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Task 4: Semiannual CSO Discharge Report No. 7
January 1, 2021 – June 30, 2021

CSO Post Construction Monitoring and Performance Assessment

MWRA Contract No. 7572

October 29, 2021

Project number: 60559027

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1. Executive Summary

1.1 Introduction to this Semiannual Progress Report

On November 8, 2017, the Massachusetts Water Resources Authority (MWRA) commenced a multi-year study to measure the performance of its $912.5 million long-term combined sewer overflow ("CSO") control plan (the "Long-Term Control Plan" or "LTCP"). This is the seventh and final semiannual report on the progress of the performance assessment (Table 1-1).

Table 1-1. Semiannual CSO Discharge Reports

Report #	Data Collection Period	Schedule
1 - link	April 15 to June 30, 2018 (2.5 months)	Nov. 2018 - complete
2 - link	July 1 to December 31, 2018 (6 months)	Apr. 2019 - complete
3 - link	January 1 to June 30, 2019 (6 months)	Oct. 2019 - complete
4 - link	July 1 to December 31, 2019 (6 months)	Apr. 2020 - complete
5 - link	January 1 to June 30, 2020 (6 months)	Oct. 2020 - complete
6 - link	July 1 to December 31, 2020 (6 months)	Apr. 2021 - complete
7	January 1 to June 30, 2021 (6 months)	Oct. 2021

Submission of a final report on MWRA's CSO performance assessment is the last scheduled milestone in the nearly 35-year-old Federal District Court Order in the Boston Harbor Case (U.S. v. M.D.C., et al, No. 85-0489 MA). MWRA has addressed 183 CSO-related court schedule milestones, including completion of the thirty-five (35) wastewater system projects that comprise the LTCP by December 2015 and commencement of the CSO performance assessment by January 2018 (which, as noted above, MWRA met in November 2017). The last court milestone requires MWRA to submit the results of its performance assessment to the U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (DEP) by December 2021[1].

The performance assessment will demonstrate whether the levels of CSO control specified in the LTCP have been achieved. MWRA's obligations for CSO control under the Court Order are defined in the March 15, 2006, *Second Stipulation of the United States and the Massachusetts Water Resources Authority on Responsibility and Legal Liability for Combined Sewer Overflow Control*, as amended on April 30, 2008 (the "Second Stipulation"). For more information about MWRA's federal court obligations for CSO control, including the LTCP levels of control, see Section 1.3.5 in Semiannual CSO Discharge Report No. 2, May 3, 2019.

[1] On July 19, 2019, Federal District Court Judge Richard G. Stearns issued an order extending the milestone for submission of the final report by one year, from December 31, 2020 to December 31, 2021. MWRA had requested the extension to provide the time necessary to perform receiving water quality modeling to support water quality assessments for the Lower Charles River/Charles Basin and the Alewife Brook/Upper Mystic River.

The CSO performance assessment has included the following key scope elements, which have been successfully completed over the last four years:

- Inspections at all CSO regulators addressed in the LTCP to confirm closed or active status and to confirm or update the physical and hydraulic conditions of the CSO regulators and outfalls that remain active;
- Collection of extensive rainfall data and overflow related data (field measurements) at remaining CSO regulators;
- Upgrade and improvement of the calibration of MWRA's hydraulic model of the wastewater system using inspection information and overflow data;
- Assessment of system performance for CSO control, and the consideration of performance improvements; and
- Assessment of the water quality impacts of remaining CSOs and compliance with Massachusetts Water Quality Standards.

With this report, the MWRA continues to forecast outfall locations expected to achieve - or not to achieve - the LTCP activation and volume goals. This forecast has not changed since Semiannual Report No. 6, with 70 of the 86 CSO outfalls in the Second Stipulation achieving LTCP activation and volume goals, and 16 of the 86 CSO outfalls continuing to present challenges to achieving their respective goals. However, as highlighted in this report, MWRA and its member CSO communities have made further advancements in investigations, planning, design and construction to work towards narrowing or eliminating these challenges. As detailed in Semiannual Report No. 4 Sections 2.1 and 4.1, MWRA reiterates that the LTCP levels of control were proposed by MWRA and approved for specific locations utilizing different versions of the hydraulic model at different times in the development of the LTCP. LTCP levels were established at some locations as early as 1997 (Final CSO Facilities Plan and Environmental Impact Report), and at others as late as 2008 from subsequent project reevaluations. The various MWRA planning reports that describe the hydraulic modeling and water quality evaluations that led to the site-specific LTCP goals, including Typical Year activations and volumes and associated water quality improvement, and that together form the LTCP are referenced in Exhibit A to the Second Stipulation.

