

## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix A

A total of (7) structures were identified to be inspected but were inaccessible. These are listed in **Table A.5** and include a description as to why they were not inspected.

**Table A.5 – Inaccessible Manholes**

Structure ID	Structure Location	Comment
A-5029	Gorham St / Holland St	Suspect MH buried or does not exist
S2-1566	Cross St / Pearl St	Steel plate potentially covering MH
S2-1579		MH cover broken
1-5284	Community Path / Buena Vista Rd / Meacham Rd	Suspect MH buried or does not exist
1-5433		Suspect MH buried or does not exist
1-6433		Suspect MH buried or does not exist
1-6434		Suspect MH buried or does not exist

During the field investigations a confined space entry was attempted within the drain manhole at the intersection of Medford Street and School Street. This structure is not listed within the City's GIS and was therefore given a manhole ID of 30-5112A, since it is located downstream from manhole 30-5112 on School Street. A confined space entry was not conducted within 30-5112A due to the gas meter alarm Lower Explosive Limit (LEL) readings that were above allowable limits. A petroleum odor along with an orange stain was observed from an inlet coming from the northwest side of Medford Street (See **Figure A.9**). The orange stain can be a sign of petroleum infiltrating through groundwater. A gas station is located at the intersection of Medford Street and School Street.



**Figure A.9 – MH 30-5112A observed petroleum odors and orange discoloration**



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix A

#### Recommendations

The field investigations that were conducted will improve the accuracy of the City's hydraulic model. Alongside the model improvements, it is recommended the City update their GIS for overall connectivity and to further capture the findings from the fieldwork.

In some scenarios, the manhole inspection findings raised additional questions as to overall system connectivity. Assumptions in these cases were made in the hydraulic model. CCTV is recommended to further refine the City's GIS and hydraulic model in the following areas:

- Broadway Street / Cross Street:
  - Determine extent of 12" VCP sleeved pipe within mainline combined sewer
  - Confirm source of connections into S2-2141 from Cross Street
- College Avenue:
  - Determine source of 24-inch connection into box culvert accessible through entry of CA-5916
- Cross Street / Pearl Street:
  - Confirm connectivity between numerous manholes in intersection
- Elm Street / Chester St:
  - Determine connectivity of drain and combined sewer
- Mystic Avenue / McGrath Highway / Foss Park:
  - Numerous unknowns within system connectivity
- Tannery Brook Conduit:
  - Evaluate condition of conduit
  - Portion of CS/SS and potentially the Tannery Brook Conduit goes under #69 Gold Star Rd in Cambridge and should be assessed for condition and potentially rerouted. Other sections of conduit extending under buildings should be evaluated

The structures identified with flap gates, debris, corrosion, or fractures should be evaluated to determine if maintenance or repairs are needed. The source of the petroleum odors and orange discoloration within drain manhole 30-5112A at School Street and Medford Street should be mitigated. In addition, it is recommended the structures that are shown in the City's GIS, but not found in the field, should be investigated with a metal detector and raised to grade for access if they exist.

#### Appendix

Appendix F – Manhole Inspection Table

Appendix G – Manhole Inspection Reports

Appendix H – Confined Space Entry Notes

Appendix I – City GIS Markups





# **APPENDIX B**

## **Data Gap Analysis**

# MODEL REFINEMENT AND CALIBRATION REPORT

## Appendix B

This section summarizes the gaps or issues found in the data provided by the City of Somerville in order to expand and refine its *InfoWorks ICM* Hydraulic Model in the tributary areas of flow meters and the methodology used to bridge the data gaps in the model.

### 1. Manholes with missing data:

- A total of 90 manholes out of 121 had missing rim elevations. Rim elevations for these manholes were updated based on LiDAR data.
- Node invert elevations were filled in by subtracting manhole depths, where available, from rim elevations or by assigning the lowest upstream elevation of any of the conduits exiting the manhole.

### 2. Conduits with missing data:

- A total of 70 conduits out of 118 had missing either upstream or downstream invert elevation. Missing invert elevations were updated with the help of Infoworks ICM inference routine.
- A total of 26 conduits out of 118 had missing size (diameter). Missing conduit size was filled by adopting the diameter of the nearest upstream or downstream conduit, in that order, with available data.

### 3. Discrepancy between GIS data and field data:

- At two locations (CA-2397, Holland St and CA-2398, Morrison Ave), field data for pipe invert elevations updated in model was creating step-up with the downstream conduit data from City's GIS. At these locations, City GIS data was ignored, and field data was retained as it was in the model.

### 4. Connectivity issues in City's GIS data:

- At Mystic Ave, downstream connectivity of manhole S2-6086 was missing in the City's GIS data. In the model, connectivity is assumed to MH 30-5476 looking at the pipe sizes and invert elevations.



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix B

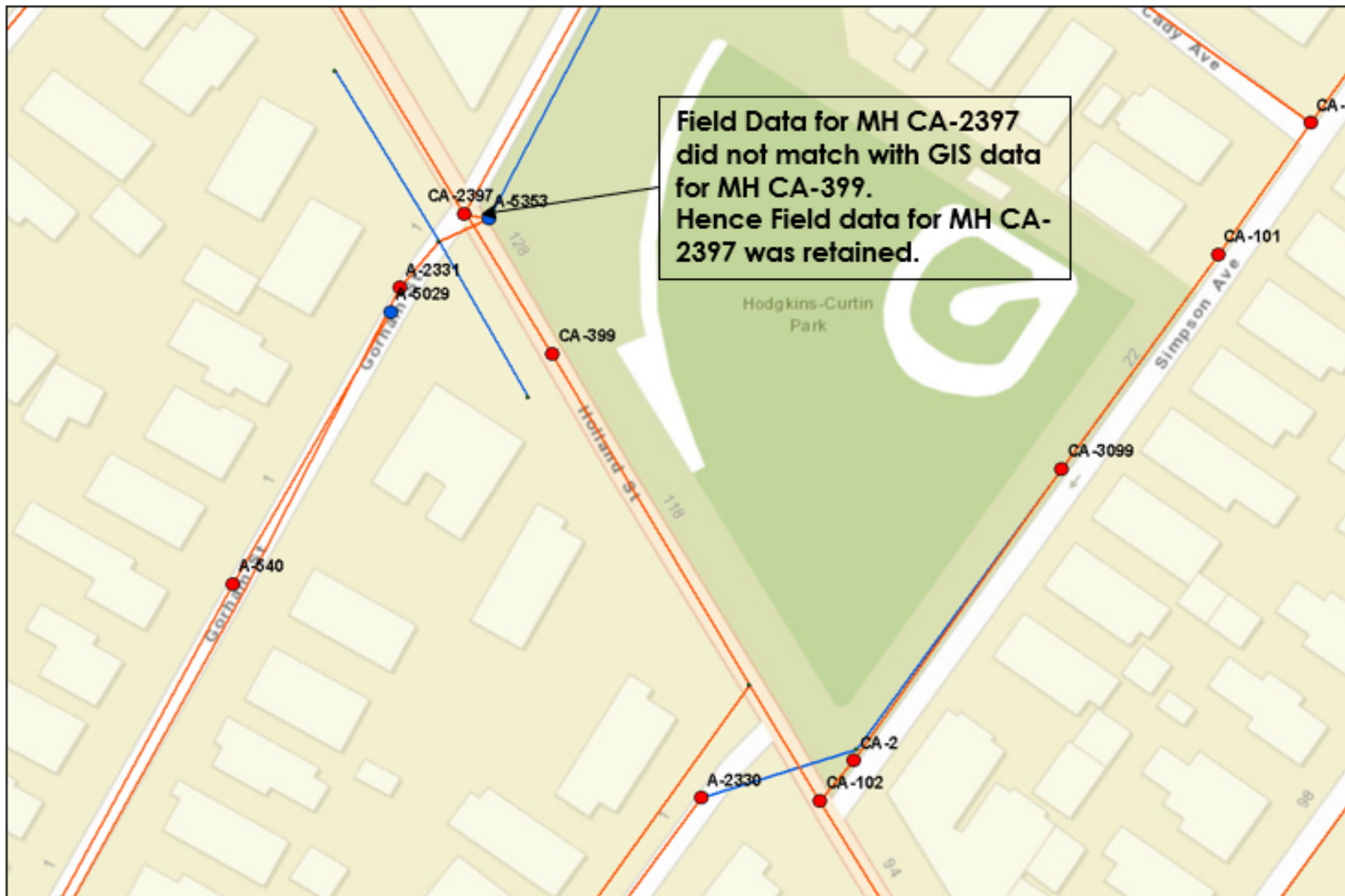


Figure B1. Discrepancy between City's GIS data and Field data at Holland Street



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix B

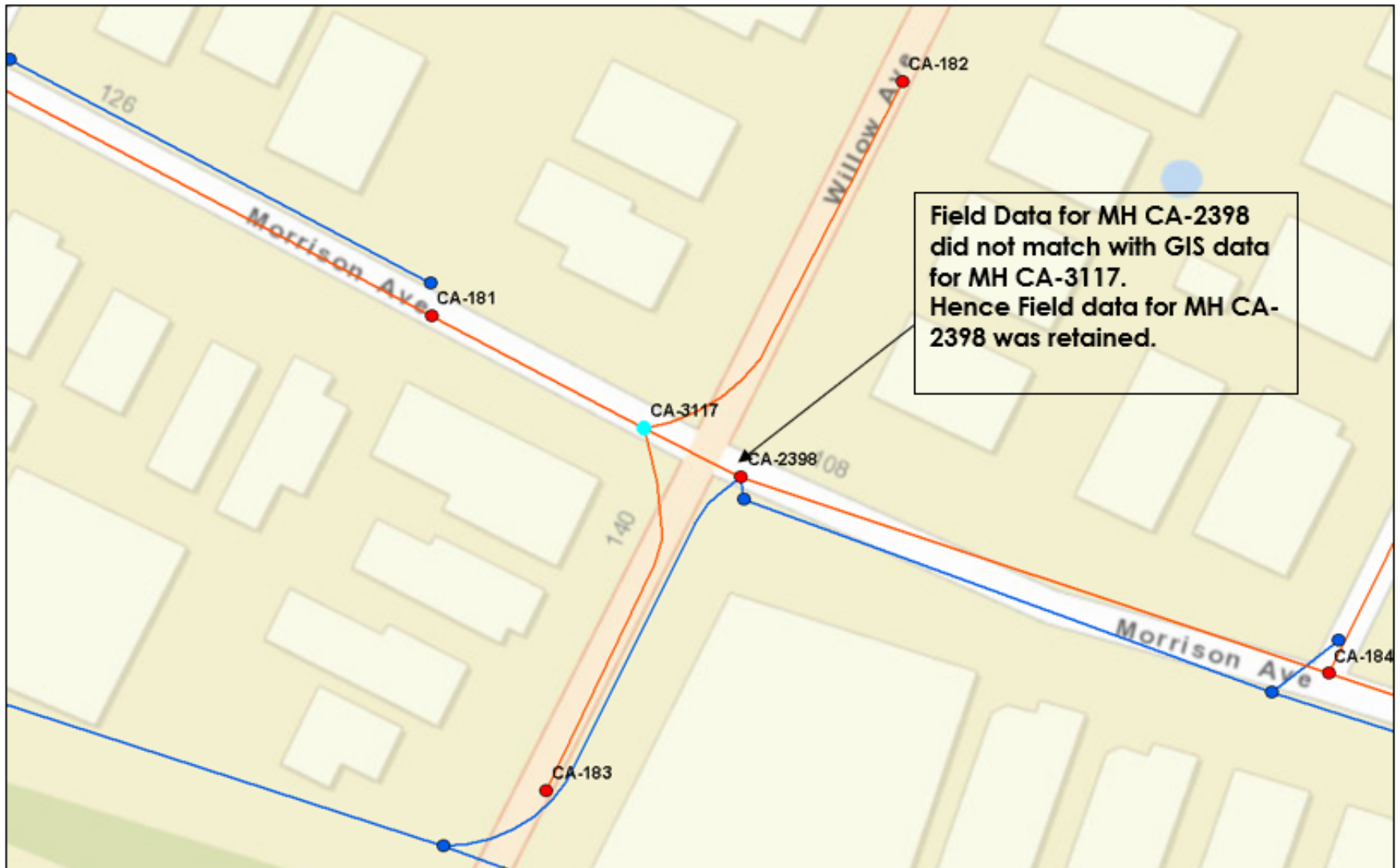


Figure B2. Discrepancy between City's GIS data and Field data at Morrison Avenue



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix B

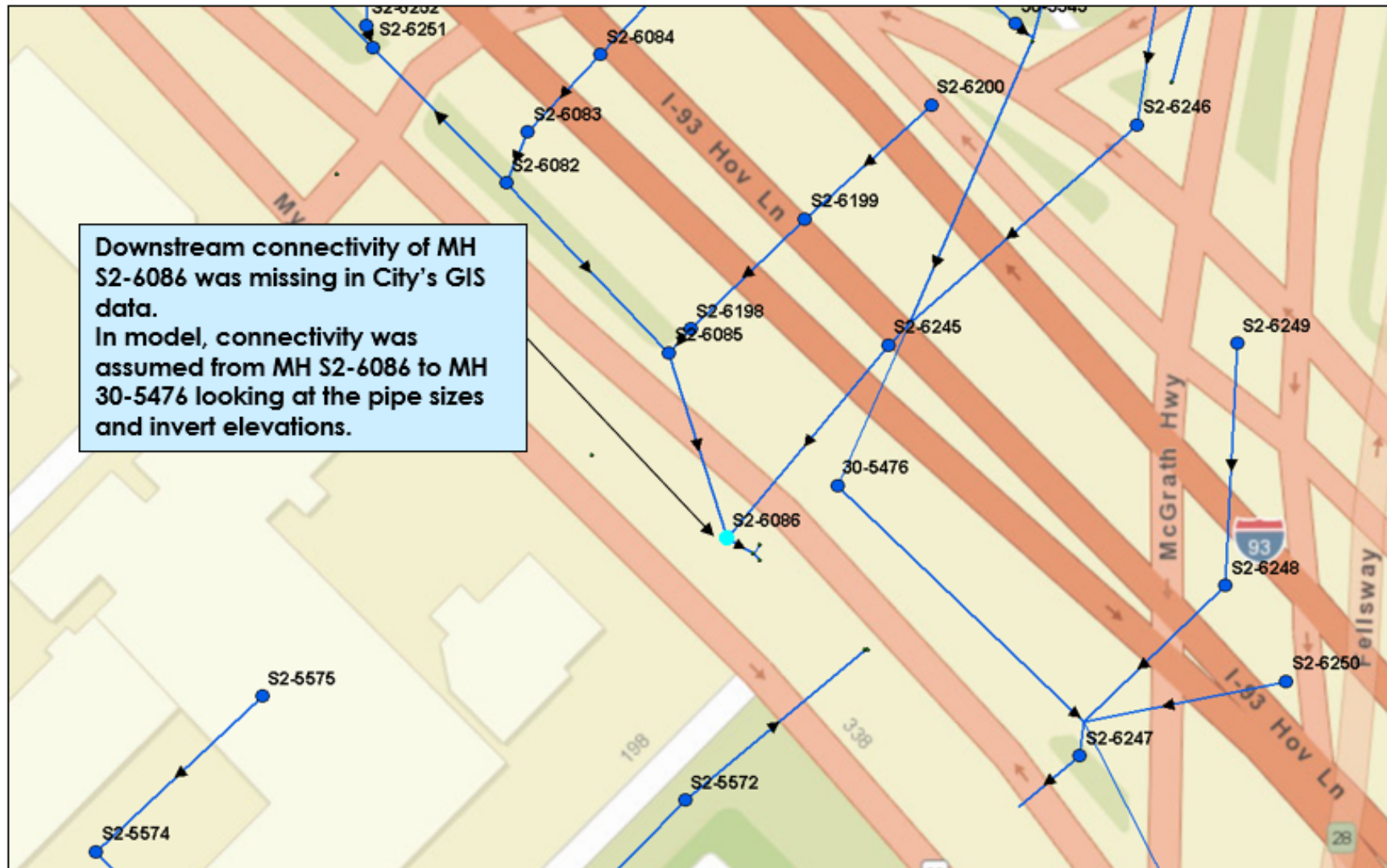


Figure B3. Connectivity Issues in City's GIS data at Mystic Avenue



# **APPENDIX C**

## **Comparison Between Metered and Modeled DWFs**





## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix C

**Table C.1: Comparison Between Metered and Modeled Peak DWFs**

Flow Meter Name	System Type	Peak Dry Weather Flow (MGD)		
		Meter	Model	% Difference
Tannery Br North (2)	Combined	0*	0	0
School St	Storm	0	0	0
Marshall St**	Storm	0.87	0.84	-3%
North St	Storm	0	0	0
Pearl St	Combined	0.81	0.81	0%
Newton St	Combined	0.53	0.57	8%
Murdock Street	Combined	0	0	0
Mystic Ave	Combined	0	0	0
Grove St	Combined	2.01	1.87	-7%
Palmer Avenue	Combined	0.06*	0.12	N/A*
Tannery Br	Combined	1.32	1.27	-4%
Mystic 72in	Storm	0	0	0
Properzi Way	Combined	0.22	0.19	-14%

\* Random spikes, suspected meter error. Likely cause due to meter malfunction thus set to zero.

