Jun-11
24-Jun-11
25-Jun-11
26-Jun-11
27-Jun-11
28-Jun-11
29-Jun-11
30-Jun-11
City's current rating curve does not exceed approx. 1.3 m³/s
March Road P.S.
Recorded Surface Runoff
Novatech Model
Initial Model Setup
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)

Figure C-1-20

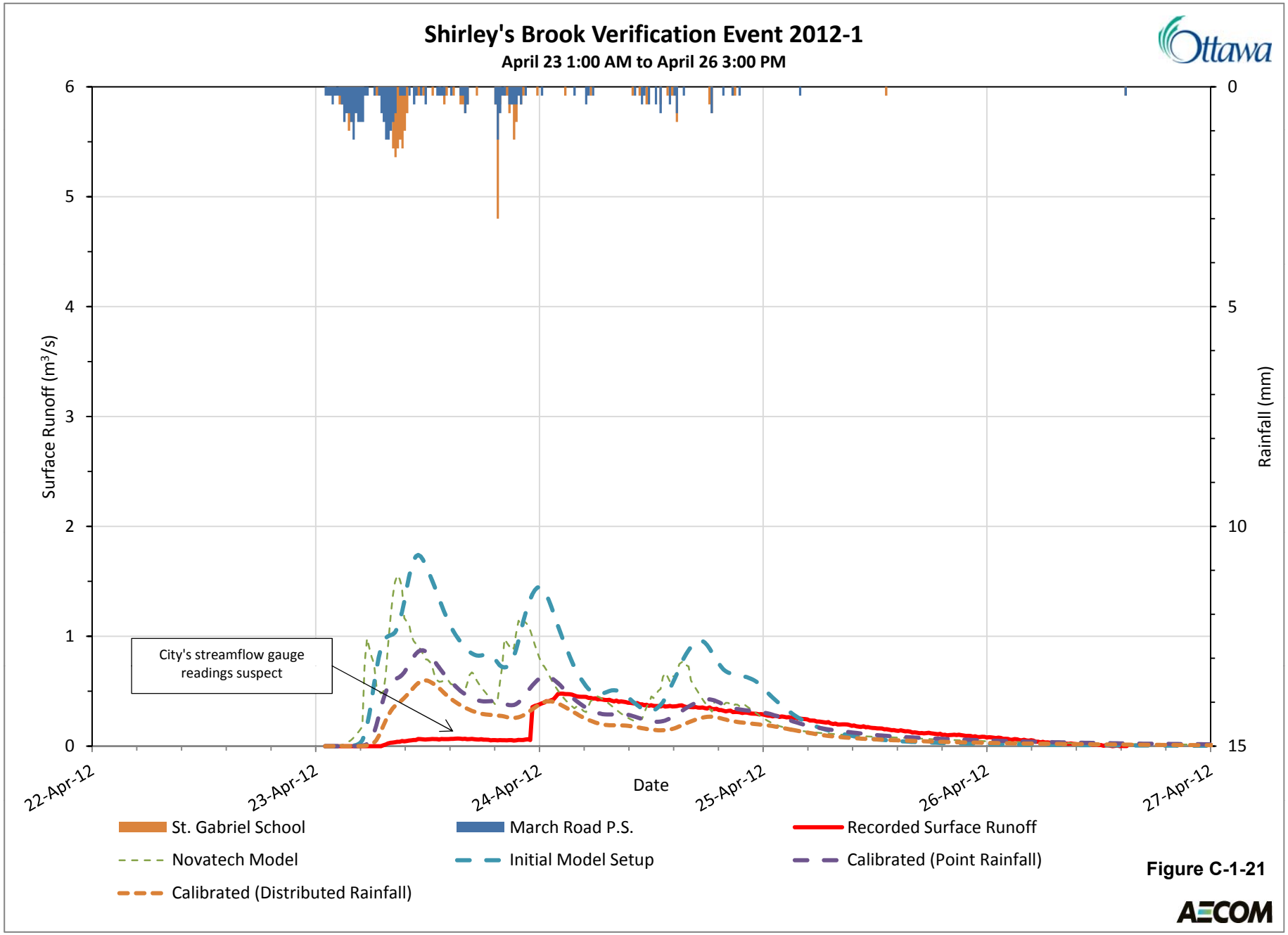

Shirley's Brook Verification Event 2012-1
April 23 1:00 AM to April 26 3:00 PM
Ottawa
Surface Runoff (m³/s)
Rainfall (mm)
Date
22-Apr-12
23-Apr-12
24-Apr-12
25-Apr-12
26-Apr-12
27-Apr-12
City's streamflow gauge readings suspect
St. Gabriel School
March Road P.S.
Recorded Surface Runoff
Novatech Model
Initial Model Setup
Calibrated (Point Rainfall)
Calibrated (Distributed Rainfall)
AECOM

Figure C-1-21

344000 345000 346000 347000 348000 349000 350000 351000 352000 353000 354000 355000 356000

5028000 5027000 5026000 5025000 5024000 5023000 5022000 5021000 5020000 5019000

DUNROBIN
MOWBRAY
KERWIN
O'HARA
REGIONAL ROAD 9
RIDDELL
MCCORD
GRIERSON
ROCKLANE
LAHEY
BATHURST
MONAGHAN
MURPHY
HEDGE
MARCH VALLEY
WILD ACRE
NADIA
MARCH
LANDEL
SECOND LINE
MALEY
ROLSTON
MARCHVALE
SHERRUBY
NASH
OLD CARP
GOWARD
WHERNSIDE
SCAMPTON
PEIKOFF
PENRITH
PALTON
KLONDIKE
LAXFORD
HALTON
IPSWICH
ALLENBY
REGIONAL ROAD 49
MCKINLEY
SANDHILL
HELMSDALE
LEGGET
HINES
SHIRLEY
LOIS
HASTINGS
VA
GRANDVIEW
RIFLE
DAVIDSON'S SIDE
CARLING
CYRUS
REGIONAL ROAD 59
FARRAR
March Road P.S.
REGIONAL ROAD 38
GOURLAY
TERRY FOX
GOULBOURN FORCED
STATION
STEACIE
RICHARDSON SIDE
HERZBERG
CORKSTOWN
RAMP
WALDEN
LISMER
CARR
MILNE
VARLEY
IRONSIDE
TERON
PENFIELD
St. Gabriel School
KNUDSON
GOULDING
LEACOCK
WALTER
HIGHWAY 417
HUNTMAR
SHAUGHNESSY
SHERRING
SHERK
OAKES
MARIONA
GOLDRIDGE
GRAY
HEARST
PEARY
TIMM
MCGEE SIDE
OAK CREEK
INSMILL
TERRY FOX
CAMPEAU
KANATA
AIRD
BEAUFORT
CHIMO
EAGLESON
ROBERTSON
HANNEL
REGIONAL ROAD 36
PRIAM
BRADLEY SIDE
RICHARDSON SIDE
REIS
CARP
TANSLEY
FRANK NIGHBOR
MCGIBBON
KATIMAVIK
KAKULU
CASTLEFRANK
VANSTONE
HEWITT
SHEARER
PICKFORD
HAZELDEAN
DESMOND
MCCURDY
MCLENNAN
MORESBY
YOHO
MATTAWA
MOODIE

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map
2011-1 Event
May 13 - 15

February 2015
60264539

AECOM

Figure C-1-22

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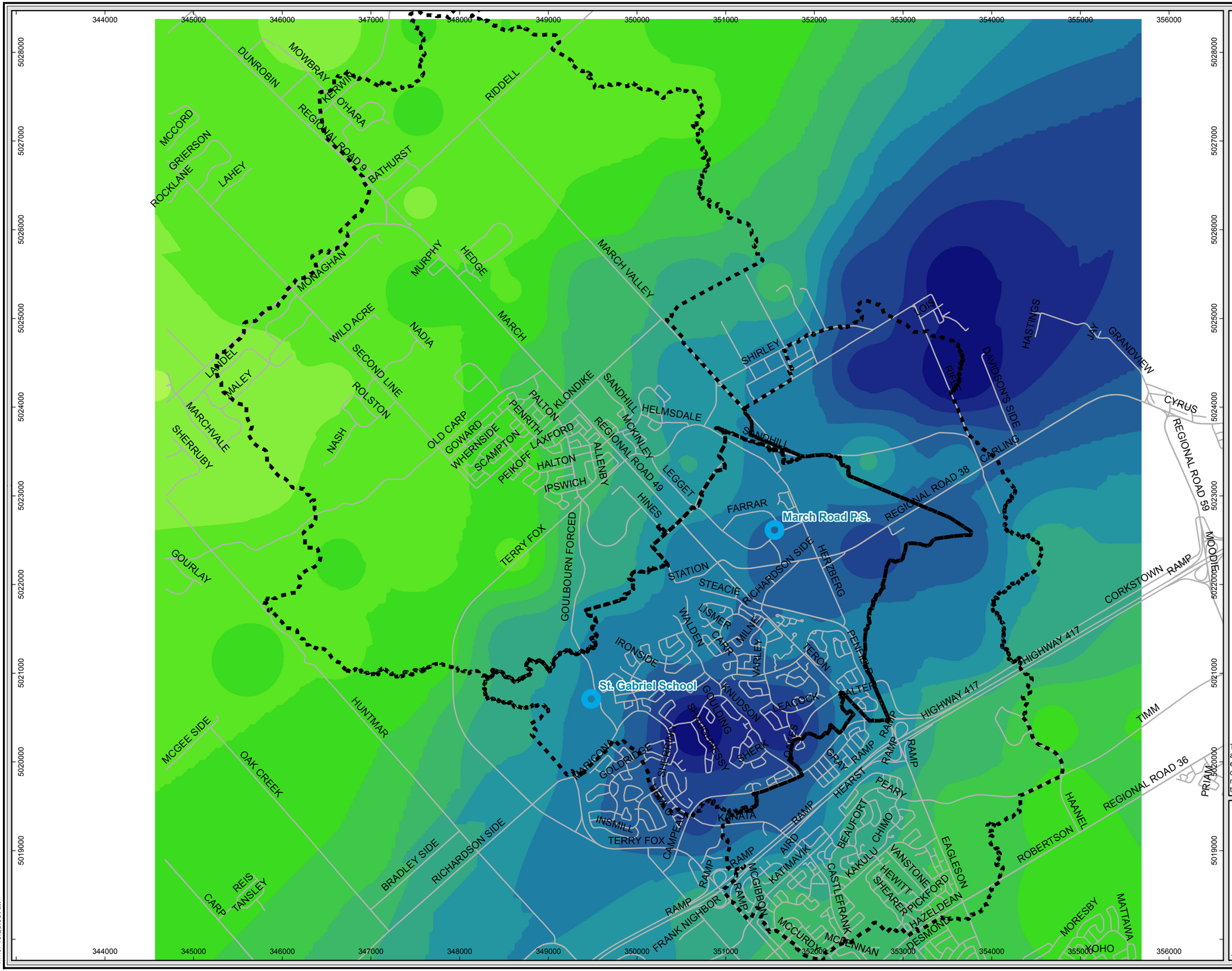


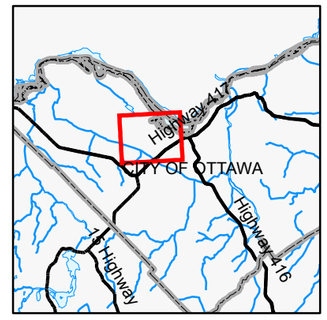
Legend

Subwatershed Boundary

City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 20
- 20-30
- 30-40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90
- 90-100
- 100-110
- 110-120
- 120-130
- 130-140
- 140-150
- > 150



Basemapping and orthophotography provided by the City of Ottawa.

N W E S

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NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map

2011-2 Event

Jun 23 - 24

February 2015

60264539

AECOM

Figure C-1-23

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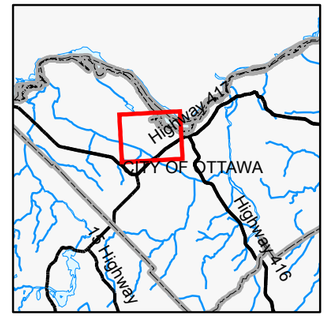
Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 20
- 20-30
- 30-40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90
- 90-100
- 100-110
- 110-120
- 120-130
- 130-140
- 140-150
- > 150



Basemapping and orthophotography provided by the City of Ottawa.

N
W E
S

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1:40,000

NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map
2011-3 Event
Oct 20

February 2015
60264539

AECOM

Figure C-1-24

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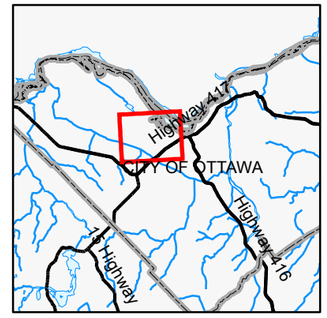
Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 20
- 20-30
- 30-40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90
- 90-100
- 100-110
- 110-120
- 120-130
- 130-140
- 140-150
- > 150



Basemapping and orthophotography provided by the City of Ottawa.

N W E S

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NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map
2012-1 Event
Apr 23 - 24

Feburary 2015
60264539

AECOM

Figure C-1-25

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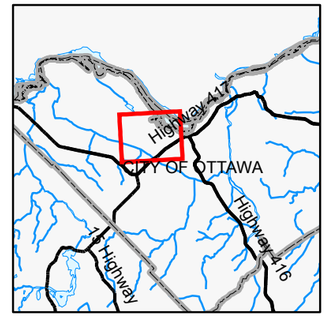
Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 20
- 20-30
- 30-40
- 40-50
- 50-60
- 60-70
- 70-80
- 80-90
- 90-100
- 100-110
- 110-120
- 120-130
- 130-140
- 140-150
- > 150



Basemapping and orthophotography provided by the City of Ottawa.

N
W E
S

0 200 400 800 1,200 1,600

1:40,000

NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map
2012-2 Event
Sept 7 - 8

February 2015
60264539

AECOM

Figure C-1-26

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C-2. Additional 2013 Hydrologic Model Calibration & Verification Assessment

TABLE C-2-1 - STORM EVENT DEPTHS RECORDED AT RAIN GAUGE STATIONS

Event	Rain Gauge	Start	End	Duration (hr)	Total Depth (mm)	3-Day (m)	5-Day (m)
2013-03	Beaver Pond RG	2013/06/01 17:45	2013/06/01 19:00	1.3	22.6	1.8	6.6
2013-03	Firehall RG	-	-	-	-	-	-
2013-03	Glen Carin	-	-	-	-	-	-
2013-03	March Rd RG	2013/06/01 17:45	2013/06/01 19:45	2.0	23.4	2.0	7.0
2013-07	Beaver Pond RG	2013/06/23 21:30	2013/06/24 03:00	5.5	35.6	3.0	3.0
2013-07	Firehall RG	-	-	-	-	-	-
2013-07	Glen Carin	-	-	-	-	-	-
2013-07	March Rd RG	2013/06/23 21:30	2013/06/24 01:30	4.0	31.6	2.4	2.4
2013-08	Beaver Pond RG	2013/06/28 07:00	2013/06/28 18:00	11.0	35.0	3.6	40.0
2013-08	Firehall RG	-	-	-	-	-	-
2013-08	Glen Carin	-	-	-	-	-	-
2013-08	March Rd RG	2013/06/28 07:00	2013/06/28 18:00	11.0	34.0	3.4	37.4
2013-10	Beaver Pond RG	2013/08/07 23:15	2013/08/08 03:30	4.3	26.4	2.4	7.2
2013-10	Firehall RG	2013/08/07 23:30	2013/08/08 00:30	1.0	12.2	9.6	13.8
2013-10	Glen Carin	-	-	-	-	-	-
2013-10	March Rd RG	2013/08/07 23:15	2013/08/08 03:15	4.0	31.4	2.2	11.0
2013-16	Beaver Pond RG	2013/09/12 14:30	2013/09/12 16:30	2.0	22.6	20.6	26.4
2013-16	Firehall RG	2013/09/12 14:30	2013/09/12 16:30	2.0	13.2	9.6	15.2
2013-16	Glen Carin	2013/09/12 14:45	2013/09/12 15:45	1.0	27.0	13.4	17.4
2013-16	March Rd RG	2013/09/12 14:45	2013/09/12 16:45	2.0	12.8	28.8	35.0
2013-17	Beaver Pond RG	2013/09/21 08:15	2013/09/22 01:30	17.3	37.2	2.8	3.0
2013-17	Firehall RG	2013/09/21 08:15	2013/09/22 02:00	17.8	30.8	1.0	1.0
2013-17	Glen Carin	2013/09/21 08:15	2013/09/22 01:30	17.3	33.6	0.4	0.4
2013-17	March Rd RG	2013/09/21 08:15	2013/09/22 01:30	17.3	35.0	4.4	4.6

TABLE C-2-2 - COMPARISON OF RAIN GAUGE & UNCALIBRATED RADAR DEPTHS

Location	Rainfall Depth (mm)					
	2013-03	2013-07	2013-08	2013-10	2013-16	2013-17
March Road (measured)	23.4	31.6	34.0	31.4	12.8	35.0
March Road (radar)	9.6	21.9	26.9	24.4	17.0	27.3
Beaver Pond (measured)	22.6	35.6	35.0	26.4	22.6	37.2
Beaver Pond (radar)	8.5	26.7	27.7	29.9	24.2	31.7
Fire Hall (measured)	-	-	-	12.2	13.2	30.8
Fire Hall (radar)	-	-	-	21.5	16.0	29.8
Glen Carin (measured)	-	-	-	-	27.0	33.6
Glen Carin (radar)	-	-	-	-	19.9	31.3
Upper Kizell [1]	8.9	23.3	28.5	24.2	20.3	31.2
Watt's Creek [1, 2]	14.3	21.0	31.6	15.0	16.5	27.7

Notes: 1. Weighted rainfall depth calculated using inverse-distance method.

2. Analysis for Watt's Creek includes only areas downstream of Beaver Pond.

TABLE C-2-3 - COMPARISON OF RAIN GAUGE & CALIBRATED RADAR DEPTHS

Location	Rainfall Depth (mm)					
	2013-03	2013-07	2013-08	2013-10	2013-16	2013-17
March Road (measured)	23.4	31.6	34.0	31.4	12.8	35.0
March Road (radar)				23.6	16.7	27.5
Beaver Pond (measured)	22.6	35.6	35.0	26.4	22.6	37.2
Beaver Pond (radar)				28.9	25.5	32.2
Fire Hall (measured)	-	-	-	12.2	13.2	30.8
Fire Hall (radar)	-	-	-	17.4	16.9	29.3
Glen Carin (measured)	-	-	-	-	27.0	33.6
Glen Carin (radar)	-	-	-	-	20.9	31.7
Upper Kizell [1]				23.5	18.2	35.9
Watt's Creek [1, 2]				16.0	15.1	31.9

Notes: 1. Weighted rainfall depth calculated using inverse-distance method.

2. Analysis for Watt's Creek includes only areas downstream of Beaver Pond.

TABLE C-2-4 - COMPARISON OF STORM EVENT RAINFALL AND OBSERVED RUNOFF

Event No.	Kizell Drain @ Beaver Pond Outlet				Watts Creek Gauge @ Carling Avenue CK6-002			
	Rainfall (mm)	Volumes (cu.m.)		Ratios Runoff/ Rainfall	Rainfall (mm)	Volumes (cu.m.)		Ratio Runoff/ Rainfall
		Rainfall	Runoff			Rainfall	Runoff	
2013-03	22.6	94016	24346	0.26	23.4	508014	78106	0.15
2013-07	35.6	148096	50212	0.34	31.6	686036	146274	0.21
2013-08	35.0	145600	67693	0.46	34.0	738140	354750	0.48
2013-10	26.4	109824	23850	0.22	16.0	347360	82682	0.24
2013-16	22.6	94016	41632	0.44	15.1	327821	105602	0.32
2013-17	37.2	154752	49308	0.32	31.9	692549	169706	0.25
Average				**0.34**				**0.28**

TABLE C-2-5 - COMPARISON OF OBSERVED AND CALCULATED RUNOFF COEFFICIENTS

Location	Total Area (ha)	Impervious				Pervious	Calculated Runoff C	Avg. Runoff/ Rain for Selected Events
		XIMP		TIMP				
		(ha)	%	(ha)	%	(ha)		
Upper Kizell (Beaver Pond) Subwatershed	416	96	23%	126	30%	290	0.36	0.34
Watt's Creek (Kizell Drain) Subwateshed (Gauge CK6-002)	2171	405	19%	461	21%	1710	0.33	0.28

TABLE C-2-6 - COMPARISON OF UPPER KIZELL (BEAVER POND) SWMHYMO RESULTS (UNADJUSTED) TO OBSERVED DATA

Event	Rainfall Depth [1] (mm)	Total Runoff					Peak Flow (cms)			Observed Hydrograph Peak (hrs)		
		Observed		Simulated		Difference	Observed	Simulated	Difference	Observed	Model	Difference
		mm	ha-m	mm	ha-m	%	cms	cms	%	hrs	hrs	hrs
2013-03	25.8	5.85	2.43	6.17	2.57	5%	0.14	0.4	186%	11.75	3.25	-8.50
2013-07	31.9	12.07	5.02	10.80	4.49	-10%	0.18	0.55	206%	12.00	3.25	-8.75
2013-08	35.9	16.27	6.77	12.98	5.40	-20%	0.17	0.54	218%	25.25	10.75	-14.50
2013-10	23.5	5.73	2.38	7.39	3.08	29%	0.13	0.46	254%	11.75	2.50	-9.25
2013-16	18.2	10.01	4.16	7.40	3.08	-26%	0.13	0.44	238%	17.00	3.00	-14.00
2013-17	35.9	11.85	4.93	11.33	4.71	-4%	0.17	0.44	159%	22.75	15.50	-7.25

Note

1 Rainfall at Beaver Pond rain gauge.

TABLE C-2-7 - UPPERT KIZELL (BEAVER POND) MODEL CALIBRATION ASSESSMENT

Event	Rainfall Depth [1]	Tp * 2						LGI * 2						SLPP = 0.2%						MNP/MNI = 0.5/0.050						+0.3m storage					
		Peak Flow			Hydrograph Peak			Peak Flow			Hydrograph Peak			Peak Flow			Hydrograph Peak			Peak Flow			Hydrograph Peak			Peak Flow			Hydrograph Peak		
		Observed (cms)	Simulated (cms)	Difference (%)	Observed (hrs)	Simulated (hrs)	Difference (hrs)	Observed (cms)	Simulated (cms)	Difference (%)	Observed (hrs)	Simulated (hrs)	Difference (hrs)	Observed (cms)	Simulated (cms)	Difference (%)	Observed (hrs)	Simulated (hrs)	Difference (hrs)	Observed (cms)	Simulated (cms)	Difference (%)	Observed (hrs)	Simulated (hrs)	Difference (hrs)	Observed (cms)	Simulated (cms)	Difference (%)	Observed (hrs)	Simulated (hrs)	Difference (hrs)
2013-08	35.9	0.17	0.53	212%	25.25	10.75	-14.50	0.17	0.54	218%	25.25	11.50	-13.75	0.17	0.53	212%	25.25	11.25	-14.00	0.17	0.53	212%	25.25	11.25	-14.00	0.17	0.42	147%	25.25	11.25	-14.00
2013-16	18.2	0.13	0.44	238%	17.00	3.00	-14.00	0.13	0.44	238%	17	3.50	-13.50	0.13	0.43	231%	17	3.25	-13.75	0.13	0.43	231%	17	3.50	-13.50	0.13	0.29	123%	17	3.50	-13.50
2013-17	35.9	0.17	0.43	153%	22.75	15.50	-7.25	0.17	0.43	153%	22.75	16.00	-6.75	0.17	0.43	153%	22.75	15.50	-7.25	0.17	0.43	153%	22.75	16.00	-6.75	0.17	0.32	88%	22.75	17.00	-5.75

TABLE C-2-8 - UPPER KIZELL (BEAVER POND) RETURN PERIOD EVENT ASSESSMENT

Return Period Event (yr)	Rainfall Depth (mm)	Peak Flow			Maximum Water Level		
		Simulated (cms)	Simulated with Additional Storage (cms)	Difference (%)	Simulated (m)	Simulated with Additional Storage (m)	Difference (%)
2	48.5	0.62	0.52	-16%	91.57	91.33	-0.27%
5	64.1	0.76	0.68	-11%	91.91	91.70	-0.22%
10	74.4	0.84	0.77	-8%	92.12	91.95	-0.19%
25	86.9	0.92	0.87	-5%	92.38	92.23	-0.17%
50	96.5	0.97	0.94	-3%	92.56	92.43	-0.15%
100	106.7	1.50	1.06	-29%	92.70	92.62	-0.08%

TABLE C-2-9 - COMPARISON OF WATT'S CREEK SWMHYMO RESULTS (UNADJUSTED) TO OBSERVED DATA

Event	Rainfall Depth [1] (mm)	Total Runoff					Peak Flow			Observed Hydrograph Peak		
		Observed		Simulated		Difference	Observed	Simulated	Difference	Observed	Model	Difference
		mm	ha-m	mm	ha-m	%	cms	cms	%	hrs	hrs	hrs
2013-03	23.4	3.60	7.81	5.12	11.11	42%	5.63	5.16	-8%	3.75	3.00	-0.75
2013-07	31.6	6.74	14.63	8.08	17.54	20%	6.04	7.07	17%	4.25	4.50	0.25
2013-08	34.0	16.34	35.48	11.34	24.62	-31%	6.55	5.38	-18%	7.25	9.75	2.50
2013-10	16.0	3.81	8.27	3.72	8.08	-2%	4.3	3.67	-15%	3.00	2.75	-0.25
2013-16	15.1	4.86	10.56	3.88	8.43	-20%	6.16	3.12	-49%	5.00	3.25	-1.75
2013-17	31.9	7.82	16.97	8.28	17.97	6%	3.23	2.44	-24%	17.50	16.00	-1.50

Note

1 Rainfall depth at March Road PS rain gauge for Event 2013-03, 07 & 08 and distributed rainfall depth for Event 2013-10, 16 & 17

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5028000 5027000 5026000 5025000 5024000 5023000 5022000 5021000 5020000 5019000

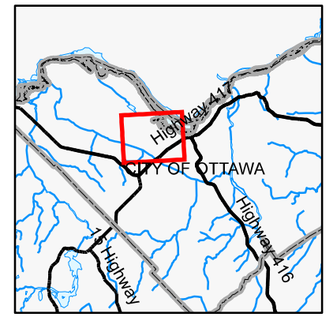
DUNROBIN
MOWBRAY
KENWAY
O'HARA
REGIONAL ROAD 9
RIDDELL
MCCORD
GRIERSON
ROCKLANE
LAHEY
BATHURST
MONAGHAN
MURPHY
HEDGE
MARCH VALLEY
WILD ACRE
NADIA
SECOND LINE
MARCH
LANDEL
MALEY
ROLSTON
MARCHVALE
SHERRUBY
NASH
Shirley's Brook Subwatershed
OLD CARP
GOWARD
WHERNSIDE
SCAMPTON
PEIKOFF
PALTON
KLONDIKE
PENRITH
LAXFORD
HALTON
IPSWICH
ALLENBY
REGIONAL ROAD 49
MCKINLEY
SANDHILL
HELMSDALE
LEGGET
HINES
FARRAR
23.4
March Road P.S.
SHIRLEY
LOIS
RIPLEY
DAVIDSON'S SIDE
HASTINGS
VAN
GRANDVIEW
CYRUS
REGIONAL ROAD 59
CARLING
REGIONAL ROAD 38
GOURLAY
TERRY FOX
GOULBOURN FORCED
STATION
STEACIE
RICHARDSON SIDE
HERZBERG
Lower Kizell Subwatershed
WALDEN
LISMER
CARR
MILNE
VARLEY
TERON
PENFIELD
ALTER
CORKSTOWN
RAMP
IRONSIDE
22.6
St. Gabriel School
KNUDSON
LEACOCK
OAKES
GOULDING
SHERRING
SHERK
Upper Kizell Subwatershed
HIGHWAY 417
HUNTMAR
MCGEE SIDE
OAK CREEK
GOLDRIDGE
MARCONA
GRAY
HEARST
PEARY
Watt's Creek Subwatershed
TIMM
REGIONAL ROAD 36
PRIAM
INSMILL
TERRY FOX
KANATA
CAMPEAU
AIRD
KATIMAVIK
BEAUFORT
CHIMO
KAKULU
CASTLEFRANK
VANSTONE
HEWITT
SHEARER
PICKFORD
EAGLESON
HAZELDEAN
ROBERTSON
HAANEL
MOORE
MCGIBBON
MCCURDY
MCCANNAN
DESMOND
MORESBY
MATTAWA
YOHO
FRANK NIGHBOR
BRADLEY SIDE
RICHARDSON SIDE
REIS
TANSLEY
CARP

Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- > 90
- Upper Kizell Subwatershed Area (Beaver Pond)
- 23.4 Point Rainfall Total (mm)



Basemapping and orthophotography provided by the City of Ottawa.

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NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map
Event 2013-03
June 1st

60264539

AECOM

Figure C-2-1

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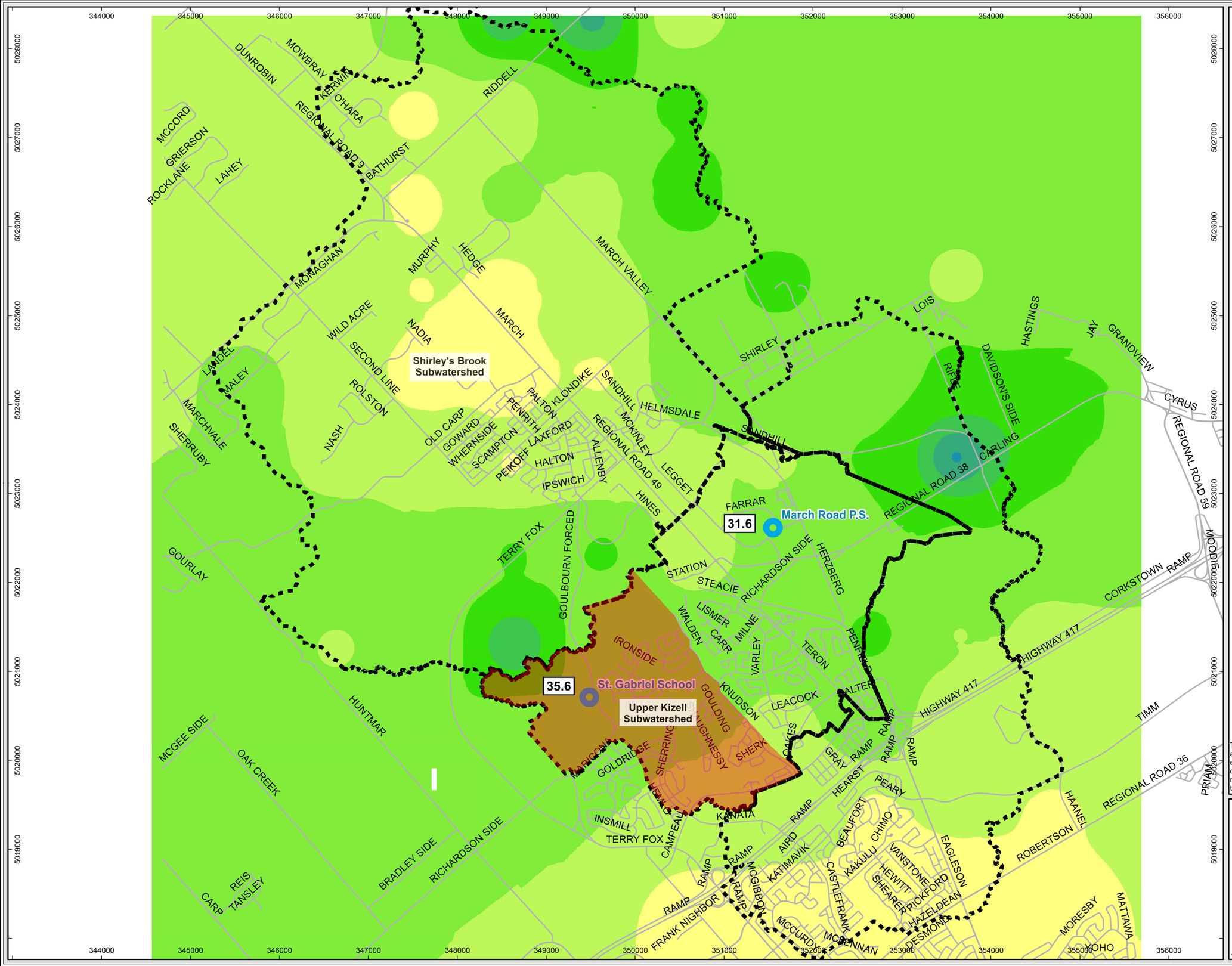

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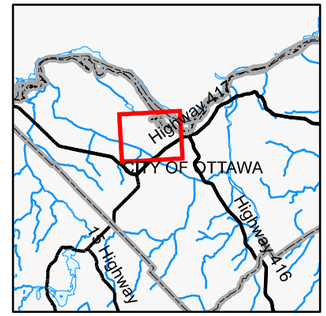
Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- > 90

- Upper Kizell Subwatershed Area (Beaver Pond)
- 23.4 Point Rainfall Total (mm)



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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map
Event 2013-07
June 23rd to 24th

60264539

AECOM

Figure C-2-2

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DUNROBIN
MOWBRAY
KENWAY
O'HARA
REGIONAL ROAD 9
RIDDELL
MCCORD
GRIERSON
ROCKLANE
LAHEY
BATHURST
MONAGHAN
MURPHY
HEDGE
MARCH VALLEY
MARCH
WILD ACRE
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LANDEL
MALEY
ROLSTON
MARCHVALE
SHERRUBY
NASH
Shirley's Brook Subwatershed
OLD CARP
GOWARD
WHERNSIDE
SCAMPTON
PEIKOFF
PENRITH
PALTON
KLONDIKE
LAXFORD
HALTON
IPSWICH
ALLENBY
SANDHILL
HELMSDALE
MCKINLEY
REGIONAL ROAD 49
LEGGET
HINES
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LOIS
RIPLEY
DAVIDSON'S SIDE
HASTINGS
JAY
GRANDVIEW
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REGIONAL ROAD 59
CARLING
SANDHILL
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34.0
March Road P.S.
REGIONAL ROAD 38
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GOULBOURN FORCED
STATION
STEACIE
RICHARDSON SIDE
HERZBERG
Lower Kizell Subwatershed
CORKSTOWN
RAMP
MOODIE
WALDEN
LISMER
CARR
MILNE
VARLEY
TERON
PENFIELD
WALTER
IRONSIDE
35.0
St. Gabriel School
Upper Kizell Subwatershed
KNUDSON
LEACOCK
GOULDING
HAUGHNESSY
SHERRING
SHERK
CAMES
HIGHWAY 417
RAMP
GRAY
HEARST
PEARY
Watt's Creek Subwatershed
TIMM
HUNTMAR
MCGEE SIDE
OAK CREEK
MERCONA
GOLDRIDGE
KANATA
INSMILL
TERRY FOX
CAMPEAU
BRADLEY SIDE
RICHARDSON SIDE
REIS
TANSLEY
CARD
RAMP
FRANK NIGHBOR
MCGIBBON
MCCURDY
MCCANNAN
AIRD
KATIMAVIK
BEAUFORT
KAKULU
CHIMO
VANSTONE
HEWITT
SHEARER
EAGLESON
RICKFORD
HAZELDEAN
DESMOND
ROBERTSON
HAANEL
REGIONAL ROAD 36
PRIAM
MORESBY
MATTAWA
YOHO

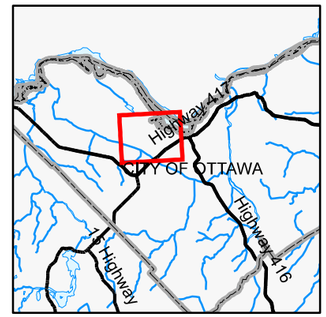
Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- > 90

- Upper Kizell Subwatershed Area (Beaver Pond)
- 23.4 Point Rainfall Total (mm)



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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map
Event 2013-08
June 28th

60264539

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Figure C-2-3

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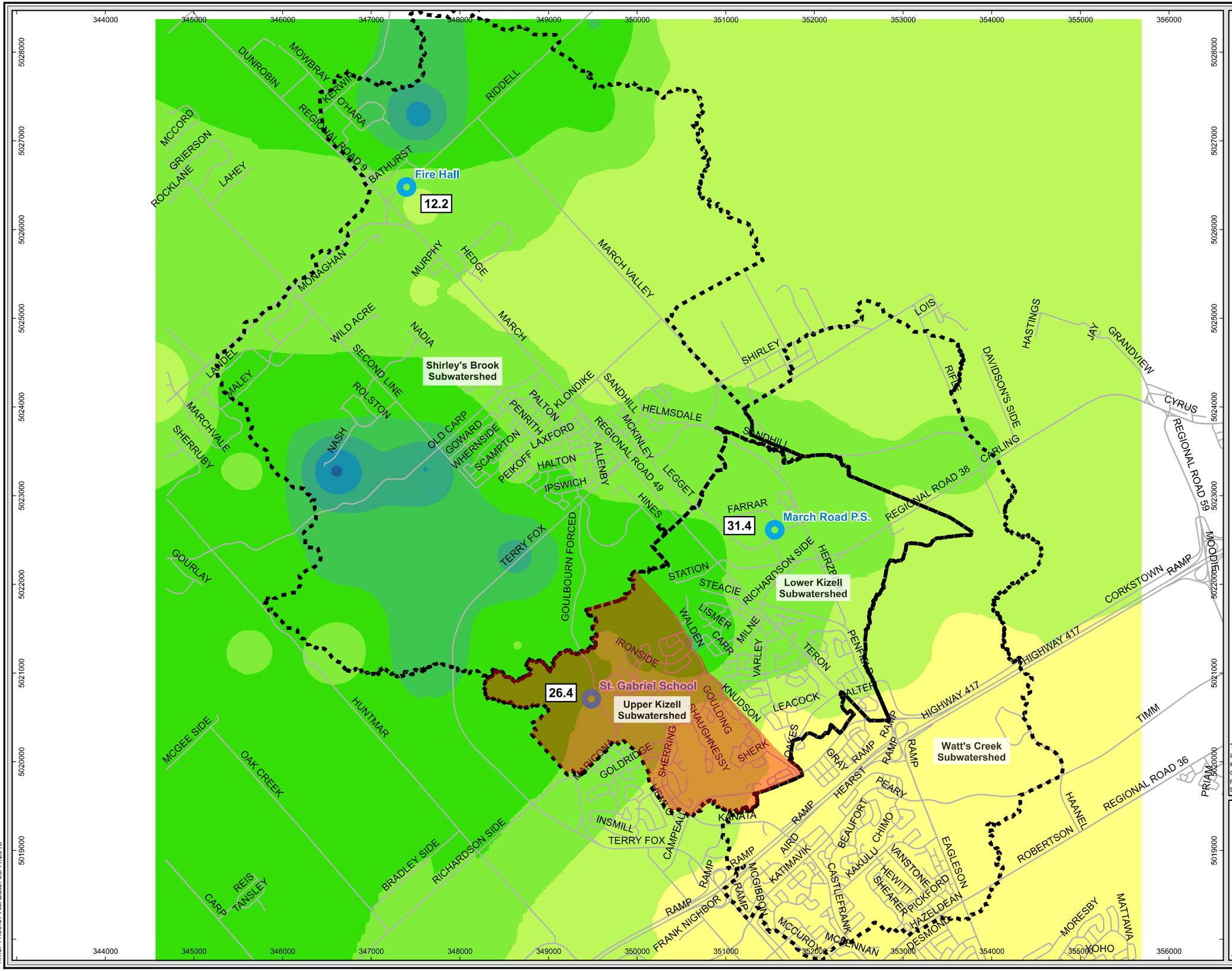
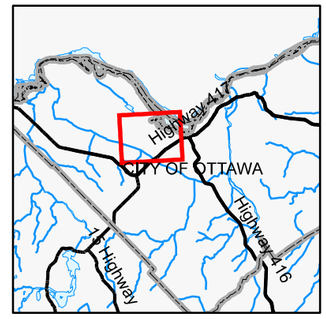


Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- > 90
- Upper Kizell Subwatershed Area (Beaver Pond)
- 23.4 Point Rainfall Total (mm)



Basemapping and orthophotography provided by the City of Ottawa.