With this final semiannual report, the MWRA continues to use a hydraulic model that includes system details and technological improvements well beyond the capabilities of the hydraulic models originally used to support the development of the LTCP goals. The model now being used has incorporated CSO and non-CSO sewer system updates, has undergone a detailed full-model calibration that employed an extensive metering program in 2018, and includes continued calibration refinements as sewer system improvements and connection/configuration information is obtained by MWRA or the CSO communities. It is not surprising that this much-improved modeling tool used to evaluate current CSO performance is now predicting CSO volumes and activations that vary in some locations from the original predictions of future performance of the 35 projects implemented since the late 1990's as part of the control plan.

This report provides a review of the Receiving Water Quality Modeling Assessment and further work to evaluate the impact of alternatives with varying pollutant loads, as summarized in Section 1.2 with further detail provided in Chapter 2.

The 70 CSO outfalls currently achieving or improving upon the activation and volume goals as a result of the completed CSO LTCP and further system improvements by MWRA and its CSO communities are identified in Section 1.3 and further discussed in Chapter 3. These 70 CSO outfalls include six locations where CSO activity has decreased to levels that the MWRA believes achieve anticipated water quality improvements (BOS013, BOS057, BOS060, BOS064, MWR203, and CAM007). MWRA anticipates that, in light of all factors and considerations, it will request a determination that any inability to meet such goals at these locations is immaterial. For the remaining 16 outfalls currently forecasted to not meet the LTCP goals by December 2021, MWRA has identified six outfalls where LTCP goals are forecasted to be met after December 2021. For each of these six locations, the measure(s) and advancements the MWRA or its CSO communities are making to achieve attainment of the LTCP goals, and updated implementation schedules are presented in Sections 1.3 and Chapter 3. For the remaining 10 of the 16

CSO outfalls not forecast to meet the LTCP goals by December 2021, information in Section 1.3 summarizes the advancement of alternative evaluations by MWRA in coordination with the CSO communities. Several of these alternatives appear to be likely candidates to advance forward after further refinement and/or evaluations of constructability, hydraulic impact during larger storm events, and associated cost/benefit considerations are conducted. Section 1.3 summarizes these alternative evaluations and Chapter 4 presents additional detail on the work performed.

With the understanding that 16 of the 86 CSO outfalls will not achieve the LTCP goals for activation frequency and/or volume by December 2021, MWRA has entered into discussions with the court parties on how to best move forward to meet MWRA's CSO obligations. These discussions have led to the following MWRA recommendations for further actions:

1) complete the performance assessment report in December 2021;
2) request three years of additional time for the Authority to focus its efforts on the 16 outfalls, with a heightened focus on, and prioritization of, those CSO outfalls located in environmental justice communities;
3) provide annual reporting on progress being made;
4) conduct periodic meetings with EPA, DEP and others to provide technical updates as well as chart plans for steps beyond the three year extension period; and
5) provide a supplemental report at the conclusion of the three year period as to the 16 outfalls, to be used in conjunction with the submission of the December 2021 Performance Assessment by EPA, DEP, and the Court in making their respective determinations as to the levels of CSO control that have been achieved.

1.2 Receiving Water Quality Modeling and Water Quality Assessments

The scope of MWRA's post-construction monitoring and CSO performance assessment also includes assessments of whether remaining CSO discharges comply with Massachusetts Surface Water Quality Standards. For the waters designated Class B (CSO Variance), including the Lower Charles River/Charles Basin and the Alewife Brook/Upper Mystic River, limited CSO discharges are authorized for the period that CSO Variances to Water Quality Standards are in effect (currently through August 31, 2024). For these Variance waters, MWRA reached agreement with EPA and DEP in 2019 to add receiving water quality modeling and supporting water quality sampling to its CSO performance assessment. MWRA used receiving water model results to assess the water quality impacts of remaining CSO discharges to these waters. These assessments were initially conducted on 2019 system conditions. The results were presented in Semiannual Report No. 6, and have been published in the *Task 5.3 Water Quality Assessment*, submitted to regulatory agencies on September 13, 2021 and available at the MWRA Technical Reports webpage. The findings from these assessments and additional evaluations are summarized below, and presented in more detail in Chapter 2.