\*\* Marshall Street meter is installed in storm drain. This meter records diurnal flow during DWF condition. This is possibly due to cross connection between combined and storm system at manhole CA-784 located at junction of Glenwood Road and Vernon Street. The model also predicts a good calibration at Marshall Street meter.



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix C

**Table C.2: Comparison Between Metered and Modeled Cumulative DWF Volumes**

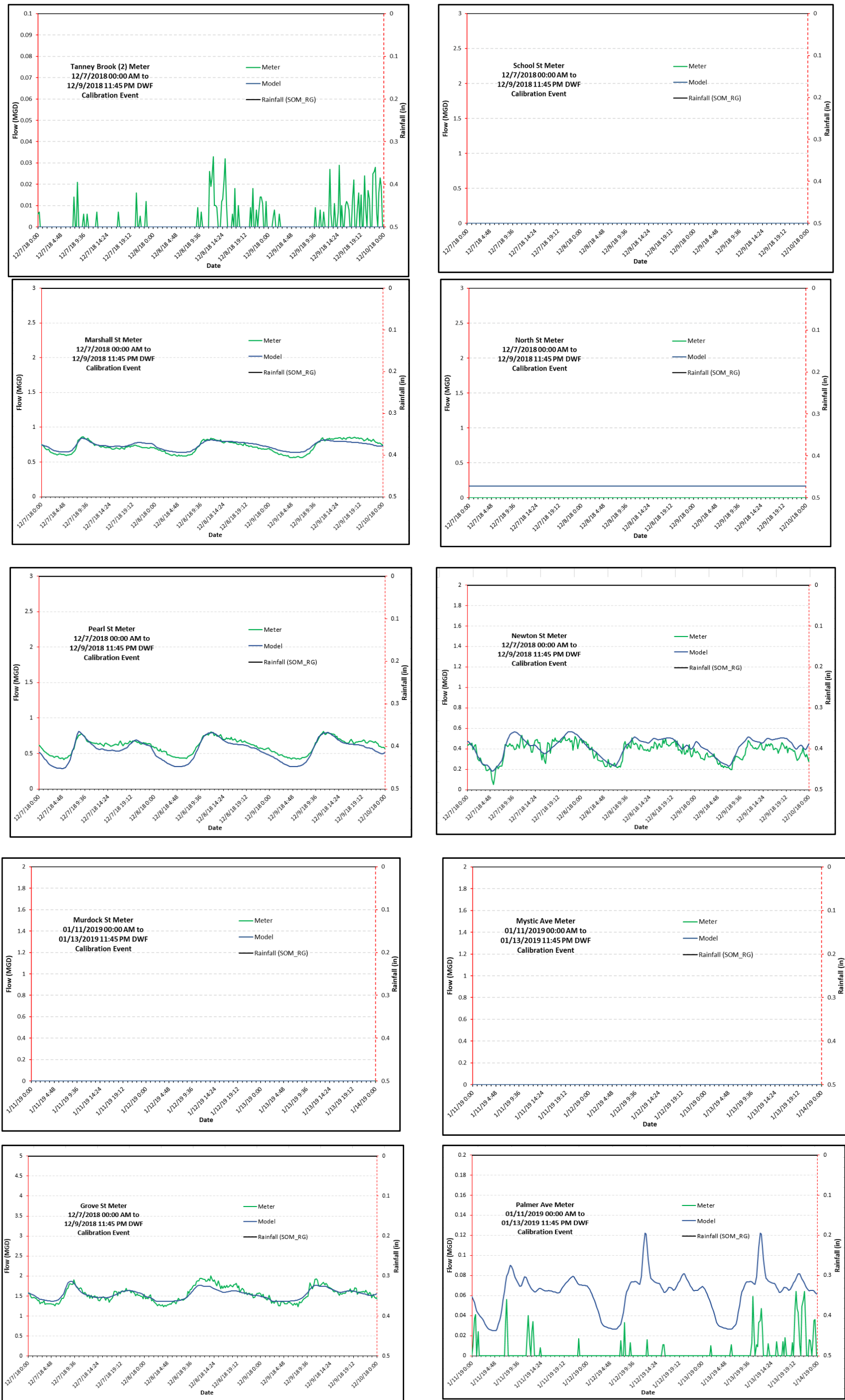
Flow Meter Name	System Type	Cumulative DWF Volumes (MGD)		
		Meter	Model	% Difference
Tannery Br North (2)	Combined	0	0	0
School St	Storm	0	0	0
Marshall St**	Storm	2.16	2.21	2%
North St	Storm	0	0	0
Pearl St	Combined	1.82	1.64	-10%
Newton St	Combined	1.12	1.26	13%
Murdock Street	Combined	0	0	0
Mystic Ave	Combined	0	0	0
Grove St	Combined	4.66	4.65	0%
Palmer Avenue*	Combined	0.01	0.19	0.18
Tannery Br	Combined	3.35	2.8	-16%
Mystic 72in	Storm	0	0	0
Properzi Way	Combined	0.5	0.55	10%

\* Random spikes, suspected meter error, thus actual flow difference presented instead.

\*\* Marshall Street meter is installed in storm drain. This meter records diurnal flow during DWF condition. This is possibly due to cross connection between combined and storm system at manhole CA-784 located at junction of Glenwood Road and Vernon Street. The model also predicts a good calibration at Marshall Street meter.

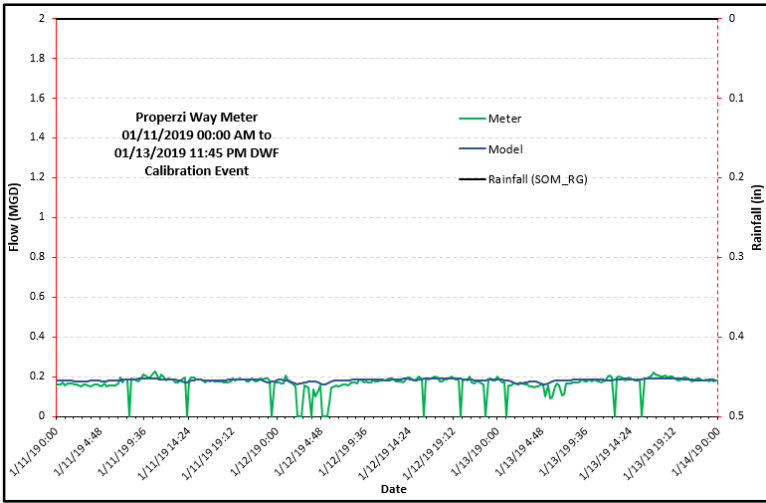
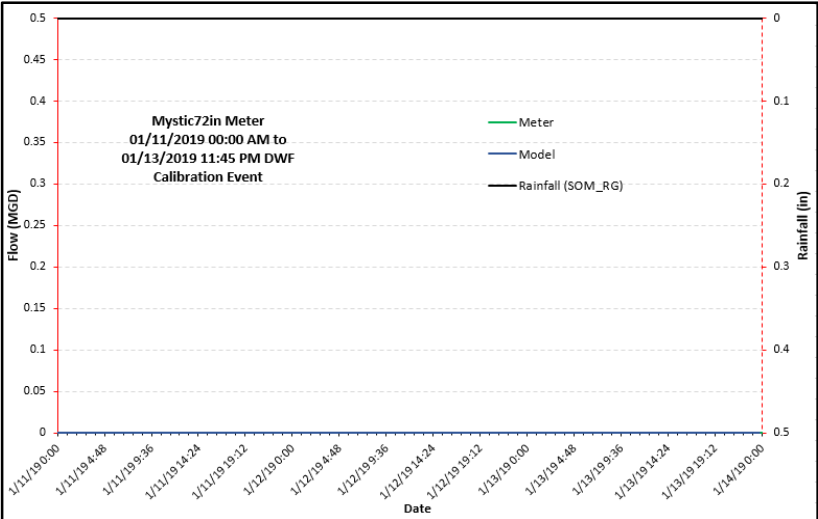
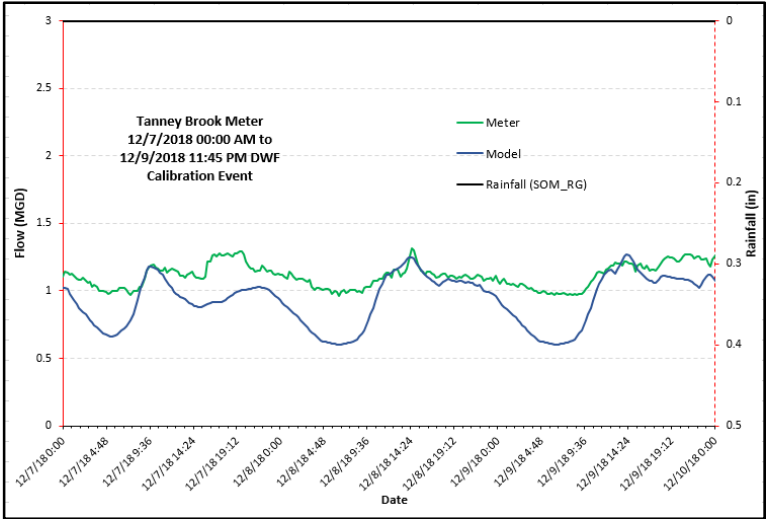


Figure C.1 Metered vs. Modeled Flows During DWF



MODEL REFINEMENT AND CALIBRATION REPORT

Appendix C



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix C

**Table C.3: Comparison Between Metered and Modeled DWF Peak Water Depth**

Flow Meter Name	System Type	Water Depth (ft)		
		Meter	Model	Difference
Tannery Br North (2)	Combined	0.11	0.13	0.02
School St	Storm	0.26	0.08	-0.18
Marshall St**	Storm	0.35	0.41	0.06
North St	Storm	0	0	0
Pearl St	Combined	1.38	1.17	-0.21
Newton St	Combined	0.96	0.83	-0.13
Murdock Street	Combined	0.88	0.72	-0.16
Mystic Ave	Combined	1.6	0.2	-1.4
Grove St	Combined	0.8	0.96	0.16
Palmer Avenue*	Combined	0.5	0.27	-0.23
Tannery Br	Combined	0.28	0.47	0.19
Mystic 72in	Storm	2	1.49	-0.51
Properzi Way	Combined	0.63	0.69	0.06

\*\* Marshall Street meter is installed in storm drain. This meter records diurnal flow during DWF condition. This is possibly due to cross connection between combined and storm system at manhole CA-784 located at junction of Glenwood Road and Vernon Street. The model also predicts a good calibration at Marshall Street meter.



# **APPENDIX D**

## **Comparison Between Metered and Modeled WWFs**





## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix D

**Table D.1: Comparison Between Metered and Modeled Peak WWF During Calibration Storms**

Flow Meter Name	Storm for which the model is calibrated	Peak Wet Weather Flow (MGD)		
		Meter	Model	% Difference
Tannery Br North (2)	November 2, 2018	2.41	2.703	12%
School St	November 2, 2018	0.554	0.8	44%
Marshall St	December 21,2018	27.6	28.9	5%
North St	November 2, 2018	1.31	1.18	-10%
Pearl St	November 2, 2018	4.52	4.56	1%
Newton St	November 2, 2018	7.7	7.71	0%
Murdock Street	December 21,2018	0.4	0.53	33%
Mystic Ave	December 21,2018	3.5	4.42	26%
Grove St	November 2, 2018	6.1	7.3	20%
Palmer Avenue	December 21,2018	0.309	0.288	-7%
Tannery Br	November 2, 2018	33	26	-21%
Mystic 72in	December 21,2018	4.8	2.54	-47%
Properzi Way	December 21,2018	1.28	1.12	-13%