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NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map
Event 2013-10

August 7th to 8th

60264539

AECOM

Figure C-2-4

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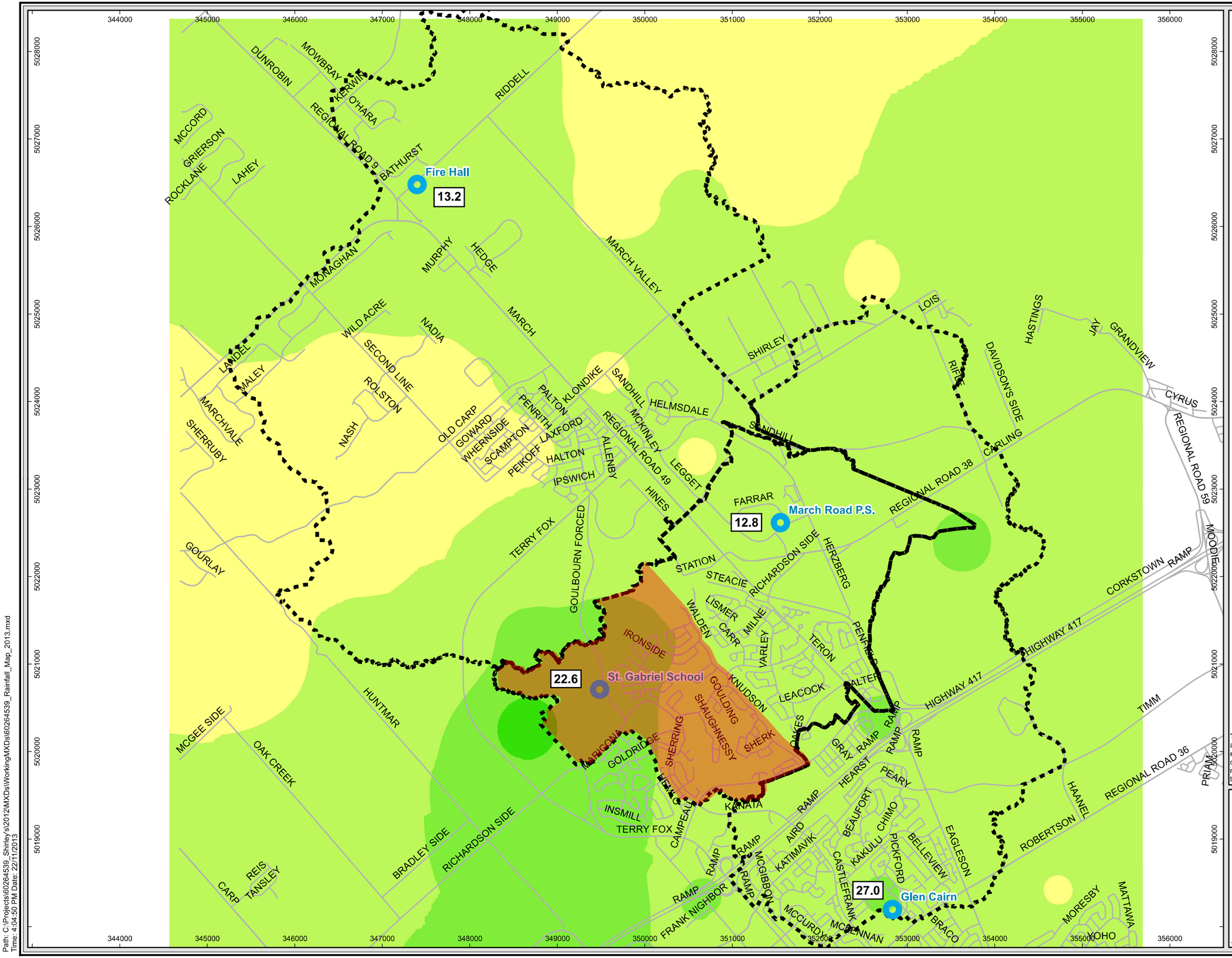


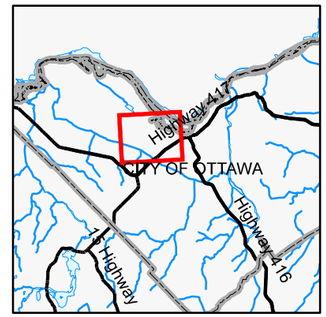
Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- > 90

- Upper Kizell Subwatershed Area (Beaver Pond)
- 23.4 Point Rainfall Total (mm)



Basemapping and orthophotography provided by the City of Ottawa.

N
W E
S

0 200 400 800 1,200 1,600 m

1:40,000

NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

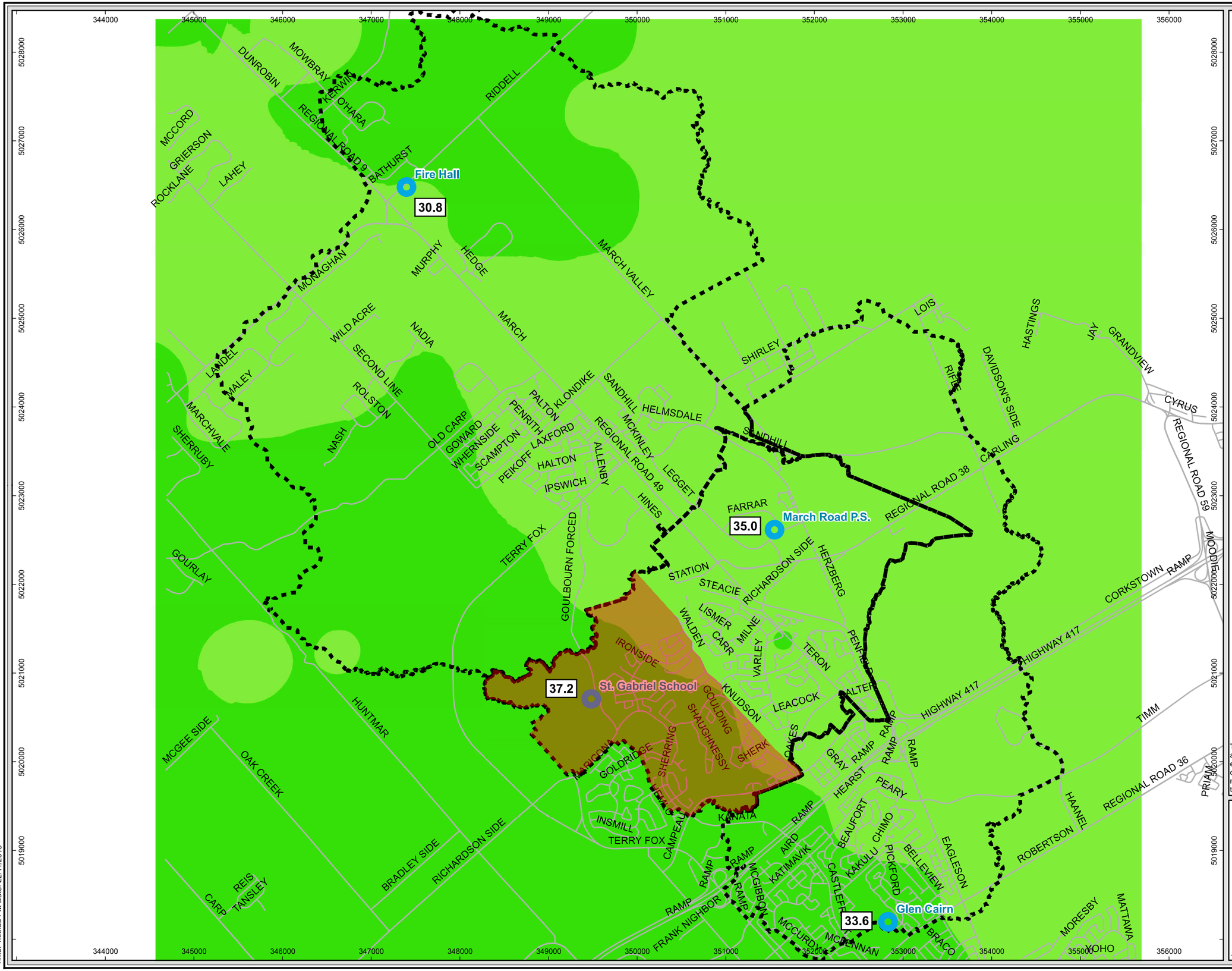
Rainfall Radar Map
2013 Event
Event 2013-16
September 12th

60264539

AECOM

Figure C-2-5

Path: C:\Projects\60264539_Shirley's\2012\MXDs\WorkingMXDs\60264539_Rainfall_Map_2013.mxd
Time: 4:04:50 PM Date: 22/11/2013



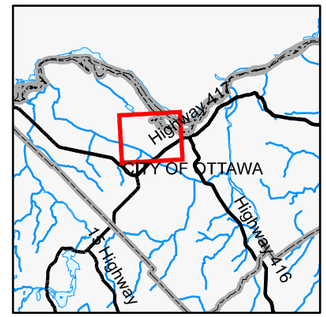
Path: C:\Projects\60264539_Shirley's\2012\MXDs\WorkingMXDs\60264539_Rainfall_Map_2013.mxd
Time: 4:08:58 PM Date: 22/11/2013

Legend

- Subwatershed Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- > 90
- Upper Kizell Subwatershed Area (Beaver Pond)
- 23.4 Point Rainfall Total (mm)



Basemapping and orthophotography provided by the City of Ottawa.

N
W E
S

0 200 400 800 1,200 1,600 m

1:40,000

NAD 83, MTM 9

This drawing has been prepared for the use of AECOM's client and may not be used, reproduced or relied upon by third parties, except as agreed by AECOM and its client, as required by law or for use by governmental reviewing agencies. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without AECOM's express written consent

Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map

Event 2013-17

September 21st to 22nd

60264539

AECOM

Figure C-2-6

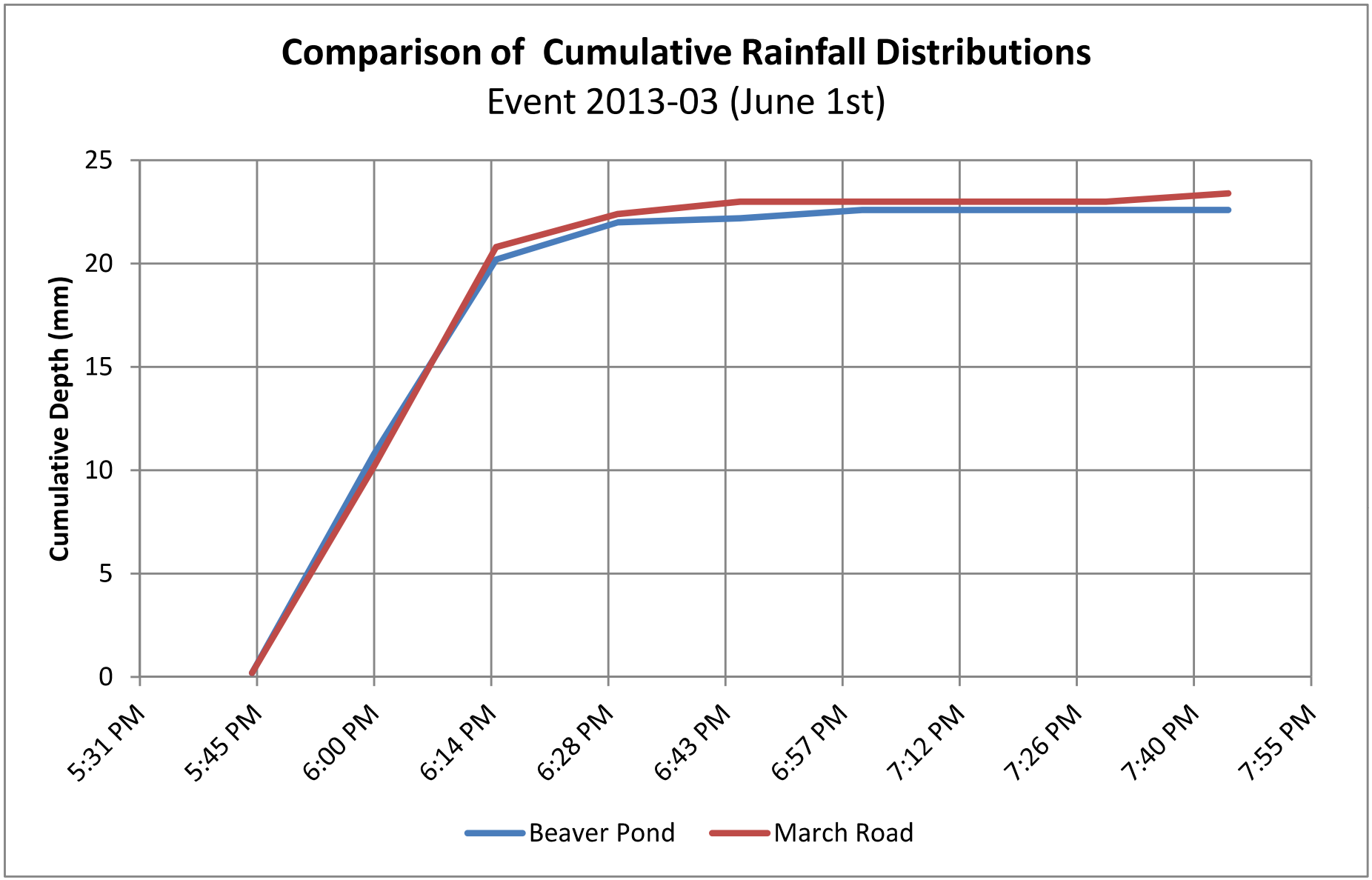

Comparison of Cumulative Rainfall Distributions
Event 2013-03 (June 1st)
Cumulative Depth (mm)
25
20
15
10
5
0
5:31 PM
5:45 PM
6:00 PM
6:14 PM
6:28 PM
6:43 PM
6:57 PM
7:12 PM
7:26 PM
7:40 PM
7:55 PM
Beaver Pond
March Road

Figure C-2-7

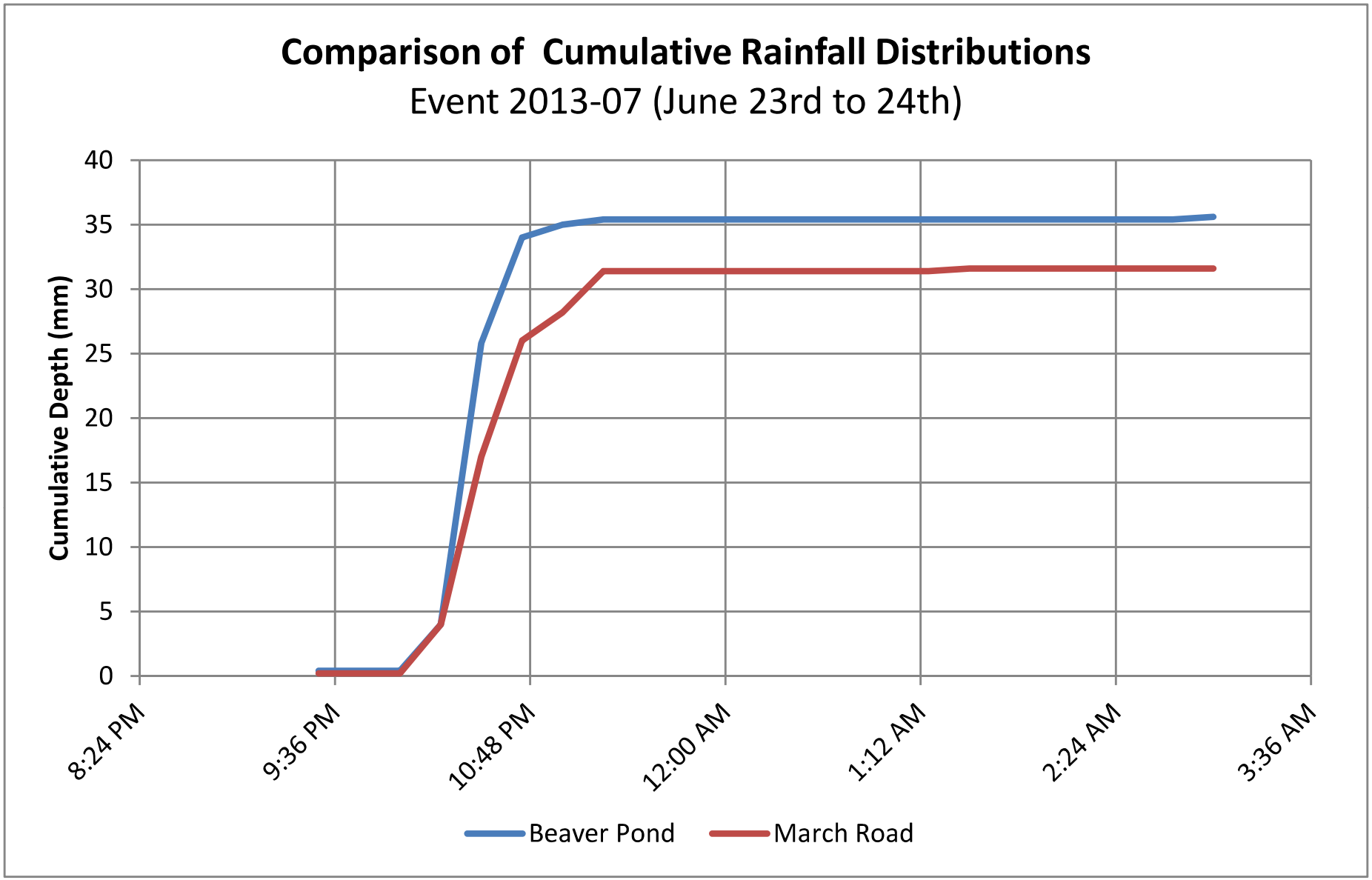

Comparison of Cumulative Rainfall Distributions
Event 2013-07 (June 23rd to 24th)
Cumulative Depth (mm)
40
35
30
25
20
15
10
5
0
8:24 PM
9:36 PM
10:48 PM
12:00 AM
1:12 AM
2:24 AM
3:36 AM
Beaver Pond
March Road

Figure C-2-8

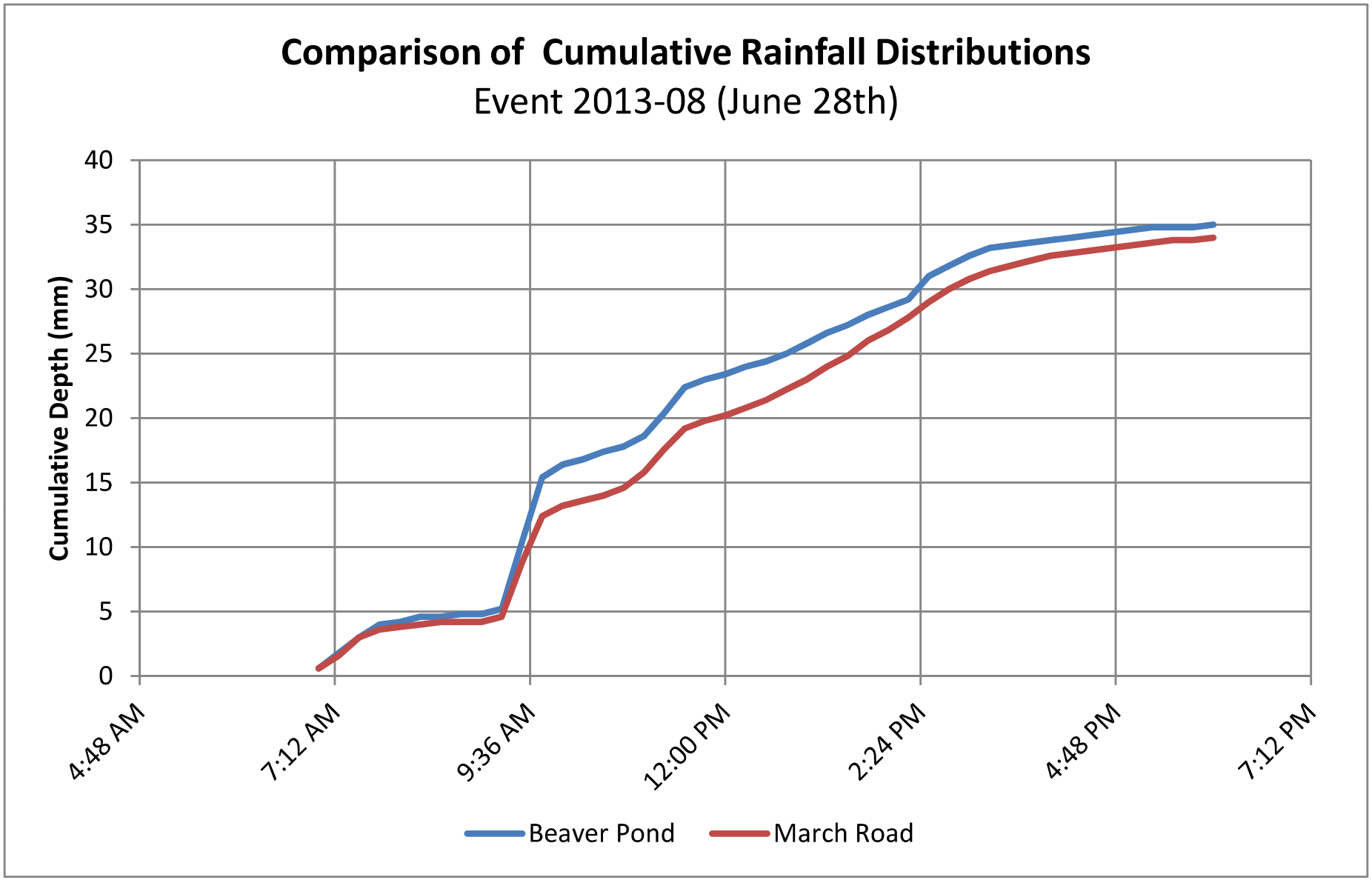

Comparison of Cumulative Rainfall Distributions
Event 2013-08 (June 28th)
Cumulative Depth (mm)
40
35
30
25
20
15
10
5
0
4:48 AM
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
Beaver Pond
March Road

Figure C-2-9

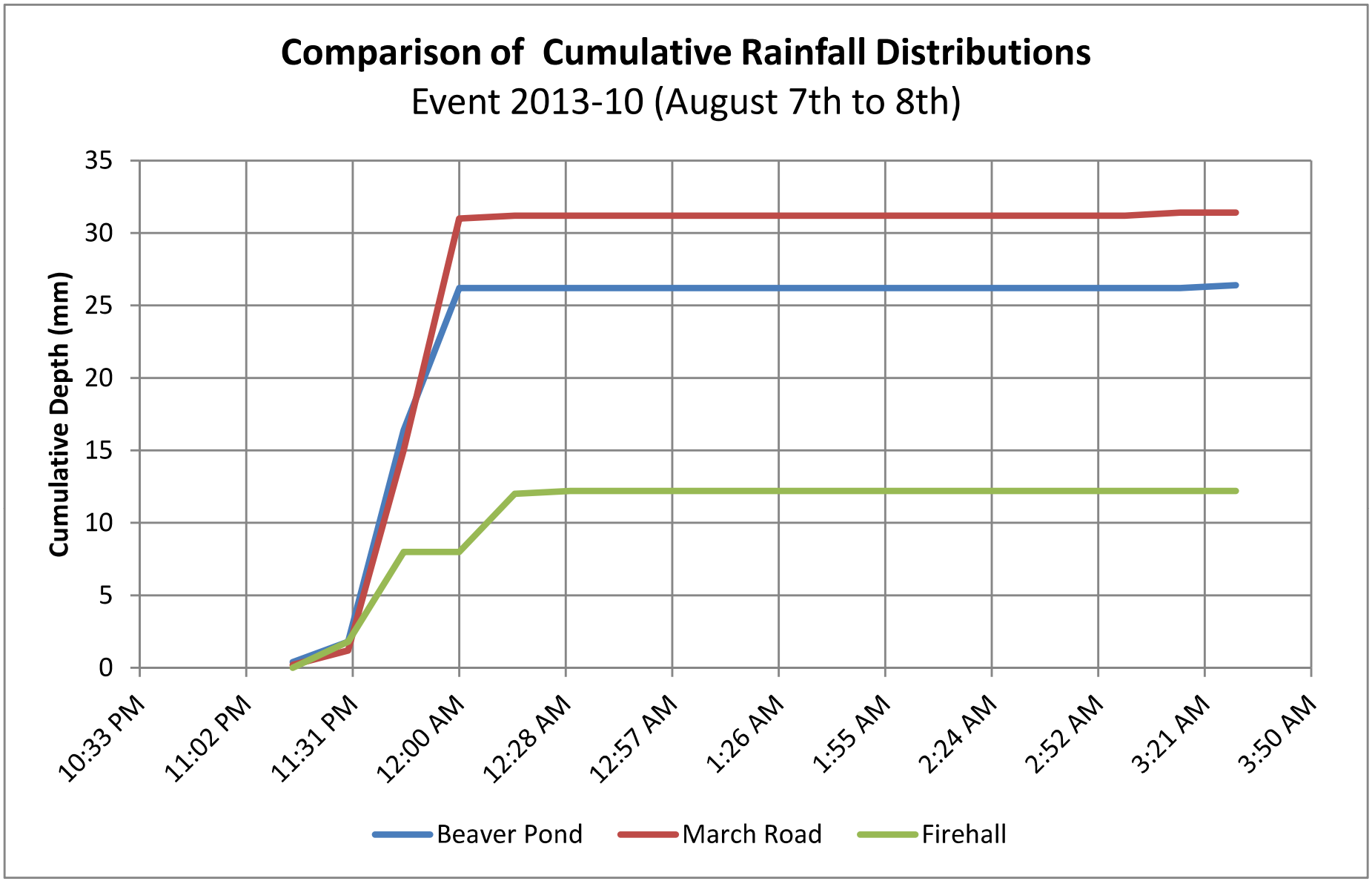

Comparison of Cumulative Rainfall Distributions
Event 2013-10 (August 7th to 8th)
Cumulative Depth (mm)
35
30
25
20
15
10
5
0
10:33 PM
11:02 PM
11:31 PM
12:00 AM
12:28 AM
12:57 AM
1:26 AM
1:55 AM
2:24 AM
2:52 AM
3:21 AM
3:50 AM
Beaver Pond
March Road
Firehall

Figure C-2-10

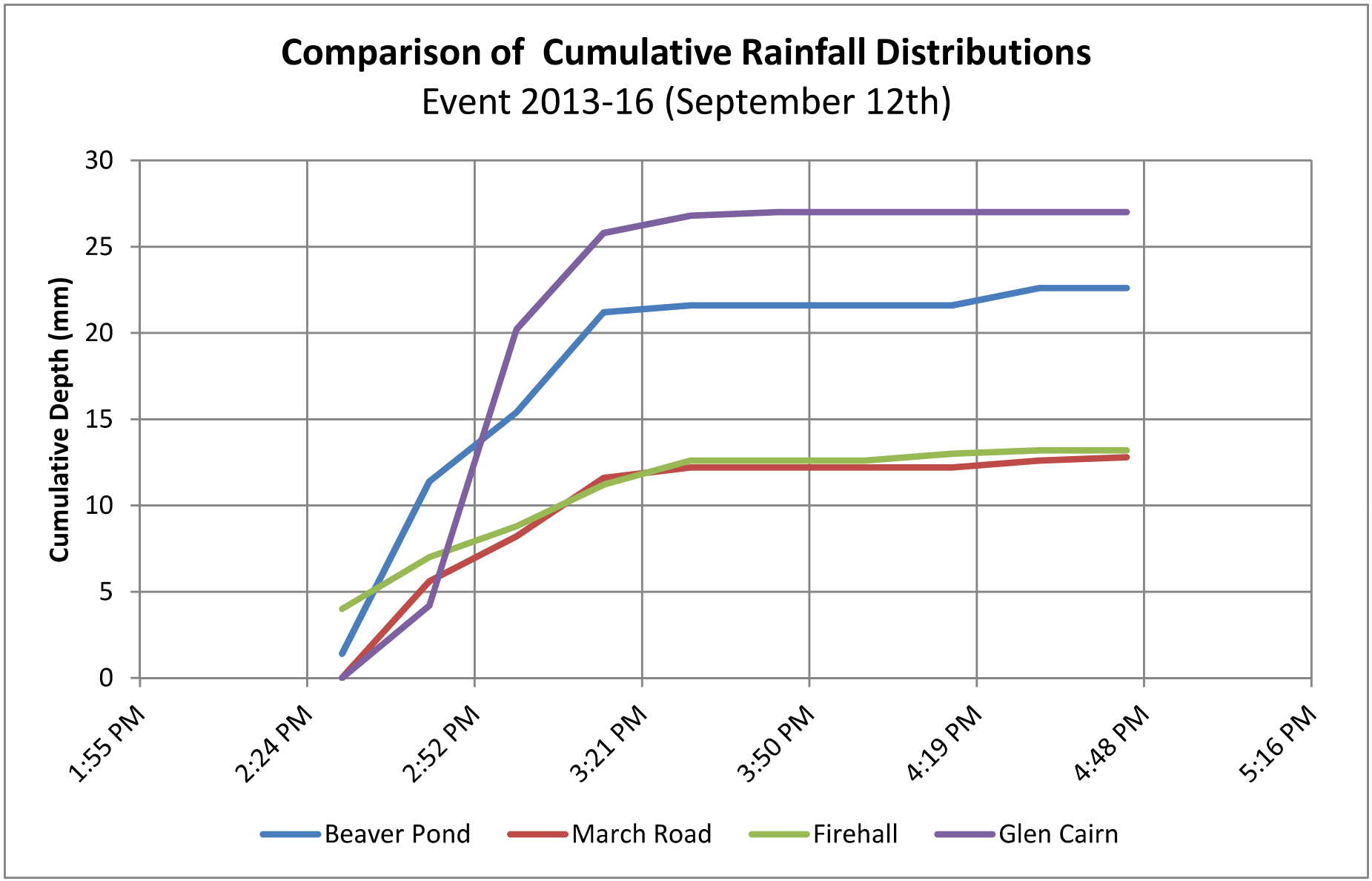

Comparison of Cumulative Rainfall Distributions
Event 2013-16 (September 12th)
Cumulative Depth (mm)
30
25
20
15
10
5
0
1:55 PM
2:24 PM
2:52 PM
3:21 PM
3:50 PM
4:19 PM
4:48 PM
5:16 PM
Beaver Pond
March Road
Firehall
Glen Cairn

Figure C-2-11

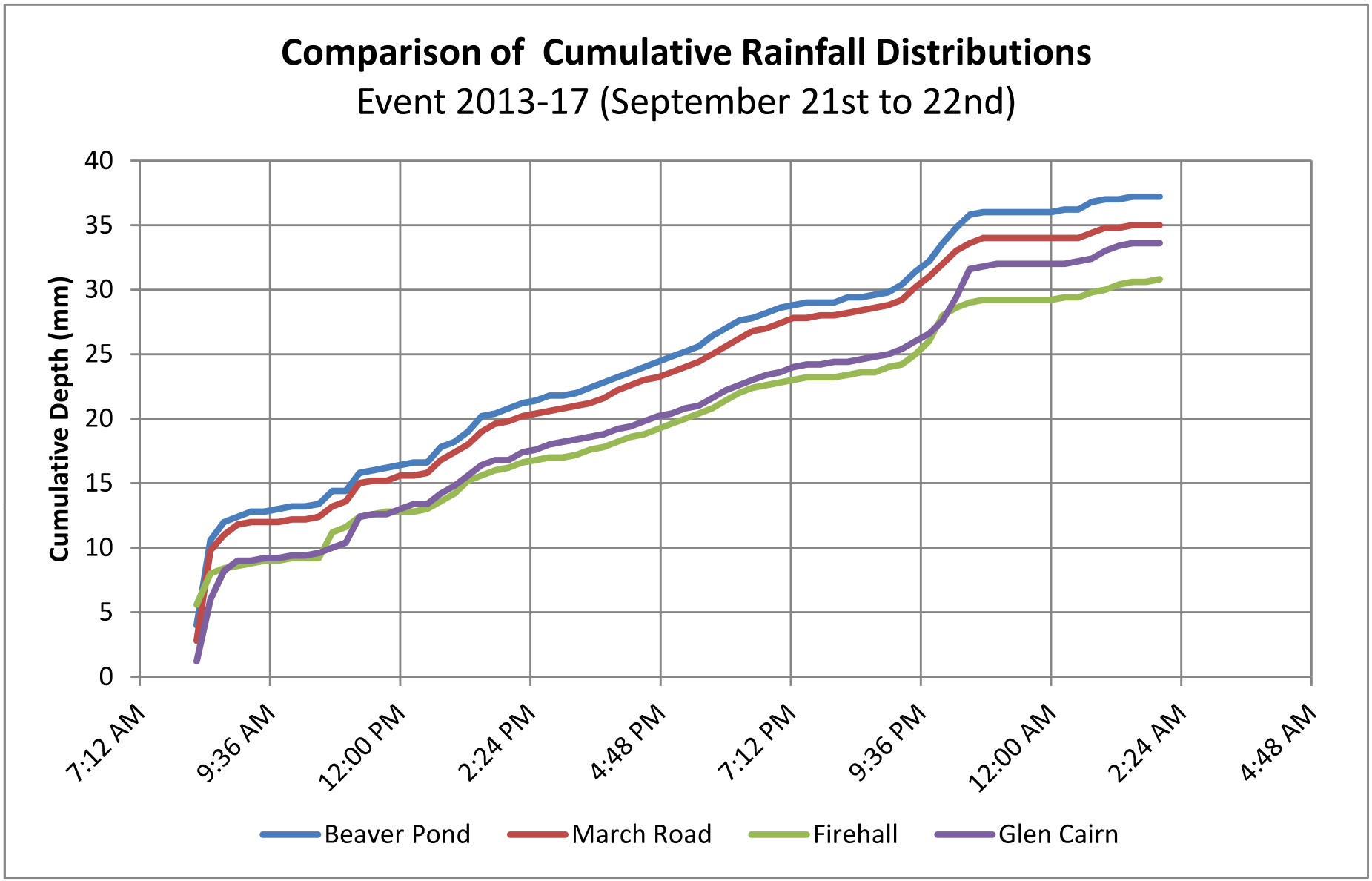

Comparison of Cumulative Rainfall Distributions
Event 2013-17 (September 21st to 22nd)
Cumulative Depth (mm)
40
35
30
25
20
15
10
5
0
7:12 AM
9:36 AM
12:00 PM
2:24 PM
4:48 PM
7:12 PM
9:36 PM
12:00 AM
2:24 AM
4:48 AM
Beaver Pond
March Road
Firehall
Glen Cairn