To assess compliance with the current water quality standards for bacteria, the model was used to compute the total duration that the bacteria count in each model cell was predicted to exceed the single-sample maximum criteria for *E. coli* and *Enterococcus* over the course of the Typical Year. As noted above, these evaluations were initially conducted for 2019 system conditions.

For both the Charles River and the Alewife Brook/Upper Mystic River the following general observations were made:

- Loadings due to stormwater and upstream boundaries were the two largest sources of *E. coli* and *Enterococcus* in both the 1-year and 3-month design storms and for the Typical Year.
- CSOs contribute bacterial loadings only during the larger storms: 8 times during the Typical Year for the Charles and 10 times for the Alewife/Upper Mystic, respectively (based on 2019 system conditions).
- For all sources, single sample maximum criteria compliance for the Typical Year over the entire water body is summarized in Table 1-2. It should be noted that for the computed percentages in Table 1-2, if any one location within the river exceeds the criterion for a model timestep, that

counts as non-compliance for the entire waterbody for that timestep. At fixed points in the waterbodies, the percent compliance would be greater than the entire water body values given in this table, but this approach allows comparison with previous assessments.

Table 1-2. Summary of Annual Compliance with Single-Sample Maximum *E. coli* Criteria, Typical Year, All Sources (2019 Conditions)

Waterbody	Annual Compliance with the 235 #/100 mL *E. coli* Single-Sample Maximum Criterion for the Typical Year
	All Sources
Charles River	48%
Alewife Brook	45%
Upper Mystic River	55%

Note: The numbers above for Alewife Brook and Upper Mystic River are slightly different than those presented in Semiannual Report No. 6 due to further results analysis. See Table 2-1 for further detail.

- For CSOs only, single sample maximum criteria compliance for the Typical Year over the entire water body is summarized in Table 1-3. As noted above for the "All Sources" case, at fixed points, compliance would be even greater than for the entire water body.

Table 1-3. Summary of Annual Compliance with Single-Sample Maximum *E. coli* Criteria, Typical Year, CSO Sources Only (2019 Conditions)

Waterbody	Annual Compliance with the 235 #/100 mL *E. coli* Single-Sample Maximum Criterion for the Typical Year
	CSOs Only
Charles River	99.6%
Alewife Brook	98.6%
Upper Mystic River	96.9%

The Water Quality Assessment also included evaluations of the impacts of the individual bacteria loading sources to the waterbodies, and the sensitivity of varying stormwater and CSO concentrations on predicted attainment of the water quality criteria (see Semiannual Report No. 6).

Following the completion of the Water Quality Assessment, MWRA has begun to use the receiving water models to evaluate alternatives for various bacterial load reduction scenarios. These alternatives include updating the baseline collection system conditions to Q1-2021 conditions, as well as potential improvements to the wastewater collection system and stormwater systems. These alternatives align with the intent of the Receiving Water Model Work Plan and include input from EPA, DEP, and other stakeholders. The alternatives will be assessed in terms of the percent compliance with the *E. coli* single sample maximum criterion over the entire river segment so the results can be compared with established baseline conditions.

The Task 5.4 Water Quality Alternatives Assessment report will contain information on the following alternatives:

- Q1-2021 collection system conditions
- Non-CSO sources capped at 100% of water quality criterion
- Non-CSO sources capped at 50% of water quality criterion
- Q1-2021 conditions but with all outfalls meeting the LTCP Goals for activation frequency and volume
- Stormwater capture scenario: This run approximated the impact of implementing stormwater management projects that would capture the first one inch of rainfall throughout the separate stormwater areas tributary to the Charles River, Alewife Brook and Upper Mystic River. This scenario was approximated in the model by eliminating the rainfall assigned to separate stormwater areas for all rain events less than 1 inch from the modeled Typical Year.

As described further in Chapter 2, evaluations of the Q1-2021 system conditions have been completed. The Q1-2021 system conditions included the implementation of projects by the City of Cambridge that reduced CSO activations and volumes at outfall CAM401A and from the Cottage Farm CSO Facility, as well as various other updates to the model based on new information. These updates resulted in a slight improvement in criteria attainment for the CSO-only case, but no change in attainment for the All-Sources case. The results are consistent with previous conclusions indicating that further reduction in CSOs would not affect the overall percent attainment with the single-sample maximum criterion when non-CSO sources are considered, and that non-CSO sources are the primary driver of non-attainment of water quality criteria in these water bodies.