## MODEL REFINEMENT AND CALIBRATION REPORT

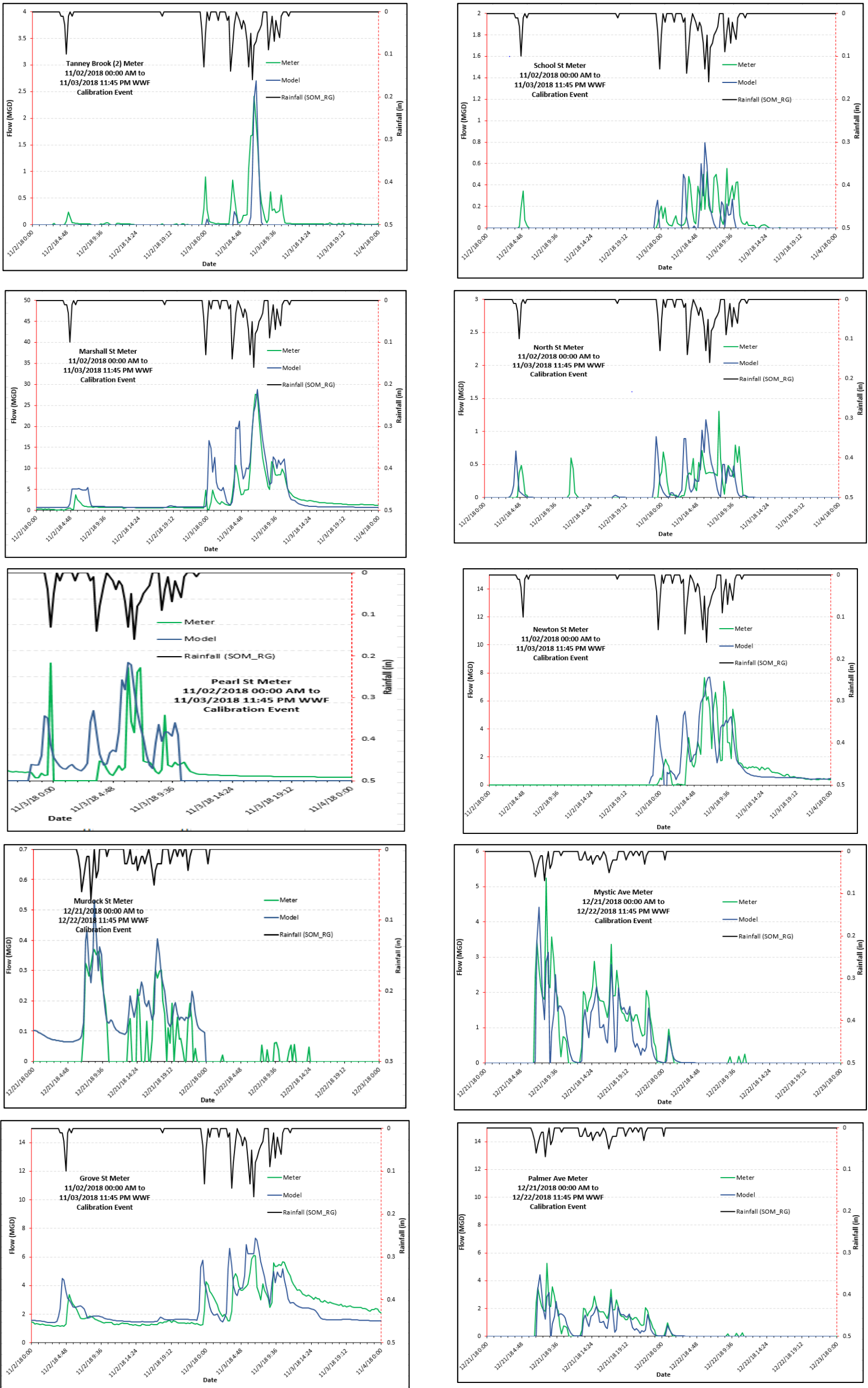
### Appendix D

**Table D.2: Comparison Between Metered and Modeled Cumulative WWF Volume During Calibration Storms**

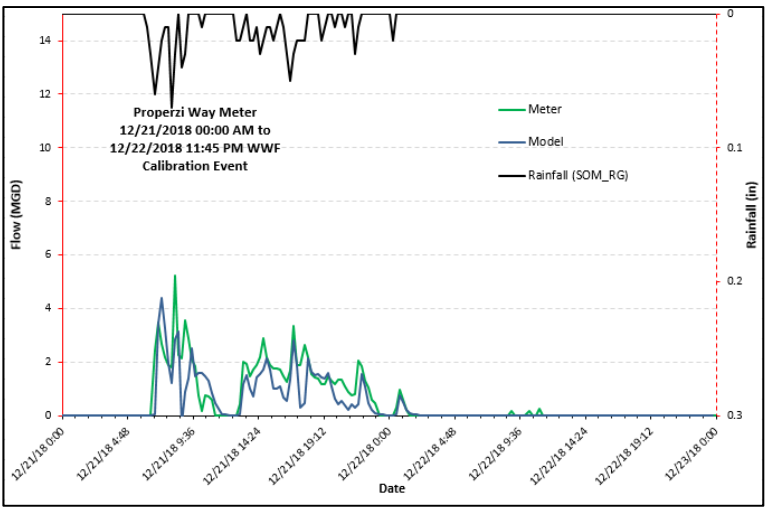
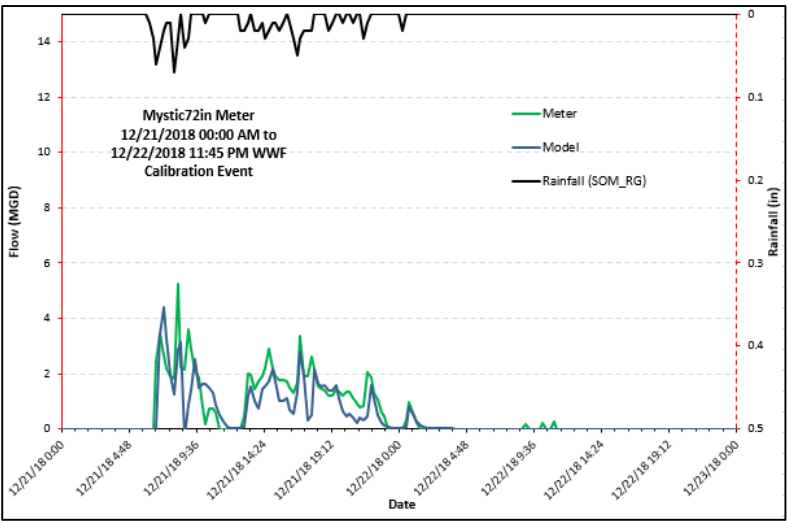
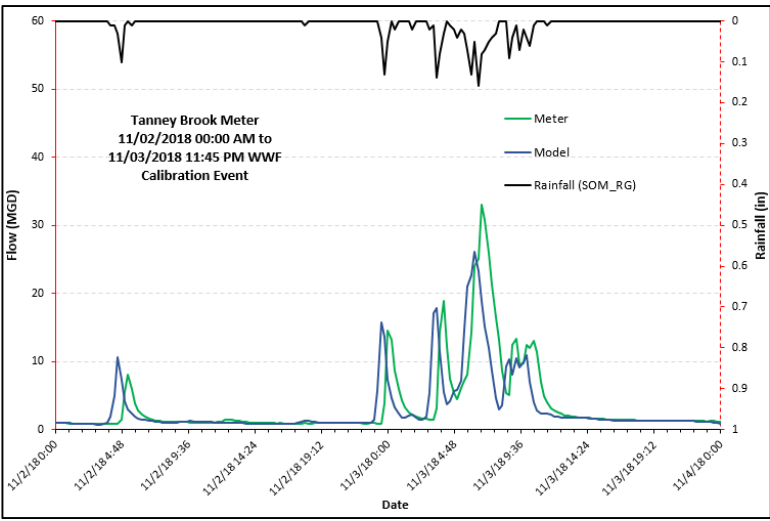
Flow Meter Name	Storm for which the model is calibrated	Cumulative Volume (MG)		
		Meter	Model	% Difference
Tannery Br North (2)	November 2, 2018	0.121	0.088	-27%
School St	November 2, 2018	0.09	0.06	-33%
Marshall St	December 21,2018	5.44	7.27	-34%
North St	November 2, 2018	0.19	0.18	-5%
Pearl St	November 2, 2018	0.65	0.76	17.7%
Newton St	November 2, 2018	1.7	1.94	14%
Murdock Street	December 21,2018	0.081	0.12	48%
Mystic Ave	December 21,2018	1.063	0.81	-24%
Grove St	November 2, 2018	4.85	4.9	1%
Palmer Avenue	December 21,2018	0.019	0.027	42%
Tannery Br	November 2, 2018	7.16	6.35	-11%
Mystic 72in	December 21,2018	0.88	0.87	-1%
Properzi Way	December 21,2018	0.54	0.55	2%



Figure D.1 Metered vs. Modeled Flows during Calibration Storms



Appendix D



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix D

**Table D.3: Comparison between metered and modeled peak WWFs during validation storms**

Flow Meter Name	Storm for which the model is calibrated	Peak Wet Weather Flow (MGD)		
		Meter	Model	% Difference
Tannery Br North (2)	November 09, 2018	2.28	2.57	13%
School St	November 09, 2018	0.533	0.74	39%
Marshall St	November 09, 2018	24.5	26.4	8%
North St	November 09, 2018	0.872	1.02	17%
Pearl St	November 09, 2018	6.2	4.42	-29%
Newton St	November 09, 2018	8.9	8	-10%
Murdock Street	December 31, 2018	0.345	0.47	36%
Mystic Ave	January 24, 2019	13	9.2	-29%
Grove St	November 09, 2018	7.2	7.1	-1%
Palmer Avenue	January 24, 2019	0.864	0.822	-5%
Tannery Br	November 09, 2018	32	24.41	-24%
Mystic 72in	January 24, 2019	6.5	5.63	-13%
Properzi Way	December 31, 2018	0.967	1.035	7%



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix D

**Table D.4: Comparison Between Metered and Modeled Cumulative WWF Volume During Validation Storms**

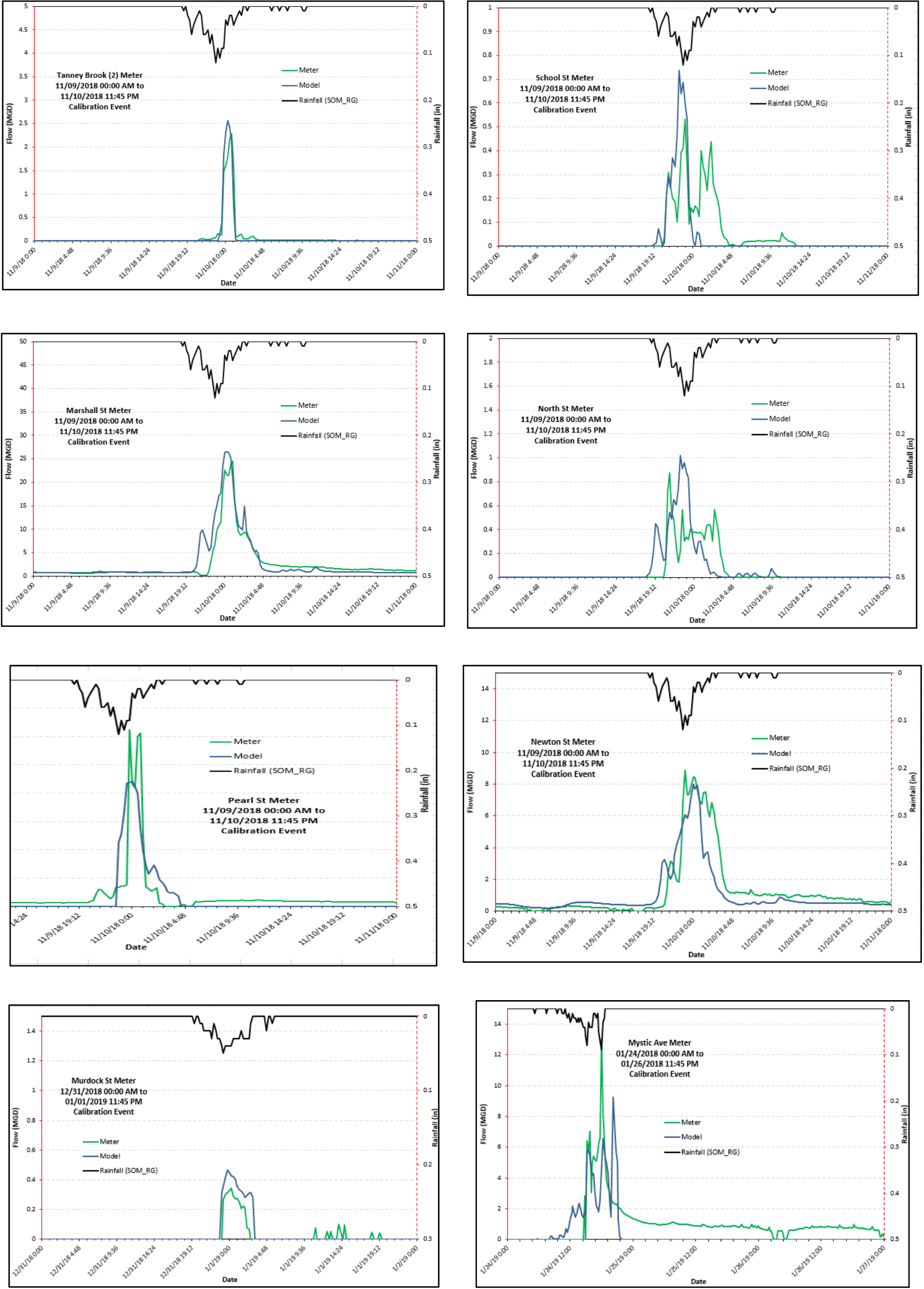
Flow Meter Name	Storm for which the model is calibrated	Cumulative Volume (MG)		
		Meter	Model	% Difference
Tannery Br North (2)	November 09, 2018	0.14	0.13	-7%
School St	November 09, 2018	0.08	0.06	-25%
Marshall St	November 09, 2018	5.13	5.57	9%
North St	November 09, 2018	0.12	0.14	17%
Pearl St	November 09, 2018	0.39	0.47	21%
Newton St	November 09, 2018	2.53	2.1	-17%
Murdock Street	December 31, 2018	0.036	0.061	69%
Mystic Ave	January 24, 2019	1.085	0.8	-26%
Grove St	November 09, 2018	5.27	4.25	-19%
Palmer Avenue	January 24, 2019	0.043	0.109	0.066*
Tannery Br	November 09, 2018	6.04	5.4	-11%
Mystic 72in	January 24, 2019	0.86	1.08	26%
Properzi Way	December 31, 2018	0.824	0.902	9%

\*Actual flow difference is more appropriate as the % error is misleading due to the small values

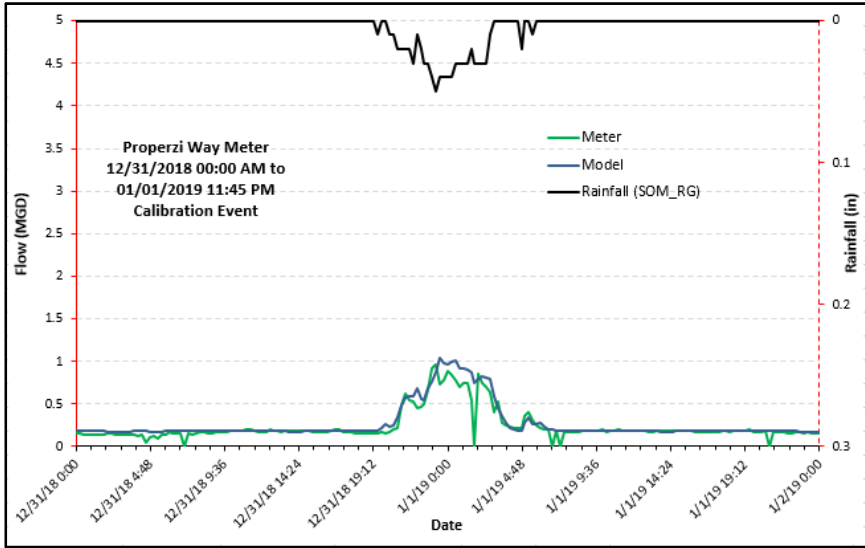
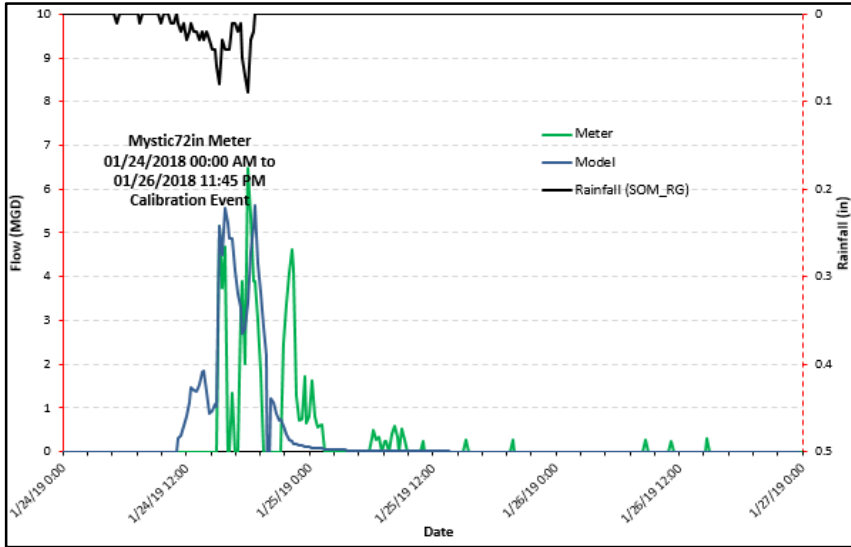
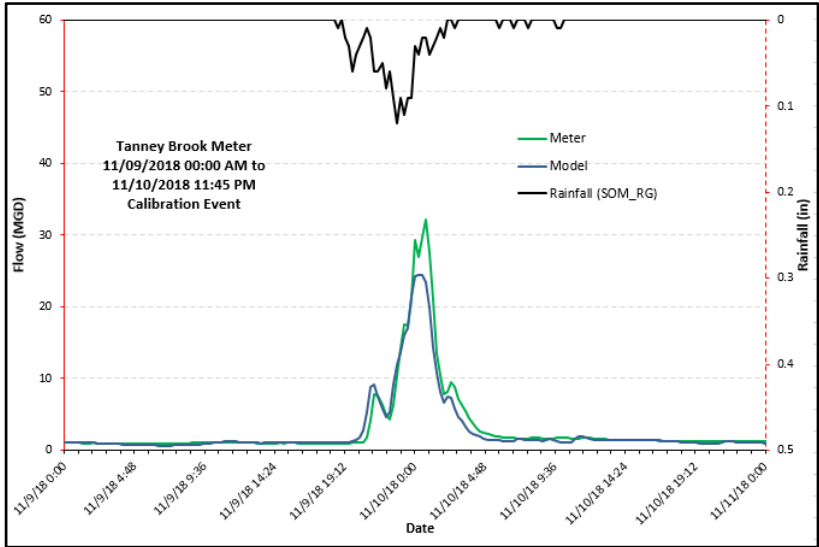
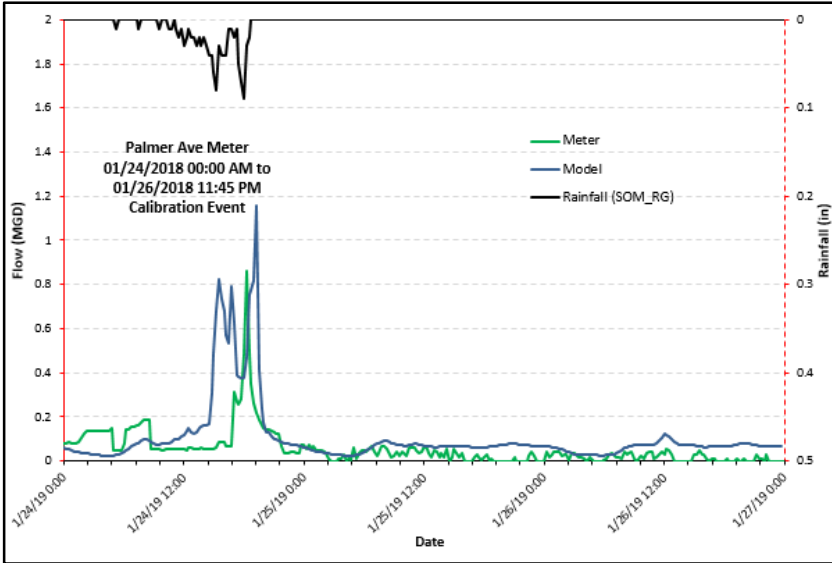
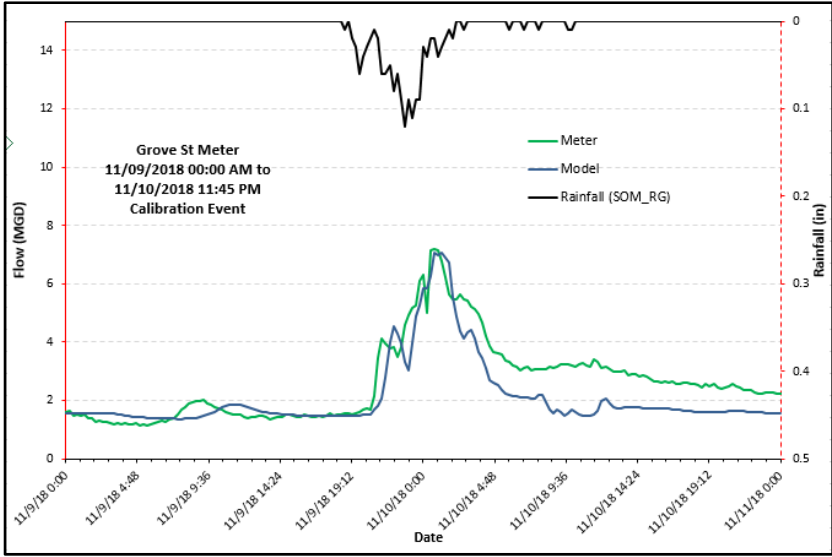




Figure D.2 Metered vs. Modeled Flows during the November 09, 2018 Validation Storm