Figure C-2-12

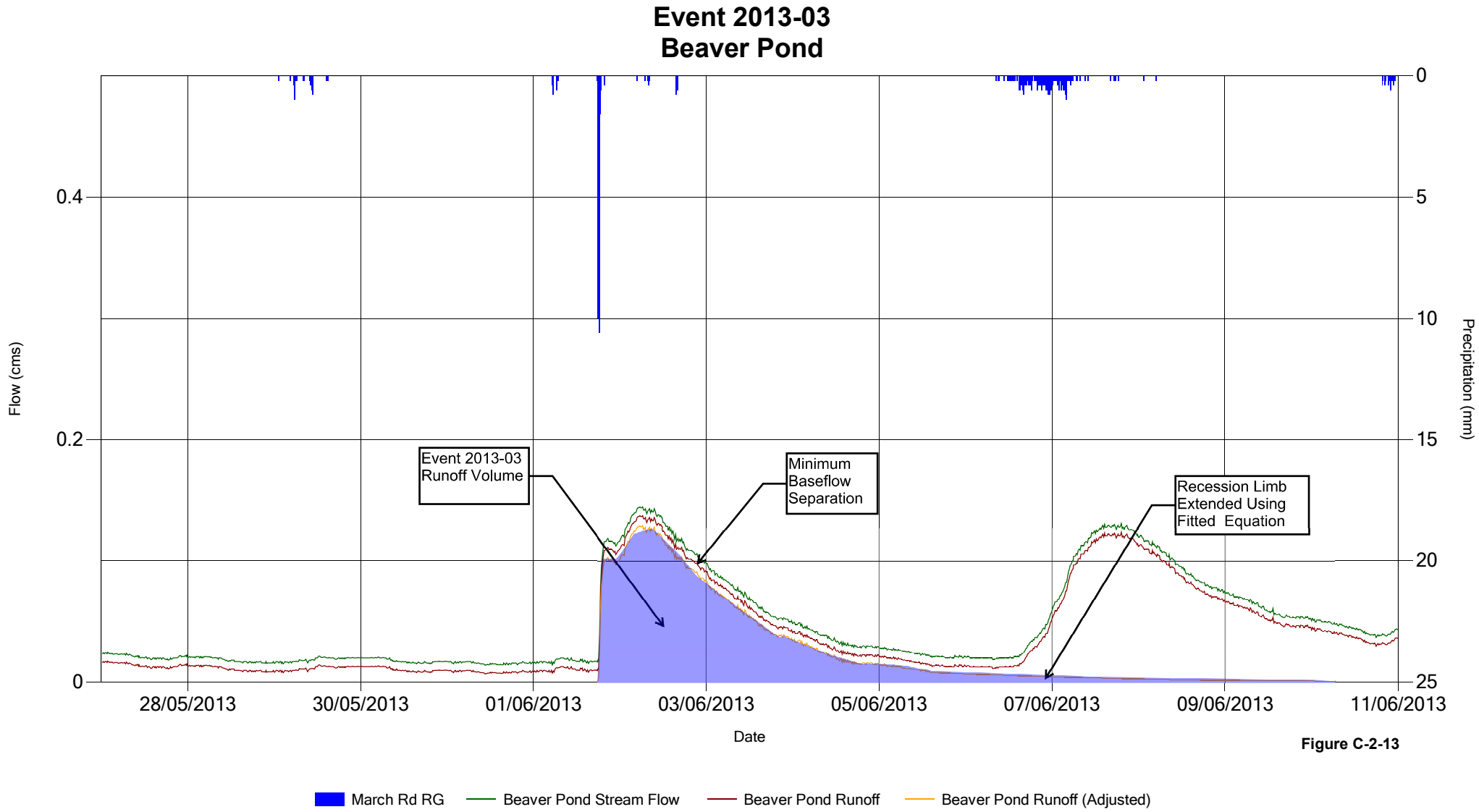

Event 2013-03
Beaver Pond
Flow (cms)
Precipitation (mm)
0
0.2
0.4
0
5
10
15
20
25
28/05/2013
30/05/2013
01/06/2013
03/06/2013
05/06/2013
07/06/2013
09/06/2013
11/06/2013
Date
Event 2013-03
Runoff Volume
Minimum
Baseflow
Separation
Recession Limb
Extended Using
Fitted Equation
March Rd RG
Beaver Pond Stream Flow
Beaver Pond Runoff
Beaver Pond Runoff (Adjusted)

Figure C-2-13

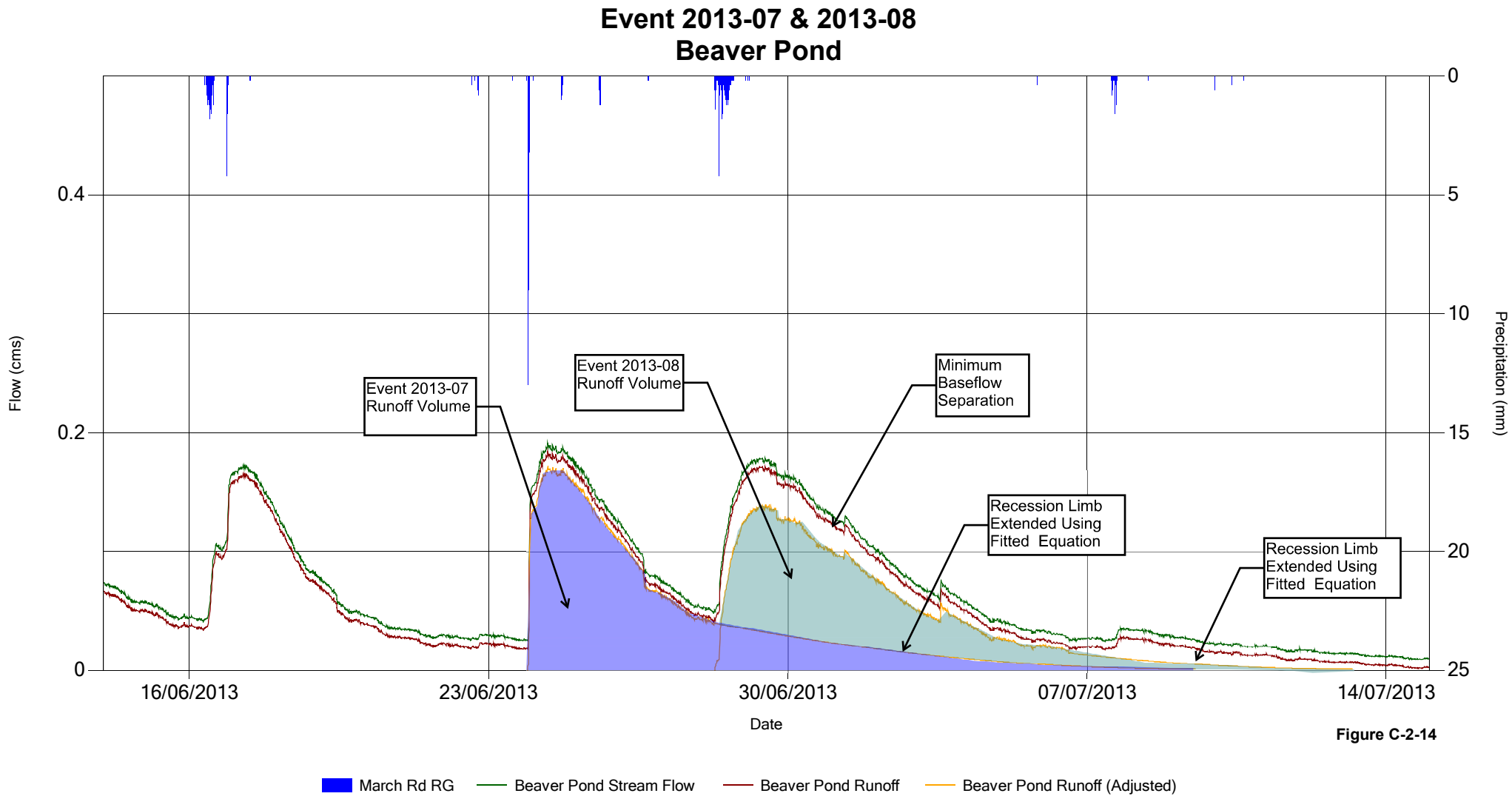

Event 2013-07 & 2013-08
Beaver Pond
Flow (cms)
Precipitation (mm)
0.4
0.2
0
0
5
10
15
20
25
16/06/2013
23/06/2013
30/06/2013
07/07/2013
14/07/2013
Date
Event 2013-07
Runoff Volume
Event 2013-08
Runoff Volume
Minimum
Baseflow
Separation
Recession Limb
Extended Using
Fitted Equation
Recession Limb
Extended Using
Fitted Equation
March Rd RG
Beaver Pond Stream Flow
Beaver Pond Runoff
Beaver Pond Runoff (Adjusted)

Figure C-2-14

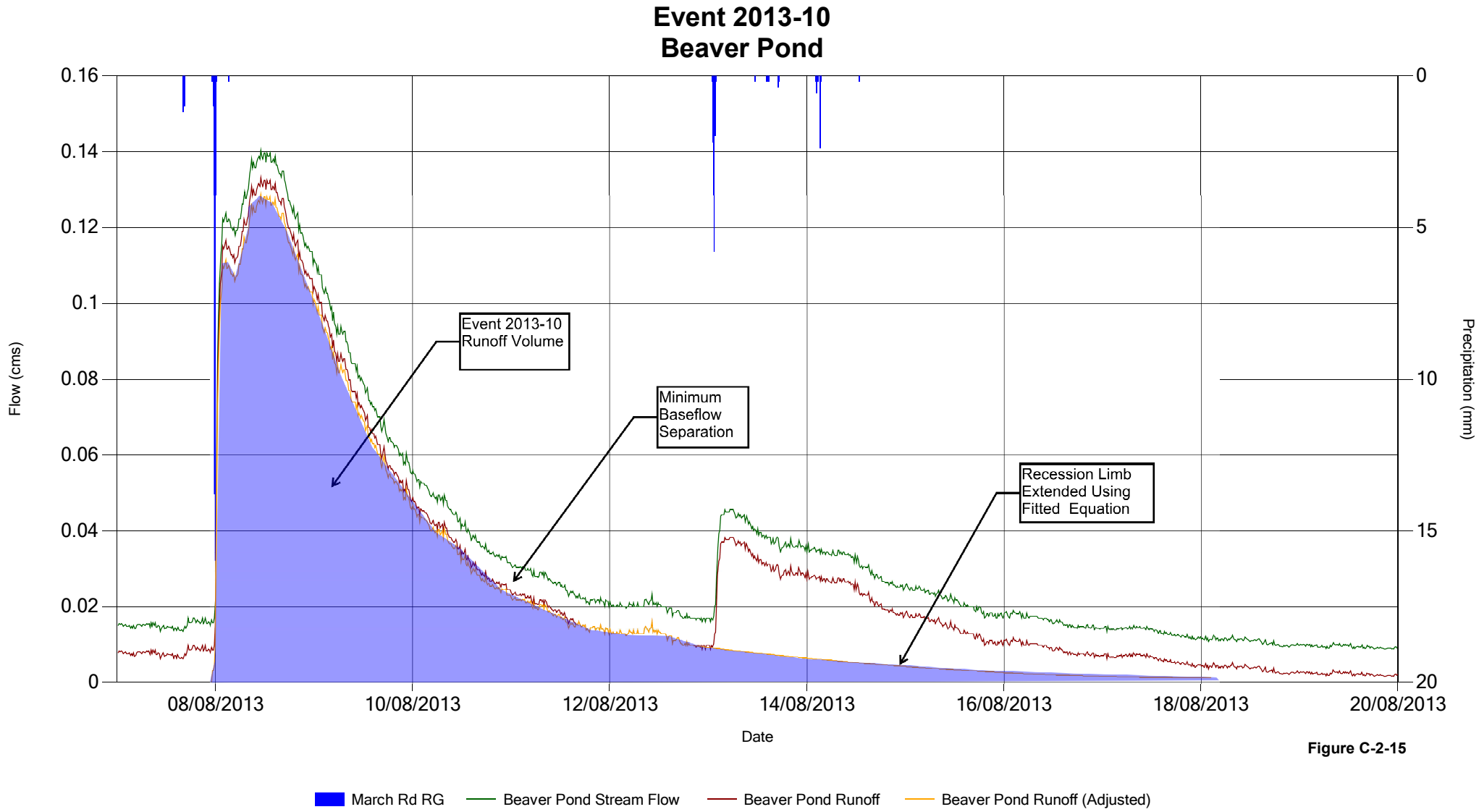

Event 2013-10
Beaver Pond
Flow (cms)
Precipitation (mm)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
5
10
15
20
08/08/2013
10/08/2013
12/08/2013
14/08/2013
16/08/2013
18/08/2013
20/08/2013
Date
Event 2013-10
Runoff Volume
Minimum
Baseflow
Separation
Recession Limb
Extended Using
Fitted Equation
March Rd RG
Beaver Pond Stream Flow
Beaver Pond Runoff
Beaver Pond Runoff (Adjusted)

Figure C-2-15

Event 2013-16 & 2013-17
Beaver Pond

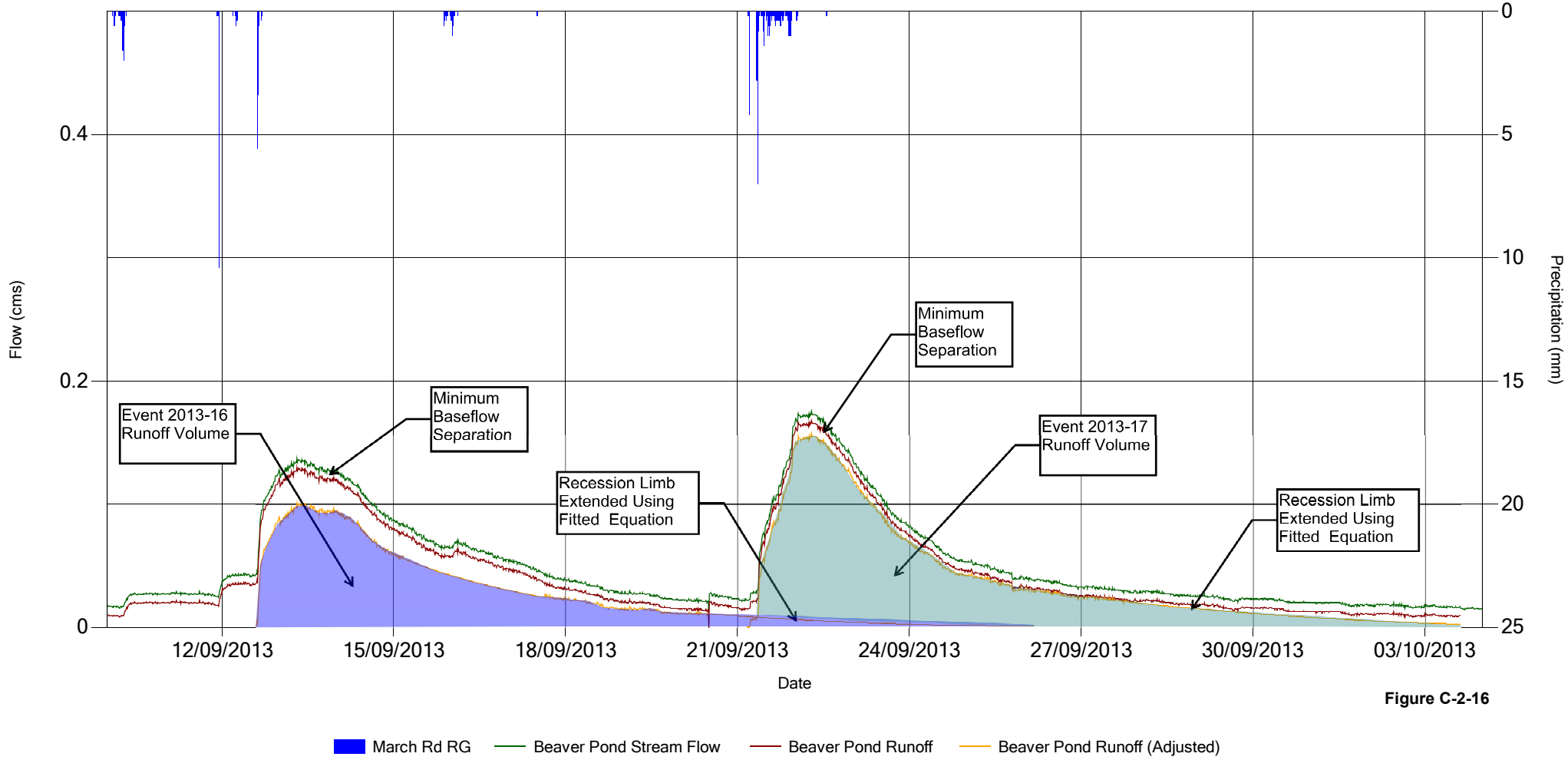


Figure C-2-16

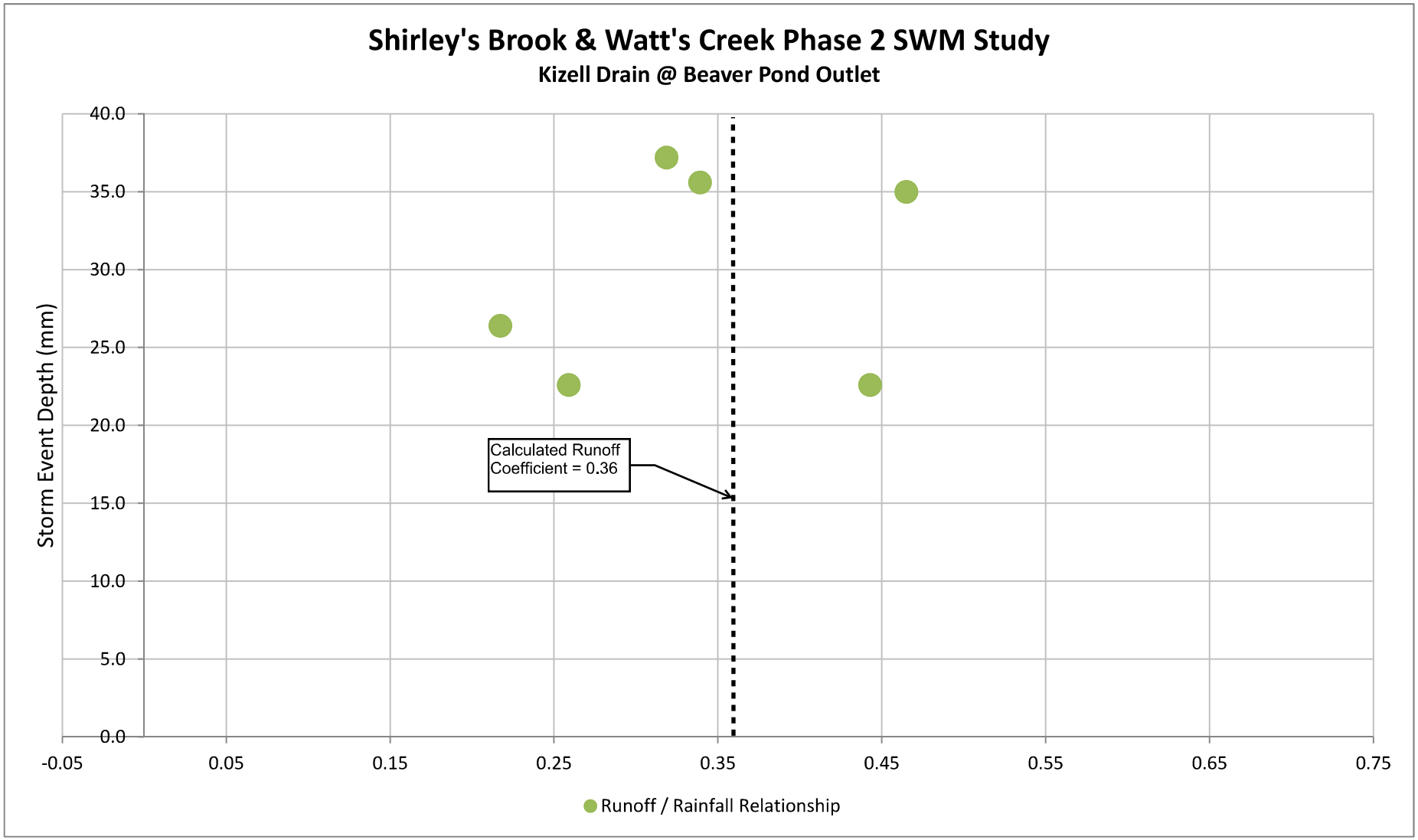

Shirley's Brook & Watt's Creek Phase 2 SWM Study
Kizell Drain @ Beaver Pond Outlet
Storm Event Depth (mm)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-0.05
0.05
0.15
0.25
0.35
0.45
0.55
0.65
0.75
Calculated Runoff Coefficient = 0.36
Runoff / Rainfall Relationship

Figure C-2-17

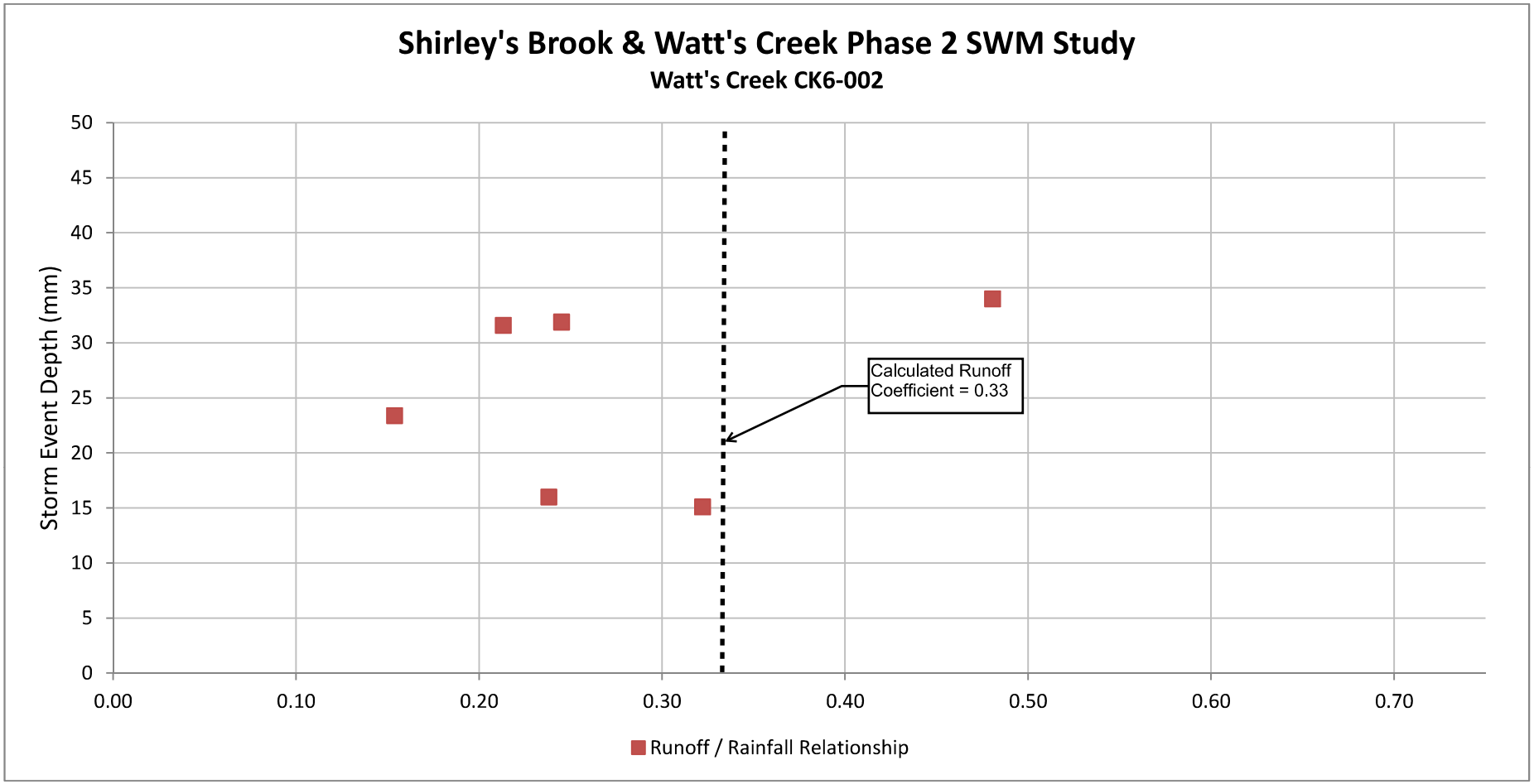

Shirley's Brook & Watt's Creek Phase 2 SWM Study
Watt's Creek CK6-002
Storm Event Depth (mm)
50
45
40
35
30
25
20
15
10
5
0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
Calculated Runoff Coefficient = 0.33
Runoff / Rainfall Relationship

Figure C-2-18

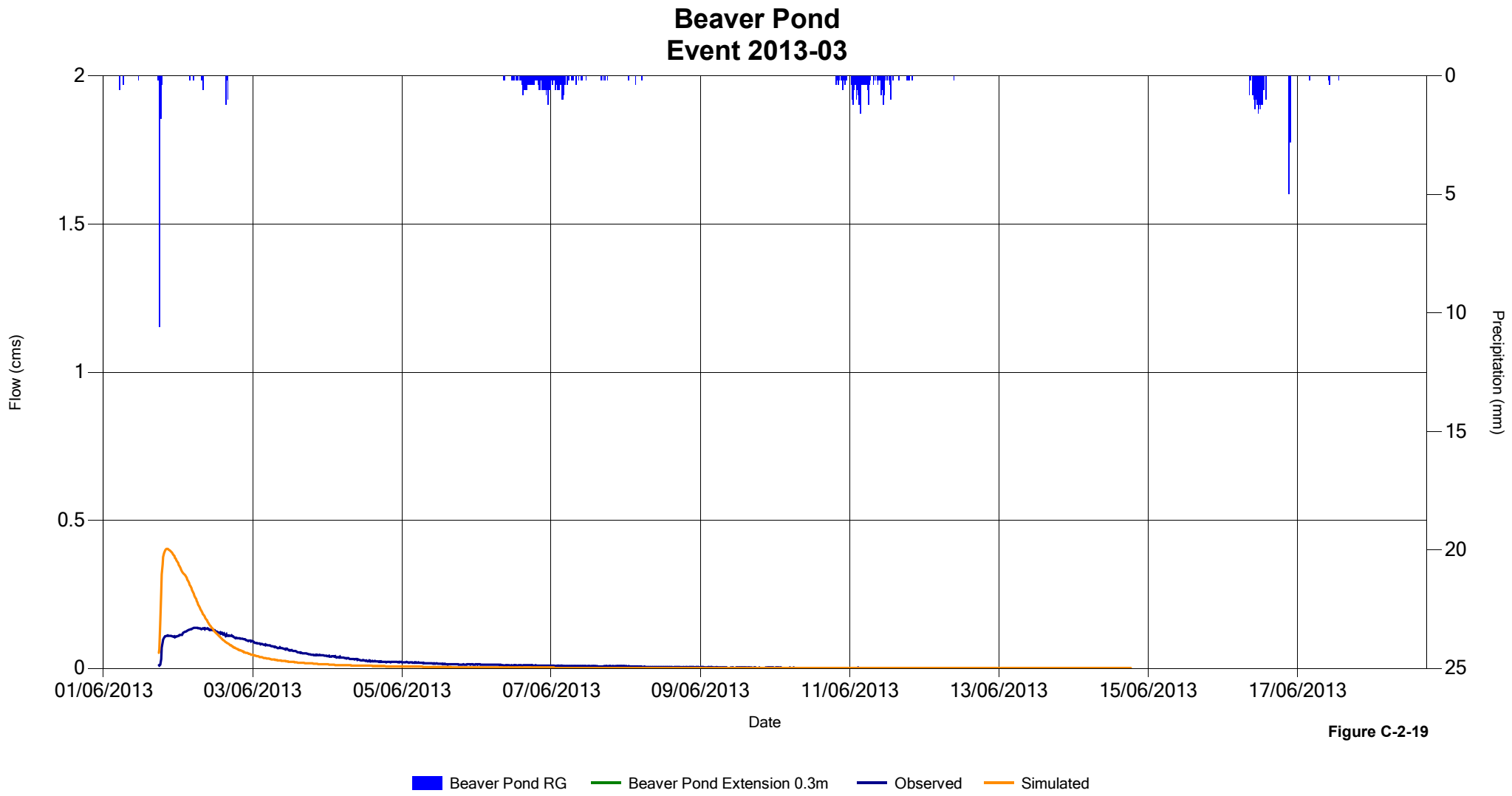

Beaver Pond
Event 2013-03
Flow (cms)
Precipitation (mm)
2
1.5
1
0.5
0
0
5
10
15
20
25
01/06/2013
03/06/2013
05/06/2013
07/06/2013
09/06/2013
11/06/2013
13/06/2013
15/06/2013
17/06/2013
Date
Beaver Pond RG
Beaver Pond Extension 0.3m
Observed
Simulated

Figure C-2-19

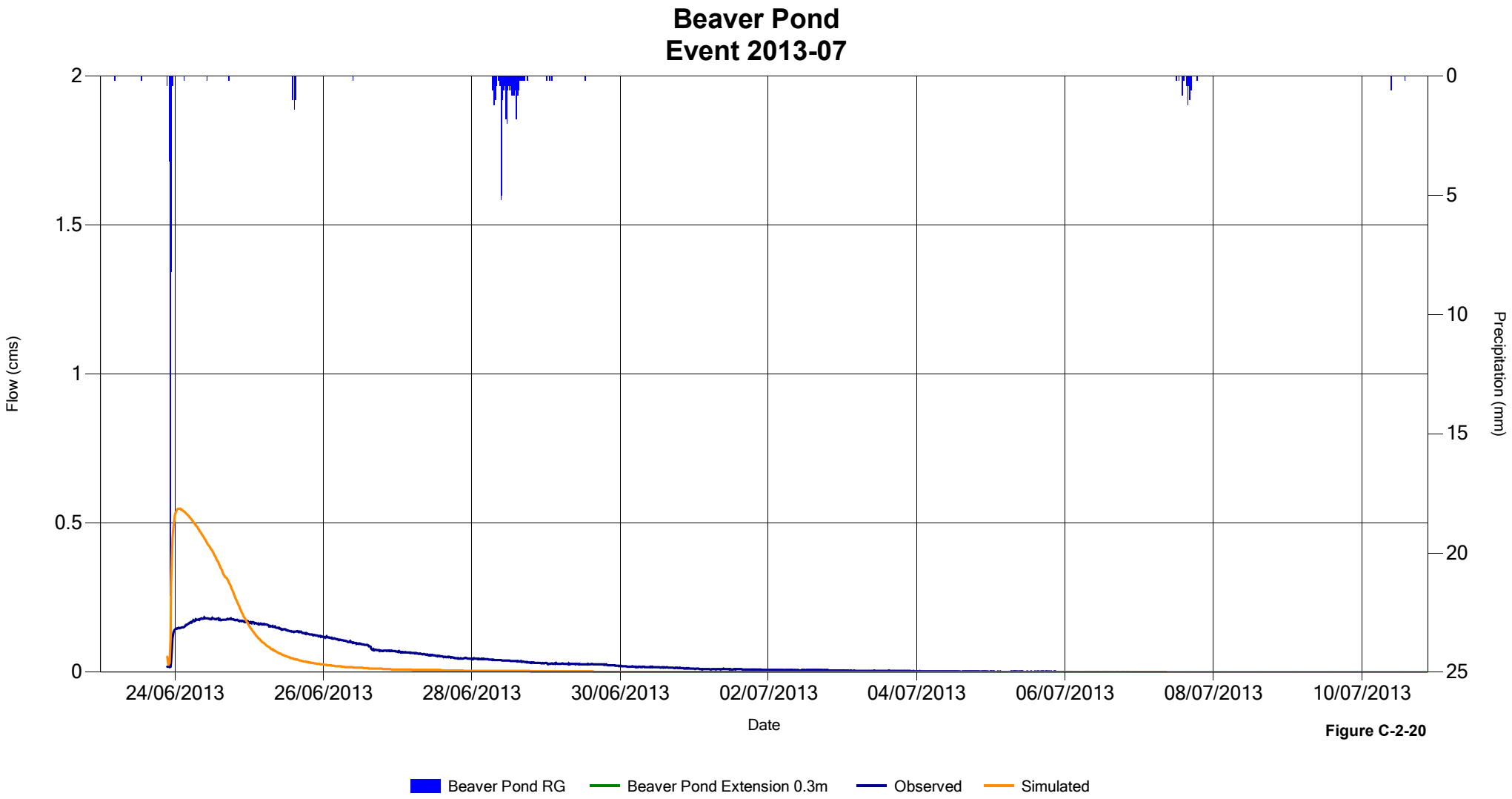

Beaver Pond
Event 2013-07
Flow (cms)
Precipitation (mm)
2
1.5
1
0.5
0
0
5
10
15
20
25
24/06/2013
26/06/2013
28/06/2013
30/06/2013
02/07/2013
04/07/2013
06/07/2013
08/07/2013
10/07/2013
Date
Beaver Pond RG
Beaver Pond Extension 0.3m
Observed
Simulated

Figure C-2-20

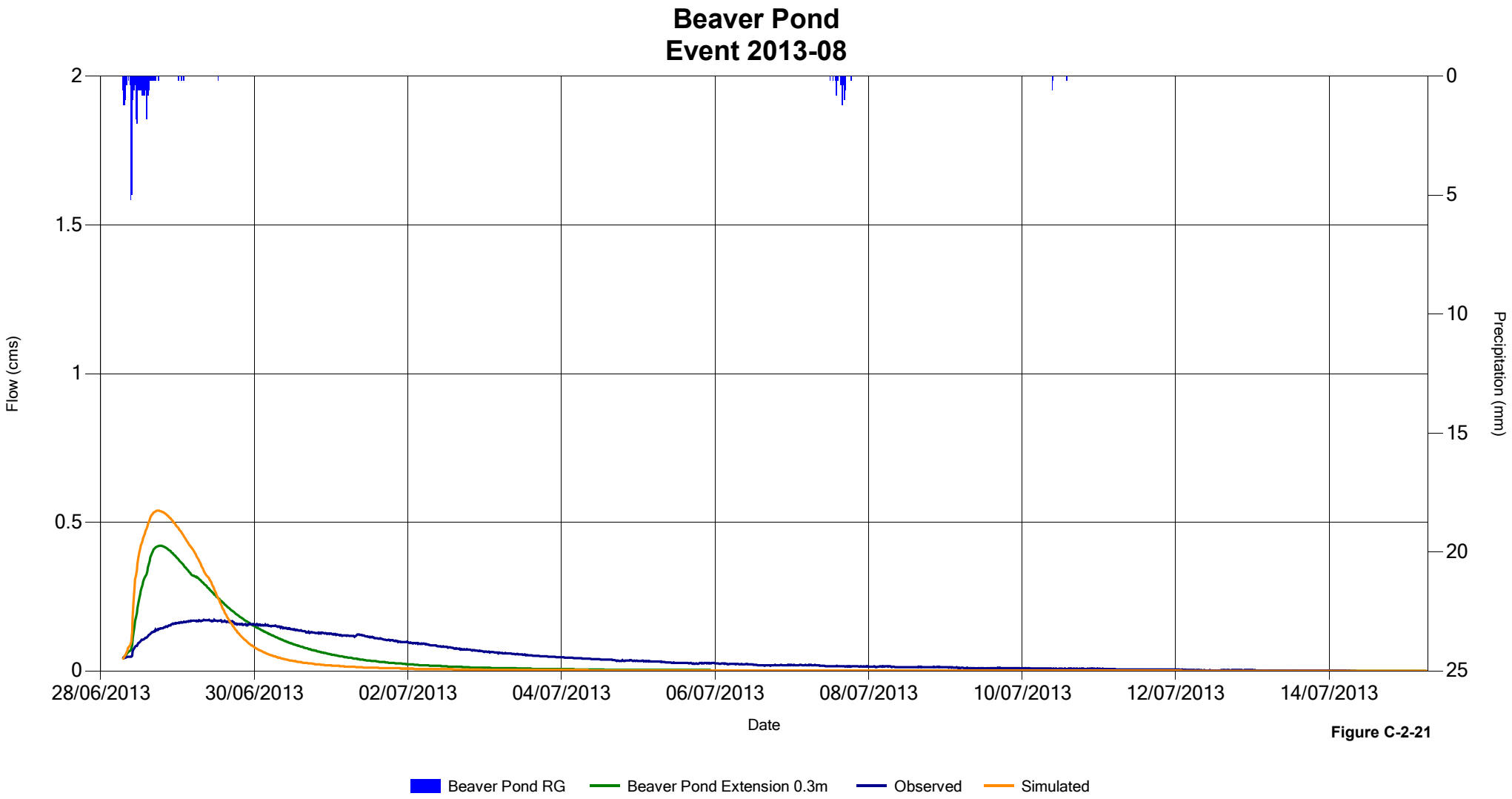

Beaver Pond
Event 2013-08
Flow (cms)
Precipitation (mm)
2
1.5
1
0.5
0
0
5
10
15
20
25
28/06/2013
30/06/2013
02/07/2013
04/07/2013
06/07/2013
08/07/2013
10/07/2013
12/07/2013
14/07/2013
Date
Beaver Pond RG
Beaver Pond Extension 0.3m
Observed
Simulated