1.3 Updated System Performance Assessment and Comparison with LTCP Levels of Control

With the completion of an extensive recalibration of MWRA's hydraulic model in early 2020, MWRA was able to present in Semiannual Progress Report No. 4 (April 30, 2020), Semiannual Progress Report No. 5 (October 30, 2020), and Semiannual Progress Report No. 6 (April 30, 2021) interim assessments of the existing system's Typical Year CSO performance relative to the LTCP activation and volume goals by outfall and receiving water segment. An updated interim assessment of Typical Year performance for current system conditions and comparison with the LTCP activation and volume goals is presented in Chapter 3 and summarized below.

1.3.1 Hydraulic Model and Typical Year Simulation Updates

Updates to MWRA's hydraulic model from "Q1-2021 System Conditions" to current system conditions ("Q1Q2-2021 System Conditions") are described in Section 3.2. The sources of the model updates included new information from MWRA or community wastewater system inspections; operation, maintenance or capital improvements made to the MWRA or community wastewater systems; and other model adjustments to improve the characterization and/or simulation of hydrologic or hydraulic conditions. A comparison of the Typical Year results from the Q1-2021 System Conditions and Q1Q2-2021 System Conditions models is presented and described in Chapter 3. At most discharge locations, Typical Year activation and volume predictions did not change or changed very little. At several locations, Typical Year activation and/or volume changed more significantly. Table 1-4 identifies the reasons for several key model updates and the outfalls and outfall performance most affected by each model change.
The updated Typical Year simulation results for all outfalls, utilizing the Q1Q2-2021 System Conditions Model, are presented in Table 1-5. The Q1Q2-2021 model results in Table 1-5 provide an outfall-by-outfall assessment of current CSO performance compared with the LTCP activation and volume goals.

Table 1-4. Recent Hydraulic Model Updates and Effects on Typical Year Predictions

Reason for Model Update	Affected Outfall(s)	Typical Year Performance: Q1-2021 System Conditions Model – Activation Frequency	Q1-2021 System Conditions Model – Volume (MG)	Q1Q2-2021 System Conditions Model – Activation Frequency	Q1Q2-2021 System Conditions Model – Volume (MG)
MWRA revised the model to include a 42-inch storm drain tributary to the 85” x 90” combined sewer upstream of Somerville Marginal CSO Facility and re-delineated its tributary area.	Somerville Marginal CSO Facility	30	100.58	30	99.66
MWRA revised the weir elevation in the model based on field conditions. The City of Chelsea was planning to raise the weir to El. 109.83 so the weir in the Q1-2021 Conditions model was set at El. 109.83. Due to construction issues and based on field observations, the weir elevation was only raised to El. 109.41. The City of Chelsea raised the weir to El. 109.83 on August 16, 2021. With the weir raised the additional 5 inches the predicted activation frequency is 3 and the volume is 0.30 MG allowing CHE004 to achieve LTCP goals.	CHE004	3	0.30	6	0.41
MWRA revised the model to include local subcatchment areas and piping tributary to the MWRA interceptor at Willard Street. Added 28 acres at 50% impervious and associated piping, based on information provided by the City of Cambridge.	CAM005	7	0.66	8	0.74
	CAM007	2	0.45	1	0.50
	Cottage Farm	2	8.95	2	9.10
The City of Cambridge reported observing 6 inches of water downstream of the CAM401A regulator as part of post cleaning measurements on April 13, 2021. MWRA updated the model to reflect the 6 inches of standing water observed during the field inspection. This did not impact the activation frequency or volume.	CAM401A	5	0.66	5	0.66
MWRA revised the model based on field investigations and a review of DCR storm drain drawings as follows: • The categorization of manholes along the Boston Marginal Conduit (BMC) as sealed vs. unsealed was updated in the model. • Catch basis were added based on review of DCR storm water drawings. • Updated the model to include an interconnection between the Old Stony Brook Conduit (OSBC) and the Stony Brook Conduit (SBC) • Removed modeling losses at the manholes along the BMC to better reflect the structural configuration of the BMC and to improve the match between modeled and measured depths in the BMC.	MWR018	2	1.14	2	1.12
	MWR019	2	0.51	2	0.48
	MWR020	2	0.57	2	0.48
	Prison Point	17	253.66	17	248.23
For the Q1-2021 period the Boston Gate House No. 1 was assumed to be closed based on available field information, so all of the flow was assumed to go out MWR023. In the Q1Q2-2021 conditions Boston Gatehouse 1 is assumed to open during storms with more than 1 inch of rain (see Boston GH#1 discussion below). If the gate is open and one or more of the upstream CSO regulators discharges, then the CSO volume from the upstream regulator(s) is split 25% out MWR023 and 75% out BOS046 based on previous model tracer analyses.	MWR023	1	0.14	1	0.04
MWRA revised the model to reflect operational information provided by BWSC. The model RTC was updated so that the gates will open for rainfall events greater than 1 inch. The gate opening height was also changed from 13 feet to 4 feet based on field information also provided by BWSC.	BOS046-Boston GH#1	1	0.00	1	0.10
MWRA updated the model to include Boston Gate House #2 based on new field information provided by BWSC. The Gates can be overtopped at El. 13 BCB (El. 112.97 MDC)	BOS046-Boston GH#2	N/A	N/A	0	0.00