Appendix D



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix D

**Table D.5: Comparison Between Metered and Modeled Peak Water Depth During Calibration Storms**

Flow Meter Name	Storm for which the model is calibrated	Water Depth (ft)		
		Meter	Model	Difference
Tannery Br North (2)	November 2, 2018	0.55	0.68	0.13
School St	November 2, 2018	0.63	0.43	-0.2
Marshall St	December 21,2018	1.95	1.89	-0.06
North St	November 2, 2018	0.33	0.43	0.1
Pearl St	November 2, 2018	2.12	1.83	-0.29
Newton St	November 2, 2018	4	3.91	-0.09
Murdock Street	December 21,2018	1.02	0.87	-0.15
Mystic Ave	December 21,2018	3.4	3.77	0.37
Grove St	November 2, 2018	1.49	2.68	1.19
Palmer Avenue	December 21,2018	0.984	0.708	-0.276
Tannery Br	November 2, 2018	1.83	1.41	-0.42
Mystic 72in	December 21,2018	4.07	4.06	-0.01
Properzi Way	December 21,2018	1.63	1.53	-0.1



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix D

**Table D.6: Comparison Between Metered and Modeled Peak Water Depth During Validation Storms**

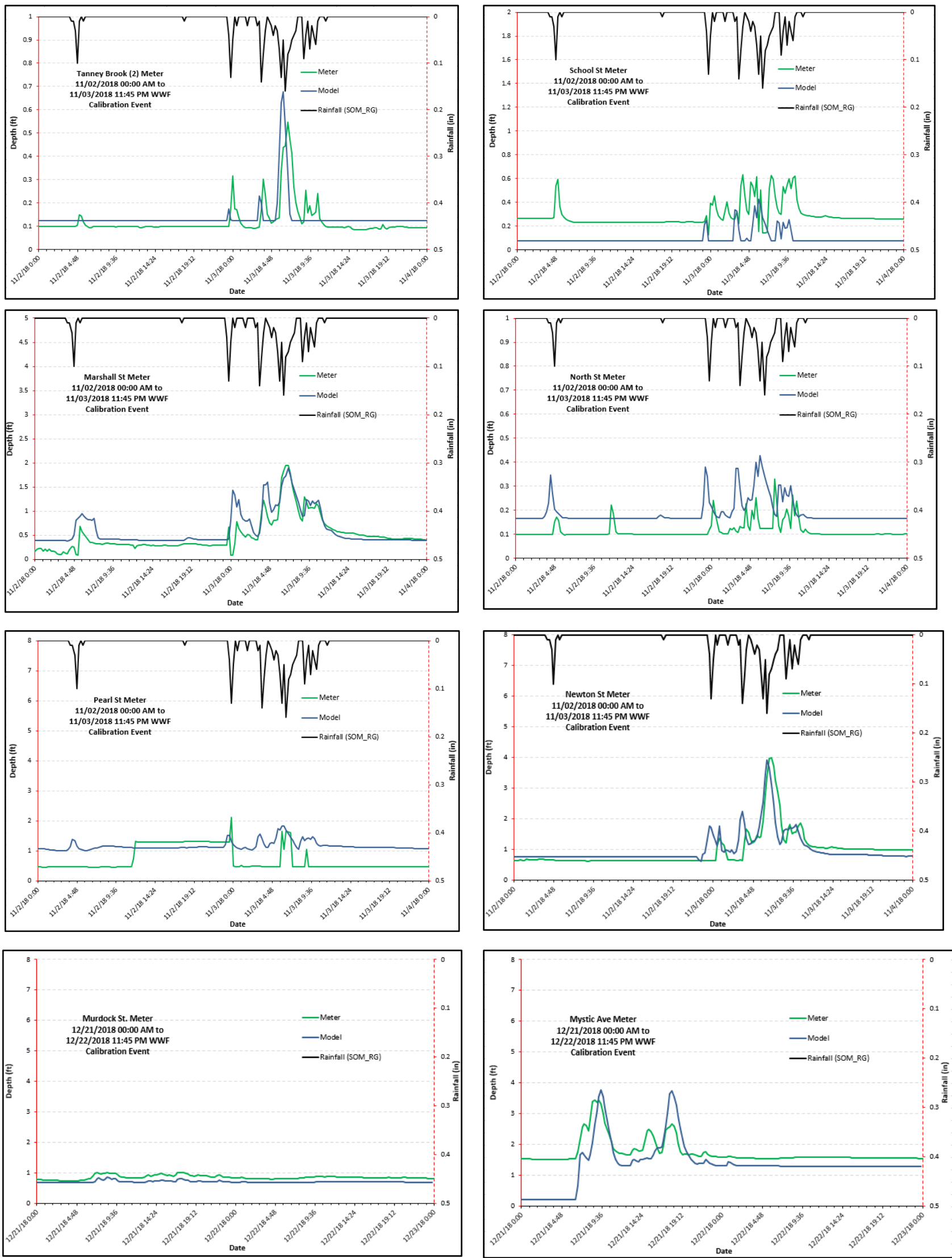
Flow Meter Name	Storm for which the model is calibrated	Water Depth (ft)		
		Meter	Model	Difference
Tannery Br North (2)	November 09, 2018	0.55	0.66	0.11
School St	November 09, 2018	0.71	0.41	-0.3
Marshall St	November 09, 2018	1.94	1.8	-0.14
North St	November 09, 2018	0.26	0.4	0.14.
Pearl St	November 09, 2018	2.22	1.81	-0.41
Newton St	November 09, 2018	4.52	4.29	-0.23
Murdock Street	December 31, 2018	1	0.85	-0.15
Mystic Ave	January 24, 2019	6.7	4	-2.7
Grove St	November 09, 2018	1.51	2.57	1.06
Palmer Avenue	January 24, 2019	1.5	4.2	2.7
Tannery Br	November 09, 2018	1.82	0.5	-1.32*
Mystic 72in	January 24, 2019	7.3	4.24	-3.06*
Properzi Way	December 31, 2018	1.852	1.809	0.043

\* The reason for such large difference during this storm is unknown; future calibration efforts shall include further investigation.



Appendix D

Figure D.5 Metered vs. Modeled peak depth during November 02, 2018 storm and December 21, 2018 calibration storms



MODEL REFINEMENT AND CALIBRATION REPORT

Appendix D

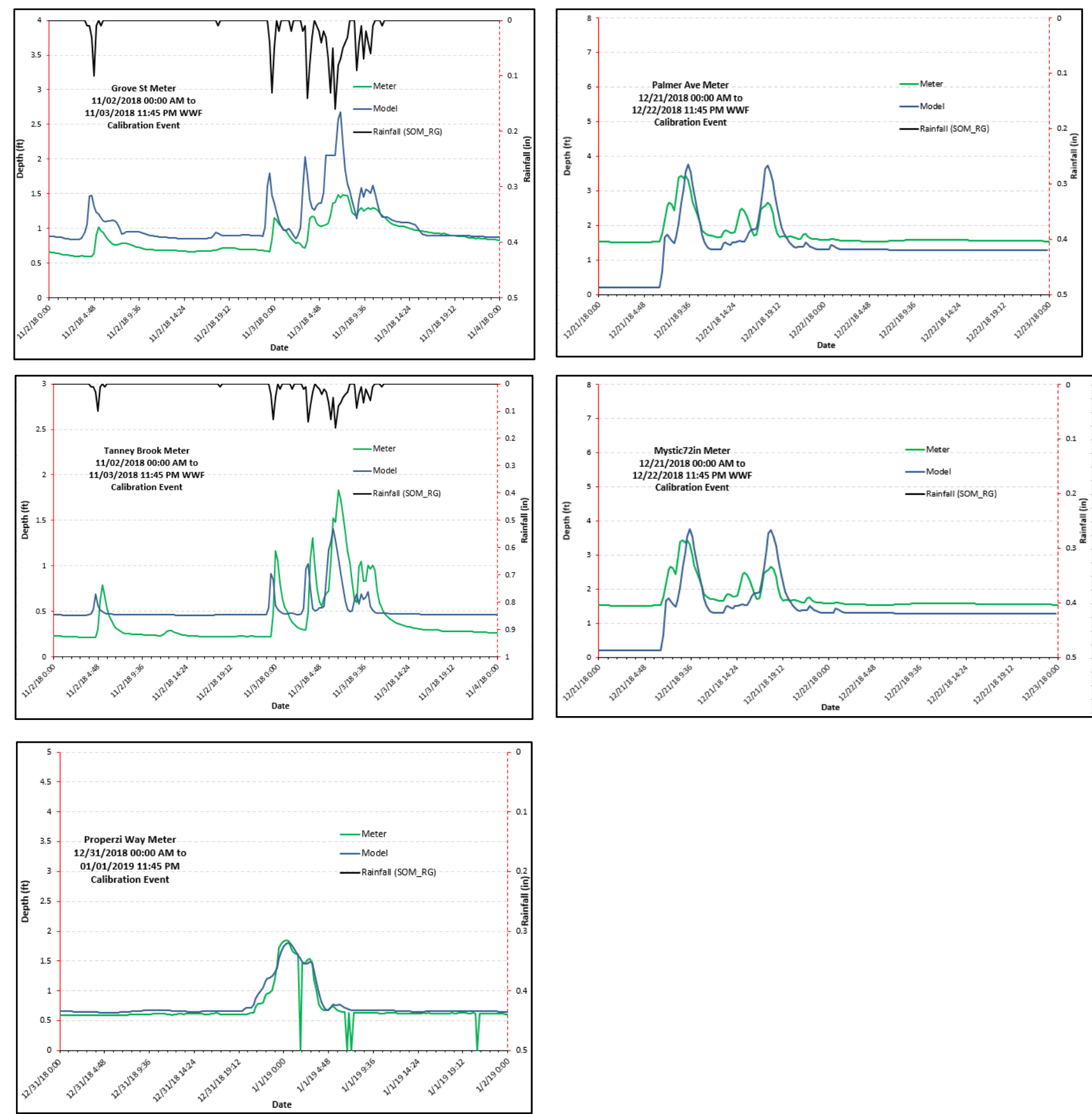
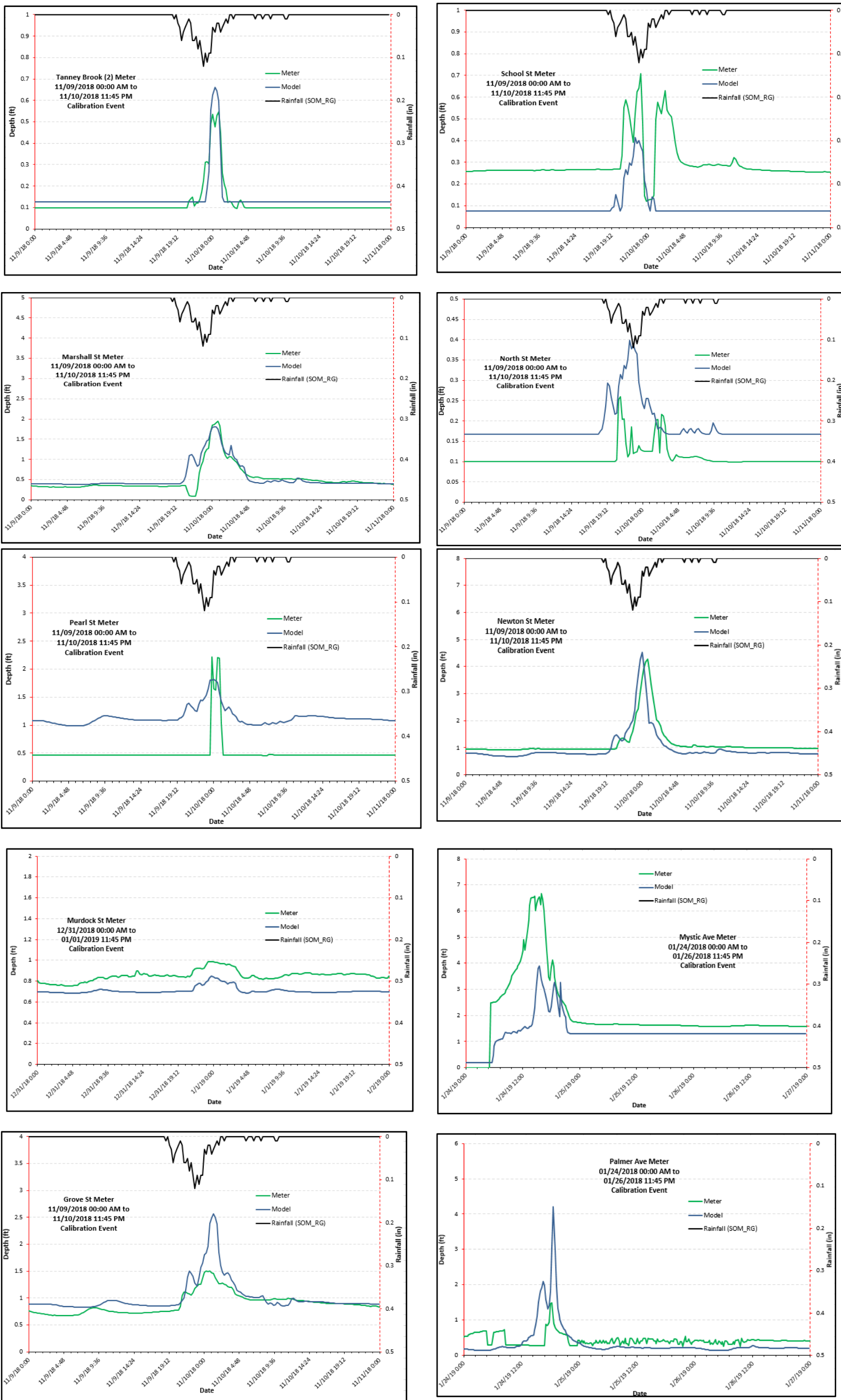


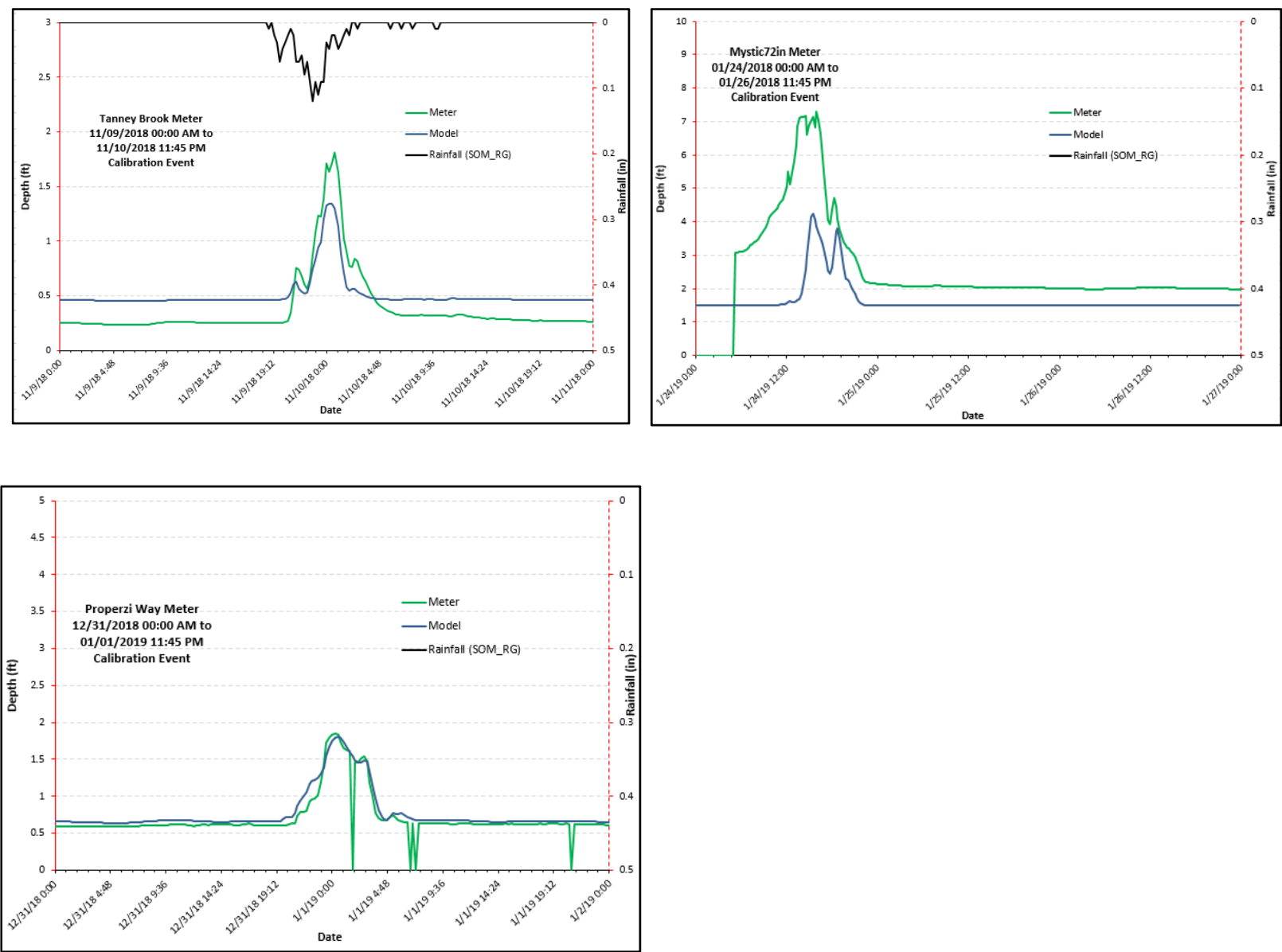


Figure D.6 Metered vs. Modeled peak depth during validation storm on November 09, 2018