Figure C-2-21

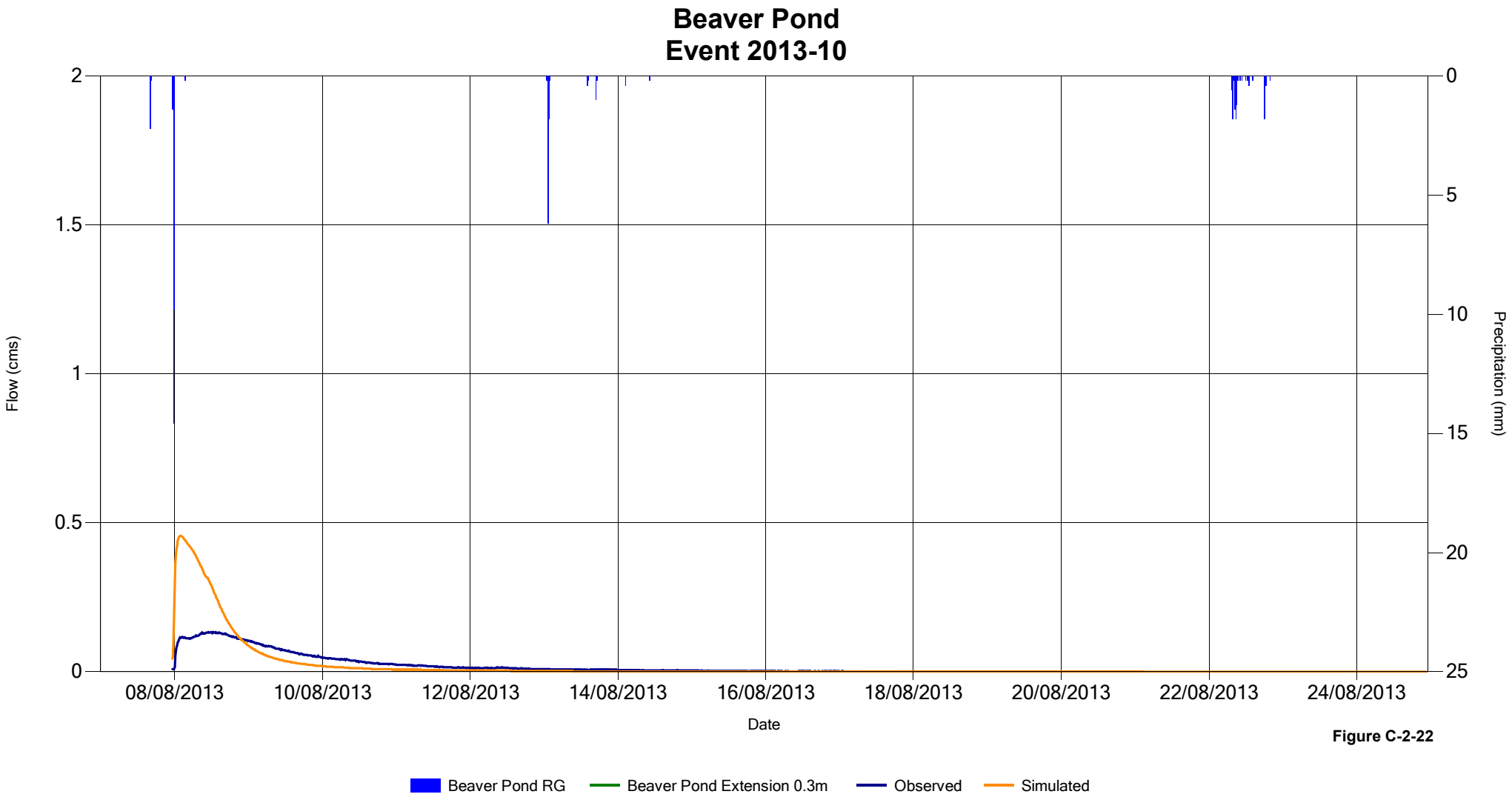

Beaver Pond
Event 2013-10
Flow (cms)
Precipitation (mm)
2
1.5
1
0.5
0
0
5
10
15
20
25
08/08/2013
10/08/2013
12/08/2013
14/08/2013
16/08/2013
18/08/2013
20/08/2013
22/08/2013
24/08/2013
Date
Beaver Pond RG
Beaver Pond Extension 0.3m
Observed
Simulated

Figure C-2-22

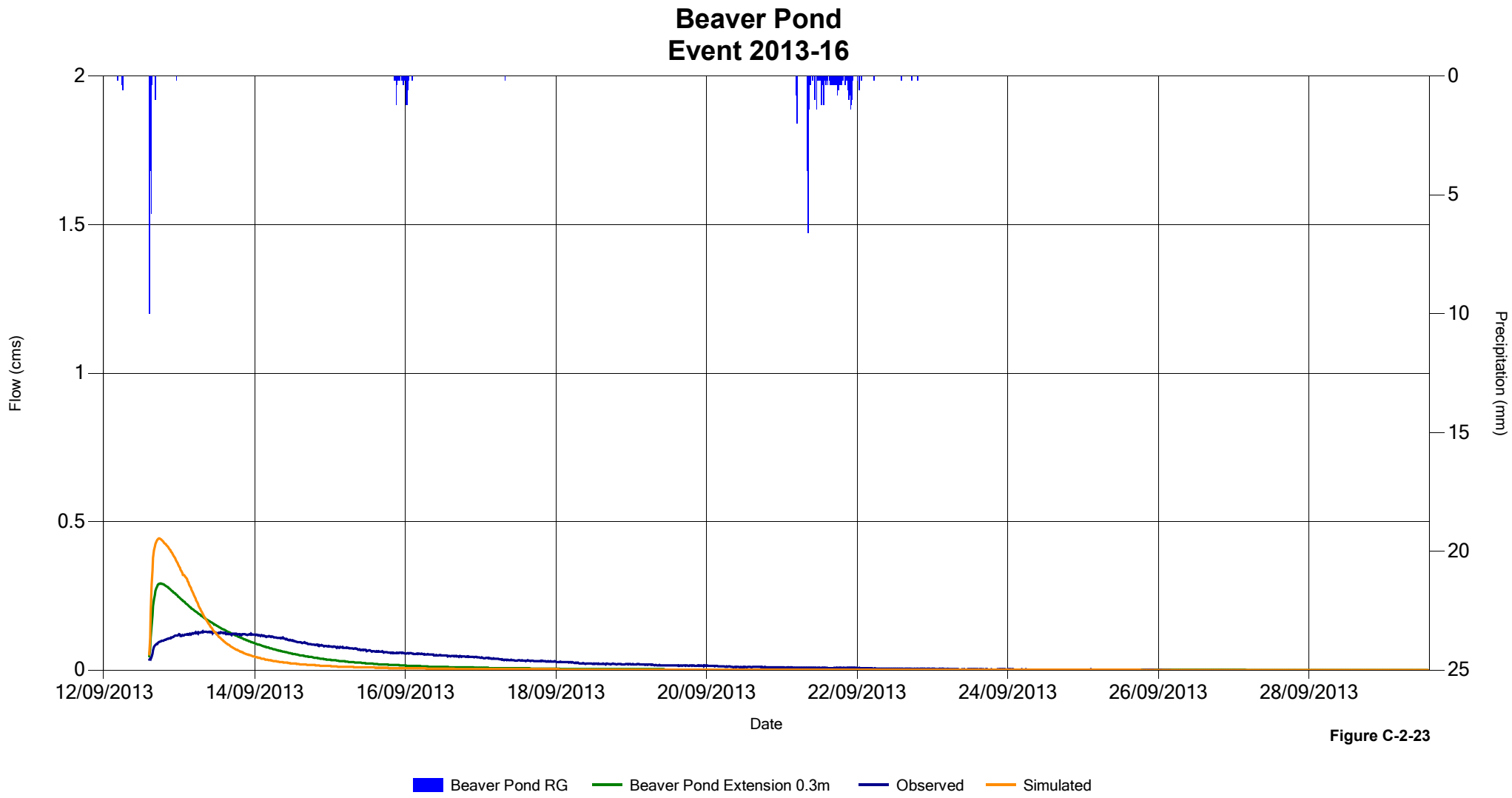

Beaver Pond
Event 2013-16
Flow (cms)
Precipitation (mm)
2
1.5
1
0.5
0
0
5
10
15
20
25
12/09/2013
14/09/2013
16/09/2013
18/09/2013
20/09/2013
22/09/2013
24/09/2013
26/09/2013
28/09/2013
Date
Beaver Pond RG
Beaver Pond Extension 0.3m
Observed
Simulated

Figure C-2-23

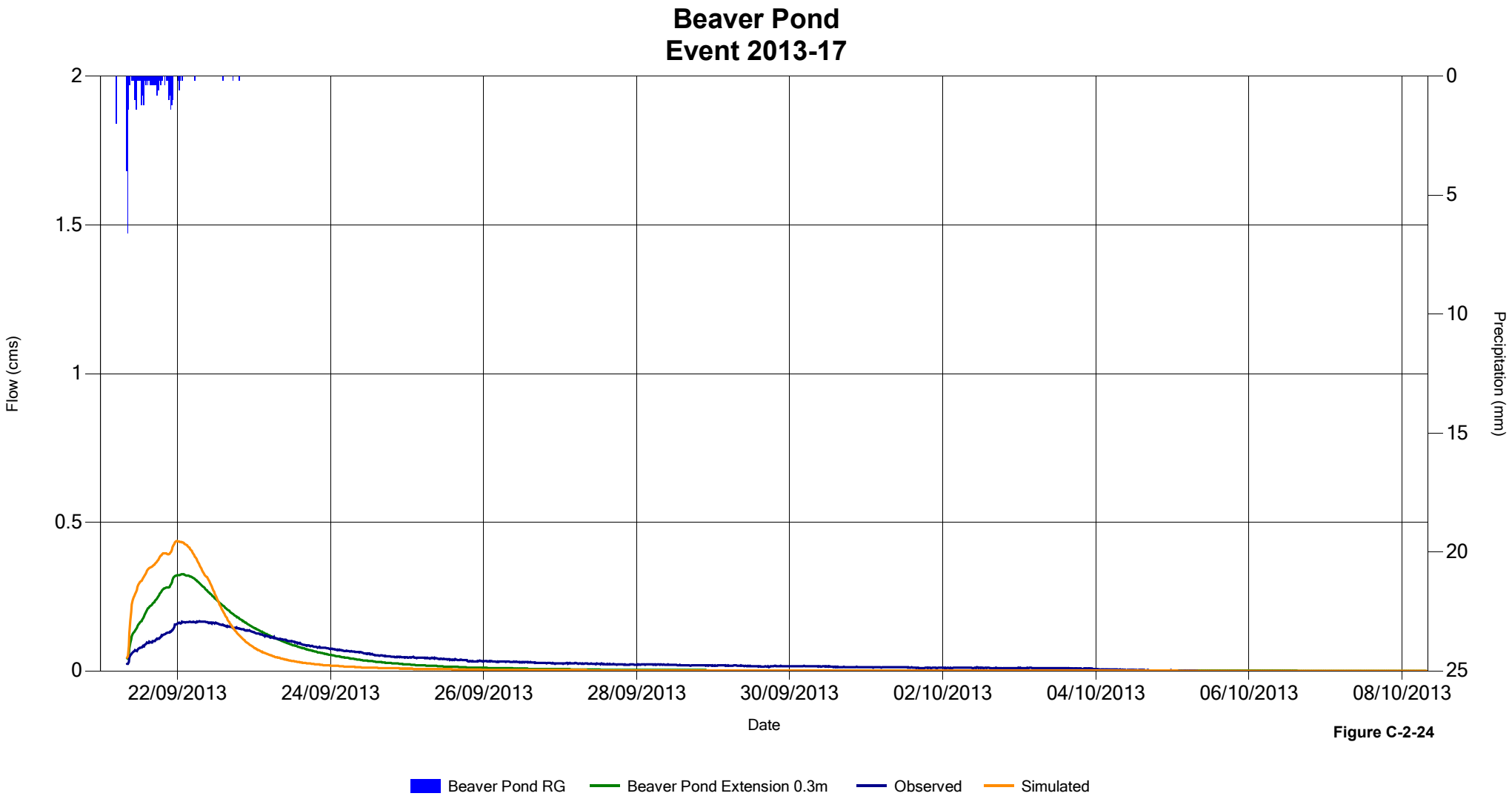

Beaver Pond
Event 2013-17
Flow (cms)
Precipitation (mm)
2
1.5
1
0.5
0
0
5
10
15
20
25
22/09/2013
24/09/2013
26/09/2013
28/09/2013
30/09/2013
02/10/2013
04/10/2013
06/10/2013
08/10/2013
Date
Beaver Pond RG
Beaver Pond Extension 0.3m
Observed
Simulated

Figure C-2-24

Evevation	Original Volume	Original Surface Area	Adjusted Volume	Adjusted Surface Area
90.5	37067	23036	37067	23036
90.6	39522	23037	41712	38690
90.7	42065	25883	46356	54345
90.8	44717	27353	51000	70000
90.9	47548	29350	53831	70387
91.0	50668	36185	56952	70774
91.1	55151	48076	61435	71161
91.2	60259	53721	66542	71548
91.3	65907	59197	72190	71935
91.4	72114	65021	78398	72322
91.5	78969	72709	85253	72709
91.6	86813	80626	93096	80626
91.7	95039	83753	101323	83753
91.8	103571	86723	109854	86723
91.9	112401	89692	118684	89692
92.0	121566	94301	127850	94301
92.1	131484	102698	137767	102698
92.2	142040	107888	148323	107888
92.3	153160	113862	159443	113862
92.4	164849	118852	171133	118852
92.5	177118	128570	183401	128570
92.55	183643		189926	
92.6	190326	135868	196610	135868
92.7	204003	139225	210287	139225
92.8	218017	142095	224301	142095
92.9	232357	144942	238640	144942
93.0	247044	151506	253327	151506
93.1	262426	156500	268710	156500
93.2	278156	159507	284439	159507
93.3	294208	162476	300491	162476
93.4	310570	165421	316854	165421
93.5	327256	169556	333540	169556
94.0				

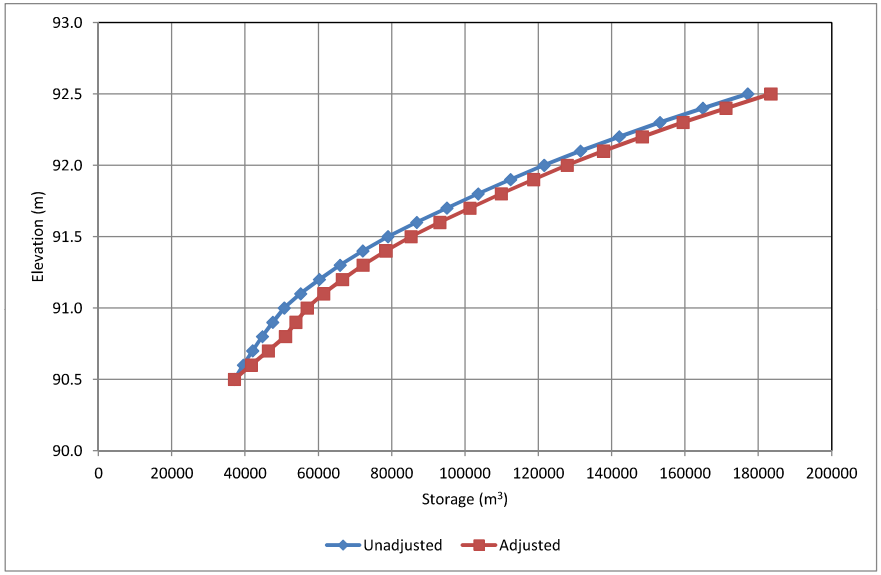


Figure C-2-25

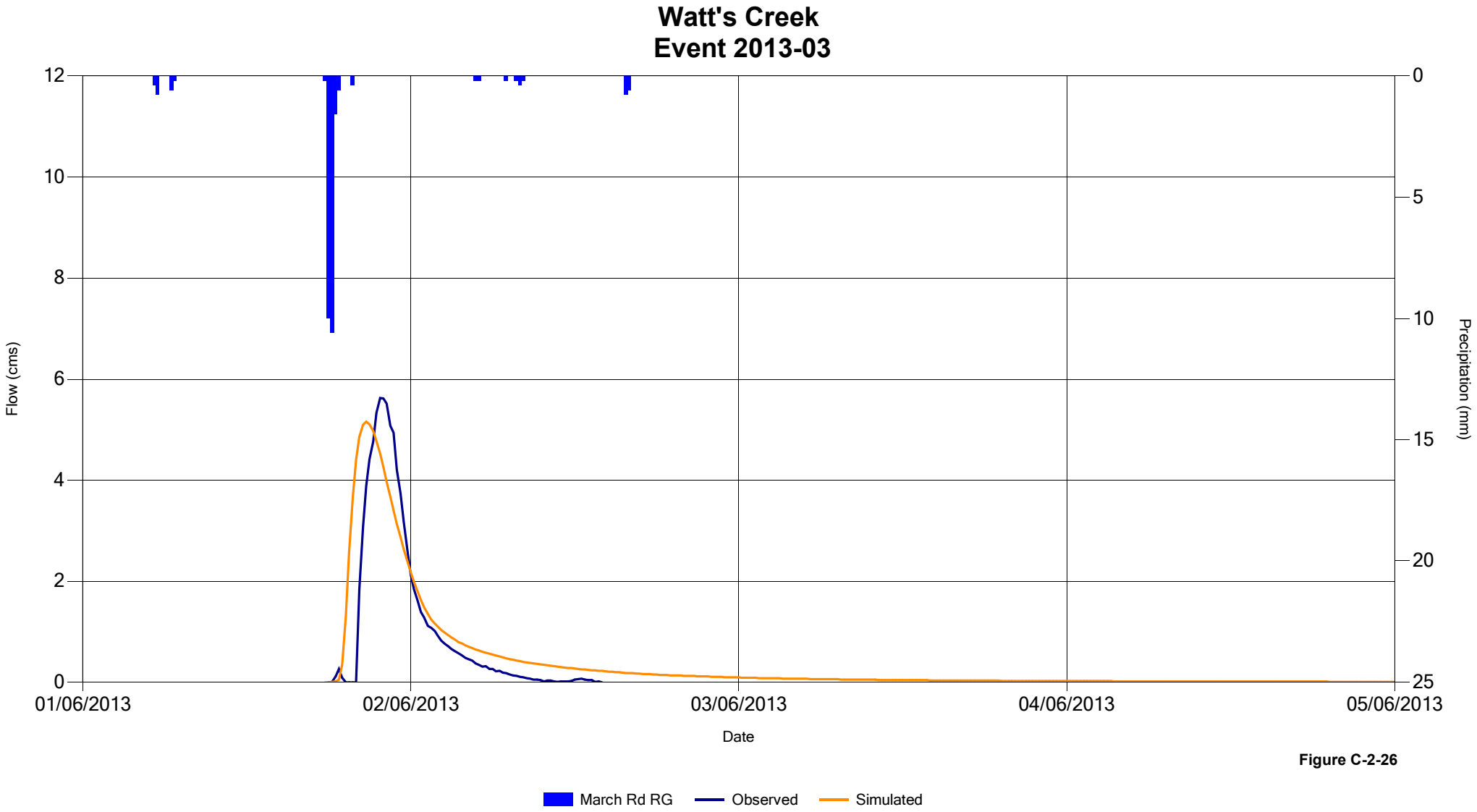

Watt's Creek
Event 2013-03
Flow (cms)
Precipitation (mm)
12
10
8
6
4
2
0
0
5
10
15
20
25
01/06/2013
02/06/2013
03/06/2013
04/06/2013
05/06/2013
Date
March Rd RG
Observed
Simulated

Figure C-2-26

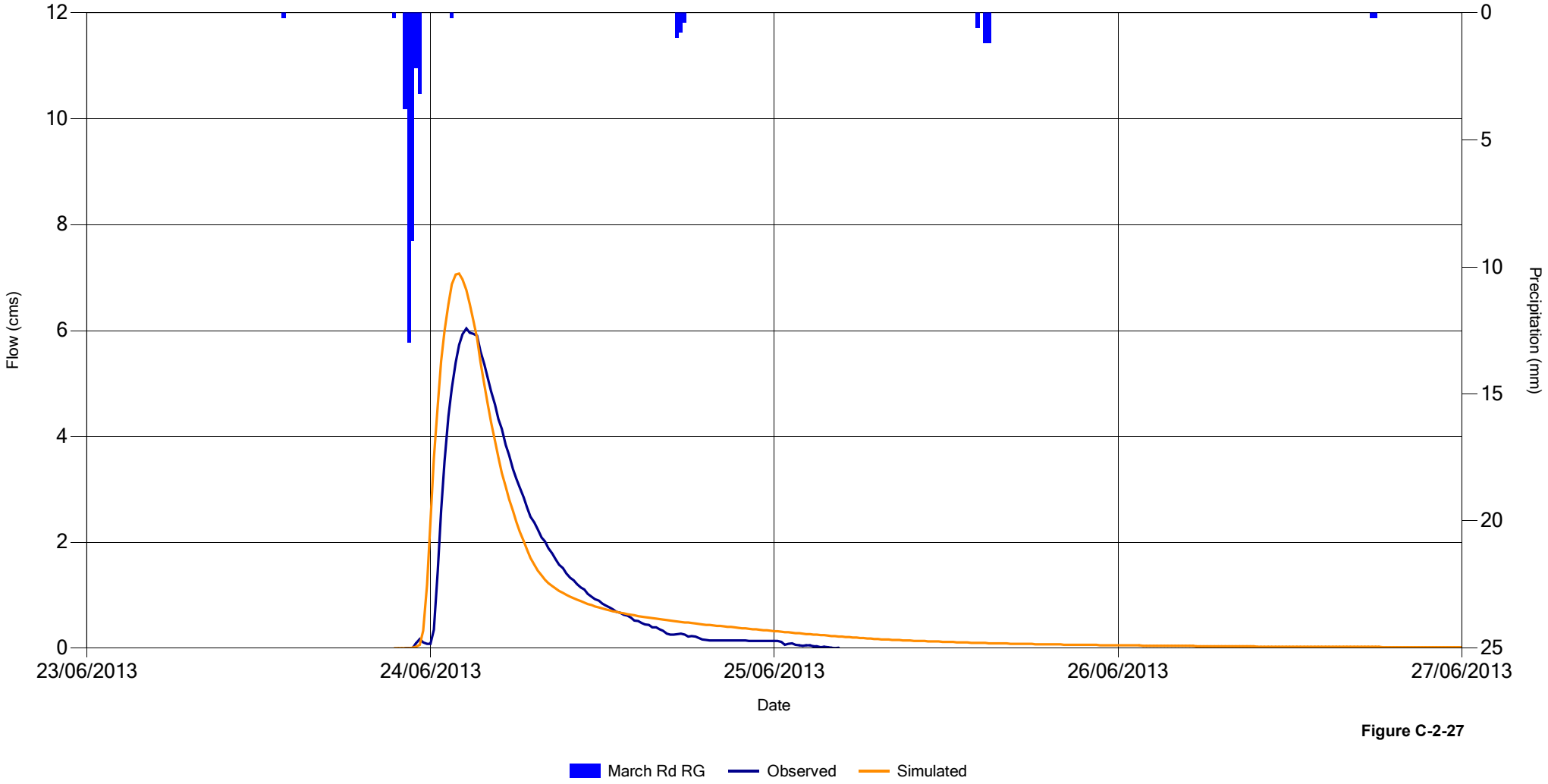

Watt's Creek
Event 2013-07
12
10
8
6
4
2
0
Flow (cms)
0
5
10
15
20
25
Precipitation (mm)
23/06/2013
24/06/2013
25/06/2013
26/06/2013
27/06/2013
Date
March Rd RG
Observed
Simulated

Figure C-2-27

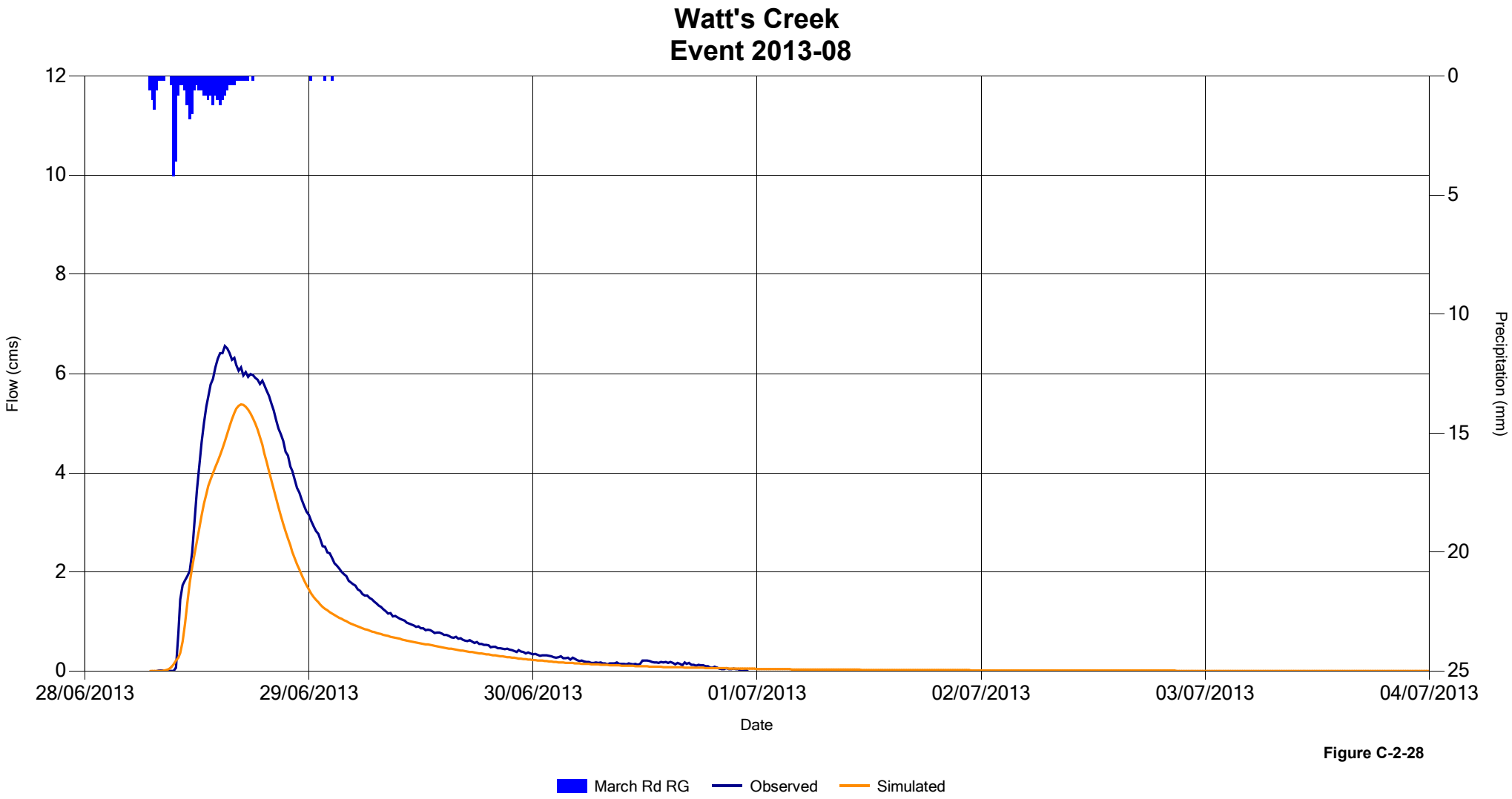

Watt's Creek
Event 2013-08
Flow (cms)
Precipitation (mm)
Date
12
10
8
6
4
2
0
0
5
10
15
20
25
28/06/2013
29/06/2013
30/06/2013
01/07/2013
02/07/2013
03/07/2013
04/07/2013
March Rd RG
Observed
Simulated

Figure C-2-28

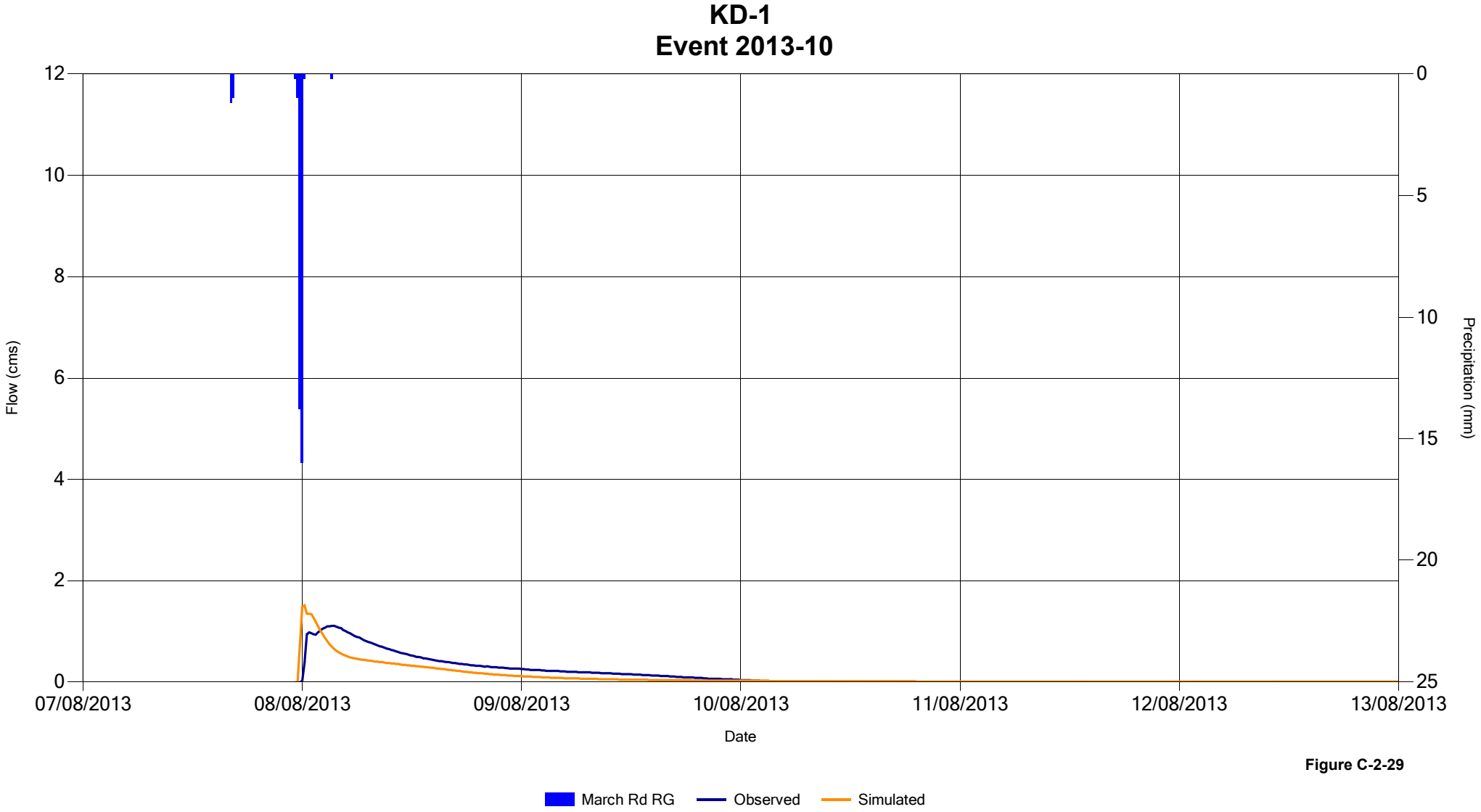

KD-1
Event 2013-10
12
10
8
6
4
2
0
Flow (cms)
0
5
10
15
20
25
Precipitation (mm)
07/08/2013
08/08/2013
09/08/2013
10/08/2013
11/08/2013
12/08/2013
13/08/2013
Date
March Rd RG
Observed
Simulated

Figure C-2-29

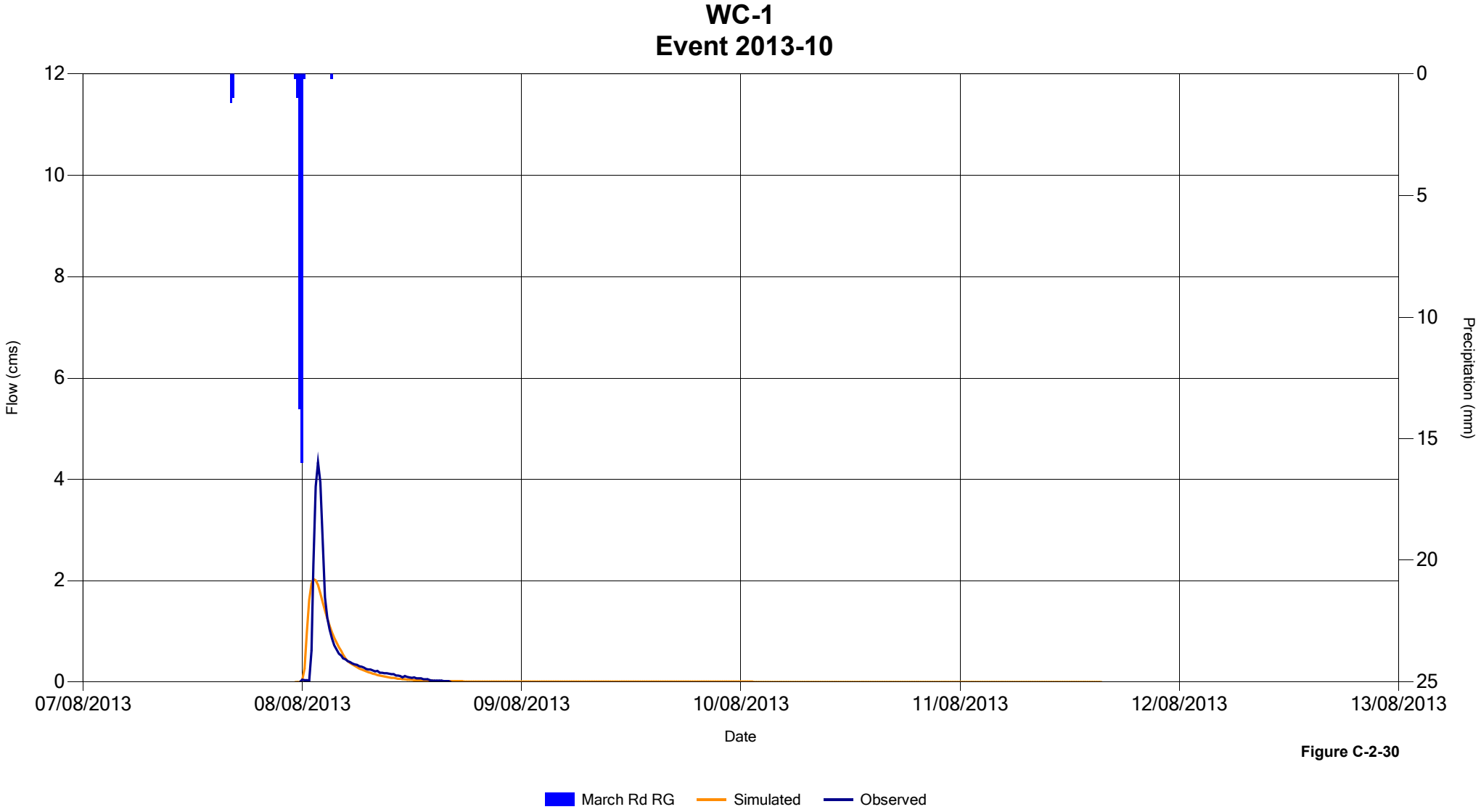

WC-1
Event 2013-10
12
10
8
6
4
2
0
Flow (cms)
0
5
10
15
20
25
Precipitation (mm)
07/08/2013
08/08/2013
09/08/2013
10/08/2013
11/08/2013
12/08/2013
13/08/2013
Date
March Rd RG
Simulated
Observed