Table 1-5. Typical Year Performance: Baseline 1992, Current (Q1Q2-2021) and LTCP (1 of 3)

Outfall currently achieves LTCP activation and volume goals.	Outfall is projected to achieve LTCP activation and volume goals by Dec 2021.	Outfall is forecast to achieve LTCP goals after Dec 2021.
Outfall investigations continue for forecast of LTCP attainment potential.	Model prediction is greater than LTCP value.	

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q1Q2-2021 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
ALEWIFE BROOK						
CAM001	5	0.15	1	0.02	5	0.19
CAM002	11	2.73	0	0.00	4	0.69
MWR003	6	0.67	3	0.61	5	0.98
CAM004	20	8.19	Closed	N/A	Closed	N/A
CAM400	13	0.93	Closed	N/A	Closed	N/A
CAM401A	18	2.12	5	0.66	5	1.61
CAM401B			4	0.50	7	2.15
SOM001A(8)	10	11.93	8	4.47	3	1.67
SOM001	0	0.00	Closed	N/A	Closed	N/A
SOM002	0	0.00	Closed	N/A	N/I(3)	N/I(3)
SOM002A	0	0.00	Closed	N/A	Closed	N/A
SOM003	0	0.00	Closed	N/A	Closed	N/A
SOM004	5	0.09	Closed	N/A	Closed	N/A
TOTAL		**26.81**		**6.26**		**7.29**
UPPER MYSTIC RIVER						
SOM007A/MWR205A(7)	9	7.61	5	4.50	3	3.48
SOM006	0	0.00	Closed	N/A	N/I(3)	N/I(3)
SOM007	3	0.06	Closed	N/A	Closed	N/A
TOTAL		**7.67**		**4.50**		**3.48**
MYSTIC/CHELSEA CONFLUENCE						
MWR205(7) (Somerville-Marginal CSO Facility)	33	120.37	30	99.66	39	60.58
BOS013*	36	4.40	8	0.27	4	0.54
BOS014(7)	20	4.91	8	1.45	0	0.00
BOS015	76	2.76	Closed	N/A	Closed	N/A
BOS017(8)	49	7.16	6	0.34	1	0.02
CHE002	49	2.51	Closed	N/A	4	0.22
CHE003	39	3.39	0	0.00	3	0.04
CHE004**	44	18.11	6	0.41	3	0.32
CHE008(7)	35	22.35	6	1.94	0	0.00
TOTAL		**185.96**		**104.06**		**61.72**
UPPER INNER HARBOR						
BOS009(7)	34	3.60	10	0.73	5	0.59
BOS010**	48	11.83	7	0.44	4	0.72
BOS012	41	7.90	0	0.00	5	0.72
BOS019	107	4.48	1	0.07	2	0.58
BOS050	No Data		Closed	N/A	N/A	N/A
BOS052	0	0.00	Closed	N/A	Closed	N/A
BOS057*	33	14.71	2	1.33	1	0.43
BOS058	17	0.29	Closed	N/A	Closed	N/A
BOS060*	64	2.90	2	0.47	0	0.00
MWR203 (Prison Point Facility)*	28	261.85	17	248.23	17	243.00
TOTAL		**307.56**		**251.27**		**246.04**

Table 1-5. Typical Year Performance: Baseline 1992, Current (Q1Q2-2021) and LTCP (2 of 3)