MODEL REFINEMENT AND CALIBRATION REPORT

Appendix D



# **APPENDIX E**

## **ADS Meter Installation Sheets**





Figure E.1 Properzi Way Meter Install Report


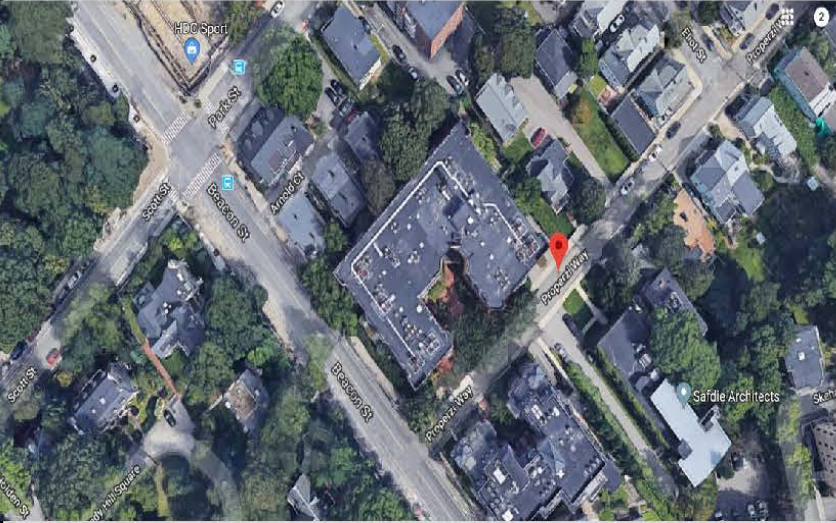



Somerville, MA			Site I.D.		
Flow Monitoring Site Installation Report			C2-1334		
Site Address / Location: Properzi Way		Monitor Series TRITON+		Location Type Temporary	
Site Access: Drive		Pipe Size (H x W) 28.00" X 25"		Pipe Shape Elliptical	
		Manhole # N/A		System Characteristics Commercial	
		Access Drive		Traffic Medium	
					
		Installation Information			
		Installation Date: Thursday, December 13, 2018		Installation Type: Doppler Standard Ring and Crank	
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole	
		Sensors / Devices: Peak Combo (CS4), Smart Depth (CS5)		Pressure Sensor Range (psi) 0 -5 psi	
		Installation Confirmation:			
		Confirmation Time: 11:30:00 AM		Pipe Size (HxW) 28.00" X 25.00"	
		Depth of Flow (Wet DOF) (in) 6"		Range (Air DOF) (in) 22.00"	
		Downlooker Physical Offset (in) 1.50"		Measurement Confidence (in) 0.25"	
		Peak Velocity (fps) 0.25		Velocity Sensor Offset (in) 5.00"	
		Silt (in) 4"		Silt Type Loss	
		Hydraulic Comments: Slow			
		Manhole / Pipe Information:			
		Manhole Depth (Approx. FT): N/A		Manhole Configuration Separate Trench	
		Manhole Material: Brick		Manhole Condition: Good	
		Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A	
		Manhole Cover Vented		Manhole Frame Normal	
		Active Drop Connections No		Air Quality: Safe To Enter	
		Pipe Material Brick		Pipe Condition: Good	
		Communication Information:			
		Communication Type Wireless		Antenna Location Drilled Pavement / Concrete	
		Additional Site Info. / Comments:			
		Serial Number: 61904 I.P. 107.80.17.206 Coordinates: N 42.37994300 W -71.10740600			
ADS Project Name:		Somerville TFM 2018			
ADS Project Number:					



Figure E.2 Mystic Avenue Meter Install Report






Somerville, MA			Site I.D.		
Flow Monitoring Site Installation Report			S2-3264		
Site Address / Location: McGrath Highway		Monitor Series TRITON+		Location Type Temporary	
Site Access: Drive		Pipe Size (H x W) 48.00" X 54.00"		Pipe Shape Elliptical	
		Manhole # N/A		System Characteristics Commercial	
		Access Drive		Traffic Heavy	
					
		Installation Information			
		Installation Date: Thursday, December 13, 2018		Installation Type: Doppler Special Installation	
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole	
		Sensors / Devices: Peak Combo (CS4), Smart Depth (CS5)		Pressure Sensor Range (psi) 0 -5 psi	
		Installation Confirmation:			
		Confirmation Time: 12:00:00 PM		Pipe Size (HxW) 48.00" X 54.00"	
		Depth of Flow (Wet DOF) (in) 23.5"		Range (Air DOF) (in) 24.50"	
		Downlooker Physical Offset (in) 1.38"		Measurement Confidence (in) 0.25"	
		Peak Velocity (fps) 0.35		Velocity Sensor Offset (in)	
		Silt (in) 7"		Silt Type Dirt	
		Hydraulic Comments: Slow			
		Manhole / Pipe Information:			
		Manhole Depth (Approx. FT): N/A		Manhole Configuration Separate Trench	
		Manhole Material: Brick		Manhole Condition: Good	
		Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A	
		Manhole Cover Vented		Manhole Frame Normal	
		Active Drop Connections No		Air Quality: Safe To Enter	
		Pipe Material Brick		Pipe Condition: Good	
		Communication Information:			
		Communication Type Wireless		Antenna Location Drilled Pavement / Concrete	
		Additional Site Info. / Comments:			
		Serial Number: 40606 I.P. 107.80.16.34 Coordinates: N 42.39345700 W -71.08609400			
ADS Project Name:		Somerville TFM 2018			
ADS Project Number:					



Figure E.3 (72in) Mystic Avenue Meter Install Report






Somerville, MA			Site I.D.		
Flow Monitoring Site Installation Report			30-6204		
Site Address / Location: McGrath Highway at Mystic Ave		Monitor Series TRITON+		Location Type Temporary	
Site Access: Drive		Pipe Size (H x W) 72.00" X 72.00"		Pipe Shape Circular	
		Manhole # N/A		System Characteristics Commercial	
		Access Drive		Traffic Heavy	
					
		Installation Information			
		Installation Date: Thursday, December 13, 2018		Installation Type: Doppler Special Installation	
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole	
		Sensors / Devices: Peak Combo (CS-4), CS-6 (LRD)		Pressure Sensor Range (psi) 0 -5 psi	
		Installation Confirmation:			
		Confirmation Time: 1:00:00 PM		Pipe Size (HxW) 72.00" X 72.00"	
		Depth of Flow (Wet DOF) (in) 23"		Range (Air DOF) (in) 49"	
		Downlooker Physical Offset (in) 13.75		Measurement Confidence (in) 0.25"	
		Peak Velocity (fps) 0		Velocity Sensor Offset (in) 20"	
		Silt (in) 14"		Silt Type Dirt	
		Hydraulic Comments: Slow/stagnant			
		Manhole / Pipe Information:			
		Manhole Depth (Approx. FT): 9'55"		Manhole Configuration Separate Trench	
		Manhole Material: Concrete		Manhole Condition: Good	
		Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A	
		Manhole Cover Vented		Manhole Frame Normal	
		Active Drop Connections No		Air Quality: Safe To Enter	
		Pipe Material Brick		Pipe Condition: Good	
		Communication Information:			
		Communication Type Wireless		Antenna Location Drilled Pavement / Concrete	
		Additional Site Info. / Comments:			
		Serial Number: 63969 I.P. 107.80.27.151 Coordinates: N 42.39204500 W -71.08613300			
ADS Project Name:		Somerville TFM 2018			
ADS Project Number:					



Figure E.4 Murdock Street Meter Install Report


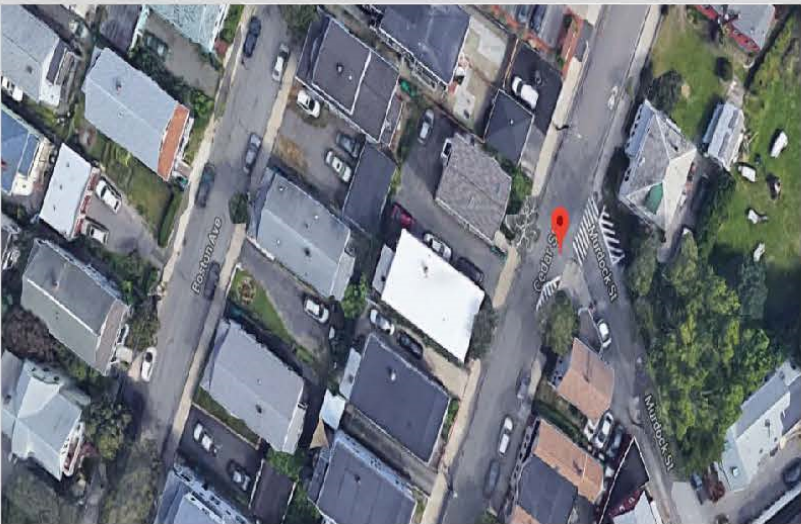


Somerville, MA			Site I.D.	
Flow Monitoring Site Installation Report			CA-453	
Site Address / Location:	Cedar St at Murdock St	Monitor Series	Location Type	
Site Access:	Drive	TRITON+	Temporary	
		Pipe Size (H x W)	Pipe Shape	
		12.00" X 12.00"	Circular	
		Manhole #	System Characteristics	
		N/A	Commercial	
		Access	Traffic	
		Drive	Medium	
				
		Installation Information		
		Installation Date: Thursday, December 13, 2018		
		Installation Type: Doppler Standard Ring and Crank		
		Monitoring Location (Sensors): Upstream 0-5 FT		
		Monitor Location: Manhole		
		Sensors / Devices: Peak Combo (CS4)		
		Pressure Sensor Range (psi) 0 -5 psi		
		Installation Confirmation:		
		Confirmation Time: 2:15:00 PM		
		Pipe Size (HxW) 12.00" X 12.00"		
		Depth of Flow (Wet DOF) (in) 9"		
		Range (Air DOF) (in) 3"		
		Downlooker Physical Offset (in) 0		
		Measurement Confidence (in) 0.25"		
		Peak Velocity (fps) 0.44		
		Velocity Sensor Offset (in) 0"		
		Silt (in) .5"		
		Silt Type Dirt		
		Hydraulic Comments: Slow		
		Manhole / Pipe Information:		
		Manhole Depth (Approx. FT): N/A		
		Manhole Configuration Separate Trench		
		Manhole Material: Brick		
		Manhole Condition: Good		
		Manhole Opening Diameter (in) N/A		
		Manhole Diameter (Approx.): N/A		
		Manhole Cover Vented		
		Manhole Frame Normal		
		Active Drop Connections Yes, Outside		
		Air Quality: Safe To Enter		
		Pipe Material Brick		
		Pipe Condition: Good		
		Communication Information:		
		Communication Type Wireless		
		Antenna Location Drilled Pavement / Concrete		
		Additional Site Info. / Comments:		
		Serial Number: 60809 I.P. 166.219.48.218		
		Coordinates: N 42.3651800 W -71.10930800		
ADS Project Name:	Somerville TFM 2018			
ADS Project Number:				



Figure E.5 Palmer Avenue Meter Install Report






Somerville, MA				Site I.D.	
Flow Monitoring Site Installation Report				C1-1355	
Site Address / Location: Palmer Ave at Franklin St		Monitor Series TRITON+		Location Type Temporary	
Site Access: Drive		Pipe Size (H x W) 24.00" X 24.00"		Pipe Shape Circular	
		Manhole # N/A		System Characteristics Commercial	
		Access Drive		Traffic Light	
					
		Installation Information			
		Installation Date: Thursday, December 13, 2018		Installation Type: Doppler Special Installation	
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole	
		Sensors / Devices: Peak Combo (CS4)		Pressure Sensor Range (psi) 0 -5 psi	
		Installation Confirmation:			
		Confirmation Time: 13:00 PM		Pipe Size (HxW) 24.00" X 24.00"	
		Depth of Flow (Wet DOF) (in) 8"		Range (Air DOF) (in) 16.00"	
		Downlooker Physical Offset (in) N/A		Measurement Confidence (in) 0.25"	
		Peak Velocity (fps) 0		Velocity Sensor Offset (in) N/A	
		Silt (in) 3"		Silt Type N/A	
		Hydraulic Comments: Water Is Usually Stagnant			
		Manhole / Pipe Information:			
		Manhole Depth (Approx. FT): N/A		Manhole Configuration Common Trench	
		Manhole Material: Concrete		Manhole Condition: Good	
		Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A	
		Manhole Cover Vented		Manhole Frame Normal	
		Active Drop Connections No		Air Quality: Safe To Enter	
		Pipe Material PVC		Pipe Condition: Good	
		Communication Information:			
		Communication Type Wireless		Antenna Location Drilled Pavement / Concrete	
		Additional Site Info. / Comments:			
		Serial Number: 52539    I.P. 166.219.172.130 Coordinates: N 42.38258900 W -71.08566400			
ADS Project Name:		Somerville TFM 2018			
ADS Project Number:					



Figure E.6 North Street Meter Install Report

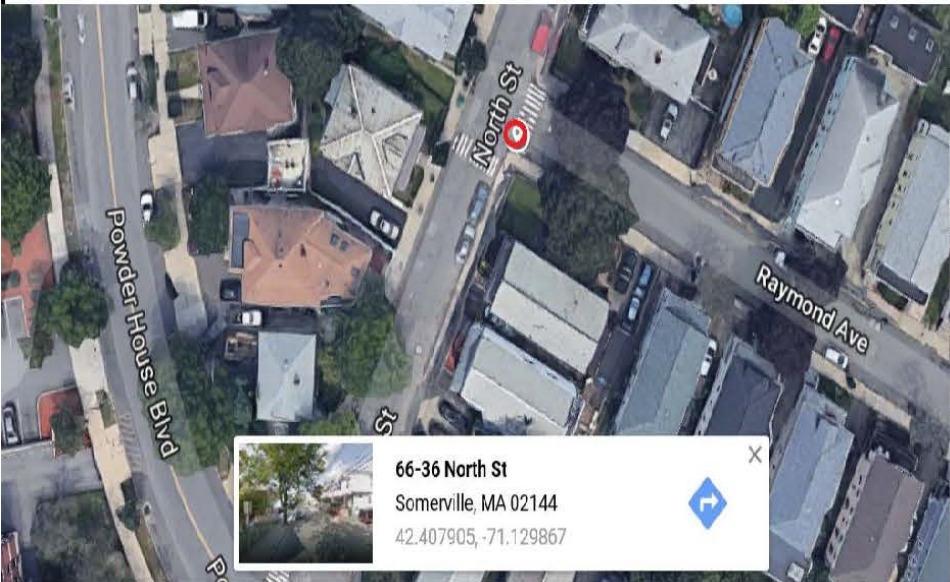


Somerville, MA Stantec 18			Site I.D.																																											
Flow Monitoring Site Installation Report			9-5186 MP1																																											
Site Address / Location: Raymond Ave at North St		Monitor Series TRITON+	Location Type Temporary																																											
Site Access: Drive		Pipe Size (H x W) 20H x 20W	Pipe Shape Circular																																											
		Manhole # N/A	System Characteristics Residential																																											
		Access Drive	Traffic Light																																											
																																														