Figure C-2-30

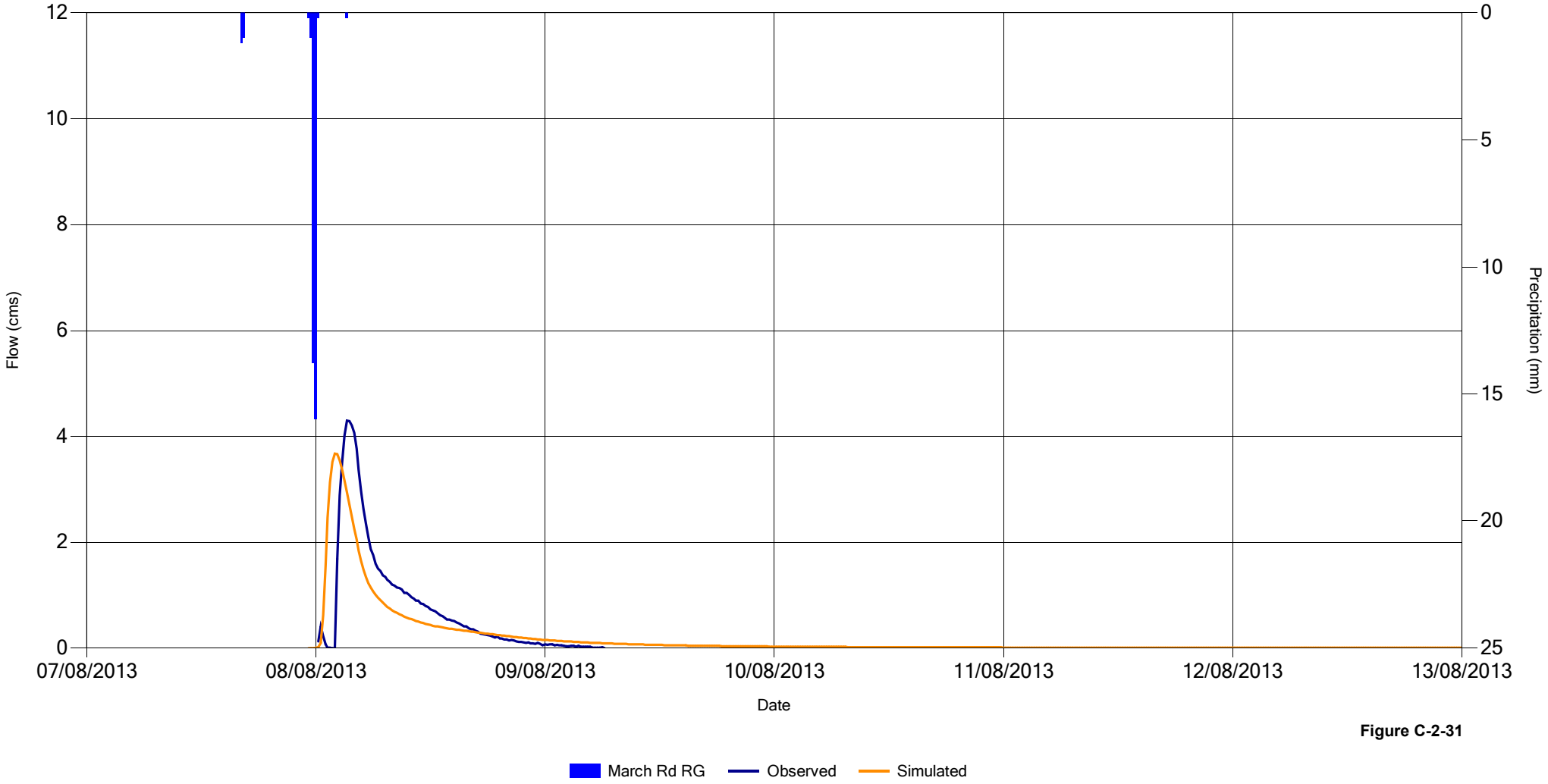

Watt's Creek
Event 2013-10
Flow (cms)
Precipitation (mm)
12
10
8
6
4
2
0
0
5
10
15
20
25
07/08/2013
08/08/2013
09/08/2013
10/08/2013
11/08/2013
12/08/2013
13/08/2013
Date
March Rd RG
Observed
Simulated

Figure C-2-31

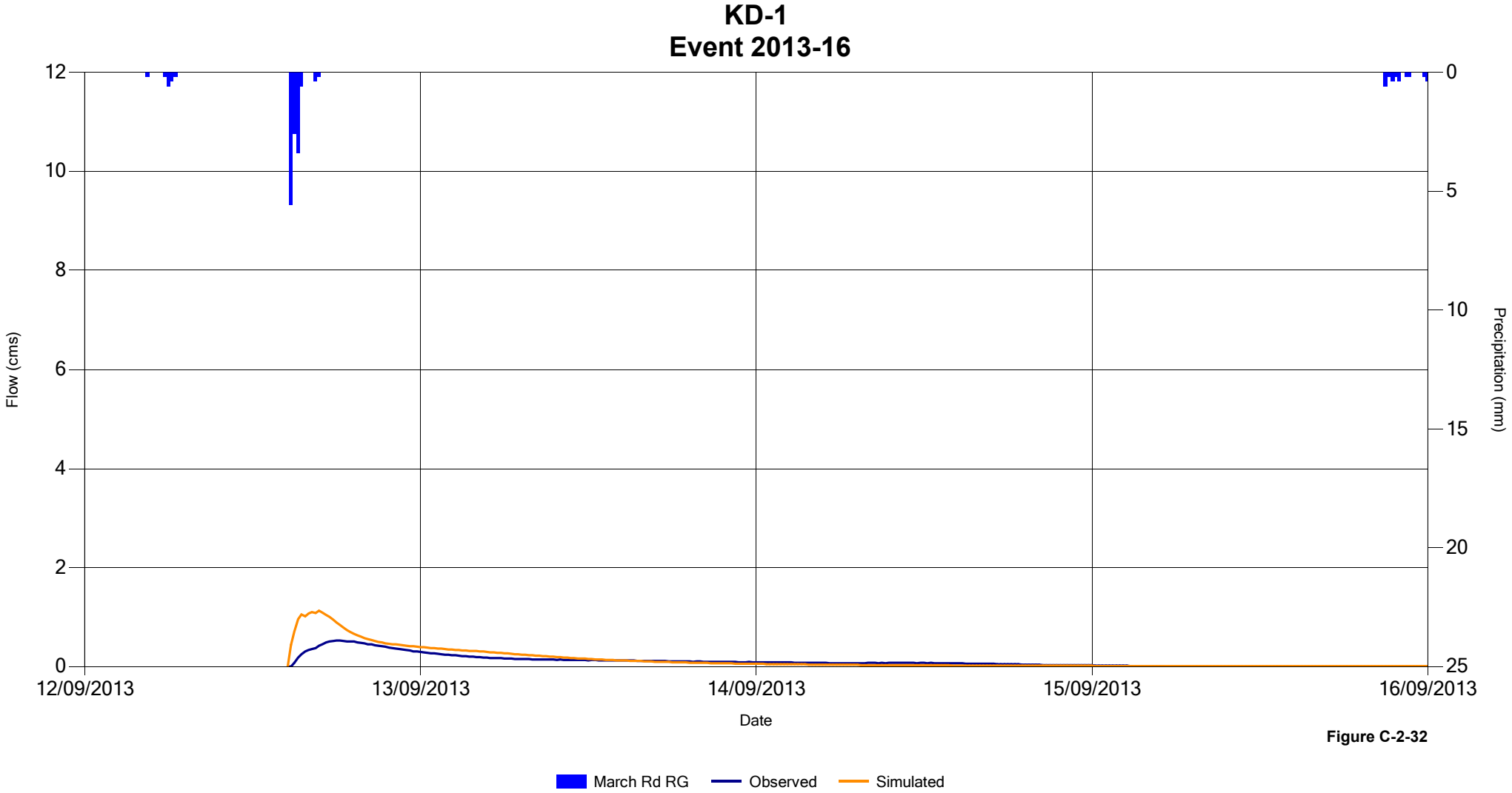

KD-1
Event 2013-16
Flow (cms)
Precipitation (mm)
12
10
8
6
4
2
0
0
5
10
15
20
25
12/09/2013
13/09/2013
14/09/2013
15/09/2013
16/09/2013
Date
March Rd RG
Observed
Simulated

Figure C-2-32

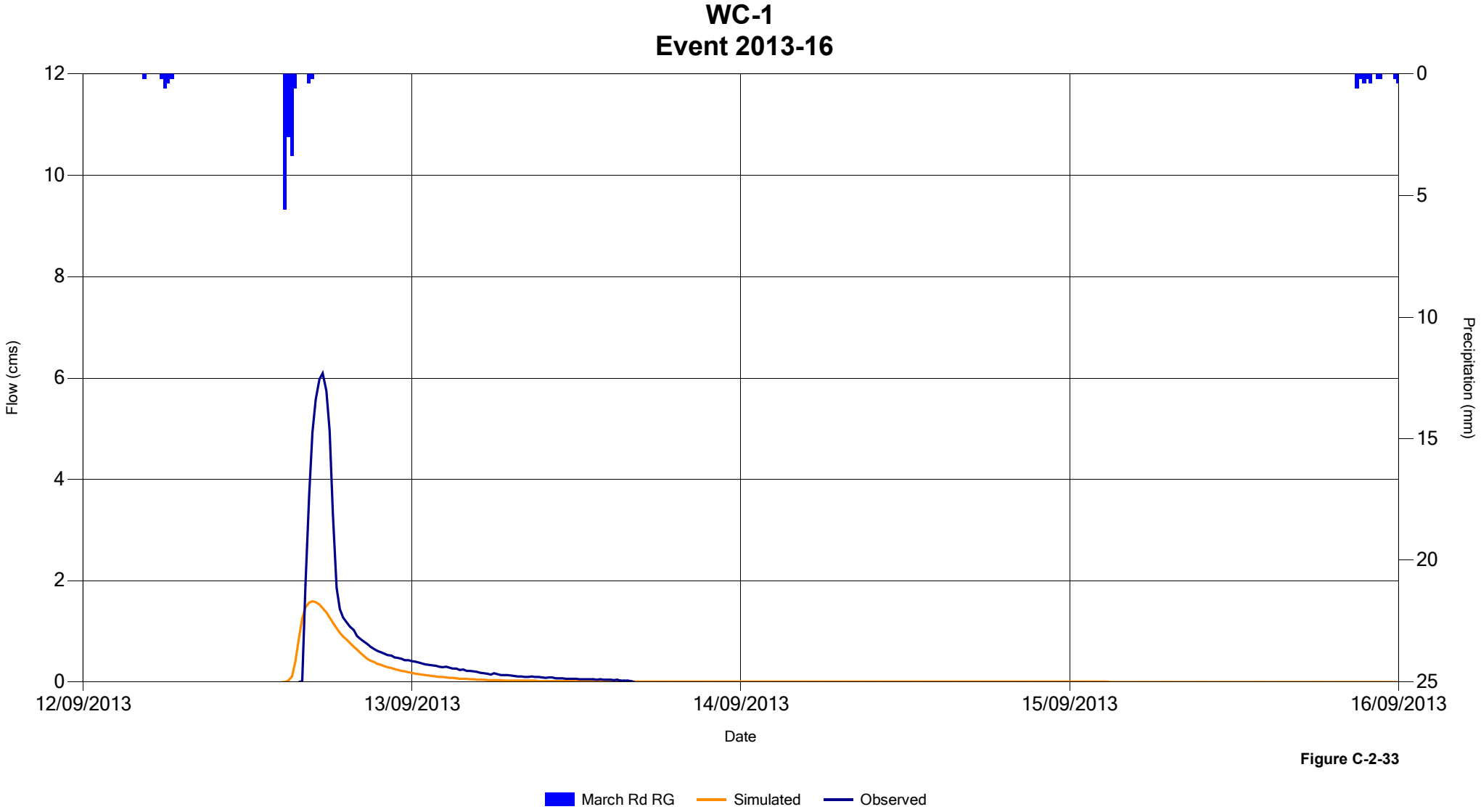

WC-1
Event 2013-16
12
10
8
6
4
2
0
Flow (cms)
0
5
10
15
20
25
Precipitation (mm)
12/09/2013
13/09/2013
14/09/2013
15/09/2013
16/09/2013
Date
March Rd RG
Simulated
Observed

Figure C-2-33

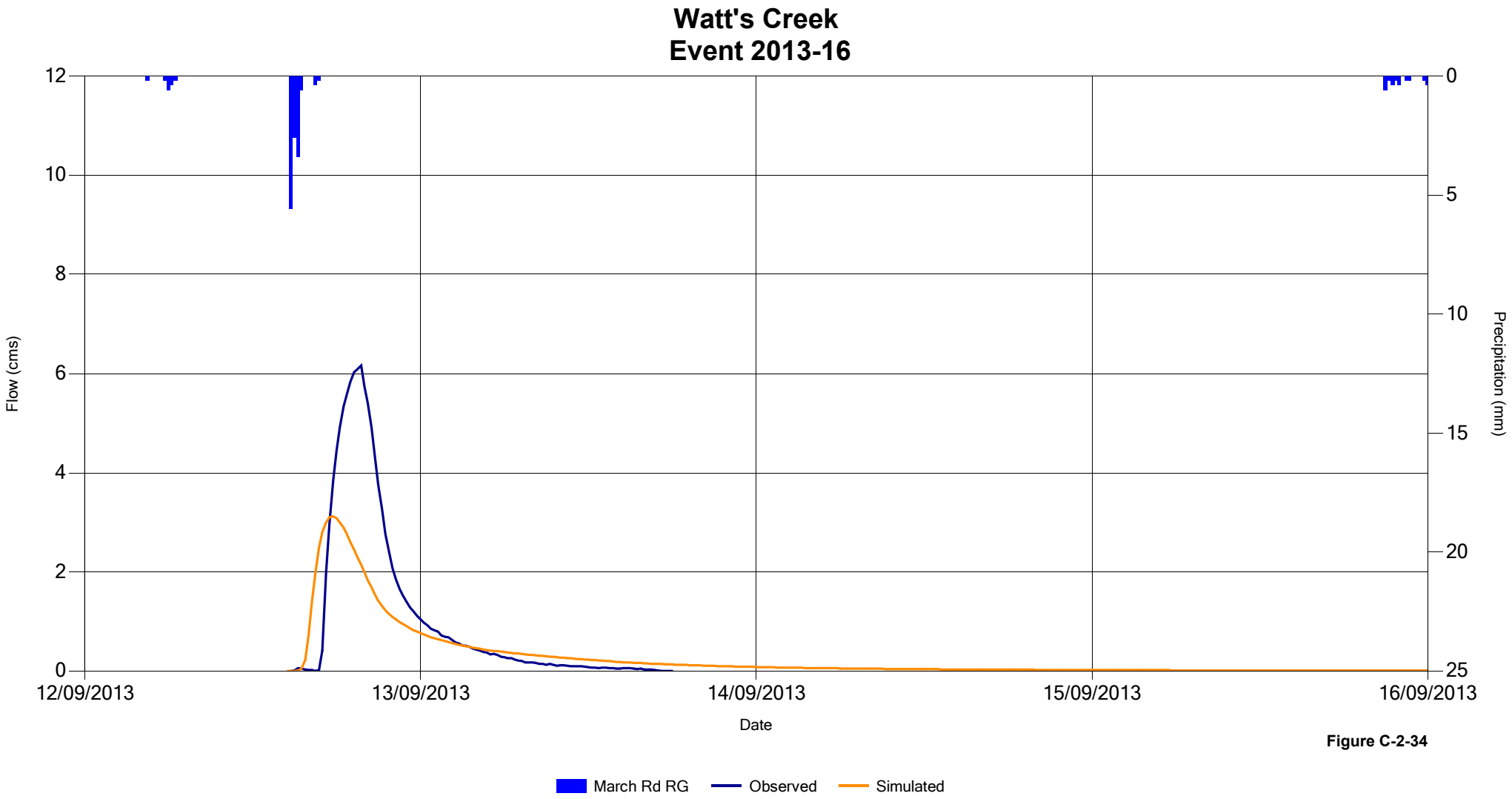

Watt's Creek
Event 2013-16
Flow (cms)
Precipitation (mm)
12
10
8
6
4
2
0
0
5
10
15
20
25
12/09/2013
13/09/2013
14/09/2013
15/09/2013
16/09/2013
Date
March Rd RG
Observed
Simulated

Figure C-2-34

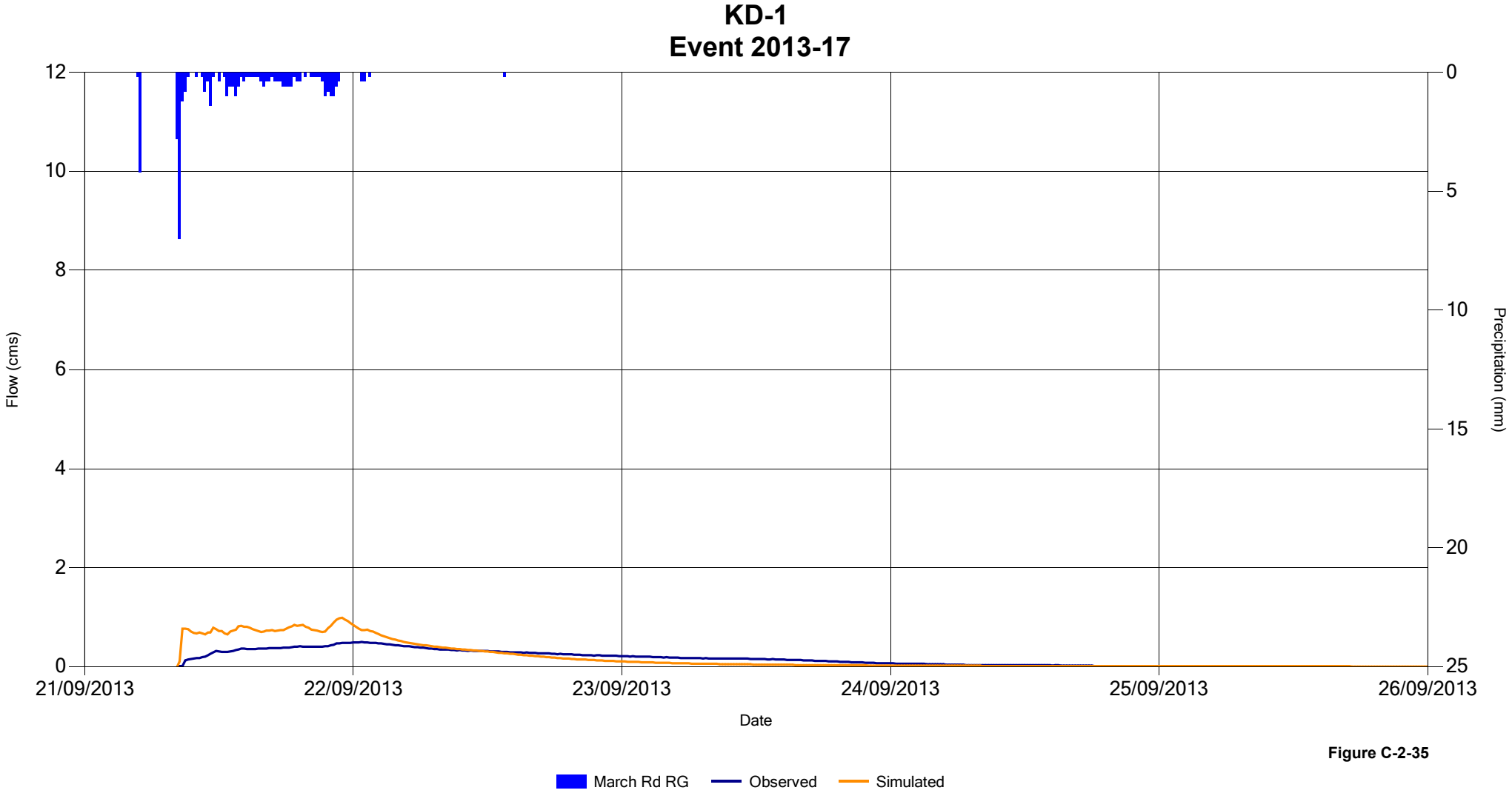

KD-1
Event 2013-17
Flow (cms)
Precipitation (mm)
12
10
8
6
4
2
0
0
5
10
15
20
25
21/09/2013
22/09/2013
23/09/2013
24/09/2013
25/09/2013
26/09/2013
Date
March Rd RG
Observed
Simulated

Figure C-2-35

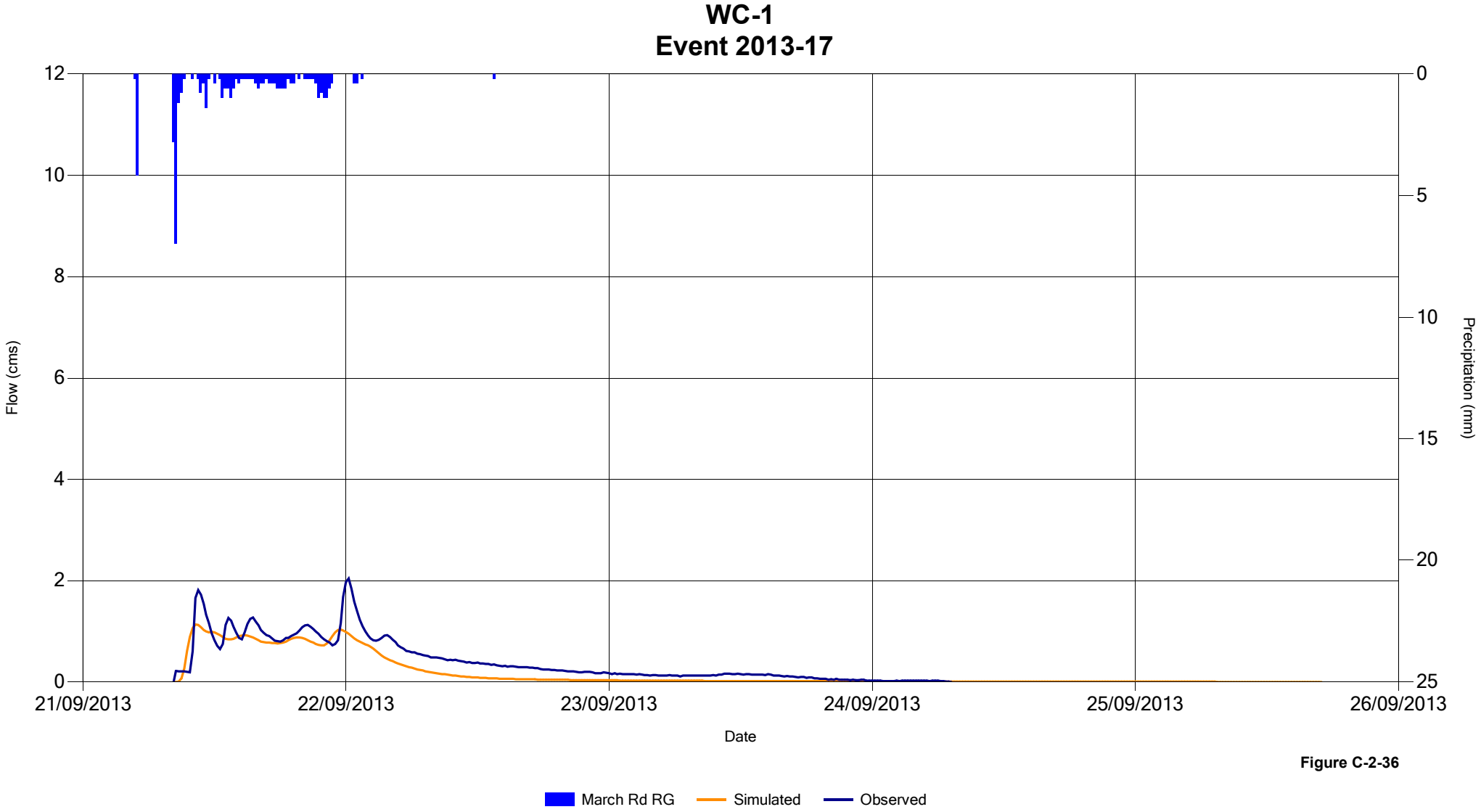

WC-1
Event 2013-17
Flow (cms)
Precipitation (mm)
12
10
8
6
4
2
0
0
5
10
15
20
25
21/09/2013
22/09/2013
23/09/2013
24/09/2013
25/09/2013
26/09/2013
Date
March Rd RG
Simulated
Observed

Figure C-2-36

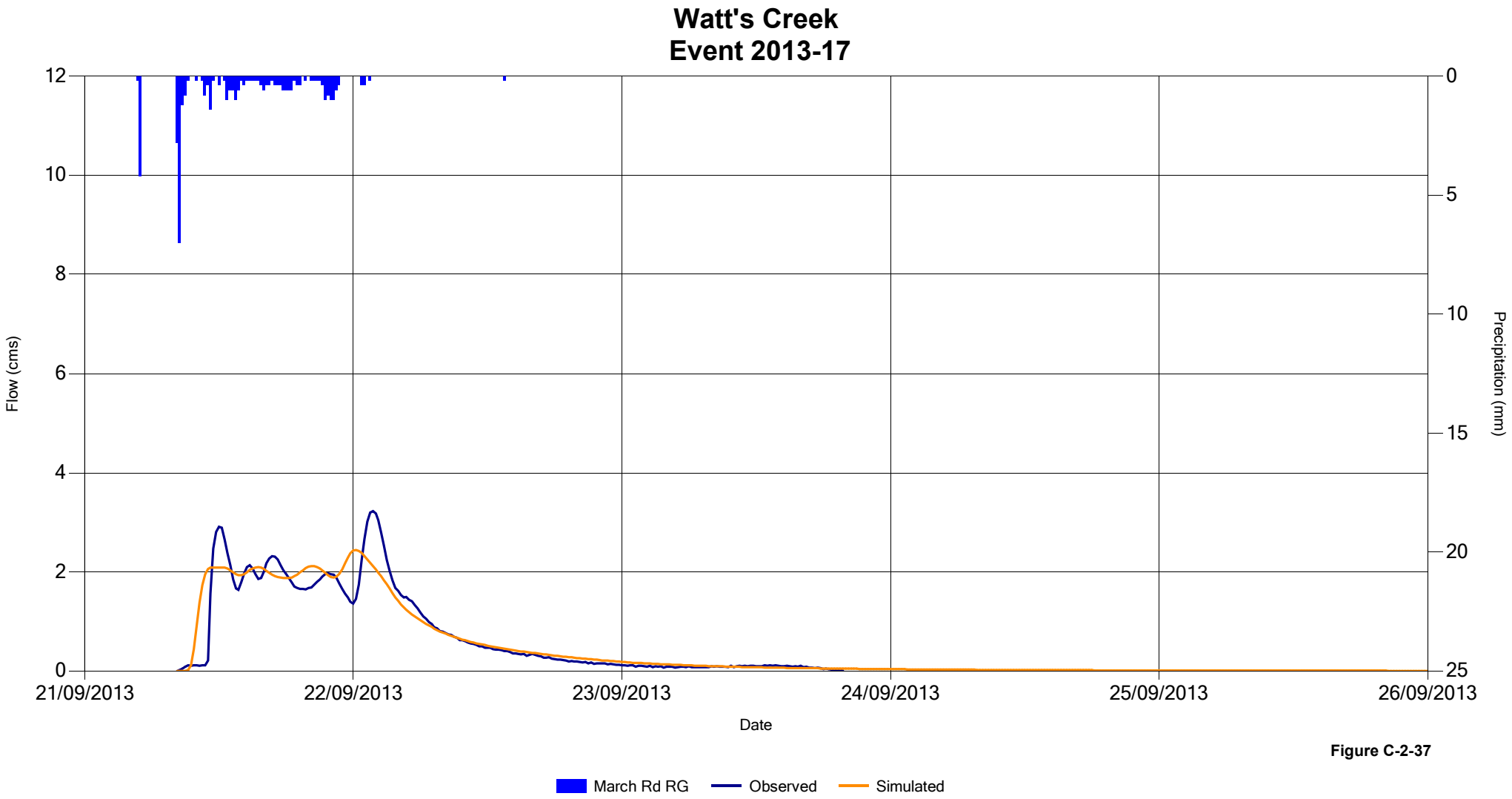

Watt's Creek
Event 2013-17
Flow (cms)
Precipitation (mm)
12
10
8
6
4
2
0
0
5
10
15
20
25
21/09/2013
22/09/2013
23/09/2013
24/09/2013
25/09/2013
26/09/2013
Date
March Rd RG
Observed
Simulated

Figure C-2-37

C-3. Beaver Pond Theoretical Storage Assessment

Elev (m)	Original Volume (cu.m.)	Original Surface Area (sq.m.)	Adjusted Volume (cu.m.)	Adjusted Surface Area (ha)
90.5	37067	23036	37067	23036
90.6	39522	23037	44648	128570
90.7	42065	25883	57514	128752
90.8	44717	27353	70398	128935
90.9	47548	29350	83301	129117
91.0	50668	36185	96222	129300
91.1	55151	48076	109161	129482
91.2	60259	53721	122118	129665
91.3	65907	59197	135094	129847
91.4	72114	65021	148088	130030
91.5	78969	72709	161100	130212
91.6	86813	80626	174130	130395
91.7	95039	83753	187179	130577
91.8	103571	86723	200245	130759
91.9	112401	89692	213330	130942
92.0	121566	94301	226434	131124
92.1	131484	102698	239555	131307
92.2	142040	107888	252695	131489
92.3	153160	113862	265853	131672
92.4	164849	118852	279029	131854
92.5	177118	128570	292224	132037
92.55	183643		298749	132219
92.6	190326	135868	305432	135868
92.7	204003	139225	319109	139225
92.8	218017	142095	333123	142095
92.9	232357	144942	347463	144942
93.0	247044	151506	362150	151506
93.1	262426	156500	377532	156500
93.2	278156	159507	393262	159507
93.3	294208	162476	409314	162476
93.4	310570	165421	425676	165421
93.5	327256	169556	442362	169556
94.0				

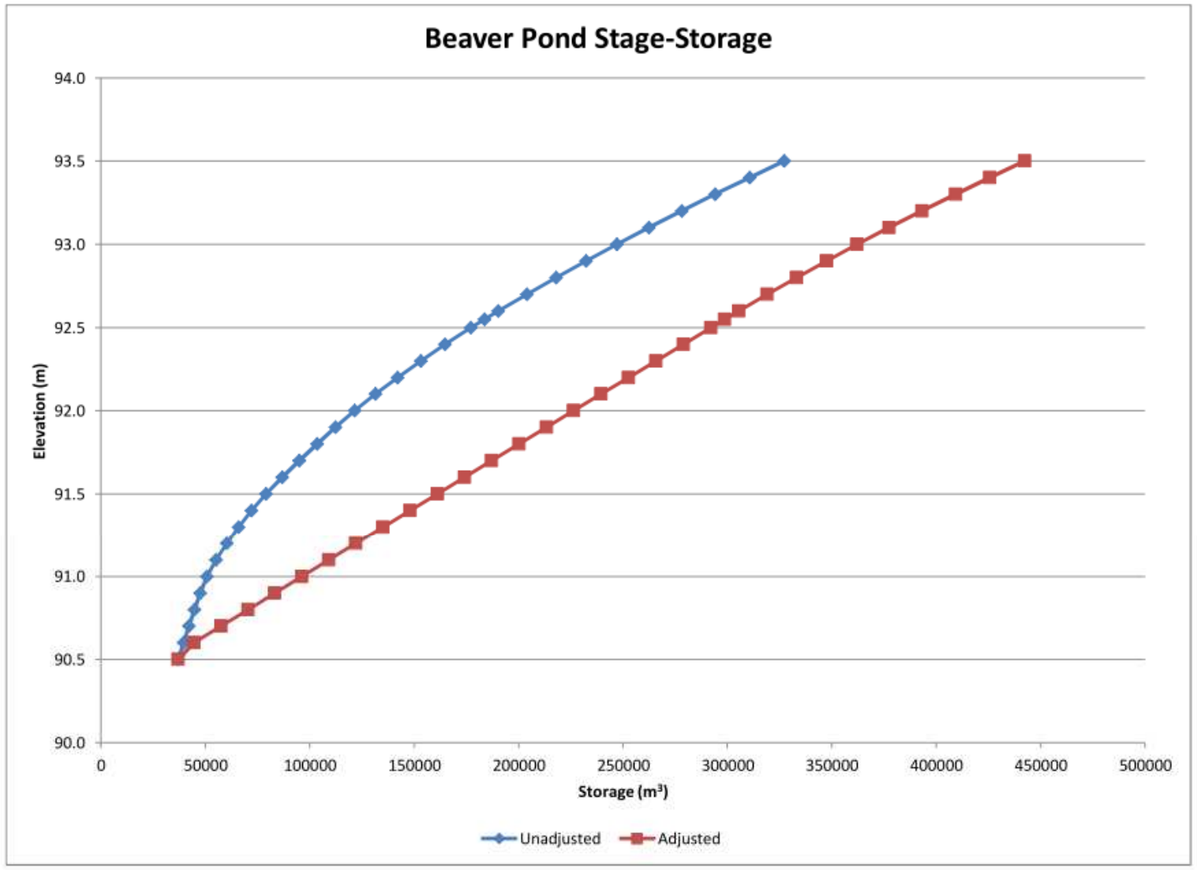


Figure C-3-1

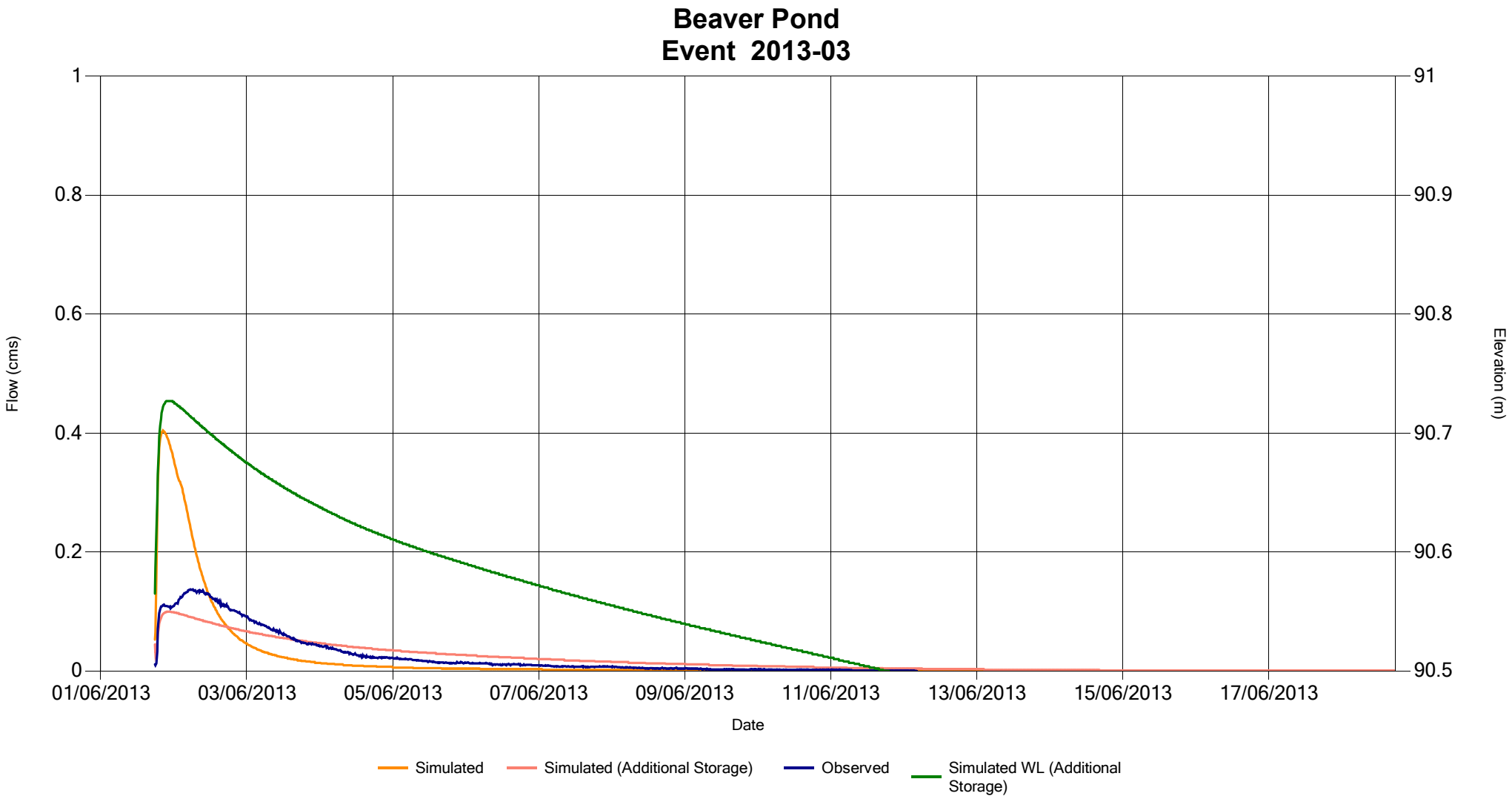

Beaver Pond
Event 2013-03
1
0.8
0.6
0.4
0.2
0
Flow (cms)
91
90.9
90.8
90.7
90.6
90.5
Elevation (m)
01/06/2013
03/06/2013
05/06/2013
07/06/2013
09/06/2013
11/06/2013
13/06/2013
15/06/2013
17/06/2013
Date
Simulated
Simulated (Additional Storage)
Observed
Simulated WL (Additional Storage)