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q1Q2-2021 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
LOWER INNER HARBOR						
BOS003(7)	28	18.09	9	6.40	4	2.87
BOS004	34	3.43	2	0.06	5	1.84
BOS005	4	10.23	0	0.00	1	0.01
BOS006	17	1.21	Closed	N/A	4	0.24
BOS007	34	3.93	Closed	N/A	6	1.05
TOTAL		**36.89**		**6.46**		**6.01**
CONSTITUTION BEACH						
MWR207	24	4.00	Closed	N/A	Closed	N/A
TOTAL		4.00		N/A		N/A
FORT POINT CHANNEL						
BOS062(8)	8	4.15	5	1.26	1	0.01
BOS064*	14	0.99	1	0.01	0	0.00
BOS065(8)	11	3.08	1	0.62	1	0.06
BOS068	4	0.62	0	0.00	0	0.00
BOS070	4	281.62				
BOS070/DBC(8)			7	6.18	3	2.19
MWR215 (Union Park Facility)			10	26.73	17	71.37
BOS070/RCC			0	0.00	2	0.26
BOS072	21	3.62	Closed	N/A	0	0.00
BOS073	23	4.73	0	0.00	0	0.00
TOTAL		**298.81**		**34.80**		**73.89**
RESERVED CHANNEL						
BOS076	65	65.94	1	0.10	3	0.91
BOS078	41	14.84	0	0.00	3	0.28
BOS079	18	2.10	0	0.00	1	0.04
BOS080	33	6.21	0	0.00	3	0.25
TOTAL		**89.09**		**0.10**		**1.48**
NORTHERN DORCHESTER BAY						
BOS081	13	0.32	0 / 25 year	N/A	0 / 25 year	N/A
BOS082	28	3.75	0 / 25 year	N/A	0 / 25 year	N/A
BOS083	14	1.05	Closed	N/A	0 / 25 year	N/A
BOS084	15	3.22	0 / 25 year	N/A	0 / 25 year	N/A
BOS085	12	1.31	0 / 25 year	N/A	0 / 25 year	N/A
BOS086	80	3.31	0 / 25 year	N/A	0 / 25 year	N/A
BOS087	9	1.27	Closed	N/A	Closed	N/A
TOTAL		**14.23**		**0.00**		**0.00**
SOUTHERN DORCHESTER BAY						
BOS088	0	0.00	Closed	N/A	Closed	N/A
BOS089 (Fox Pt.)	31	87.11	Closed	N/A	Closed	N/A
BOS090 (Commercial Pt.)	19	10.16	Closed	N/A	Closed	N/A
TOTAL		**97.27**		**0.00**		**0.00**
UPPER CHARLES						
BOS032	4	3.17	Closed	N/A	Closed	N/A
BOS033	7	0.26	Closed	N/A	Closed	N/A
CAM005(8)	6	41.56	8	0.74	3	0.84
CAM007*	1	0.81	1	0.50	1	0.03
CAM009(4)	19	0.19	Closed	N/A	2	0.01
CAM011(4)	1	0.07	Closed	N/A	0	0.00
TOTAL		**46.06**		**1.24**		**0.88**

Table 1-5. Typical Year Performance: Baseline 1992, Current (Q1Q2-2021) and LTCP (3 of 3)

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q1Q2-2021 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
LOWER CHARLES						
BOS028	4	0.02	Closed	N/A	Closed	N/A
BOS042	0	0.00	Closed	N/A	Closed	N/A
BOS049	1	0.01	Closed	N/A	Closed	N/A
CAM017	6	4.72	0	0.00	1	0.45
MWR010	16	0.08	0	0.00	0	0.00
MWR018(8)	2	3.18	2	1.12	0	0.00
MWR019(8)	2	1.32	2	0.48	0	0.00
MWR020(8)	2	0.64	2	0.48	0	0.00
MWR021	2	0.50	Closed	N/A	Closed	N/A
MWR022	2	0.43	Closed	N/A	Closed	N/A
MWR201(8) (Cottage Farm Facility)	18	214.10	2	9.10	2	6.30
MWR023(5)	39	114.60	1	0.04	2	0.13
SOM010	18	3.38	Closed	N/A	Closed	N/A
TOTAL		**342.98**		**11.22**		**6.88**
NEPONSET RIVER						
BOS093	72	1.61	Closed	N/A	Closed	N/A
BOS095	11	5.37	Closed	N/A	Closed	N/A
TOTAL		**6.98**		**0.00**		**0.00**
BACK BAY FENS						
BOS046 – Boston GH1(5)	2	5.25	1	0.10	2	5.38
BOS046 – Boston GH2(6)			0	0.00		
TOTAL		**5.25**		**0.10**		**5.38**
Total Treated		**698**		**384**		**381**
Total Untreated		**759**		**32**		**23**
GRAND TOTAL		**1457**		**416**		**404**

*Model predicted activation and volume for Q1Q2-2021 System Conditions has decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to meet such goals at these locations is considered immaterial.