		<table><tr><th colspan="2">Installation Information</th></tr><tr><td>Installation Date: Wednesday, October 24, 2018</td><td>Installation Type: Doppler Standard Ring and Crank</td></tr><tr><td>Monitoring Location (Sensors): Upstream 0-5 FT</td><td>Monitor Location: Manhole</td></tr><tr><td>Sensors / Devices: Peak Combo (CS4)</td><td>Pressure Sensor Range (psi) 0 -5 psi</td></tr><tr><th colspan="2">Installation Confirmation:</th></tr><tr><td>Confirmation Time: 11:30:00 AM</td><td>Pipe Size (HxW) 20H x 20W</td></tr><tr><td>Depth of Flow (Wet DOF) (in) 1</td><td>Range (Air DOF) (in) 19</td></tr><tr><td>Downlooker Physical Offset (in) N/A</td><td>Measurement Confidence (in) 0.38"</td></tr><tr><td>Peak Velocity (fps) 1</td><td>Velocity Sensor Offset (in) N/A</td></tr><tr><td>Silt (in) 0</td><td>Silt Type N/A</td></tr><tr><td colspan="2">Hydraulic Comments: Dry Pipe</td></tr><tr><th colspan="2">Manhole / Pipe Information:</th></tr><tr><td>Manhole Depth (Approx. FT): 8</td><td>Manhole Configuration Common Trench</td></tr><tr><td>Manhole Material: Brick</td><td>Manhole Condition: Fair</td></tr><tr><td>Manhole Opening Diameter (in) N/A</td><td>Manhole Diameter (Approx.): N/A</td></tr><tr><td>Manhole Cover Vented</td><td>Manhole Frame Normal</td></tr><tr><td>Active Drop Connections No</td><td>Air Quality: Good</td></tr><tr><td>Pipe Material Vitrified Clay Pipe</td><td>Pipe Condition: Good</td></tr><tr><th colspan="2">Communication Information:</th></tr><tr><td>Communication Type Serial</td><td>Antenna Location Drilled Pavement / Concrete</td></tr><tr><td colspan="2">Additional Site Info. / Comments: S/N: 64724 I/P: 107.80.24.39</td></tr></table>			Installation Information		Installation Date: Wednesday, October 24, 2018	Installation Type: Doppler Standard Ring and Crank	Monitoring Location (Sensors): Upstream 0-5 FT	Monitor Location: Manhole	Sensors / Devices: Peak Combo (CS4)	Pressure Sensor Range (psi) 0 -5 psi	Installation Confirmation:		Confirmation Time: 11:30:00 AM	Pipe Size (HxW) 20H x 20W	Depth of Flow (Wet DOF) (in) 1	Range (Air DOF) (in) 19	Downlooker Physical Offset (in) N/A	Measurement Confidence (in) 0.38"	Peak Velocity (fps) 1	Velocity Sensor Offset (in) N/A	Silt (in) 0	Silt Type N/A	Hydraulic Comments: Dry Pipe		Manhole / Pipe Information:		Manhole Depth (Approx. FT): 8	Manhole Configuration Common Trench	Manhole Material: Brick	Manhole Condition: Fair	Manhole Opening Diameter (in) N/A	Manhole Diameter (Approx.): N/A	Manhole Cover Vented	Manhole Frame Normal	Active Drop Connections No	Air Quality: Good	Pipe Material Vitrified Clay Pipe	Pipe Condition: Good	Communication Information:		Communication Type Serial	Antenna Location Drilled Pavement / Concrete	Additional Site Info. / Comments: S/N: 64724 I/P: 107.80.24.39	
Installation Information																																														
Installation Date: Wednesday, October 24, 2018	Installation Type: Doppler Standard Ring and Crank																																													
Monitoring Location (Sensors): Upstream 0-5 FT	Monitor Location: Manhole																																													
Sensors / Devices: Peak Combo (CS4)	Pressure Sensor Range (psi) 0 -5 psi																																													
Installation Confirmation:																																														
Confirmation Time: 11:30:00 AM	Pipe Size (HxW) 20H x 20W																																													
Depth of Flow (Wet DOF) (in) 1	Range (Air DOF) (in) 19																																													
Downlooker Physical Offset (in) N/A	Measurement Confidence (in) 0.38"																																													
Peak Velocity (fps) 1	Velocity Sensor Offset (in) N/A																																													
Silt (in) 0	Silt Type N/A																																													
Hydraulic Comments: Dry Pipe																																														
Manhole / Pipe Information:																																														
Manhole Depth (Approx. FT): 8	Manhole Configuration Common Trench																																													
Manhole Material: Brick	Manhole Condition: Fair																																													
Manhole Opening Diameter (in) N/A	Manhole Diameter (Approx.): N/A																																													
Manhole Cover Vented	Manhole Frame Normal																																													
Active Drop Connections No	Air Quality: Good																																													
Pipe Material Vitrified Clay Pipe	Pipe Condition: Good																																													
Communication Information:																																														
Communication Type Serial	Antenna Location Drilled Pavement / Concrete																																													
Additional Site Info. / Comments: S/N: 64724 I/P: 107.80.24.39																																														
ADS Project Name: Smerville, MA Stantec 18																																														
ADS Project Number: 32547.11.325																																														



Figure E.7 Tannery Brook Meter Install Report


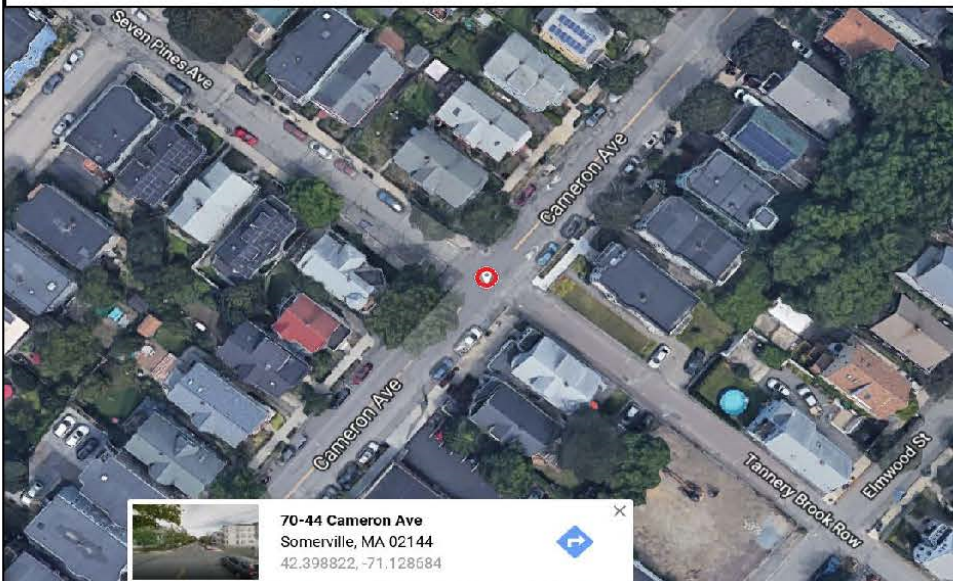



Somerville, MA Stantec 18			Site I.D.		
Flow Monitoring Site Installation Report			1-6432 MP1		
Site Address / Location: Cameron Ave at Seven Pines Ave		Monitor Series TRITON+	Location Type Temporary		
Site Access: Middle of Intersection of Cameron Ave, Seven Pines Ave and Tannery Broo Row		Pipe Size (H x W) 53.25H x 60.5W	Pipe Shape Rectangular		
		Manhole # N/A	System Characteristics Residential		
		Access Drive	Traffic Medium		
					
		Installation Information			
		Installation Date: Wednesday, October 24, 2018		Installation Type: Doppler Special Installation	
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole	
		Sensors / Devices: Peak Combo (CS4)		Pressure Sensor Range (psi) 0 -5 psi	
		Installation Confirmation:			
		Confirmation Time: 1:43:00 PM		Pipe Size (HxW) 53.25H x 60.5W	
		Depth of Flow (Wet DOF) (in) 2.25		Range (Air DOF) (in) 51	
		Downlooker Physical Offset (in) N/A		Measurement Confidence (in) 0.38"	
		Peak Velocity (fps) 1.65		Velocity Sensor Offset (in) N/A	
		Silt (in) 0		Silt Type N/A	
		Hydraulic Comments: Low Flow			
		Manhole / Pipe Information:			
		Manhole Depth (Approx. FT): 10		Manhole Configuration Common Trench	
		Manhole Material: Brick		Manhole Condition: Fair	
		Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A	
		Manhole Cover Vented		Manhole Frame Normal	
		Active Drop Connections No		Air Quality: Good	
		Pipe Material Concrete		Pipe Condition: Fair	
		Communication Information:			
		Communication Type Serial		Antenna Location Drilled Pavement / Concrete	
		Additional Site Info. / Comments: S/N: 52132 I/P: 107.80.16.192			
ADS Project Name:		Smerville, MA Stantec 18			
ADS Project Number:		32547.11.325			



Figure E.8 Tannery Brook (2) Meter Install Report


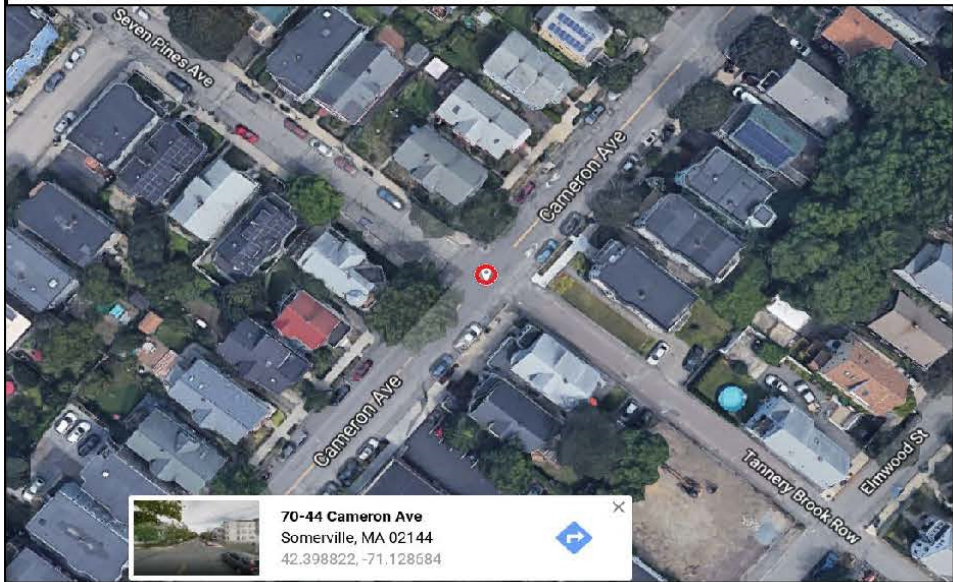


Somerville, MA Stantec 18			Site I.D.	
Flow Monitoring Site Installation Report			1-6432 MP2	
Site Address / Location:	Cameron Ave at Seven Pines Ave	Monitor Series	Location Type	
		TRITON+	Temporary	
Site Access:	Middle of Intersection of Cameron Ave, Seven Pines Ave and Tannery Brook Row	Pipe Size (H x W)	Pipe Shape	
		30.5H x 30.5W	Circular	
		Manhole #	System Characteristics	
		N/A	Residential	
		Access	Traffic	
		Drive	Medium	
				
		Installation Information		
		Installation Date:		Installation Type:
		Wednesday, October 24, 2018		Doppler Special Installation
		Monitoring Location (Sensors):		Monitor Location:
		Upstream 0-5 FT		Manhole
		Sensors / Devices:		Pressure Sensor Range (psi)
		Peak Combo (CS4)		0 -5 psi
		Installation Confirmation:		
		Confirmation Time:		Pipe Size (HxW)
		1:43:00 PM		30.5H x 30.5W
		Depth of Flow (Wet DOF) (in)		Range (Air DOF) (in)
		0		30.5
		Downlooker Physical Offset (in)		Measurement Confidence (in)
		N/A		0.38"
		Peak Velocity (fps)		Velocity Sensor Offset (in)
		0		N/A
		Silt (in)		Silt Type
		0		N/A
		Hydraulic Comments:		
		Dry Pipe		
		Manhole / Pipe Information:		
		Manhole Depth (Approx. FT):		Manhole Configuration
		10		Common Trench
		Manhole Material:		Manhole Condition:
		Brick		Fair
		Manhole Opening Diameter (in)		Manhole Diameter (Approx.):
		N/A		N/A
		Manhole Cover		Manhole Frame
		Vented		Normal
		Active Drop Connections		Air Quality:
		No		Good
		Pipe Material		Pipe Condition:
		Concrete		Fair
		Communication Information:		
		Communication Type		Antenna Location
		Serial		Drilled Pavement / Concrete
		Additional Site Info. / Comments:		
		S/N: 52132 I/P: 107.80.16.192		
ADS Project Name:		Smerville, MA Stantec 18		
ADS Project Number:		32547.11.325		



Figure E.9 School Street Meter Install Report


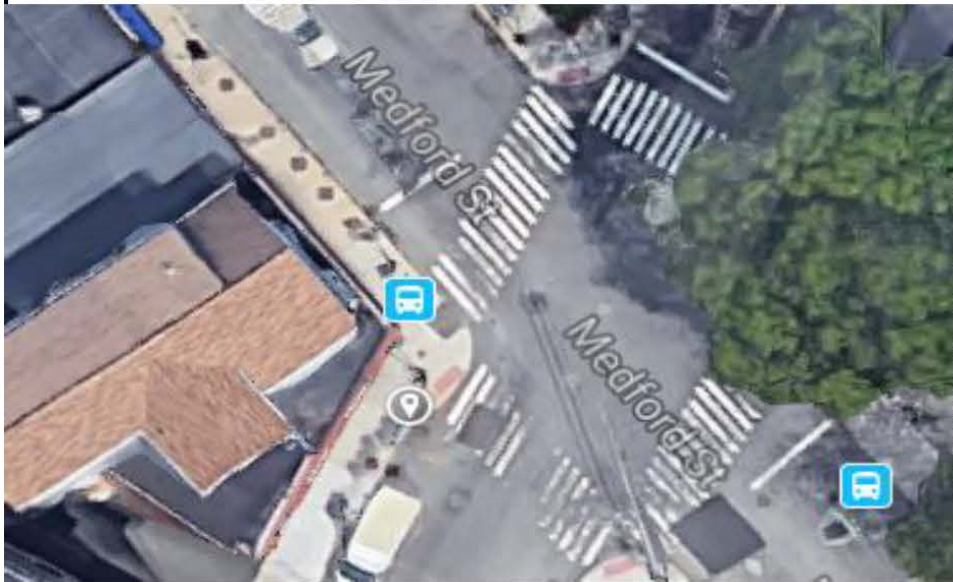


Somerville, MA			Site I.D.	
Flow Monitoring Site Installation Report			30-5112	
Site Address / Location: School Street At Medford Stree, Somerville, MA		Monitor Series TRITON+	Location Type Temporary	
Site Access: Drive		Pipe Size (H x W) 18.00" X 18.50"	Pipe Shape Elliptical	
		Manhole # N/A	System Characteristics Commercial	
		Access Drive	Traffic Medium	
				
		Installation Information		
		Installation Date: Tuesday, October 23, 2018		Installation Type: Doppler Standard Ring and Crank
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole
		Sensors / Devices: Peak Combo (CS4)		Pressure Sensor Range (psi) 0 -5 psi
		Installation Confirmation:		
		Confirmation Time: 11:16:00 AM		Pipe Size (HxW) 18.00" X 18.50"
		Depth of Flow (Wet DOF) (in) 1.5"		Range (Air DOF) (in) 16.00"
		Downlooker Physical Offset (in) N/A		Measurement Confidence (in) 0.38"
		Peak Velocity (fps) 0		Velocity Sensor Offset (in) N/A
		Silt (in) 0		Silt Type N/A
		Hydraulic Comments: Water Is Usually Stagnant		
		Manhole / Pipe Information:		
		Manhole Depth (Approx. FT): N/A		Manhole Configuration CSO Flow Divider
		Manhole Material: Concrete		Manhole Condition: Good
Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A		
Manhole Cover Unbolted		Manhole Frame Normal		
Active Drop Connections No		Air Quality: Safe To Enter		
Pipe Material Concrete		Pipe Condition: Good		
Communication Information:				
Communication Type Wireless		Antenna Location Drilled Pavement / Concrete		
Additional Site Info. / Comments:				
Serial Number: 64702 I.P. 166.219.19.166 Coordinates: N 42.389092 W -71.097266				
ADS Project Name:		Somerville TFM 2018		
ADS Project Number:				



Figure E.10 Marshall Street Meter Install Report

Somerville, MA			Site I.D.		
Flow Monitoring Site Installation Report			30-5116		
Site Address / Location: Stickney Ave at Marshall Street, Somerville, MA		Monitor Series TRITON+	Location Type Temporary		
Site Access: Drive		Pipe Size (H x W) 63.75" X 63.75"	Pipe Shape Circular		
		Manhole # N/A	System Characteristics Commercial		
		Access Drive	Traffic Medium		
					
		Installation Information			
		Installation Date: Tuesday, October 23, 2018		Installation Type: Doppler Standard Ring and Crank	
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole	
		Sensors / Devices: Peak Combo (CS4)		Pressure Sensor Range (psi) 0 -5 psi	
		Installation Confirmation:			
		Confirmation Time: 2:43:00 PM		Pipe Size (HxW) 63.75" X 63.75"	
		Depth of Flow (Wet DOF) (in) 3.75		Range (Air DOF) (in) 60.00"	
		Downlooker Physical Offset (in) N/A		Measurement Confidence (in) 0.25"	
		Peak Velocity (fps) 1.3		Velocity Sensor Offset (in) N/A	
		Silt (in) 0		Silt Type N/A	
		Hydraulic Comments: Slow & Smooth Flow			
		Manhole / Pipe Information:			
		Manhole Depth (Approx. FT): 10'		Manhole Configuration CSO Flow Divider	
		Manhole Material: Brick		Manhole Condition: Good	
		Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A	
		Manhole Cover Unbolted		Manhole Frame Normal	
		Active Drop Connections No		Air Quality: Safe To Enter	
		Pipe Material Brick		Pipe Condition: Good	
		Communication Information:			
		Communication Type Wireless		Antenna Location Manhole Pick / Vent Hole	
		Additional Site Info. / Comments:			
		Serial Number: 61821 I.P.: 107.80.16.145			
		Coordinates: N 42.388761 W -71.095405			
		ADS Project Name:		Somerville, MA	
ADS Project Number:					