Figure C-3-2

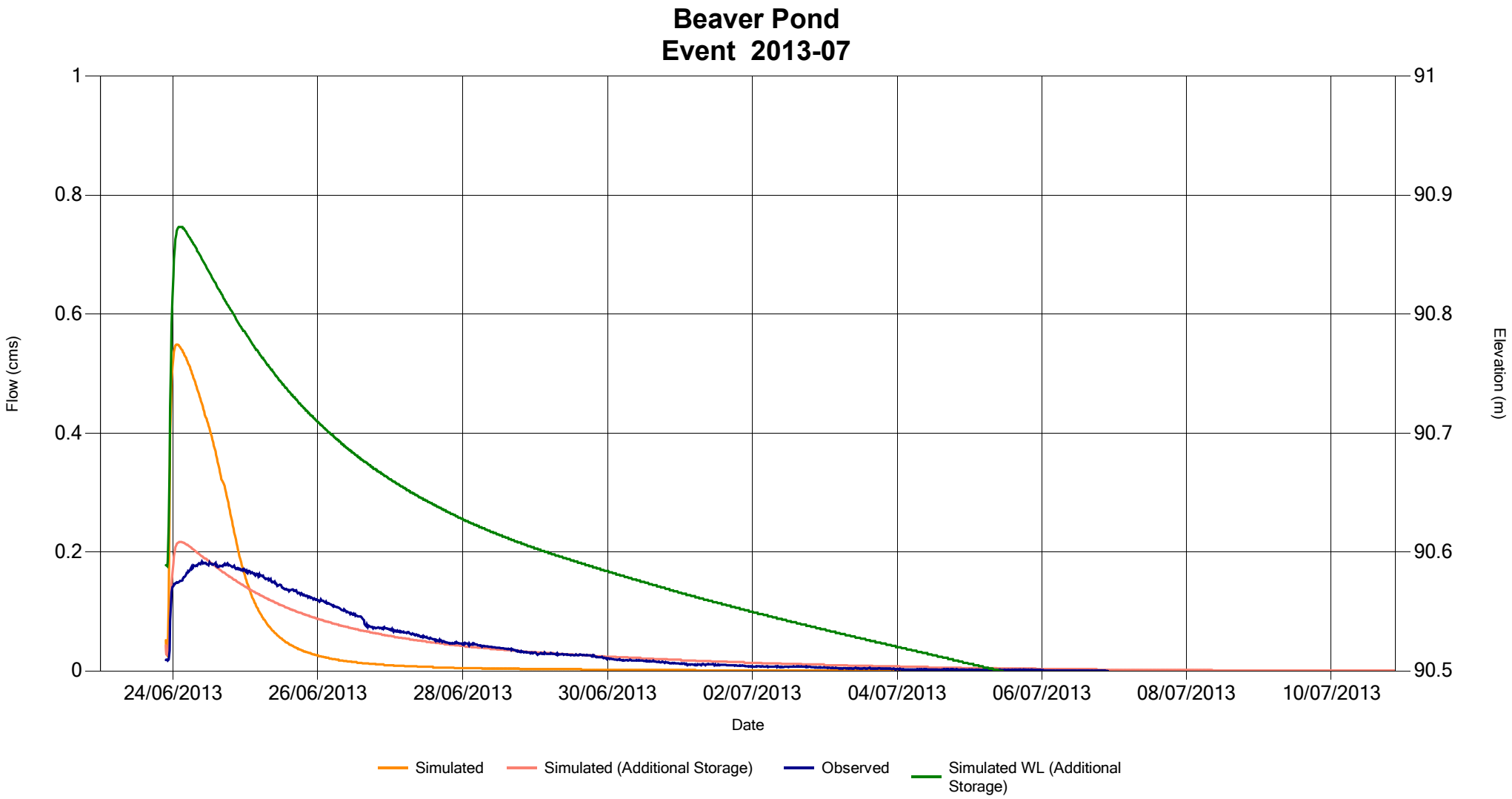

Beaver Pond
Event 2013-07
Flow (cms)
Elevation (m)
1
0.8
0.6
0.4
0.2
0
91
90.9
90.8
90.7
90.6
90.5
24/06/2013
26/06/2013
28/06/2013
30/06/2013
02/07/2013
04/07/2013
06/07/2013
08/07/2013
10/07/2013
Date
Simulated
Simulated (Additional Storage)
Observed
Simulated WL (Additional Storage)

Figure C-3-3

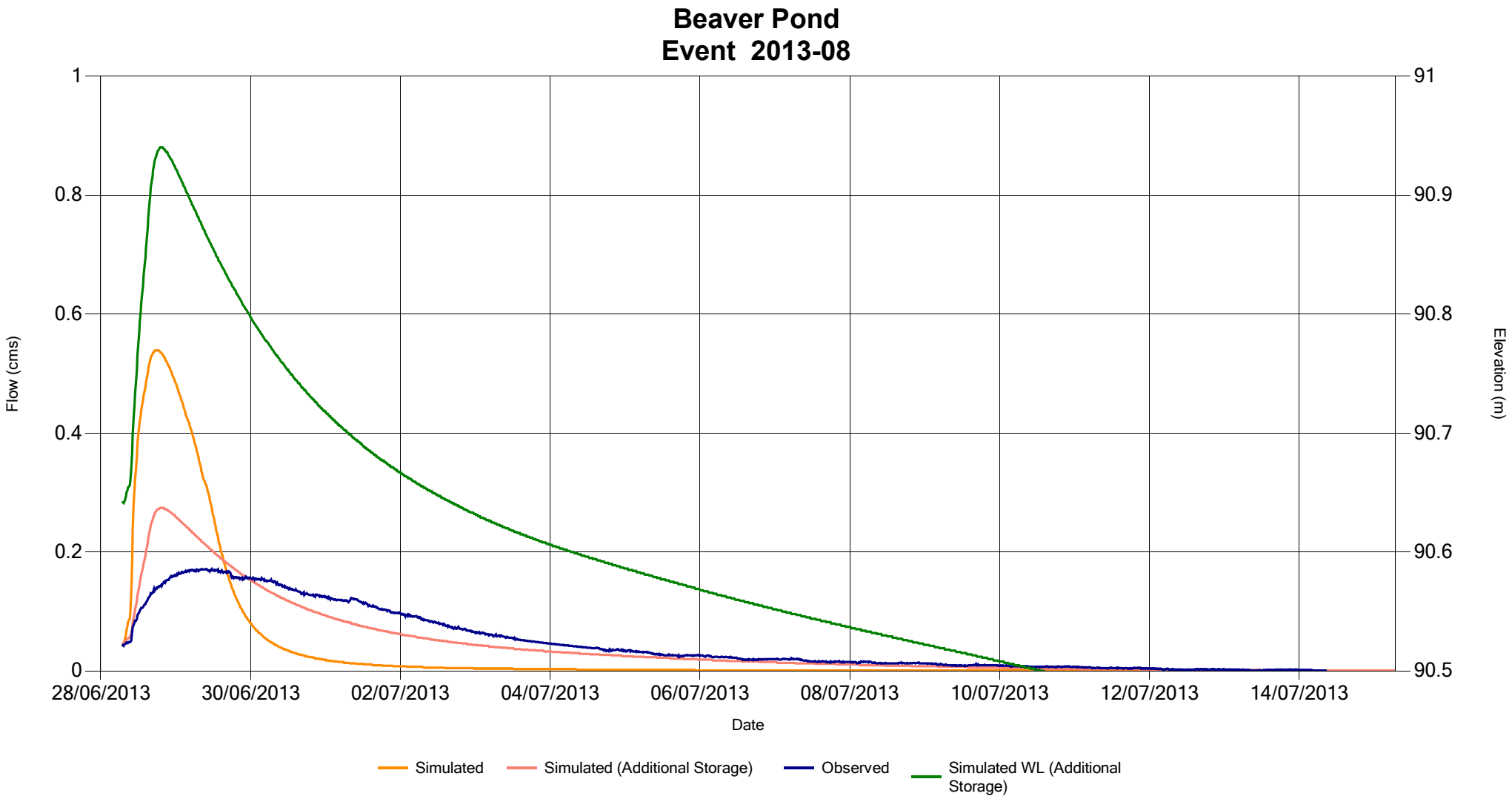

Beaver Pond
Event 2013-08
Flow (cms)
Elevation (m)
1
0.8
0.6
0.4
0.2
0
91
90.9
90.8
90.7
90.6
90.5
28/06/2013
30/06/2013
02/07/2013
04/07/2013
06/07/2013
08/07/2013
10/07/2013
12/07/2013
14/07/2013
Date
Simulated
Simulated (Additional Storage)
Observed
Simulated WL (Additional Storage)

Figure C-3-4

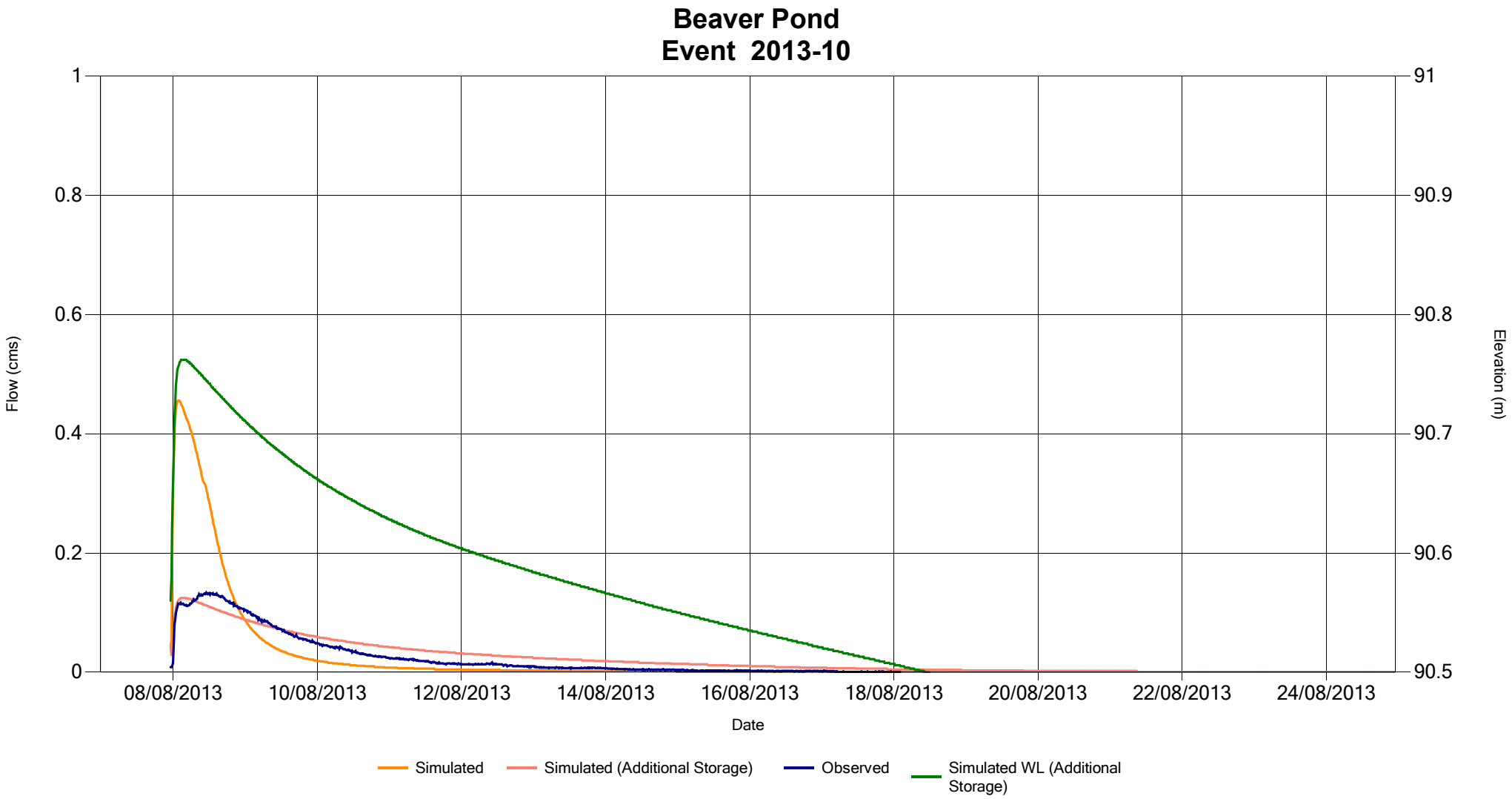

Beaver Pond
Event 2013-10
Flow (cms)
Elevation (m)
1
0.8
0.6
0.4
0.2
0
91
90.9
90.8
90.7
90.6
90.5
08/08/2013
10/08/2013
12/08/2013
14/08/2013
16/08/2013
18/08/2013
20/08/2013
22/08/2013
24/08/2013
Date
Simulated
Simulated (Additional Storage)
Observed
Simulated WL (Additional Storage)

Figure C-3-5

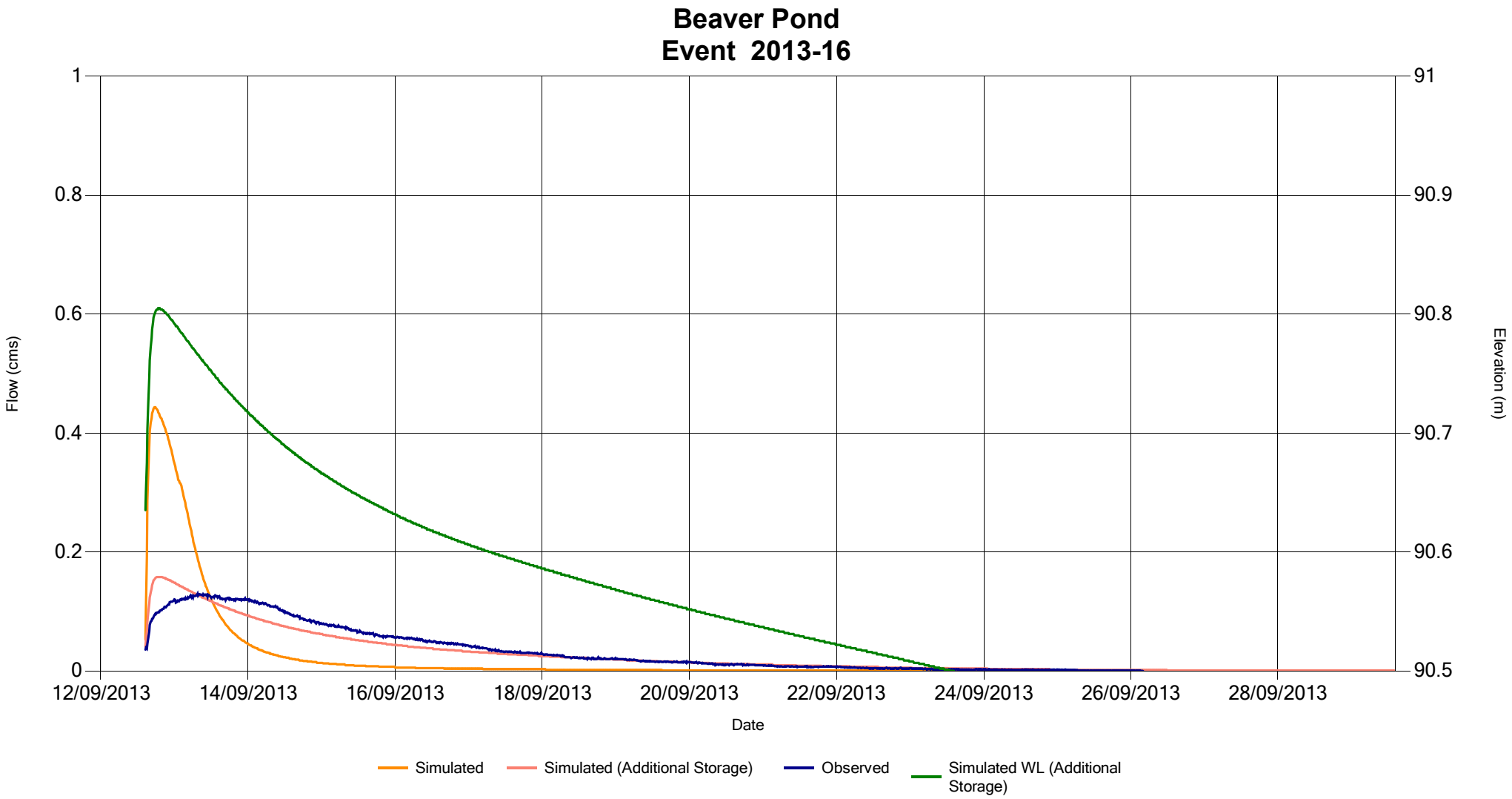

Beaver Pond
Event 2013-16
Flow (cms)
Elevation (m)
1
0.8
0.6
0.4
0.2
0
91
90.9
90.8
90.7
90.6
90.5
12/09/2013
14/09/2013
16/09/2013
18/09/2013
20/09/2013
22/09/2013
24/09/2013
26/09/2013
28/09/2013
Date
Simulated
Simulated (Additional Storage)
Observed
Simulated WL (Additional Storage)

Figure C-3-6

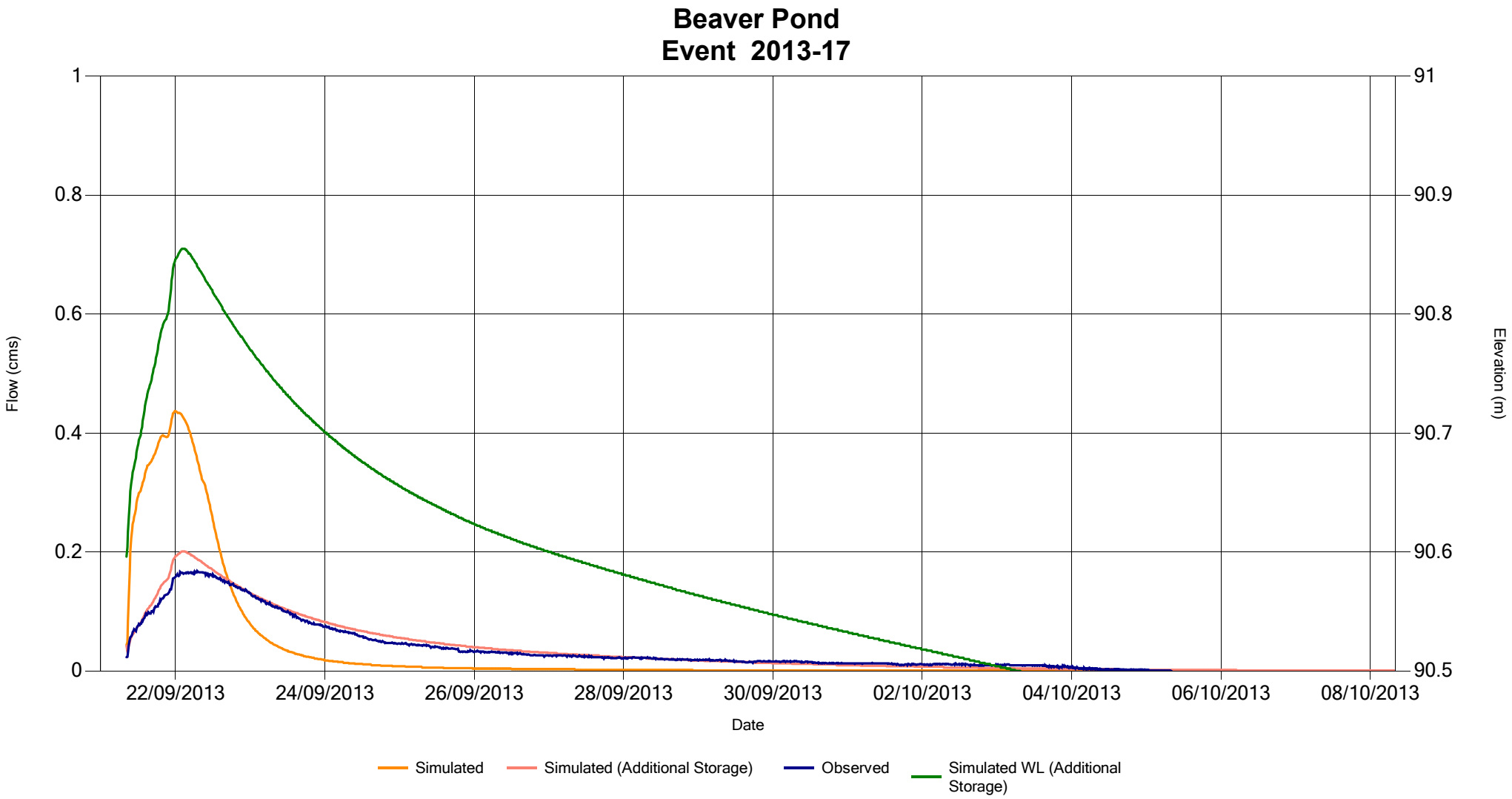

Beaver Pond
Event 2013-17
1
0.8
0.6
0.4
0.2
0
Flow (cms)
91
90.9
90.8
90.7
90.6
90.5
Elevation (m)
22/09/2013
24/09/2013
26/09/2013
28/09/2013
30/09/2013
02/10/2013
04/10/2013
06/10/2013
08/10/2013
Date
Simulated
Simulated (Additional Storage)
Observed
Simulated WL (Additional Storage)

Figure C-3-7

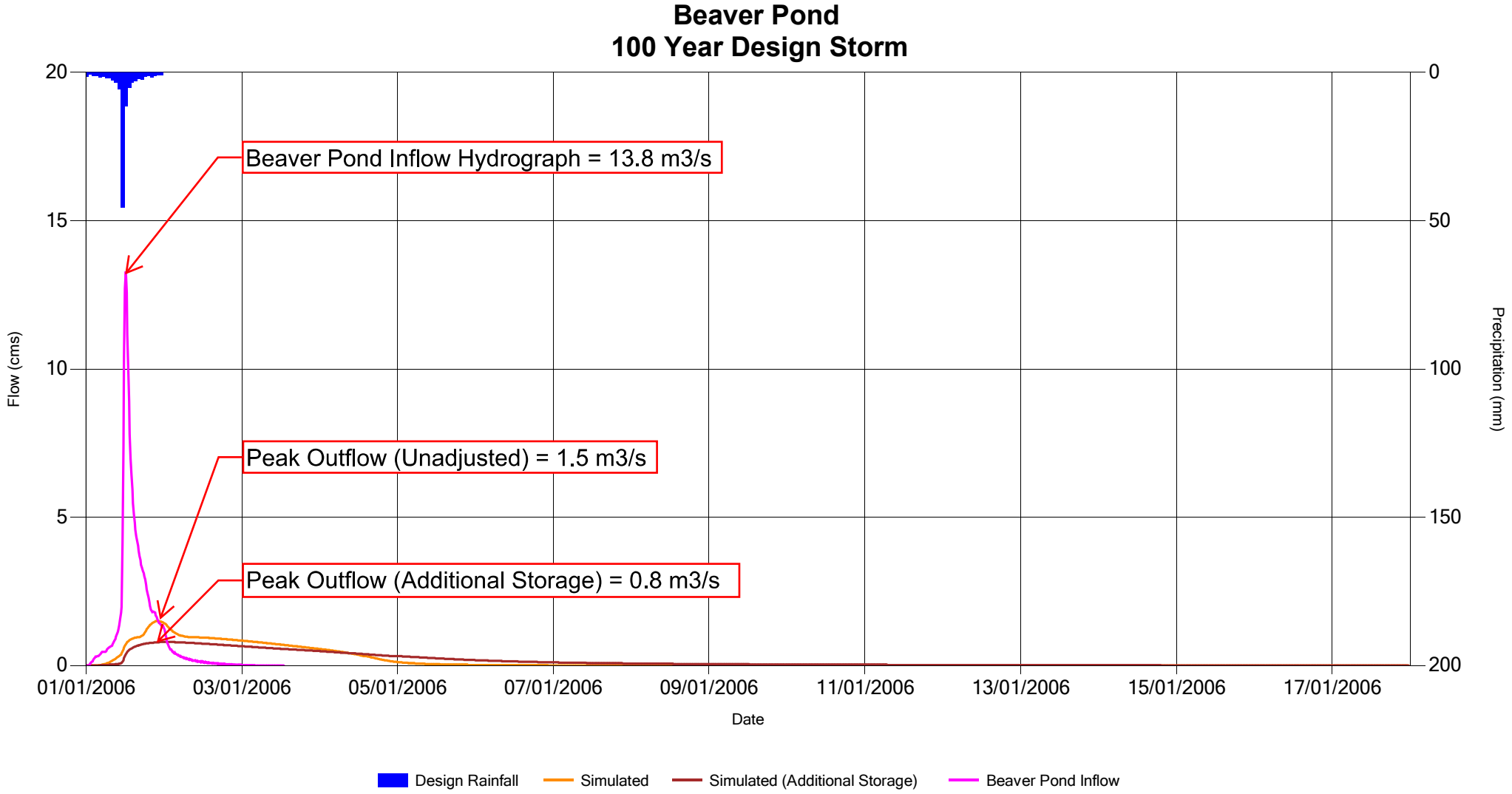

Beaver Pond
100 Year Design Storm
Beaver Pond Inflow Hydrograph = 13.8 m3/s
Peak Outflow (Unadjusted) = 1.5 m3/s
Peak Outflow (Additional Storage) = 0.8 m3/s
Flow (cms)
Precipitation (mm)
Date
20
15
10
5
0
0
50
100
150
200
01/01/2006
03/01/2006
05/01/2006
07/01/2006
09/01/2006
11/01/2006
13/01/2006
15/01/2006
17/01/2006
Design Rainfall
Simulated
Simulated (Additional Storage)
Beaver Pond Inflow

Figure C-3-8

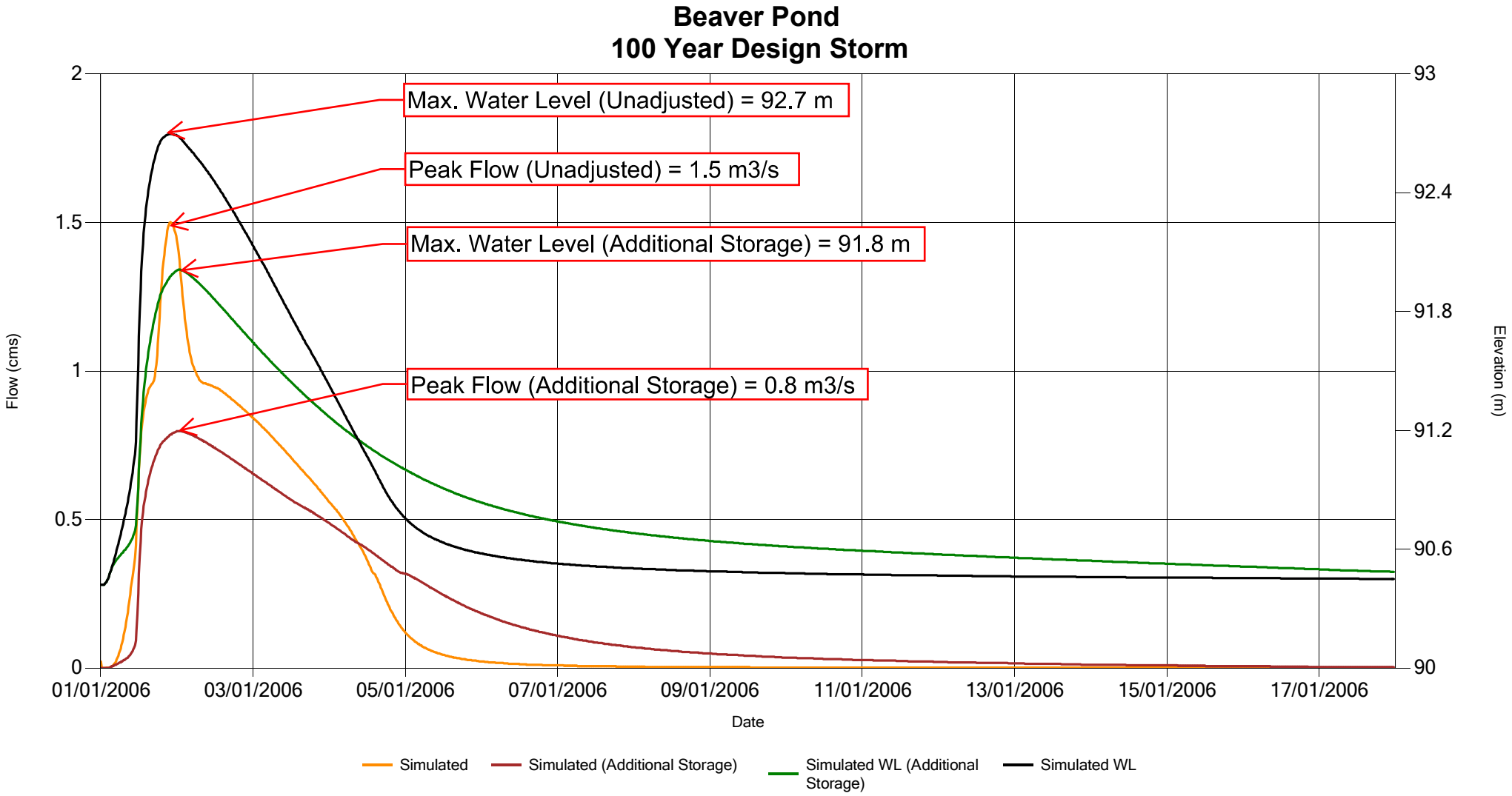

Beaver Pond
100 Year Design Storm
Max. Water Level (Unadjusted) = 92.7 m
Peak Flow (Unadjusted) = 1.5 m3/s
Max. Water Level (Additional Storage) = 91.8 m
Peak Flow (Additional Storage) = 0.8 m3/s
Flow (cms)
Elevation (m)
Date
2
1.5
1
0.5
0
93
92.4
91.8
91.2
90.6
90
01/01/2006
03/01/2006
05/01/2006
07/01/2006
09/01/2006
11/01/2006
13/01/2006
15/01/2006
17/01/2006
Simulated
Simulated (Additional Storage)
Simulated WL (Additional Storage)
Simulated WL

Figure C-3-9

C-4. Sub-Surface Storage Attenuation Assessment within the Upper Kizell Drain

Table C-4-1 - Peak Flow Comparison

Event	Peak Flow (cms)			
			Difference	
	Observed	Simulated (300 mm dia.)	(m3/s)	(%)
2013-03	0.14	0.11	-0.03	-21%
2013-07	0.18	0.21	0.03	17%
2013-08	0.17	0.25	0.08	47%
2013-10	0.13	0.14	0.01	8%
2013-16	0.13	0.14	0.01	8%
2013-17	0.17	0.21	0.04	24%
		Max=	0.08	47%
		Min=	-0.03	-21%
		Average=	0.02	14%

Table C-4-2 - Runoff Volume

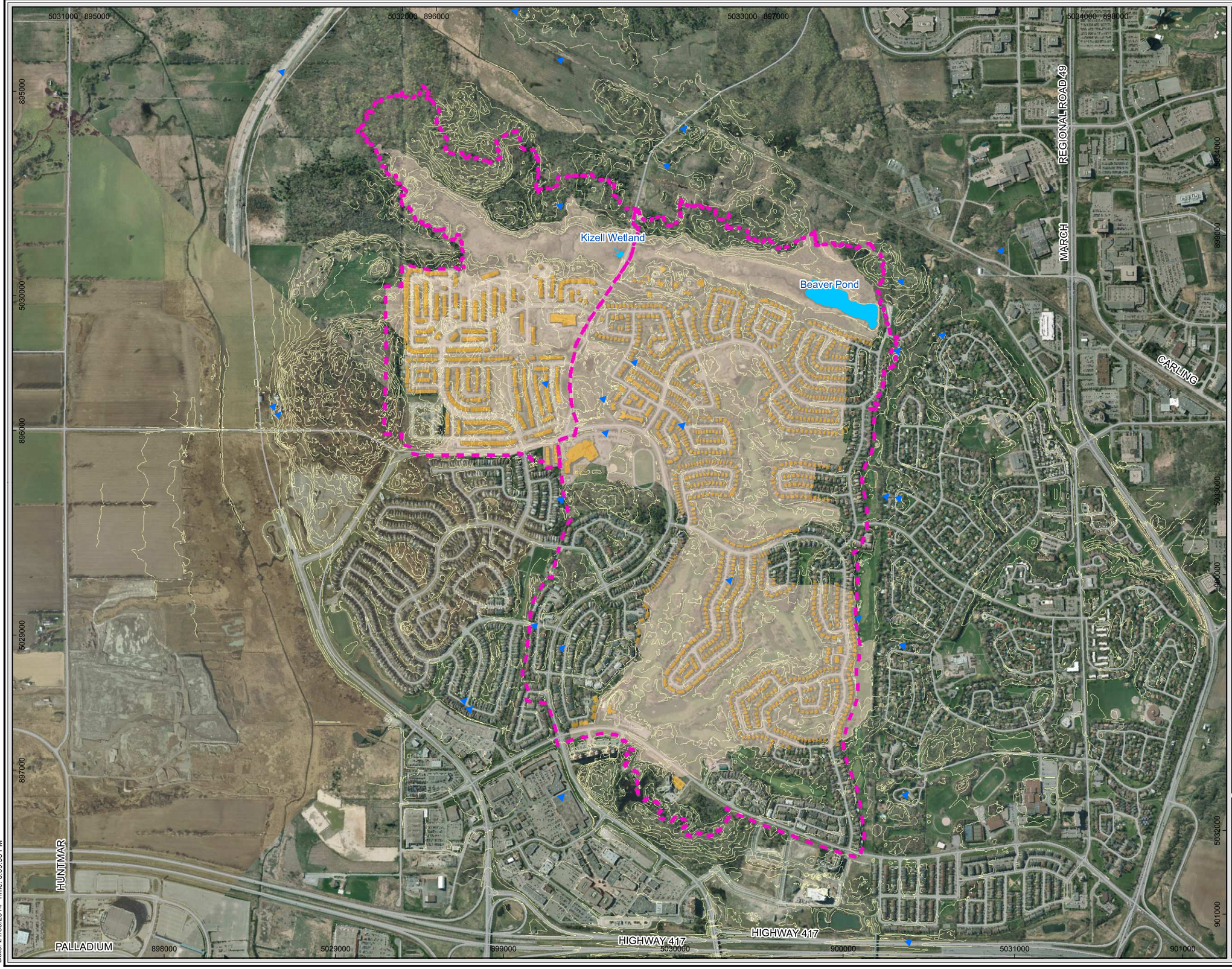
Event	Total Runoff (ha-m)			
			Difference	
	Observed	Simulated (300 mm dia.)	(ha-m)	(%)
2013-03	2.43	2.50	0.06	2%
2013-07	5.02	4.37	-0.65	-13%
2013-08	6.77	5.36	-1.40	-21%
2013-10	2.38	2.96	0.57	24%
2013-16	4.16	3.04	-1.12	-27%
2013-17	4.93	4.66	-0.27	-5%
		Max=	0.57	24%
		Min=	-1.40	-27%
		Average=	-0.47	-7%

Table C-4-3 - Hydrograph Timing

Event	Runoff Lag Time (hr)		
	Observed	Simulated (300 mm dia.)	+/- Diff. (hrs)
2013-03	11.75	17.00	5.25
2013-07	12.00	17.25	5.25
2013-08	25.25	22.50	-2.75
2013-10	11.75	17.25	5.50
2013-16	17.00	16.00	-1.00
2013-17	22.75	25.75	3.00
	Max=		5.50
	Min=		-2.75
	Average=		2.54

Table C-4-4 - Maximum Storage Used

Event	Total RESERVOIR ROUTING Storage	
	ha.m	%
2013-03	2.01	28%
2013-07	3.53	49%
2013-08	3.68	51%
2013-10	2.43	34%
2013-16	2.24	31%
2013-17	3.04	42%
Max=		51%
Min=		28%
Average=		39%



Legend

- Upper Kizell Drainage Boundary
- Area of Shallow Bedrock (< 2.5m from ground)
- Residential Buildings within Shallow Bedrock Area
- MOE Water Well Record Location
- Contours

Basemapping and orthophotography provided by the City of Ottawa.

m
0 75 150 300 450 600

1:15,000

NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Upper Kizell Subwatershed Sub-Surface Storage Assessment

March 2014
60264539

AECOM

Figure C-4-1

Path: C:\Projects\60264539_Shirley's\2012\MXDs\WorkingMXDs\60264539_Upper_Kizell_System_Storage.mxd
Date: 21/03/2014 Time: 6:09:56 PM