** The City of Chelsea raised the weir at the regulator associated with outfall CHE004 on August 16, 2021. With the weir raised an additional 3 inches the predicted activation frequency is 3 and the volume is 0.30 MG allowing CHE004 to achieve LTCP goals. The BWSC is anticipated to complete Contract 2 sewer separation in East Boston by the end of 2021. That work is projected to reduce the activation frequency at outfall BOS010 to 1 and the volume to 0.07 MG, meeting the LTCP goals.

(1) 1992 System Conditions include completion of Deer Island Fast-Track Improvements, upgrades to headworks, and new Caruso and DeLauri pumping stations. Estimated 1988 Grand Total Typical Year CSO volume (prior to these improvements) is 3,300 million gallons.

(2) From Exhibit B to Second Stipulation of the United States and the Massachusetts Water Resources Authority on Responsibility and Legal Liability for Combined Sewer Overflows, as amended by the Federal District Court on May 7, 2008 (the "Second CSO Stipulation").

(3) N/I: Outfall was closed prior to 2006 and is not included in Exhibit B to the Second CSO Stipulation.

(4) Tentatively closed pending additional hydraulic evaluation by City of Cambridge.

(5) BOS046 (Gatehouse 1) is primarily a stormwater discharge but may contain CSO if the upstream regulators overflow. The upstream regulators are monitored directly. Gatehouse 1 is normally closed but may be opened for flood mitigation. Flow can discharge at the Gatehouse if either the gate is opened or if water overtops the gate. Based on model tracer studies, when a discharge occurs during model simulations at BOS046 it was estimated that 25% of the CSO from the upstream regulators discharges at the MWR023 outfall (Charles River) and 75% discharges at BOS046 (Back Bay Fens).

(6) BOS046 (Gatehouse 2) contains a gate which may also be overtopped in extreme wet weather; this gate was added to the model after the Q1-2021 system conditions model run per new field information.

(7) See Table 1-6 below for outfalls forecast to attain LTCP goals after 2021.

(8) See Table 1-8 below for site-specific investigations underway where attainment of LTCP goals cannot yet be forecast.

1.3.2 Locations Where LTCP Activation and Volume Goals are Attained

From the updated Typical Year model simulation results in Table 1-5, MWRA has determined that 70 outfalls now attain the LTCP activation and volume goals, including 40 outfalls where CSO is eliminated (outfall "Closed") or eliminated up to the 25-year storm (North Dorchester Bay - South Boston beaches). The 70 outfalls attaining LTCP goals include six outfalls where CSO activity has decreased to levels that the MWRA believes achieve anticipated water quality improvements (BOS013, BOS057, BOS060, BOS064, MWR203, and CAM007). MWRA anticipates that, in light of all factors and considerations, it will request a determination that any inability to meet such goals at these locations is immaterial. There was no change to the number of outfalls that meet the LTCP goals between Q1-2021 and Q1Q2-2021 conditions.

1.3.3 Attainment of LTCP Activation and Volume Goals After 2021

The continuing site-specific investigations by MWRA and the CSO communities have also identified CSO control measures that hydraulic model results show can bring additional outfalls into attainment with their LTCP activation and volume goals. Implementation of these additional measures involves design and construction activities already underway or planned that would be completed after December 2021. The locations that are forecast to attain LTCP goals after December 2021 and the respective control measures are shown in Table 1-6, are summarized below, and are discussed in more detail in Chapter 4.