Figure E.11 Pearl Street Meter Install Report


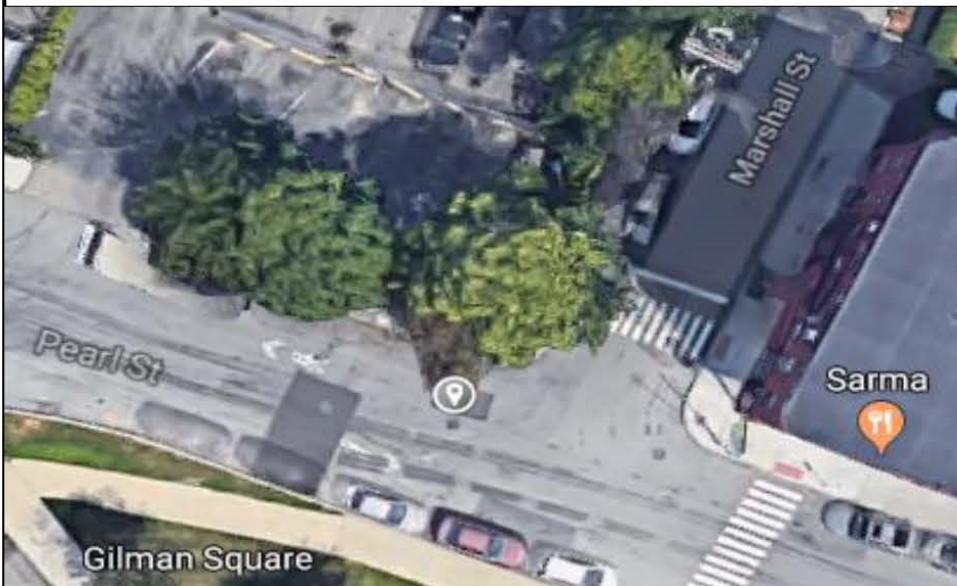



Somerville, MA			Site I.D.																									
Flow Monitoring Site Installation Report			30-5600																									
Site Address / Location: Pearl Street AT Marshall Street, Somerville, MA		Monitor Series	Location Type																									
		TRITON+	Temporary																									
Site Access: Drive		Pipe Size (H x W)	Pipe Shape																									
		28.00" X 28.00"	Circular																									
		Manhole #	System Characteristics																									
		N/A	Commercial																									
		Access	Traffic																									
		Drive	Medium																									
																												
		Installation Information																										
		<table><tr><td>Installation Date:</td><td>Installation Type:</td></tr><tr><td>Tuesday, October 23, 2018</td><td>Doppler Standard Ring and Crank</td></tr><tr><td>Monitoring Location (Sensors):</td><td>Monitor Location:</td></tr><tr><td>Upstream 0-5 FT</td><td>Manhole</td></tr><tr><td>Sensors / Devices:</td><td>Pressure Sensor Range (psi)</td></tr><tr><td>Peak Combo (CS4)</td><td>0 -5 psi</td></tr></table>			Installation Date:	Installation Type:	Tuesday, October 23, 2018	Doppler Standard Ring and Crank	Monitoring Location (Sensors):	Monitor Location:	Upstream 0-5 FT	Manhole	Sensors / Devices:	Pressure Sensor Range (psi)	Peak Combo (CS4)	0 -5 psi												
Installation Date:	Installation Type:																											
Tuesday, October 23, 2018	Doppler Standard Ring and Crank																											
Monitoring Location (Sensors):	Monitor Location:																											
Upstream 0-5 FT	Manhole																											
Sensors / Devices:	Pressure Sensor Range (psi)																											
Peak Combo (CS4)	0 -5 psi																											
		Installation Confirmation:																										
		<table><tr><td>Confirmation Time:</td><td>Pipe Size (HxW)</td></tr><tr><td>1:01:00 PM</td><td>28.00" X 28.00"</td></tr><tr><td>Depth of Flow (Wet DOF) (in)</td><td>Range (Air DOF) (in)</td></tr><tr><td>16.00"</td><td>12.00"</td></tr><tr><td>Downlooker Physical Offset (in)</td><td>Measurement Confidence (in)</td></tr><tr><td>N/A</td><td>0.38"</td></tr><tr><td>Peak Velocity (fps)</td><td>Velocity Sensor Offset (in)</td></tr><tr><td>0.5</td><td>4.50"</td></tr><tr><td>Silt (in)</td><td>Silt Type</td></tr><tr><td>1.0"</td><td>Sandy</td></tr></table>			Confirmation Time:	Pipe Size (HxW)	1:01:00 PM	28.00" X 28.00"	Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)	16.00"	12.00"	Downlooker Physical Offset (in)	Measurement Confidence (in)	N/A	0.38"	Peak Velocity (fps)	Velocity Sensor Offset (in)	0.5	4.50"	Silt (in)	Silt Type	1.0"	Sandy				
Confirmation Time:	Pipe Size (HxW)																											
1:01:00 PM	28.00" X 28.00"																											
Depth of Flow (Wet DOF) (in)	Range (Air DOF) (in)																											
16.00"	12.00"																											
Downlooker Physical Offset (in)	Measurement Confidence (in)																											
N/A	0.38"																											
Peak Velocity (fps)	Velocity Sensor Offset (in)																											
0.5	4.50"																											
Silt (in)	Silt Type																											
1.0"	Sandy																											
		Hydraulic Comments: Very Slow & Smooth Flow																										
		Manhole / Pipe Information:																										
		<table><tr><td>Manhole Depth (Approx. FT):</td><td>Manhole Configuration</td></tr><tr><td>12'</td><td>CSO Flow Divider</td></tr><tr><td>Manhole Material:</td><td>Manhole Condition:</td></tr><tr><td>Brick</td><td>Good</td></tr><tr><td>Manhole Opening Diameter (in)</td><td>Manhole Diameter (Approx.):</td></tr><tr><td>N/A</td><td>N/A</td></tr><tr><td>Manhole Cover</td><td>Manhole Frame</td></tr><tr><td>Unbolted</td><td>Normal</td></tr><tr><td>Active Drop Connections</td><td>Air Quality:</td></tr><tr><td>No</td><td>Safe To Enter</td></tr><tr><td>Pipe Material</td><td>Pipe Condition:</td></tr><tr><td>Concrete</td><td>Good</td></tr></table>			Manhole Depth (Approx. FT):	Manhole Configuration	12'	CSO Flow Divider	Manhole Material:	Manhole Condition:	Brick	Good	Manhole Opening Diameter (in)	Manhole Diameter (Approx.):	N/A	N/A	Manhole Cover	Manhole Frame	Unbolted	Normal	Active Drop Connections	Air Quality:	No	Safe To Enter	Pipe Material	Pipe Condition:	Concrete	Good
Manhole Depth (Approx. FT):	Manhole Configuration																											
12'	CSO Flow Divider																											
Manhole Material:	Manhole Condition:																											
Brick	Good																											
Manhole Opening Diameter (in)	Manhole Diameter (Approx.):																											
N/A	N/A																											
Manhole Cover	Manhole Frame																											
Unbolted	Normal																											
Active Drop Connections	Air Quality:																											
No	Safe To Enter																											
Pipe Material	Pipe Condition:																											
Concrete	Good																											
		Communication Information:																										
		<table><tr><td>Communication Type</td><td>Antenna Location</td></tr><tr><td>Wireless</td><td>Manhole Pick / Vent Hole</td></tr></table>			Communication Type	Antenna Location	Wireless	Manhole Pick / Vent Hole																				
Communication Type	Antenna Location																											
Wireless	Manhole Pick / Vent Hole																											
		Additional Site Info. / Comments:																										
		Serial Number: 52101    I.P: 166.219.9.244    Physical Offset: 4.5"    Coordinates: N 42.388219    W -71.095800																										
ADS Project Name:		Somerville, MA																										
ADS Project Number:																												



Figure E.12 Newton Street Meter Install Report



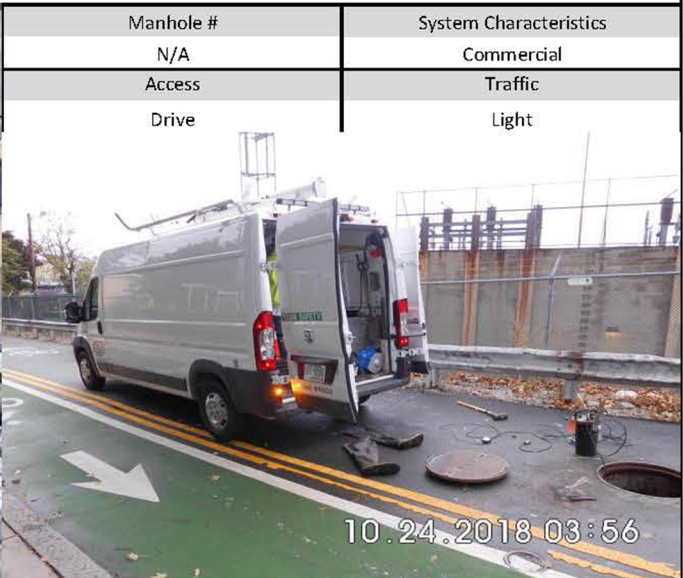


Somerville, MA Stantec 18				Site I.D.	
Flow Monitoring Site Installation Report				C2-1994 MP1	
Site Address / Location: Webster Ave at Newton St.		Monitor Series TRITON+		Location Type Temporary	
Site Access: Drive, Close Off Newton St.		Pipe Size (H x W) 35.75H x 37.5W		Pipe Shape Elliptical	
		Manhole # N/A		System Characteristics Commercial	
		Access Drive		Traffic Light	
					
		Installation Information			
		Installation Date: Wednesday, October 24, 2018		Installation Type: Doppler Standard Ring and Crank	
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole	
		Sensors / Devices: Peak Combo (CS4)		Pressure Sensor Range (psi) 0 -5 psi	
		Installation Confirmation:			
		Confirmation Time: 3:44:00 PM		Pipe Size (HxW) 35.75H x 37.5W	
		Depth of Flow (Wet DOF) (in) 11		Range (Air DOF) (in) 24.75	
		Downlooker Physical Offset (in) N/A		Measurement Confidence (in) 0.38"	
		Peak Velocity (fps) 0.5		Velocity Sensor Offset (in) N/A	
		Silt (in) 2.5		Silt Type N/A	
		Hydraulic Comments: Slow, Smooth Flow, 6.5 P.O.			
		Manhole / Pipe Information:			
		Manhole Depth (Approx. FT): 30		Manhole Configuration Common Trench	
		Manhole Material: Brick		Manhole Condition: Fair	
		Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A	
		Manhole Cover Vented		Manhole Frame Normal	
		Active Drop Connections No		Air Quality: Good	
		Pipe Material Concrete		Pipe Condition: Fair	
		Communication Information:			
		Communication Type Serial		Antenna Location Drilled Pavement / Concrete	
		Additional Site Info. / Comments: S/N: 61873 I/P: 107.80.27.184			
ADS Project Name:		Smerville, MA Stantec 18			
ADS Project Number:		32547.11.325			



Figure E.13 Grove Street Meter Install Report


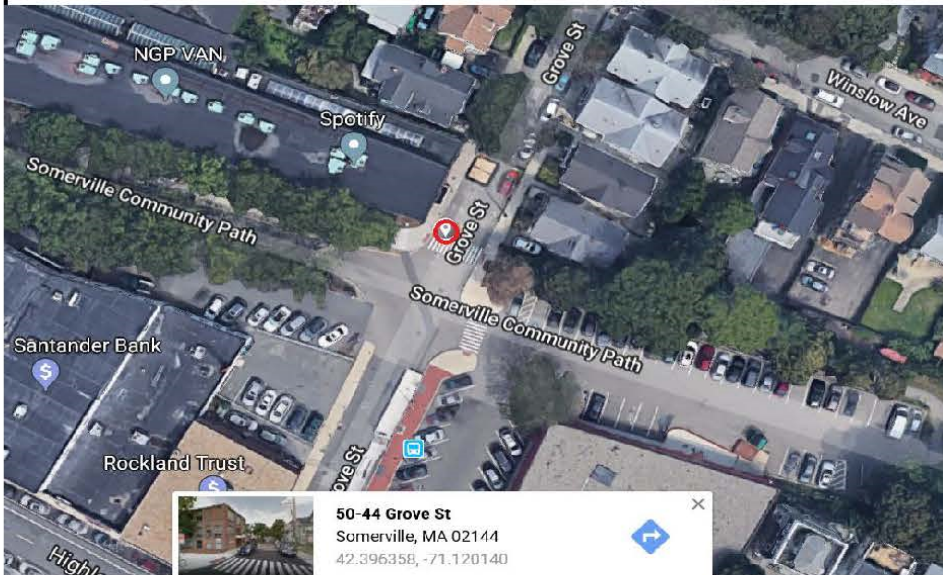









Somerville, MA Stantec 18			Site I.D.		
Flow Monitoring Site Installation Report			CA-2401 MP1		
Site Address / Location: 48 Grove St.		Monitor Series TRITON+		Location Type Temporary	
Site Access: Site Located at Dead End in Cross Wal		Pipe Size (H x W) 24H x 26.25W		Pipe Shape Elliptical	
		Manhole # N/A		System Characteristics Residential	
		Access Drive		Traffic Light	
					
		Installation Information			
		Installation Date: Wednesday, October 24, 2018		Installation Type: Pulse Standard Ring and Crank	
		Monitoring Location (Sensors): Upstream 0-5 FT		Monitor Location: Manhole	
		Sensors / Devices: Peak Combo (CS4)		Pressure Sensor Range (psi) 0 -5 psi	
		Installation Confirmation:			
		Confirmation Time: 10:27AM		Pipe Size (HxW) 24H x 26.25W	
		Depth of Flow (Wet DOF) (in) 8		Range (Air DOF) (in) 51	
		Downlooker Physical Offset (in) N/A		Measurement Confidence (in) 0.38"	
		Peak Velocity (fps) 2.1		Velocity Sensor Offset (in) N/A	
		Silt (in) 0		Silt Type N/A	
		Hydraulic Comments: Smooth Flow			
		Manhole / Pipe Information:			
		Manhole Depth (Approx. FT): 10		Manhole Configuration Common Trench	
		Manhole Material: Brick		Manhole Condition: Fair	
Manhole Opening Diameter (in) N/A		Manhole Diameter (Approx.): N/A			
Manhole Cover Vented		Manhole Frame Normal			
Active Drop Connections No		Air Quality: Good			
Pipe Material Brick		Pipe Condition: Fair			
		Communication Information:			
		Communication Type Serial		Antenna Location Drilled Pavement / Concrete	
		Additional Site Info. / Comments:			
		S/N: 61477 I/P: 107.80.27.185			
ADS Project Name:		Smerville, MA Stantec 18			
ADS Project Number:		32547.11.325			



Figure E.14 Franey Road Meter Install Report

			Site I.D.	
Flow Monitoring Site Installation Report			SOM_RG	
Site Address / Location:	1 Franey Rd. Somerville DPW	Monitor Series	Location Type	
		Rain Alert III	Permanent	
Site Access:	Drive, climb N 42.396913 w -71.107411	Pipe Size (H x W)	Pipe Shape	
		Manhole #	System Characteristics	
			Industrial	
		Access	Traffic	
		Walk (Commercial)	None	
				
		Installation Information		
		Installation Date:		Installation Type:
		Wednesday, October 24, 2018		Rain Gauge
		Monitoring Location (Sensors):		Monitor Location:
		Rooftop		Building
		Sensors / Devices:		Pressure Sensor Range (psi)
		Rain Gauge Tipping Bucket		
		Installation Confirmation:		
		Confirmation Time:		Pipe Size (HxW)
		Depth of Flow (Wet DOF) (in)		Range (Air DOF) (in)
		Downlooker Physical Offset (in)		Measurement Confidence (in)
Peak Velocity (fps)		Velocity Sensor Offset (in)		
Silt (in)		Silt Type		
		Hydraulic Comments:		
		Manhole / Pipe Information:		
		Manhole Depth (Approx. FT):		Manhole Configuration
		Manhole Material:		Manhole Condition:
		Manhole Opening Diameter (in)		Manhole Diameter (Approx.):
		Manhole Cover		Manhole Frame
		Active Drop Connections		Air Quality:
		Pipe Material		Pipe Condition:
				Communication Information:
Communication Type		Antenna Location		
Wireless		Cabinet		
		Additional Site Info. / Comments:		
		S/N:4198 I/P: 107.80.26.24		
ADS Project Name:	Somerville, MA			
ADS Project Number:	32556.11.325			