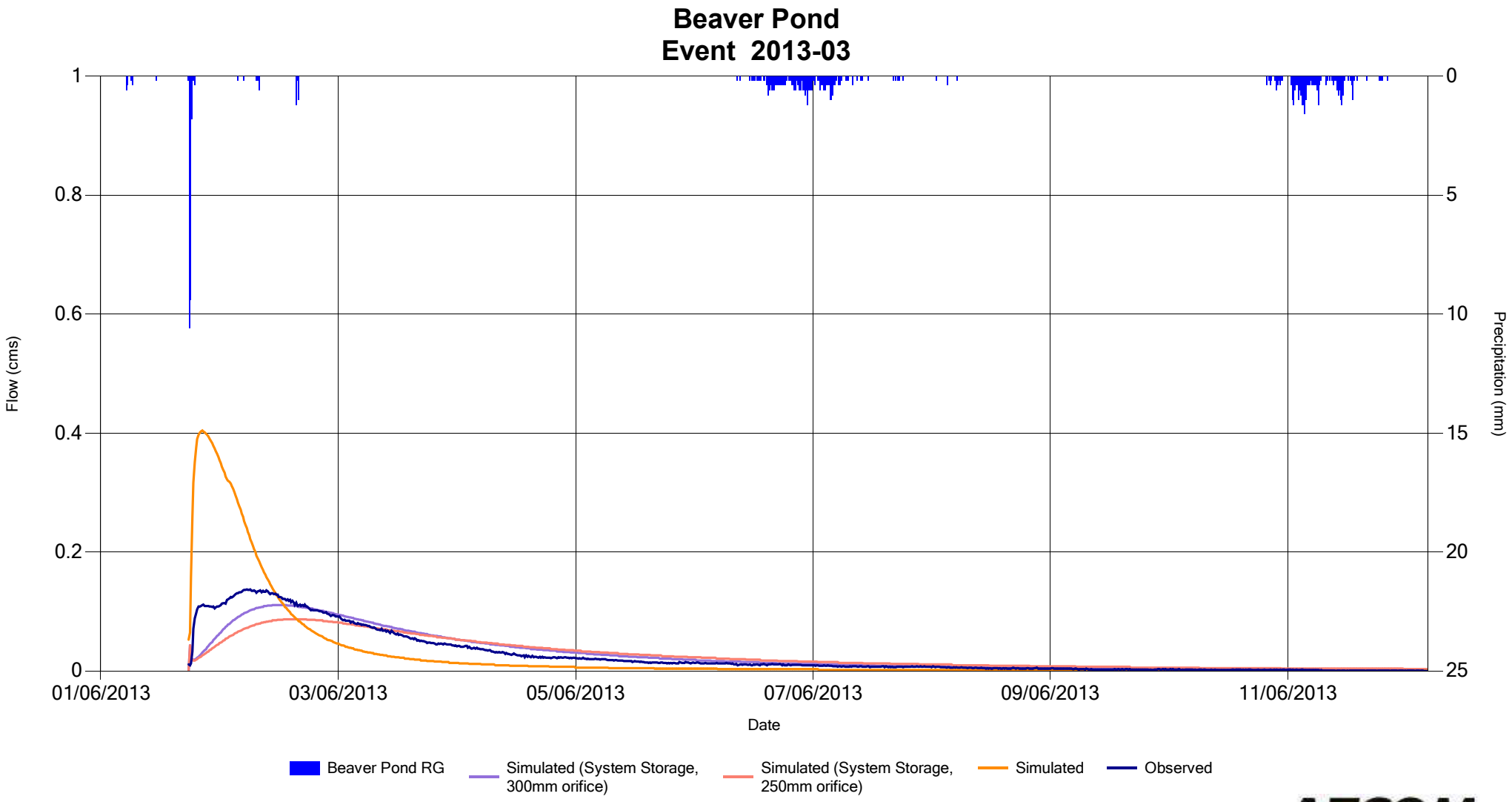

Beaver Pond
Event 2013-03
Flow (cms)
Precipitation (mm)
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
01/06/2013
03/06/2013
05/06/2013
07/06/2013
09/06/2013
11/06/2013
Date
Beaver Pond RG
Simulated (System Storage, 300mm orifice)
Simulated (System Storage, 250mm orifice)
Simulated
Observed

Figure C-4-2

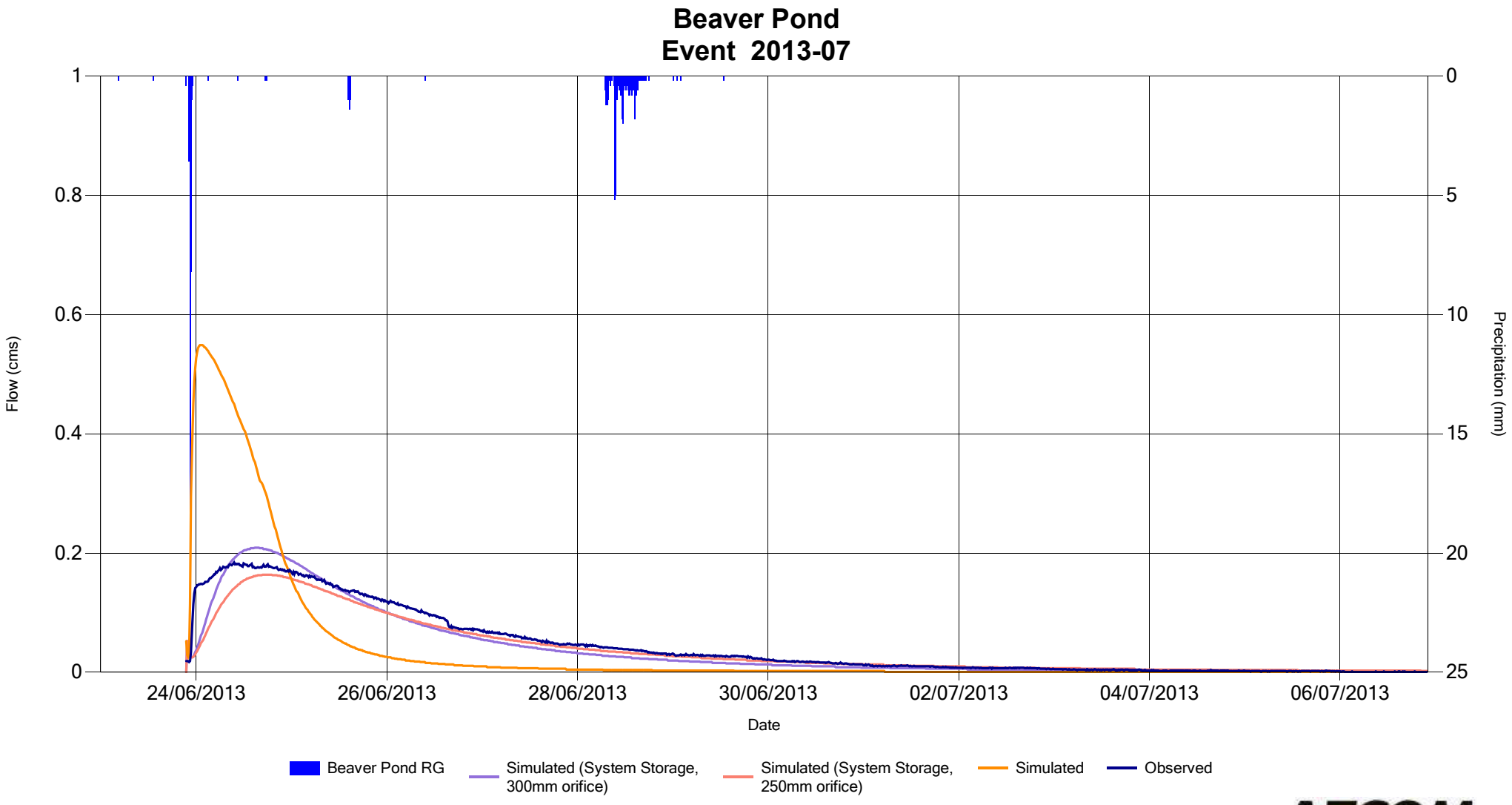

Beaver Pond
Event 2013-07
Flow (cms)
Precipitation (mm)
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
24/06/2013
26/06/2013
28/06/2013
30/06/2013
02/07/2013
04/07/2013
06/07/2013
Date
Beaver Pond RG
Simulated (System Storage, 300mm orifice)
Simulated (System Storage, 250mm orifice)
Simulated
Observed

Figure C-4-3

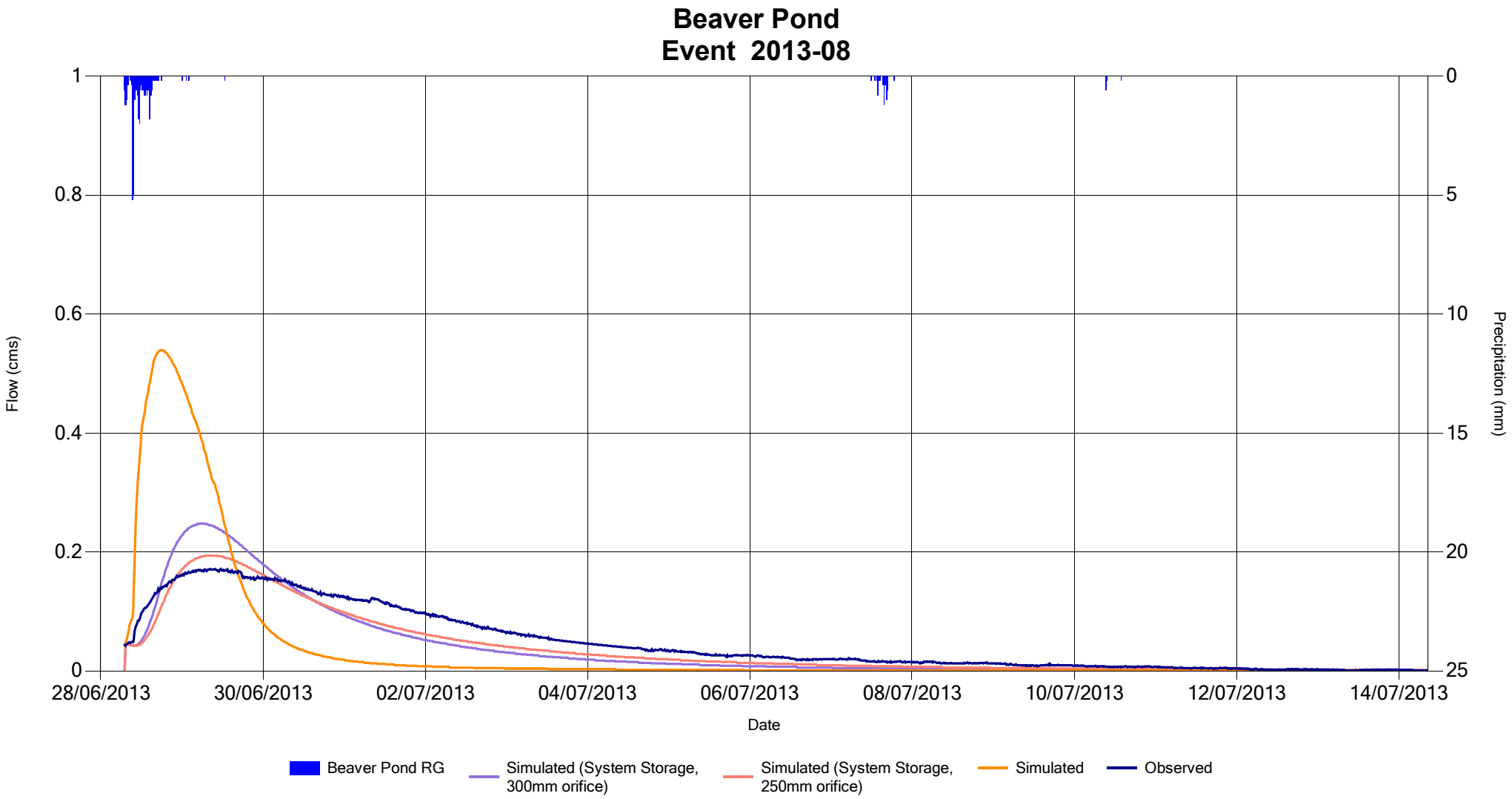

Beaver Pond
Event 2013-08
Flow (cms)
Precipitation (mm)
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
28/06/2013
30/06/2013
02/07/2013
04/07/2013
06/07/2013
08/07/2013
10/07/2013
12/07/2013
14/07/2013
Date
Beaver Pond RG
Simulated (System Storage, 300mm orifice)
Simulated (System Storage, 250mm orifice)
Simulated
Observed

Figure C-4-4

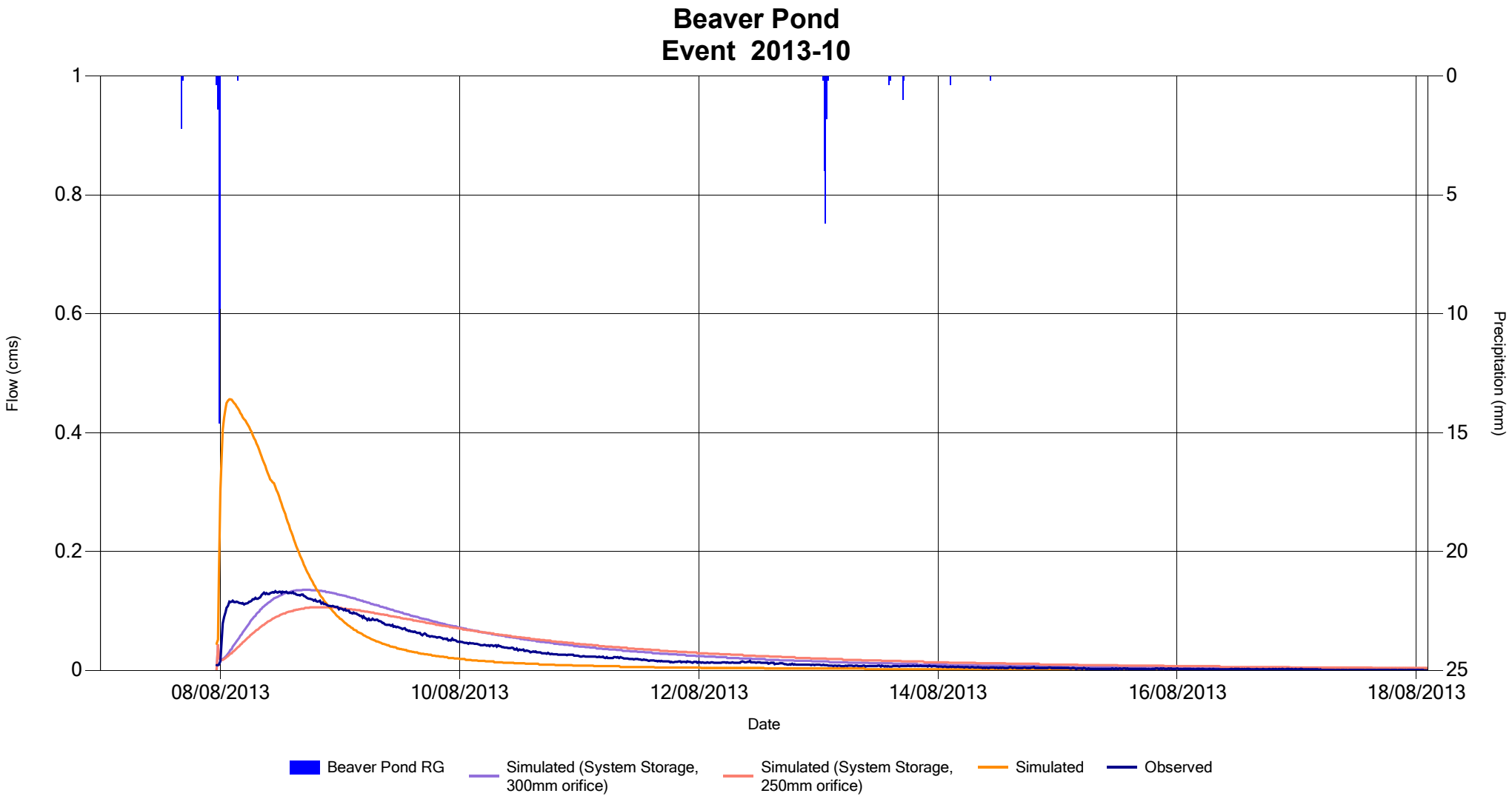

Beaver Pond
Event 2013-10
Flow (cms)
Precipitation (mm)
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
08/08/2013
10/08/2013
12/08/2013
14/08/2013
16/08/2013
18/08/2013
Date
Beaver Pond RG
Simulated (System Storage, 300mm orifice)
Simulated (System Storage, 250mm orifice)
Simulated
Observed

Figure C-4-5

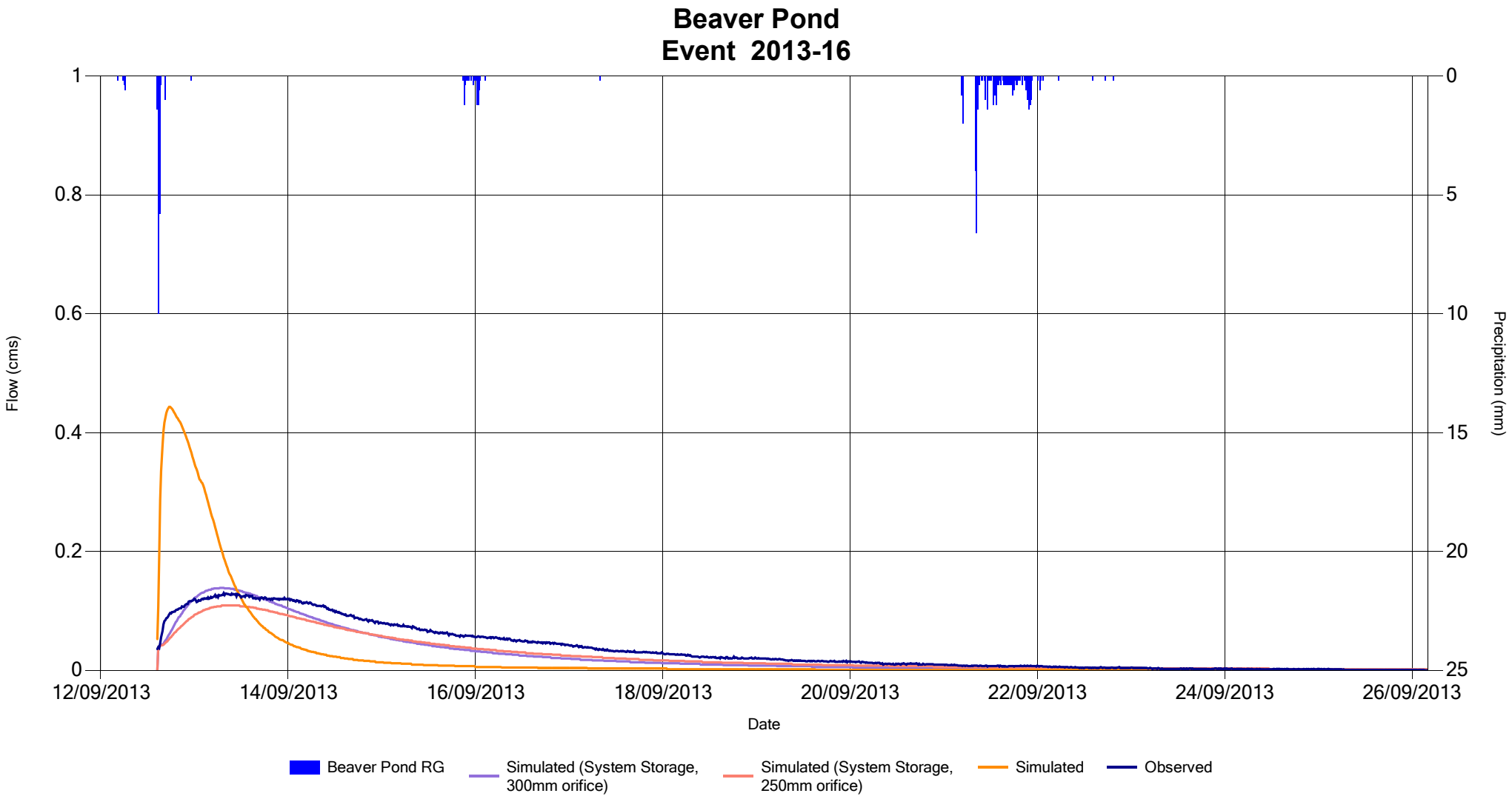

Beaver Pond
Event 2013-16
Flow (cms)
Precipitation (mm)
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
12/09/2013
14/09/2013
16/09/2013
18/09/2013
20/09/2013
22/09/2013
24/09/2013
26/09/2013
Date
Beaver Pond RG
Simulated (System Storage, 300mm orifice)
Simulated (System Storage, 250mm orifice)
Simulated
Observed

Figure C-4-6

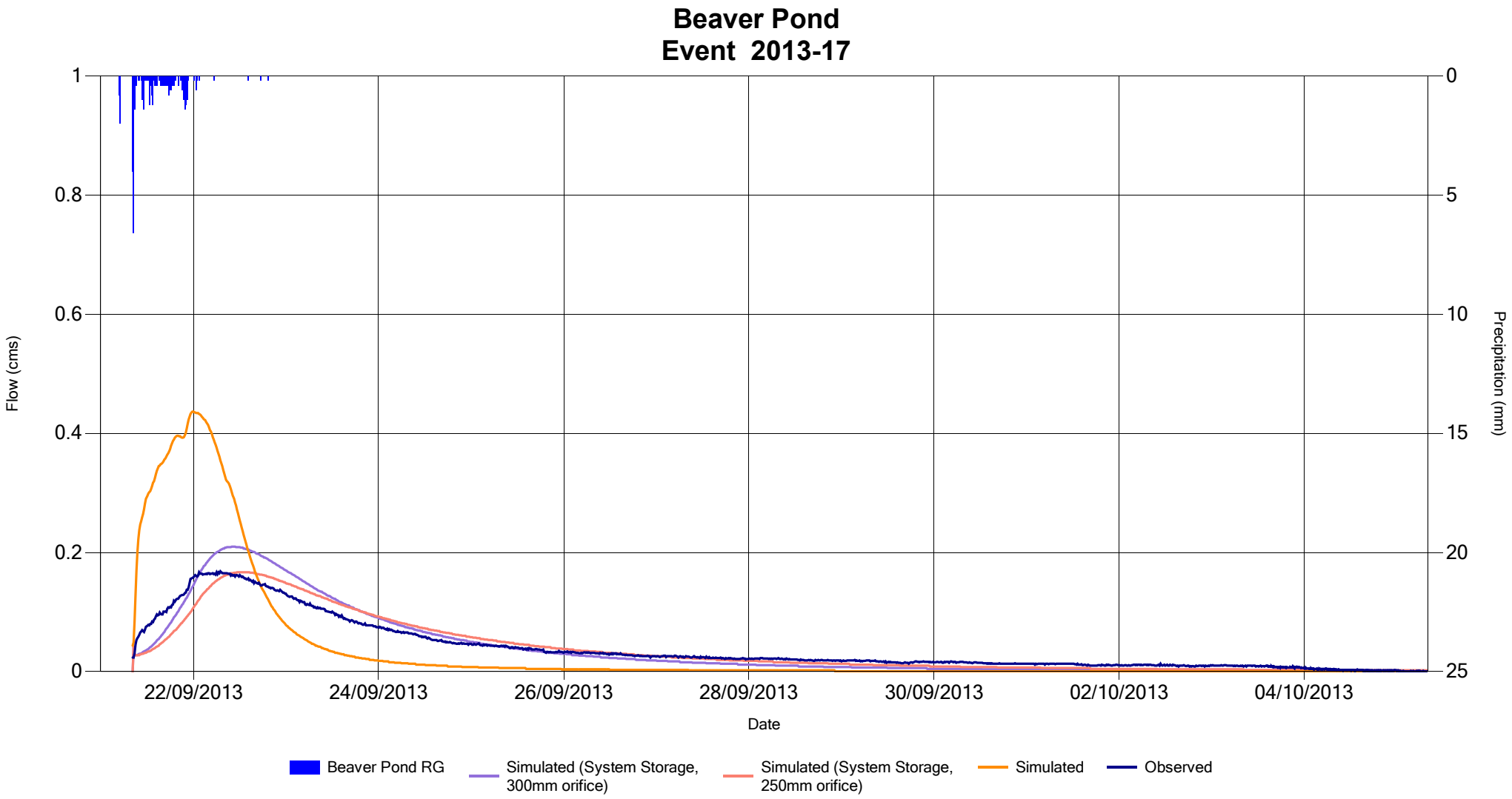

Beaver Pond
Event 2013-17
Flow (cms)
Precipitation (mm)
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
22/09/2013
24/09/2013
26/09/2013
28/09/2013
30/09/2013
02/10/2013
04/10/2013
Date
Beaver Pond RG
Simulated (System Storage, 300mm orifice)
Simulated (System Storage, 250mm orifice)
Simulated
Observed

Figure C-4-7

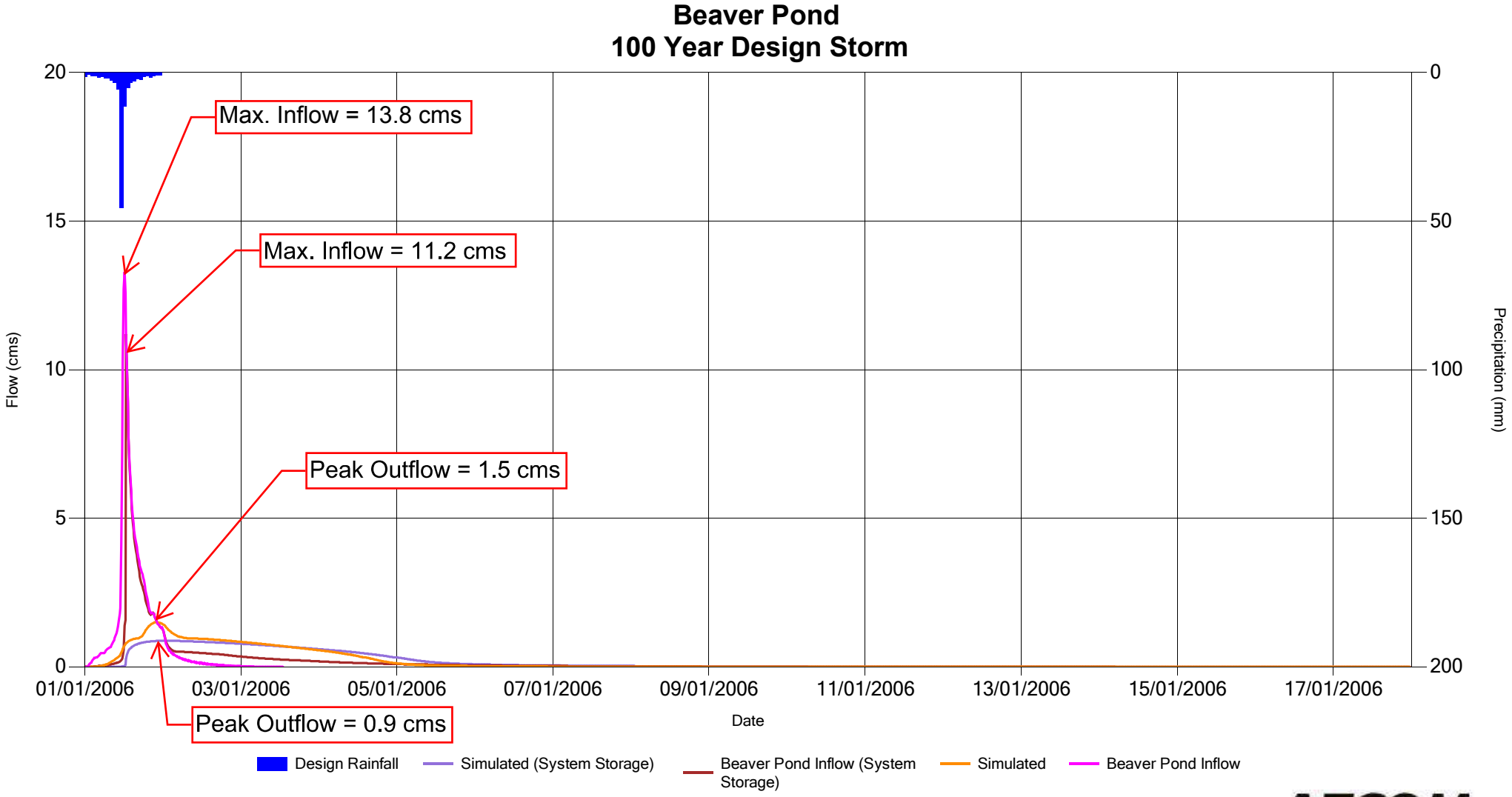

Beaver Pond
100 Year Design Storm
Max. Inflow = 13.8 cms
Max. Inflow = 11.2 cms
Peak Outflow = 1.5 cms
Peak Outflow = 0.9 cms
Flow (cms)
Precipitation (mm)
Date
20
15
10
5
0
0
50
100
150
200
01/01/2006
03/01/2006
05/01/2006
07/01/2006
09/01/2006
11/01/2006
13/01/2006
15/01/2006
17/01/2006
Design Rainfall
Simulated (System Storage)
Beaver Pond Inflow (System Storage)
Simulated
Beaver Pond Inflow

FIGURE 8

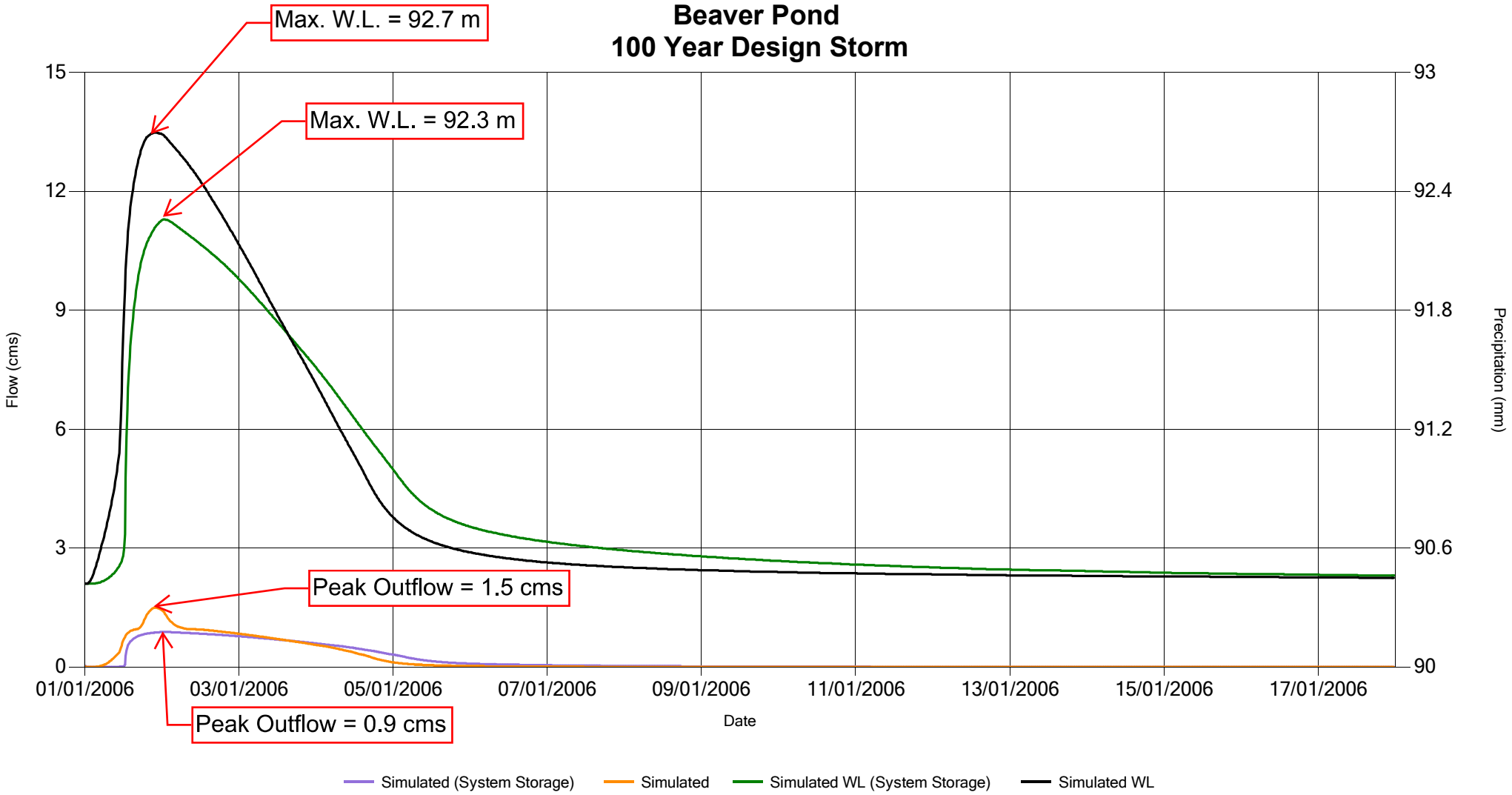

Beaver Pond
100 Year Design Storm
Max. W.L. = 92.7 m
Max. W.L. = 92.3 m
Peak Outflow = 1.5 cms
Peak Outflow = 0.9 cms
Flow (cms)
Precipitation (mm)
Date
15
12
9
6
3
0
93
92.4
91.8
91.2
90.6
90
01/01/2006
03/01/2006
05/01/2006
07/01/2006
09/01/2006
11/01/2006
13/01/2006
15/01/2006
17/01/2006
Simulated (System Storage)
Simulated
Simulated WL (System Storage)
Simulated WL

FIGURE 9

C-5. Upper Kizell Drain Hydrologic Model Verification Assessment - June 24, 2014 Storm Event

Table C-5-1 - June 24, 2014 Storm Event Details

Event	Rain Gauge	Start	End	Duration (hr)	Total Depth (mm)	3-Day (m)	5-Day (m)
2014-01	Beaver Pond RG	2014/06/24 03:00	2014/06/24 21:45	18.8	64.6	0.0	0.0
2014-01	March Rd RG	2014/06/24 03:15	2014/06/24 21:45	18.5	65.8	0.0	0.0
2014-01	Average	-	-	18.6	65.2	0.0	0.0
2014-01	Range	-	-	18.5-18.75	64.6-65.8	0.0	0.0

Table C-5-2 - June 24, 2014 Storm Comparison with City's Design Storm IDF

Time (min)	City of Ottawa IDF Curves (I mm/hr)						Jun 24, 2014
	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	
10	76.8	104.2	122.1	144.7	161.5	178.6	52.8
60	24.6	32.9	38.5	45.4	50.5	55.9	26.2
360	6.1	8.2	9.5	11.2	12.4	13.7	7.2
720	3.5	4.7	5.4	6.4	7.1	7.8	5.0

Time (min)	City of Ottawa IDF Curves (D mm)						Jun 24, 2014
	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	
10	12.8	17.4	20.4	24.1	26.9	29.8	8.8
60	24.6	32.9	38.5	45.4	50.5	55.9	26.2
360	36.9	49.0	57.0	66.9	74.5	82.3	43.4
720	42.3	56.2	65.2	76.4	84.9	93.9	59.8

Range

Table C-5-3 - June 24, 2014 Storm Event Radar Assessment

Location	Rainfall Event Comparison vs. Radar Data (Distributed Rainfall)														
	Rainfall Depth (mm)							Rainfall Depth Ratio [1]							
	2013-03	2013-07	2013-08	2013-10	2013-16	2013-17	2014-01	2013-03	2013-07	2013-08	2013-10	2013-16	2013-17	2014-01
March Road (measured)	23.4	31.6	34.0	31.4	12.8	35.0	65.8	-	-	-	-	-	-	-
March Road (radar)	8.1	21.7	26.8	23.6	16.7	27.5	62.2	0.348	0.685	0.789	0.751	1.302	0.785	0.945
Beaver Pond (measured)	22.6	35.6	35.0	26.4	22.6	37.2	64.6	-	-	-	-	-	-	-
Beaver Pond (radar)	7.8	26.7	27.9	28.9	25.5	32.2	61.5	0.344	0.751	0.798	1.094	1.127	0.867	0.952
Fire Hall (measured)	-	-	-	12.2	13.2	30.8	-	-	-	-	-	-	-	-
Fire Hall (radar)	-	-	-	17.4	16.9	29.3	-	-	-	-	1.423	1.277	0.950	-
Glen Carin (measured)	-	-	-	-	27.0	33.6	-	-	-	-	-	-	-	-
Glen Carin (radar)	-	-	-	-	20.9	31.7	-	-	-	-	-	0.774	0.943	-
Upper Kizell [1]	25.8	31.9	35.9	23.5	18.2	35.9	64.2	1.14	0.90	1.03	0.89	0.80	0.97	0.99
Watt's Creek [1, 2]	41.2	29.6	39.8	16.0	15.1	31.9	-	1.76	0.94	1.17	0.51	1.18	0.91	-
Watt's Creek [3]	44.3	27.8	41.7	11.5	15.4	31.8	-	1.89	0.88	1.23	0.37	1.21	0.91	-
Shirley's Brook [1]	39.7	26.9	36.1	27.0	9.6	33.6	-	1.70	0.85	1.06	0.86	0.75	0.96	-

Notes: 1. Ratio = Radar Value/Measured Value

2. Downstream of Beaver Pond.

3. Excluding Upper and Lower Kizell

AMC I

Table C-5-4 - DIVERT HYD Command Sensitivity Assessment

Storm Event	SWMHYMO Model Scenario	Total Inflow to Kizell & Beaver Pond (cms)	Beaver Pond Outflow (cms)	Beaver Pond Max. Level (m)
24-Jun-14	Base Conditions (AECOM Phase 2 Draft Report - no sub-surface Storage)	9.94	0.70	91.77
24-Jun-14	Without DIVERT HYD Commands	0.50	0.36	91.07
24-Jun-14	With DIVERT HYD Commands	1.76	0.39	91.11
100-Year	Base Conditions (AECOM Phase 2 Draft Report - no sub-surface Storage)	13.80	1.50	92.70
100-Year	Without DIVERT HYD Commands	12.43	0.91	92.34
100-Year	With DIVERT HYD Commands	8.57	0.90	92.32

Table C-5-5 - Comparison of Simulated vs. Observed for June 24, 2014 Verification Storm Event

Event	Total Depth [1] (mm)	Peak Flow (cms)			Total Runoff (ha-m)			Runoff Lag Time (hr)		
		Observed	No System Storage	Limited System Storage + No DIVERT HYD)	Observed	No System Storage	Limited System Storage + No DIVERT HYD)	Observed	No System Storage	Limited System Storage + No DIVERT HYD)
2014-01	64.6	0.31	0.70	0.36	8.39	9.32	9.27	27.00	19.25	35.00

Note

1 Point rainfall depth recorded at the St. Gabriel School (Beaver Pond) rain gauge.

AMC I

Table C-5-6 - 100 Year Design Event Summary

Event	Total Depth (mm)	Peak Flow (cms)				Maximum Water Level (m)			Total Runoff (ha-m)			
				Diff.				Diff.			Diff.	
		No System Storage	Limited System Storage + No DIVERT HYD)	(cms)	(%)	No System Storage	Limited System Storage + No DIVERT HYD)	(m)	No System Storage	Limited System Storage + No DIVERT HYD)	(ha-m)	(%)
100 Year	106.7	1.50	0.91	-0.59	-39%	92.70	92.34	-0.36	23.95	24.38	0.43	1.80%

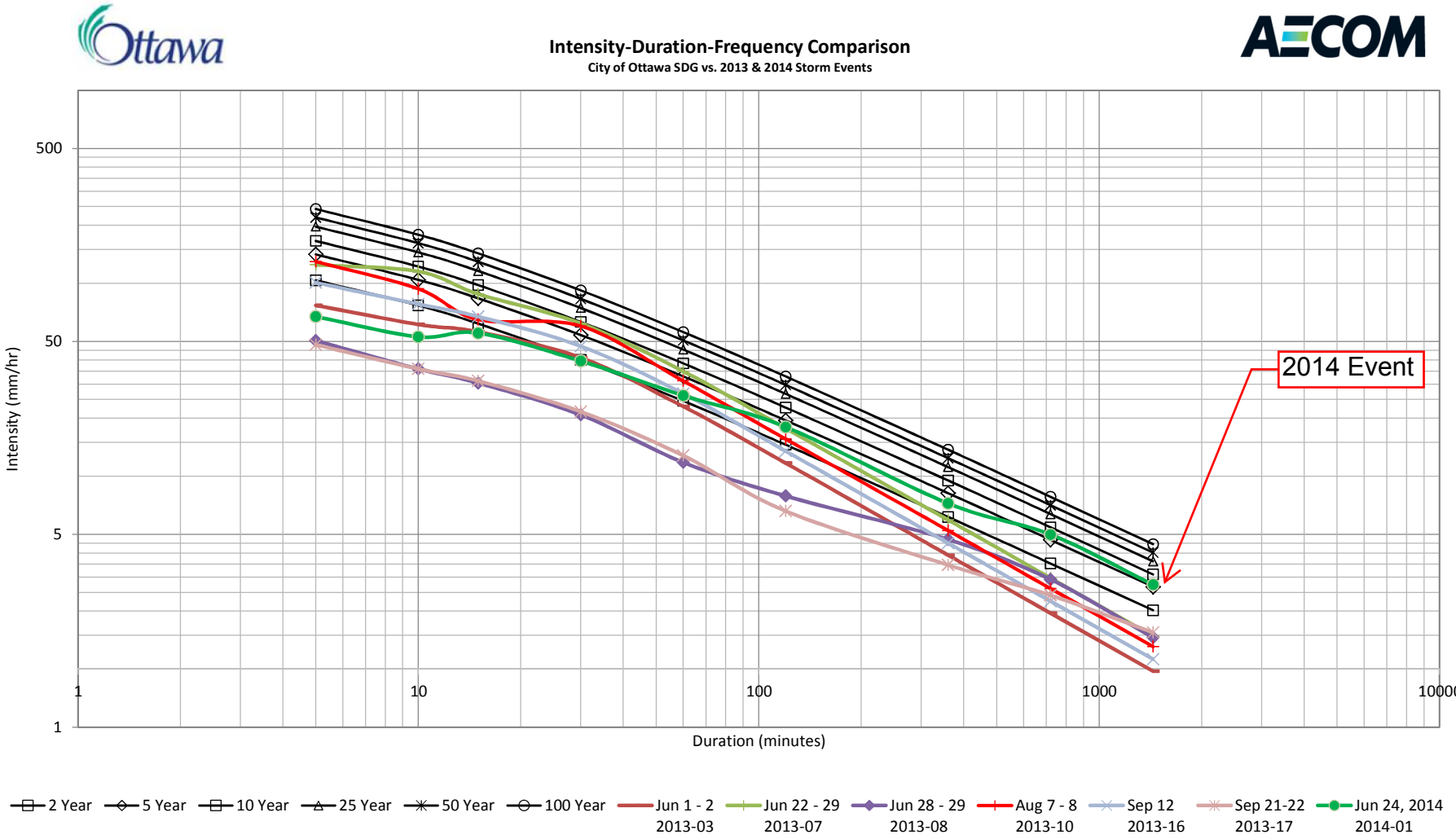

Intensity-Duration-Frequency Comparison
City of Ottawa SDG vs. 2013 & 2014 Storm Events
Intensity (mm/hr)
500
50
5
1
1
10
100
1000
10000
Duration (minutes)
2014 Event
2 Year
5 Year
10 Year
25 Year
50 Year
100 Year
Jun 1 - 2 2013-03
Jun 22 - 29 2013-07
Jun 28 - 29 2013-08
Aug 7 - 8 2013-10
Sep 12 2013-16
Sep 21-22 2013-17
Jun 24, 2014 2014-01

Figure C-5-1

344000 345000 346000 347000 348000 349000 350000 351000 352000 353000 354000 355000 356000

5028000 5027000 5026000 5025000 5024000 5023000 5022000 5021000 5020000 5019000

March Road P.S.