# **APPENDIX F**

## **Manhole Inspection Table**



# MODEL REFINEMENT AND CALIBRATION REPORT

## Appendix F

Table F.1 Somerville MVP - Manhole Inspections



Street	Address / Intersection	MH ID	MH Type (DMH, SMH, CMH, COM)	Level of Data Collection (MH Inspection, Photos Only, CSE)	Inspection Date	Comments
Broadway St	Broadway / Paulina St	CA-106	CMH	MH Inspection	11/14/2018	Remnants of flap gate observed on drain inlet from CA-5208 and on inlet from CA-5209
		CA-5208	CMH	MH Inspection	11/14/2018	(1) mainline outlet to CA-106; no connection to CA-5209
		CA-5209	DMH	MH Inspection	11/14/2018	Bulkhead observed on connection towards CA-106; No connection observed to CA-5208
	Broadway / Cross St	S2-2767	CMH	CSE	11/20/2018 12/20/2018	Overflow connection to S2-2141
		S2-2141	CMH	CSE	11/20/2018 12/20/2018	Connection from S2-2767; VCP pipe sleeved at invert of mainline inlet/outlet
		S2-2750 / S2-2309	CMH	MH Inspection	11/20/2018	MH recently lined and portion of structure encased; suspect no longer common manhole
Buena Vista Rd	#26 Thorndike St	1-5792	DMH	Popped for Connectivity	11/21/2018	Could not determine connectivity from surface; recommend CCTV if pipe configuration needed
Cameron Ave	Cameron Ave / Mead St	CA-520	CMH	MH Inspection	11/14/2018	Appears to match GIS; weir observed on connection towards A-722
	Cameron Ave / Seven Pines Ave	1-6432	CMH	Photos Only	10/24/2018	Photos taken as part of flow metering
Cedar St	Cedar St / Community Path	CA-2752	CMH	MH Inspection	11/20/2018	SD and SS combine into MH with (1) CS outlet; flap gate observed on SD inlet
	Cedar St / Murdock St	CA-453	CMH	Photos Only	12/13/2018	Photos taken as part of flow metering
Clarendon Ave	#32 Clarendon Ave	D41DMH9965 / A-5438	DMH	MH Inspection	11/21/2018	Connection to S78CMH9500 confirmed with weir; weir directs base flows to SMH A-729
		S78COM0210 / A-729	CMH	MH Inspection	11/21/2018	Underflow from Tannery Brook comes into A-729; SD and SS from Clarendon Ave (North) inlet into structure
		S78CMH9500	CMH	CSE	11/21/2018 12/20/2018	See CSE notes for details
College Ave	College Ave / Holland St	CA-5916	DMH	CSE	11/21/2018 12/20/2018	Riser offset from structure; see confined space entry notes
Cross St	Cross St / Pearl St	S2-1577	CMH	MH Inspection	11/20/2018	Steel plate in intersection makes it difficult to determine all manholes in street; Inspection report may be for S2-1566; difficult to confirm connectivity; recommend CCTV or cse
		S2-2481	CMH	MH Inspection	11/20/2018	Difficult to confirm connectivity; recommend CCTV
		S2-1578	CMH	MH Inspection	11/20/2018	Weir observed in manhole with SS service on one side; suspect SS/CS on both sides of weir
		S2-1442	SMH	MH Inspection	11/20/2018	CB inlet observed, unknown where outlet discharges to
Day St	Day St / Elm St	CA-3075	COM	MH Inspection	11/21/2018	Common manhole; weir and drop observed
Elm St	Elm St / Chester St	1-5026	CMH	MH Inspection	11/21/2018	Findings do not match GIS; connectivity unknown; recommend CCTV
Elmwood St	Elmwood St / Elmwood Ter	A-532	COM	MH Inspection	11/14/2018	Common mh with weir separating SD and SS
	Elmwood St / Harrison Rd	A-533	COM	MH Inspection	11/14/2018	Common MH with SD thru MH; SS service or GW weeping into MH; recommend cleaning
Gold Star Rd	Gold Star Rd / Seven Pines Ave	S78CMH8485/A-732	CMH	MH Inspection	11/21/2018	No cross connect over to Tannery Brook; outlet goes under house of #69 Gold Star Rd
		ACCESS244 / 1-5057	DMH	Popped for Connectivity	11/21/2018	No cross connection observed from CS
Gorham St	Gorham St / Holland St	A-2331	COM	MH Inspection	11/14/2018	Common MH with SD adjacent to SS and weir separating
	Gorham St / Tannery Brook ROW	1-5030	DMH	MH Inspection	11/14/2018	Connection in photo is from CB; suspect no cross connection present
Grand Union Blvd	Grand Union Blvd or Assembly Sq Dr (Back northeast corner of Home Depot)	S2-6178	DMH	Popped for Connectivity	11/20/2018	No additional manholes observed from surface; recommend CCTV to confirm if additional access points at nearby junctions
Grove St	Grove St / Community Path	CA-2401	COM	MH Inspection	10/24/2018 11/21/2018	Common MH with CS elevated within MH and SD below; MH inspected and photos taken as part of flow metering
	Grove St / Community Path	C2-6438	DMH	Popped for Connectivity	11/21/2018	Pipe configuration cannot be determined from surface; already have info needed from previous inspection; CSE not conducted
Highland Rd	Highland Rd / Kidder Ave	CA-254	COM	MH Inspection	11/20/2018	Common MH with separation weir
Holland St	Holland St / Paulina St / Gorham St	CA-2397	CMH	MH Inspection	11/14/2018	Connection/overflow observed over to A-5353; Overflow observed to Gorham St confirmed to be bulkheaded
		A-5353	CMH	MH Inspection	11/14/2018 12/20/2018	Connection/overflow observed over to CA-2397
Marshall St	Marshall St / Evergreen Ave	30-5119	CMH	MH Inspection	11/20/2018	CI pipe thru MH; turbulent flow from S2-1760 dropping into drain manhole
	Marshall St / Stickney Ave	30-5116	CMH	Photos Only	10/23/2018	PVC pipe thru MH; photos taken as part of flow metering
McGrath Highway / Mystic Ave	McGrath Highway / Mystic Ave / Foss Park	S2-6086	DMH	MH Inspection	12/13/2018	MH configuration does not match GIS; orange discolored flow
		S2-3215	COM	MH Inspection	12/13/2018	Common MH with tapered weir; outlet drops into unknown chamber
		S2-3264	SMH	Photos Only	12/13/2018	Photos taken as part of flow metering
		30-6204	CMH	Photos Only	12/13/2018	Photos taken as part of flow metering



## MODEL REFINEMENT AND CALIBRATION REPORT

### Appendix F

Street	Address / Intersection	MH ID	MH Type (DMH, SMH, CMH, COM)	Level of Data Collection (MH Inspection, Photos Only, CSE)	Inspection Date	Comments
Medford St	Medford St / School St	30-5112	DMH	Photos Only	10/23/2018	Photos taken as part of flow metering
		30-5112A	DMH	MH Inspection	10/15/2018 12/20/2018	CSE not able to be conducted due to high LEL; petroleum odor and orange discoloration observed
		S2-2686	SMH	MH Inspection	12/20/2018	Overflow to DMH 30-5112A; Fracture observed on MH wall
Morrison Ave	Morrison Ave / Willow Ave	CA-2398	CMH	MH Inspection	11/20/2018	Overflow weir observed; suspect in-line over to SD; connection not observed in CA-5372
	Morrison Ave / Highland Rd	CA-2399	CMH	MH Inspection	11/20/2018	Overflow and weir observed from CS towards Highland Rd (South)
Newton St	Newton St / Webster Ave	C2-1994	CMH	Photos Only	10/24/2018	Photos taken as part of flow metering
North St	North St / Raymond Ave	8-5043	DMH	MH Inspection	10/15/2018	MH inspected as part of pre-flow meter investigations
		9-5186	DMH	MH Inspection	10/15/2018 10/24/2018	MH inspected and photos taken as part of flow metering
	North St / Broadway St	9-5187	DMH	Photos Only	10/15/2018	Photos taken as part of pre-flow meter investigations
Palmer Ave	Palmer Ave / Franklin St	C1-1355	DMH	MH Inspection	10/15/2018 12/13/2018	MH inspected and photos taken as part of flow metering
Pearl St	Pearl St / Marshall St	30-5600	CMH	Photos Only	10/15/2018 10/23/2018	Photos taken as part of flow metering
	Pearl St / Cross St	S2-1579	SMH	MH Inspection	11/20/2018	Broken MH frame and cover; did not open
Properzi Way	#100 Properzi Way	C2-1334	CMH	Photos Only	12/13/2018	Photos taken as part of flow metering
Simpson Ave	Simpson Ave / Holland Ave	CA-2	COM	MH Inspection	11/14/2018	Common MH with weir separating flows
	#15 Simpson Ave	CA-3099	COM	MH Inspection	11/14/2018	Common MH with C-shaped channel above lower SS
	Simpson Ave / Cady Ave	CA-100	COM	MH Inspection	11/14/2018	Common MH with SD thru MH with open tap
	#47 Simpson Ave	CA-99	COM	MH Inspection	11/14/2018	Common MH with SD thru MH with open tap
Somerville Ave	Somerville Ave / Properzi Way	C2-1337	CMH	MH Inspection	11/21/2018	Weir observed in manhole with connection towards Properzi Way; Connection sound tested and confirmed to C2-3170
	Somerville Ave / Laurel St	C2-3170	CMH	MH Inspection	11/21/2018	Connection sound tested and confirmed to C2-1337
Washburn Ave	Washburn Ave / Washburn Ter	S78COM8500 / A-731	CMH	MH Inspection	11/21/2018	Confirmed no cross connect over to Tannery Brook SD
Willow Ave	Willow Ave / Lexington Ave	C2-6439	DMH	MH Inspection	11/20/2018	Connection to CS bulkheaded

No. of Manhole Inspections	42
No. Structures popped for connectivity only	4
No. of Photos Only	10
No. of Confined Space Entries (CSE)	4
<b>Total</b>	<b>60</b>

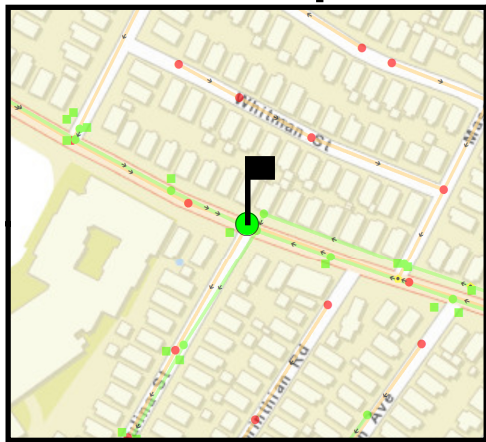


# **APPENDIX G**

## **Manhole Inspection Reports**



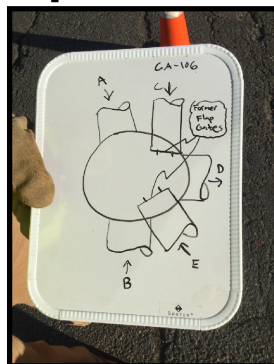
# Manhole Inspection Report



Service Layer Credits: Source: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), Swisstopo, IGN, Esri, Mapbox, OpenStreetMap contributors, and the GIS User Community

Latitude / Y: 42.401855

Longitude / X: -71.1237



**Manhole Type:**  
Common Manhole

**MH#**

CA-106

**Catchment Area:**

**Inspector:** Greg Frazier

**Date:** 11/14/2018 2:03:33 PM

**Temp:** 33

**Weather:** Sunny

**Street:** BROADWAY

**General Comments:** Corroded Flap Gates on E and C Pipes

**Location of MH -** Roadway  
**Comment -**

**Manhole Material -** Brick  
**Comment -**

**Flow -** Steady  
**Comment -**

**Clarity of Flow -** Normal Sewer Appearance

**Recommendations-** Clean/Remove Debris from invert

**Cover Size:** 24" **Other:**

**Manhole Size:** 4' **Other:**

**Drop:** N

**Depth to Wet Ring from Rim or Invert:**

N/A

**Weir- (Y/N):** N

**Rim to top of weir:** NA

**MH Channel- (Y/N):** Y

**MH Channel Condition:** Fair

**Area Around MH Condition:**

Paved- Cracked

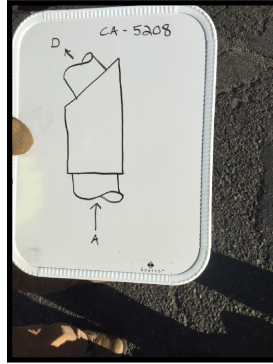
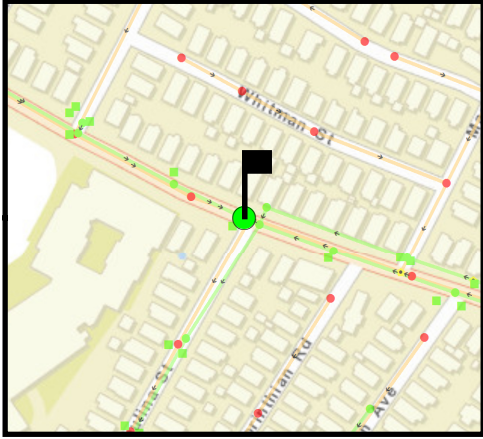
**MH Condition:**

Good

	Pipe Size	Material	From / To MH#	Invert Depth (from rim)	Flow Depth (from invert)	Debris Depth (from invert)	Condition
A.	36"	Brick	FIT-148	13.89'	12"	8"	Good
B.	Unknown	Brick	CA-341	13.86'	12"	0"	Good
C.	24"	RCP	CA-5209	12.63'	0"	0"	Good
D.	Unknown	Unknown	CA-107	13.92'	12"	8"	Good
E.	24"	RCP	CA-5208	7.86'	0"	4"	Good
F.							
G.							
H.							

# Manhole Inspection Report

MH# CA-5208



**Manhole Type:**  
Storm Manhole

**Latitude / Y:** 42.401853

**Longitude / X:** -71.12374

**General Comments:**

**Location of MH -** Roadway  
**Comment -**

**Manhole Material -** Precast Concrete  
**Comment -**

**Flow -** Stagnant  
**Comment -**

**Clarity of Flow -** Clear

**Recommendations- Clean/Remove Depris from invert**

**Catchment Area:**

**Inspector:** Greg Frazier

**Date:** 11/14/2018 2:08:27 PM

**Temp:** 33

**Weather:** Sunny

**Street:** BROADWAY

**Cover Size:** 24" **Other:**

**Manhole Size:** Other **Other:** 5' x 6'

**Drop:** N

**Depth to Wet Ring from Rim or Invert:**

N/A

**Weir- (Y/N):** N

**Rim to top of weir:** NA

**MH Channel- (Y/N):** N

**MH Channel Condition:** N/A

**Area Around MH Condition:**

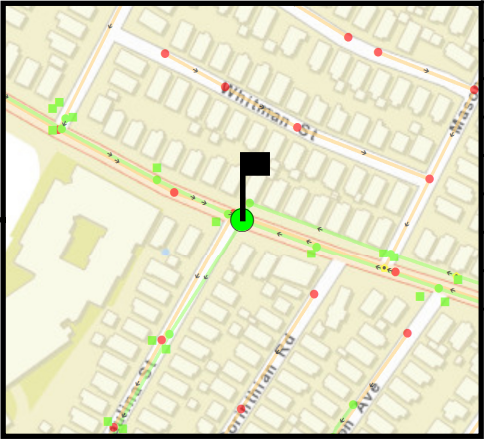
Paved- Cracked

**MH Condition:**

Good

	Pipe Size	Material	From / To MH#	Invert Depth (from rim)	Flow Depth (from invert)	Debris Depth (from invert)	Condition
A.	48"	RCP	CA-5207	8.64'	3"	0"	Good
B.							
C.							
D.	24"	RCP	CA-106	8.54'	2"	1"	Good
E.							
F.							
G.							
H.							

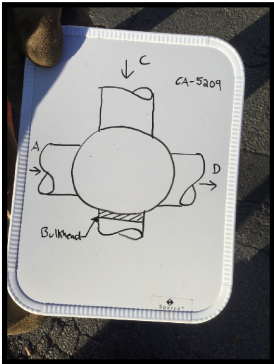
# Manhole Inspection Report



Service Layer Credits: Source: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), Swisstopo, IGN, Esri, Mapbox, OpenStreetMap contributors, and the GIS User Community

Latitude / Y: 42.40182  
Longitude / X: -71.123636

General Comments:



Manhole Type:  
Storm Manhole

MH#CA-5209

Catchment Area:

Inspector: Greg Frazier

Date:11/14/2018 2:42:36 PM

Temp:33

Weather:Sunny

Street:BROADWAY

Cover Size: 24"Other:

Manhole Size: 5'Other:

Drop: N

Depth to Wet Ring from Rim or Invert:  
N/A

Weir- (Y/N): N

Rim to top of weir: NA

MH Channel- (Y/N): N

MH Channel Condition: N/A

Area Around MH Condition:  
Paved- Cracked

MH Condition:  
Good

Location of MH - Roadway  
Comment -

Manhole Material - Manhole Block  
Comment -

Flow - Steady  
Comment -

Clarity of Flow - Clear

Recommendations- No Action

	Pipe Size	Material	From / To MH#	Invert Depth (from rim)	Flow Depth (from invert)	Debris Depth (from invert)	Condition
A.	36"	RCP	CA-5210	8.70'	<1"	0"	Good
B.							
C.	Unknown	Unknown	CA-5212	12.05'	<1"	0"	Good
D.	Unknown	RCP	A-5351	12.30'	<1"	0"	Good
E.							
F.							
G.							
H.							