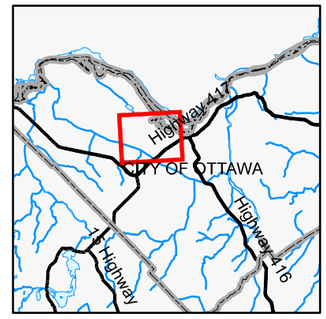
St. Gabriel School

Legend

- Subwatershed Boundary
- Upper Kizell Boundary
- City of Ottawa Rain Gauge

Total Rainfall (mm)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- > 90



Basemapping and orthophotography provided by the City of Ottawa.

N
W E
S

0 200 400 800 1,200 1,600 m

1:40,000

NAD 83, MTM 9

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Shirley's Brook & Watt's Creek Phase 2 SWM Study

Rainfall Radar Map 2014 Event June 24

July 2014
60264539

Ottawa
AECOM

Figure C-5-2

Path: C:\Projects\60264539_Shirley's\2012\MXDs\WorkingMXDs\60264539_Rainfall_Map_2014.mxd
Time: 2:11:54 PM Date: 31/07/2014

Beaver Pond Outflow Hydrograph Comparison - Event 2014-01

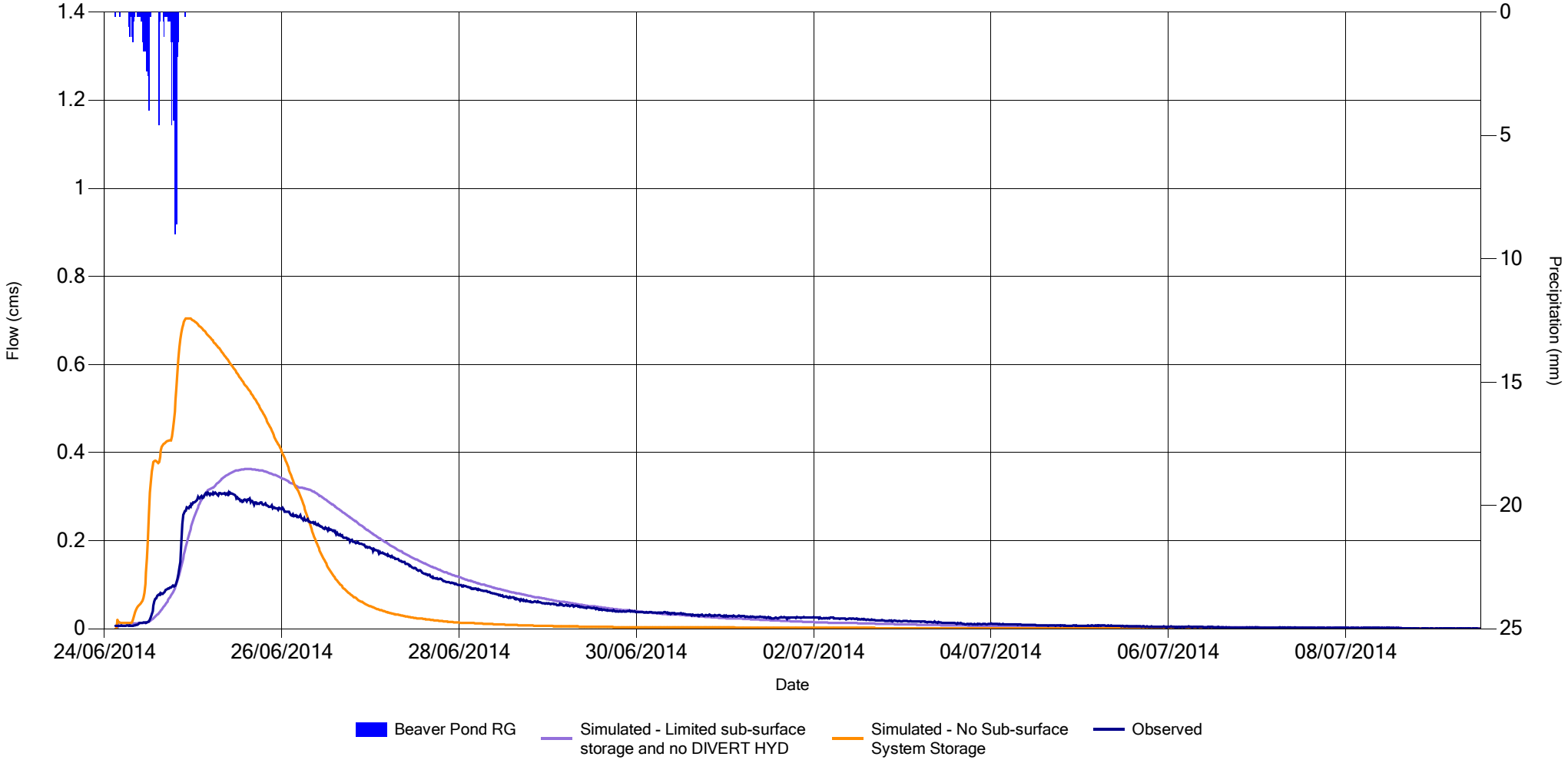

Figure C-5-3

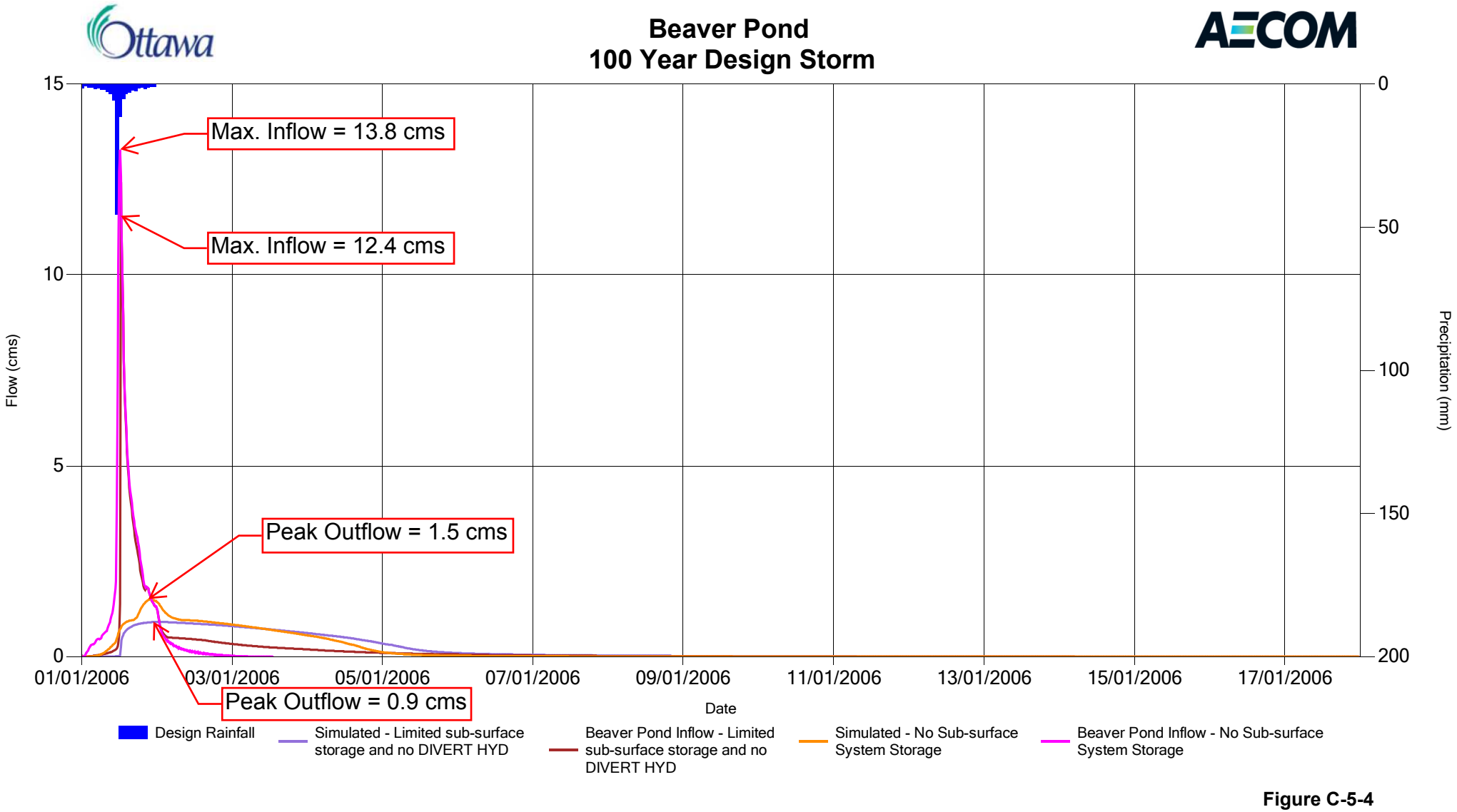
Beaver Pond
100 Year Design Storm
Max. Inflow = 13.8 cms
Max. Inflow = 12.4 cms
Peak Outflow = 1.5 cms
Peak Outflow = 0.9 cms
Flow (cms)
Precipitation (mm)
Date
15
10
5
0
0
50
100
150
200
01/01/2006
03/01/2006
05/01/2006
07/01/2006
09/01/2006
11/01/2006
13/01/2006
15/01/2006
17/01/2006
Design Rainfall
Simulated - Limited sub-surface storage and no DIVERT HYD
Beaver Pond Inflow - Limited sub-surface storage and no DIVERT HYD
Simulated - No Sub-surface System Storage
Beaver Pond Inflow - No Sub-surface System Storage

Figure C-5-4

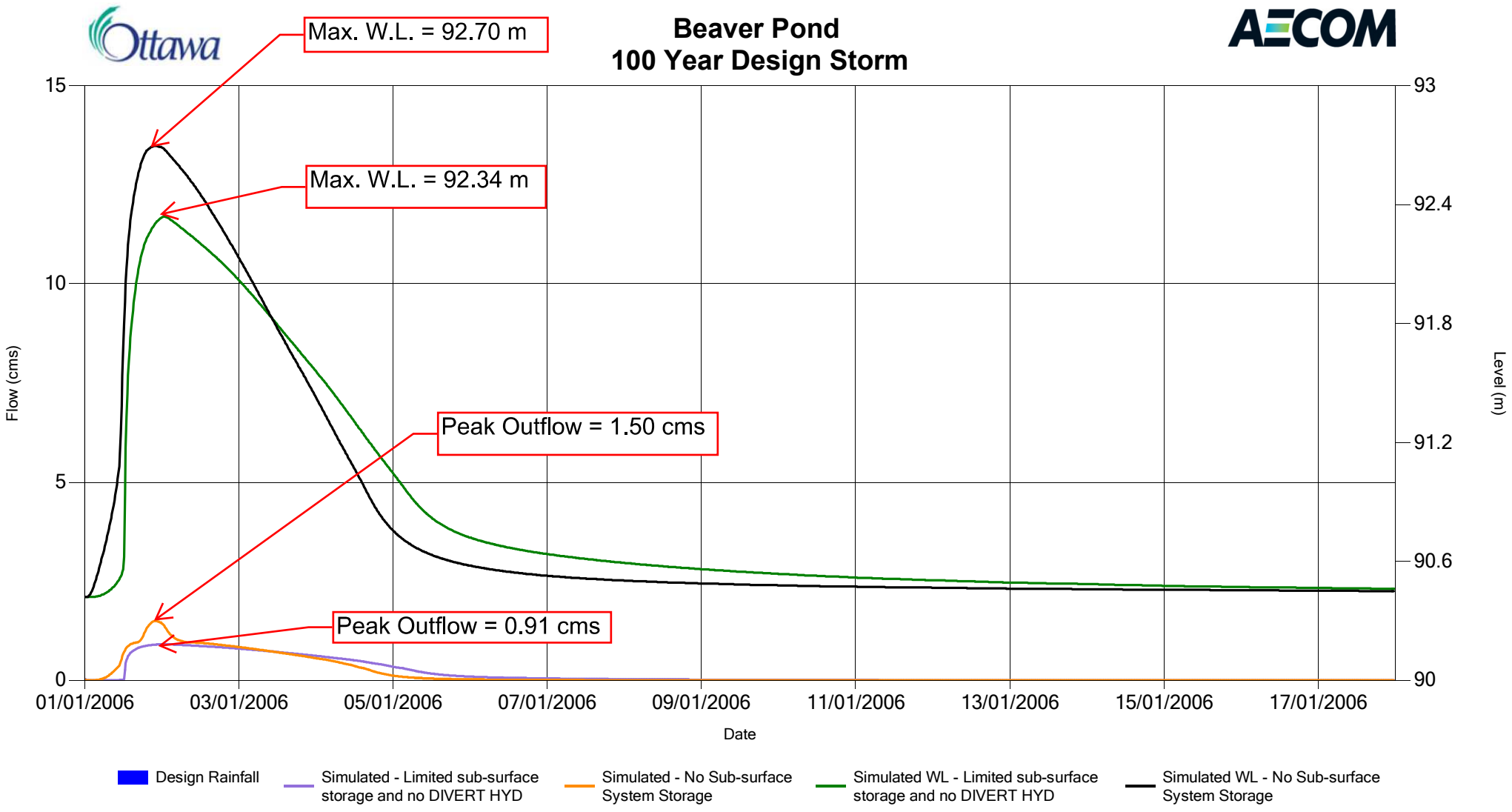
Beaver Pond
100 Year Design Storm
Max. W.L. = 92.70 m
Max. W.L. = 92.34 m
Peak Outflow = 1.50 cms
Peak Outflow = 0.91 cms
Flow (cms)
Level (m)
Date
15
10
5
0
93
92.4
91.8
91.2
90.6
90
01/01/2006
03/01/2006
05/01/2006
07/01/2006
09/01/2006
11/01/2006
13/01/2006
15/01/2006
17/01/2006
Design Rainfall
Simulated - Limited sub-surface storage and no DIVERT HYD
Simulated - No Sub-surface System Storage
Simulated WL - Limited sub-surface storage and no DIVERT HYD
Simulated WL - No Sub-surface System Storage

Figure C-5-5

C-6. Design Event Peak Flows & Beaver Pond and Kizell Cell Performance Assessment

TABLE C-6-1
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SWMHYMO PEAK FLOW SUMMARY - WATT'S CREEK / KIZELL DRAIN

Version 1.0
oject No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes: 1. Bold values represent the maximum peak flow within specific design storm distribution.
2. Values shaded grey represent maximum peak flows between distributions and are used in HEC-RAS model.
3. Values shaded orange represent historical storm peak flows that exceed 100-year design event flows.

Flow Point	Location (refer to Figure X.X)	SWMHYMO Design Event & Historical Peak Flows (m3/s)																													
		CHICAGO IDF												SCS TYPE II												AES 30 % DIST.			HISTORICAL EVENTS		
		6 Hour			12 Hour			24 Hour						6 Hour			12 Hour			24 Hour						12 Hour					
		5	25	100	5	25	100	2	5	10	25	50	100	5	25	100	5	25	100	2	5	10	25	50	100	5	25	100	Jul-79	Aug-88	Aug-96
KFP1	Kizell Drain @ Outlet of Beaver Pond (XPSWMM)	0.32	0.52	0.71	0.39	0.64	0.80	0.32	0.46	0.58	0.71	0.81	0.91	0.32	0.53	0.69	0.39	0.64	0.82	0.32	0.47	0.61	0.73	0.81	0.91	0.73	0.89	1.02	0.76	0.68	0.13
KFP2	Kizell Drain @ CP Rail Line	0.33	0.59	0.81	0.40	0.71	0.91	0.33	0.49	0.62	0.78	0.89	1.01	0.33	0.59	0.80	0.40	0.72	0.94	0.33	0.51	0.66	0.80	0.90	1.02	0.78	0.98	1.14	0.87	0.77	0.13
KFP3	Kizell Drain @ March Road/ Station Road	0.98	1.73	2.48	1.04	1.82	2.62	0.64	1.09	1.43	1.92	2.28	2.76	0.98	1.73	2.51	0.98	1.67	2.45	0.56	0.91	1.17	1.53	1.82	2.19	1.24	1.71	2.14	3.04	2.33	0.60
KFP4	Kizell Drain @ Herzberg Road	4.86	8.23	11.5	5.16	8.62	12.1	3.09	5.38	6.86	9.02	10.6	12.7	4.94	8.22	11.6	4.89	8.05	11.2	2.84	4.55	5.83	7.40	8.74	10.3	3.90	5.87	7.70	14.4	11.0	2.59
KFP5	Kizell Drain @ Carling Ave	4.28	7.27	10.3	4.56	7.72	10.9	2.97	4.80	6.19	8.12	9.7	11.5	4.39	7.40	10.5	4.45	7.43	10.5	2.68	4.31	5.53	7.11	8.40	10.0	4.13	6.32	8.39	12.9	10.1	2.13
KFP6	Kizell Drain @ Outlet (Confluence with Watt's Creek)	7.56	12.0	16.9	8.11	12.6	18.0	5.61	8.56	10.6	13.2	16.0	19.0	7.80	12.2	17.3	7.79	12.3	17.4	4.77	7.63	9.7	12.0	14.1	16.8	6.96	10.8	14.3	21.2	16.6	3.80
WFP1	Watt's Creek @ U/S of Confluence with Kizell Drain	8.00	13.3	16.5	8.51	14.1	17.5	5.55	8.96	11.3	14.9	17.9	18.5	8.29	13.7	16.7	7.35	12.0	16.9	4.50	7.25	9.24	11.8	13.9	16.3	6.25	10.0	13.5	21.5	16.4	3.99
WFP2	Watt's Creek @ D/S of Confluence with Kizell Drain	15.4	24.3	33.4	16.4	25.7	35.5	11.2	17.4	21.2	27.0	32.4	37.5	15.9	24.9	33.9	15.1	24.3	34.3	9.26	14.9	19.0	23.8	28.0	33.1	13.2	20.8	27.9	42.8	33.0	7.75
WFP3	Watt's Creek	15.6	24.8	34.2	16.7	26.2	36.3	11.3	17.7	21.6	27.6	33.1	38.4	16.2	25.4	34.7	15.4	24.9	35.1	9.48	15.2	19.5	24.5	28.8	34.0	13.6	21.5	28.8	43.6	33.7	7.82
WFP4	Watt's Creek @ Carling Ave	15.4	24.5	33.7	16.5	26.0	35.8	11.1	17.5	21.4	27.4	32.7	37.7	16.0	25.2	34.3	15.3	24.9	34.7	9.44	15.2	19.4	24.5	28.8	33.8	13.7	21.7	29.1	42.2	33.2	7.35
WFP5	Watt's Creek @ Outlet	10.9	17.9	24.8	11.7	19.2	26.6	8.06	12.5	15.7	20.4	24.3	28.2	11.3	18.4	25.6	11.6	19.3	26.8	7.48	11.8	15.0	19.5	23.0	27.0	11.6	18.9	26.0	28.8	24.1	4.78

TABLE C-6-2
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SWMHYMO PEAK FLOW SUMMARY - SHIRLEY'S BROOK
Version 1.0
oject No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes: 1. Bold values represent the maximum peak flow within specific design storm distribution.
2. Values shaded grey represent maximum peak flows between distributions.
3. Values shaded orange represent historical storm peak flows that exceed 100-year design event flows.

Flow Point	Location (refer to Figure 3)	SWMHYMO Design Event & Historical Peak Flows (m3/s)																						
		CHICAGO IDF												SCS TYPE II						AES 30 % DIST.			HISTORICAL EVENTS		
		6 Hour			12 Hour			24 Hour						24 Hour						12 Hour					
		5	25	100	5	25	100	2	5	10	25	50	100	2	5	10	25	50	100	5	25	100	Jul-79	Aug-88	Aug-96
SB1	Goulbourn Forced Road	0.63	2.08	3.87	0.78	2.46	4.48	0.25	0.98	1.73	2.89	3.95	5.18	0.31	1.12	1.91	3.08	4.14	5.38	1.15	2.83	4.63	5.74	4.11	0.00
SB2	CN Railway	0.74	2.29	4.19	0.91	2.69	4.83	0.32	1.12	1.92	3.15	4.26	5.56	0.39	1.27	2.11	3.35	4.47	5.76	1.29	3.09	5.01	6.08	4.40	0.02
SB3	Hydro Corridor U/S Hines Road	0.69	2.25	4.15	0.87	2.63	4.78	0.32	1.07	1.84	3.07	4.19	5.47	0.37	1.22	2.04	3.30	4.42	5.70	1.24	3.10	5.09	5.75	4.30	0.09
SB4	March Road	1.01	2.74	4.77	1.23	3.16	5.41	0.56	1.45	2.32	3.63	4.79	6.11	0.63	1.61	2.51	3.85	5.02	6.38	1.61	3.65	5.81	6.22	4.84	0.20
SB5	Terry Fox Drive	1.59	2.97	5.12	1.73	3.47	5.81	1.13	1.88	2.59	3.94	5.16	6.54	1.03	1.83	2.81	4.20	5.43	6.83	1.74	3.95	6.23	6.25	5.25	0.71
SB6	D/S Shirley Brook Drive	4.44	7.40	9.95	4.71	8.05	10.4	3.09	4.97	6.28	8.48	9.72	10.9	2.70	4.26	5.50	7.06	8.44	9.84	3.22	5.17	7.66	12.2	10.2	1.93
SB7	Klondike Road	4.60	7.77	11.1	4.89	8.26	11.8	4.43	5.16	6.63	8.77	10.86	13.1	3.88	6.06	7.89	10.3	12.5	11.2	4.64	7.47	10.4	14.9	11.6	2.69
SB8	U/S Confluence with North Tributary	4.55	7.67	11.0	4.84	8.21	11.8	4.38	5.12	6.61	8.72	10.77	12.5	3.86	6.05	7.85	10.2	12.4	10.9	4.63	7.47	10.4	14.6	11.2	2.65
SB9	Marconi Ave	6.62	11.5	16.2	7.09	12.3	17.5	5.90	7.55	9.89	13.1	15.8	18.5	5.27	8.30	10.8	14.1	16.9	16.4	6.60	10.7	15.0	21.0	16.7	3.50
SB10	CN Railway	6.58	11.2	15.7	7.05	11.9	17.0	5.83	7.50	9.77	12.8	15.3	18.2	5.27	8.27	10.7	13.8	16.6	16.1	6.65	10.8	15.2	20.5	15.9	3.42
SB11	4th Line Road	6.78	11.5	16.5	7.29	12.3	17.7	5.95	7.75	10.0	13.1	16.1	18.9	5.43	8.57	11.0	14.2	17.1	16.9	6.97	11.3	15.9	21.4	16.6	3.40
SB12	D/S 4th Line Road (Stream Gauge Location CK5-001)	6.46	11.0	15.5	6.97	11.8	16.7	5.71	7.45	9.69	12.6	15.1	17.9	5.33	8.38	10.8	14.0	16.7	16.6	7.10	11.6	16.3	20.0	15.6	3.20
SB13	Outlet	6.69	11.5	16.1	7.26	12.4	17.4	5.82	7.81	10.1	13.2	15.8	18.6	5.53	8.84	11.4	14.7	17.6	17.7	7.79	12.9	18.1	20.1	16.1	3.13

TABLE C-6-3
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SUMMARY OF KIZELL CELL & BEAVER POND 100-YEAR PERFORMANCE COMPARISON

Version 2.0
Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes: *1. Based on previous City design 100-year rainfall depth of 88.6 mm using 24 hr SCS Type II distribution.*
2. Results from Table 1, Scenario 11 in Phase 1 SWM Study (AECOM, Oct 2011) based on City's updated 100-year design rainfall of 106.7 mm using 24 hr SCS Type II distribution.
3. Results from Phase 2 SWM Study (AECOM, February 2015) based on calibrated SWMHYMO model.
4. Peak inflow to Kizell Wetland and Beaver Pond.
5. Inflow runoff volume to Kizell Wetland and Beaver Pond.

Location	KNL Seviceability Study (March, 2007) [1]				AECOM Phase 1 SWM Study (Oct, 2012) [2]				AECOM Phase 2 SWM Study (February, 2015) [3]			
	Peak Inflow (m^3/s) [4]	Inflow Runoff Volume (mm) [5]	Peak Outflow (m^3/s)	Max. Water Level (m)	Peak Inflow (m^3/s) [4]	Inflow Runoff Volume (mm) [5]	Peak Outflow (m^3/s)	Max. Water Level (m)	Peak Inflow (m^3/s) [4]	Inflow Runoff Volume (mm) [5]	Peak Outflow (m^3/s)	Max. Water Level (m)
Kizell Wetland - Outlet to Beaver Pond	11.3	61.6	0.88	92.72	13.7	74.2	4.48	93.53	4.8	56.9	1.40	93.14
Kizell Wetland - West Overflow to Carp							0.26					
Beaver Pond - Outlet Control Structure	23.1	60.7	0.86	92.24	38.0	78.6	1.60	92.85	11.1	58.1	0.91	92.34
Beaver Pond - North Overflow							2.95				0.00	

Additional Observations:

1 Lower outflows and water levels reported in KNL study resulted from assumption that Kizell Wetland developed as SWM pond (storage-discharge) and also over-estimated storage in Beaver Pond.
2 Higher peak flows and runoff volume in AECOM Phase 1 report resulted from 20% increase in design storm depth.
3 Increases in outflows and water levels reported in AECOM Phase 1 report resulted from 20% rainfall + corrections to Kizell Wetland and Beaver Pond storage-discharge information.
4 Decrease in peak inflows and runoff volume reported in AECOM Phase 2 report a result of calibrated SWMHYMO model (lower CN, increased Ia and increase in MNI) and additional sub-surface storage routing.
5 Decrease in outflows and water levels reported in AECOM Phase 2 report resulted from reductions associated with hydrologic model. No changes to Kizell Wetland or Beaver Pond storage-discharge.

TABLE C-6-4
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SWMHYMO PEAK FLOW COMPARISON WITH PREVIOUS STUDIES - WATT'S CREEK / KIZELL DRAIN
Version 1.0
Project No. 60264539
Date: 2/6/2015
Design: GAF/OC

Notes:
1. AECOM Phase 2 SWM Study (February 2015) based on calibrated SWMHYMO model. Black highlighted values represent 24 hr SCS Type II, blue highlighted values based on 24 hr Chicago using updated 100-year rainfall depth = 106.7 mm (Ottawa SDG).
2. Uncalibrated OTTHYMO model used to prepare MVCA Flood Risk Mapping for Shirley's Brook & Watt's Creek / Kizell Drain. Utilized 100-year rainfall depth = 88.6 mm.
3. Future condition OTTHYMO flows assumed diversion of 317 ha Shirley's Brook to Watt's Creek (Marchwood-Lakeside MDP), on-line detention facility upstream of March Road (HWY 17), no SWM for portion of Study Area (South March development + major developments).
4. Dillon Study utilized calibrated QUALHYMO model with 1 hour computational time step which may under estimate peak flows for smaller urban areas.
5. Dillon Study future condition flows based on OP with no SWM control.
6. Klondike Road Development study does not include Watt's Creek / Kizell Drain.

AECOM Flow Point	Location (refer to Figure 2)	100-Year Peak Flow Comparison (m3/s)						Comments
		AECOM Phase 2 SWM Study [1]	MVCA Water Management Plan for SBWC (A.J. Robinson, Dec 1989) [2]		SBWC Subwatershed Study(Dillon, 1999) [4]		Klondike Road Development	
			Existing	Future [3]	Existing	Future [5]	Post-Dev [6]	
KFP1	Kizell Drain @ Outlet of Beaver Pond (XPSWMM)	0.91	0.69	1.35	0.81	0.89		A.J. Robinson assumes diversion of 317 ha from Shirley's Brook & SWM within Beaver Pond based on Marchwood-Lakeside MDP
KFP2	Kizell Drain @ CP Rail Line	1.02	1.49	2.17				
KFP3	Kizell Drain @ March Road/ Station Road	2.76	1.62	2.33				
KFP4	Kizell Drain @ Herzberg Road	12.7	4.34	5.25				
KFP5	Kizell Drain @ Carling Ave	11.5	4.68	5.53	7.2	16.5		Dillon study assumes no SWM under future & utilizes 1 hour time step which may under estimate peak flows for urban areas
KFP6	Kizell Drain @ Outlet (Confluence with Watt's Creek)	19.0	12.6	13.8				
WFP1	Watt's Creek @ U/S of Confluence with Kizell Drain	18.5	34.4	49.3				
WFP2	Watt's Creek @ D/S of Confluence with Kizell Drain	37.5	46.0	60.8	28.1	40.2		
WFP3	Watt's Creek	38.4						
WFP4	Watt's Creek @ Carling Ave	37.7	26.9	28.1				A.J. Robinson includes significant flow routing through CN rail embankment U/S of Carling Ave.
WFP5	Watt's Creek @ Outlet	28.2	25.9	27.8	41.6	47.2		AECOM Phase 2 SWM Study maintains greater floodplain storage D/S of confluence with Kizell Drain

TABLE C-6-5
CITY OF OTTAWA
SHIRLEY'S BROOK & WATT'S CREEK - PHASE 2 STORMWATER MANAGEMENT STUDY
SWMHYMO PEAK FLOW COMPARISON WITH PREVIOUS STUDIES - SHIRLEY'S BROOK

Version 1.0
Project No.: 60264539
Date: 2/6/2015
Design: GAF/OC

Notes: 1. AECOM Phase 2 SWM Study (February 2015) based on calibrated SWMHYMO model. Black highlighted values represent 24 hr SCS Type II, blue highlighted values based on 24 hr Chicago using updated 100-year rainfall depth = 106.7 mm (Ottawa SDG).
2. Uncalibrated OTTHYMO model used to prepare MVCA Flood Risk Mapping for Shirley's Brook & Watt's Creek / Kizell Drain. Utilized 100-year rainfall depth = 88.6 mm.
3. Future condition OTTHYMO flows assumed diversion of 317 ha Shirley's Brook to Watt's Creek (Marchwood-Lakeside MDP), on-line detention facility upstream of March Road (HWY 17), no SWM for portion of Study Area (South March development) + major developments.
4. Dillon Study utilized calibrated QUALHYMO model with 1 hour computational time step which may under estimate peak flows for smaller urban areas.
5. Dillon Study future condition flows based on OP with no SWM control.
6. Klondike Road Development study utilized uncalibrated SWMHYMO model. Post development flows assume SWM with slight increase to pre-development levels. Utilized 100-year rainfall depth = 96 mm.

AECOM Flow Point	Location (refer to Figure 2)	100-Year Peak Flow Comparison (m3/s)						Comments
		AECOM Phase 2 SWM Study [1]	MVCA Water Management Plan for SBWC (A.J. Robinson, Dec 1989) [2]		SBWC Subwatershed Study(Dillon, 1999) [4]		Klondike Road Development (Novatech,2007)	
			Existing	Future [3]	Existing	Future [5]	Post-Dev [6]	
SB1	Goulbourn Forced Road	5.38	2.10	-				A.J. Robinson includes 317 ha flow diversion to Watt's Creek
SB2	CN Railway	5.76						
SB3	Hydro Corridor U/S Hines Road	5.70			1.7	8.2		
SB4	March Road (HWY 17)	6.38	3.52	3.21				A.J Robinson includes flow diversion to Watt's Creek & on-line SWM facility within Hydro Corridor U/S March Road (HWY 17)
SB5	Terry Fox Drive	6.83						
SB6	D/S Shirley Brook Drive	10.9						A.J. Robinson assumes uncontrolled discharge for portions of Morgan's Grant (6 to 9)
SB7	Klondike Road	13.1	6.05	17.3	3.6	12.2		A.J. Robinson includes flow routing through road Klondike road embankment
SB8	U/S Confluence with North Tributary	12.5						
SB9	Marconi Ave	18.5						
SB10	CN Railway	18.2	13.8	26.0				A.J. Robinson includes flow routing through railway embankment U/S March Valley Road
SB11	March Valley Road (4th Line)	18.9	13.7	23.8			30.5	Klondike Development model (Novatech 2007) uncalibrated
SB12	D/S 4th Line Road (Stream Gauge Location CK5-001)	17.9						
SB13	Outlet	18.6	15.2	25.2	9.5	28.1		Dillon model calibrated but utilized 1 hour time step which may under estimate peak flows