Table 1-6. Outfalls Forecast to Attain LTCP Goals After 2021

OUTFALL	LOCATION	SYSTEM IMPROVEMENT(S)	TO BE IMPLEMENTED BY	SCHEDULED COMPLETION
MWR205	Somerville-Marginal CSO Facility	Add new dry weather flow (DWF) connection to the interceptor; redirect separate stormwater; and replace tide gate	MWRA	2024
SOM007A/ MWR205A				
BOS003	East Boston	Complete BWSC Sewer Separation Contract 3, including upgrade interceptor connection at regulator RE003-12.	BWSC	2023
BOS009				
BOS014		Add interceptor connection		
CHE008	Chelsea Creek	Replace/upgrade interceptor connection	MWRA	2022

- **BOS003, BOS009 & BOS014 -** BWSC will complete East Boston sewer separation Contract 2 in the fall of 2021. BWSC awarded the construction contract for Contract 3 in late spring of 2021, with an estimated completion date of 2023. Contract 3 includes separating combined sewers in part of East Boston and also includes upgrading the restricted interceptor connection at Regulator RE003-12 and reconstructing regulators RE003-2 and RE003-7 as extreme storm high outlet reliefs. Separately, MWRA and BWSC have also identified that constructing a new interceptor connection to relieve the existing connections associated with Outfall BOS014 can bring this outfall into attainment with its LTCP goals. BWSC is moving forward with final design of the new interceptor connection and it will be constructed as part of Contract 3. MWRA model results presented in Section 4.1 show that completion of Contracts 2 and 3 and the new interceptor connection at BOS014 can bring all East Boston CSO outfalls into attainment with their LTCP activation and volume goals. MWRA has approved a financial assistance agreement whereby the MWRA will reimburse BWSC up to approximately $2.2M for eligible expenses associated with the Contract 3 sewer separation work and CSO improvements to the BOS014 combined sewer system. BWSC will construct the improvements.

- **CHE008 -** MWRA completed preliminary design to replace the 30-inch interceptor connection at Outfall CHE008 with a 48-inch pipe, and began final design in in March 2021. MWRA's project schedule calls for the completion of design in fall 2021, commencement of construction in early 2022, and completion of construction in the summer of 2022.

- **MWR205, SOM007A/MWR205A -** As noted in Semiannual Report No. 6, increasing the capacity of the connection to the Somerville-Medford Branch Sewer showed promise in terms of reducing activation frequency and volume at the Somerville-Marginal CSO Facility during the Typical Year. The initial modeling of this modification resulted in adverse impacts on the peak hydraulic grade line in the Somerville-Medford Branch Sewer in larger storms as well as increased discharge volume at Prison Point. In addition, separating the stormwater upstream of the Somerville Marginal CSO Facility had much less of an impact on the discharge frequency and volume at the facility than anticipated. As a result of these findings, subsequent evaluations focused on constructing a new dry weather flow connection to the Somerville Medford Branch Sewer with a gate to maximize performance during the Typical Year without adversely affecting the hydraulic grade line in the interceptor and minimizing the increase in volume at Prison Point. Two options have been evaluated using the model. MWRA is in the process of developing concept designs for each of the two options and will then select one to move forward with a preliminary design. Additional detail on the options and the model results are provided in Section 4.2 below.

1.3.4 Continuing Site-Specific Investigations

MWRA has continued to track CSO performance and the causes of higher overflow activity at 10 locations where Typical Year CSO activation and/or volume exceed the LTCP goals. MWRA has identified candidate projects or system adjustments that may further mitigate CSO discharges to bring activations and volumes to or closer to the LTCP goals. Four of the 10 projects affecting outfalls BOS017, BOS062, BOS065, and BOS070 have preliminary plans that are being evaluated that are forecasted to achieve LTCP goals. At this time MWRA is coordinating with BWSC regarding furthering the design and evaluating costs and construction feasibility. MWRA is continuing to develop alternatives for the other six locations to meet LTCP goals. Table 1-7 lists the 10 locations and potential action plans identified so far. Information on the progress of these evaluations is presented in Chapter 4.

Table 1-7. Investigations Where Attainment of LTCP Goals Cannot Yet be Forecast

OUTFALL	Q1Q2-2021 SYSTEM CONDITIONS MODEL		LONG TERM CONTROL PLAN		POTENTIAL ACTION PLAN
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	
ALEWIFE BROOK					
SOM001A	8	4.47	3	1.67	• Potential modifications to the regulator structure including raising the weir and interceptor connection relief, relining portions of the Alewife Brook Conduit (ABC) and Alewife Brook Branch Sewer (ABBS,) and upstream flow controls have been evaluated but a feasible plan to meet the LTCP goals has not yet been identified. MWRA is coordinating with City of Somerville to investigate whether flood control measures being considered by the City of Somerville may provide CSO reduction benefit.
MYSTIC/CHELSEA CONFLUENCE					
BOS017	6	0.34	1	0.02	• Concept design has been developed to construct modifications to the Sullivan Square siphon structure including adjustable stop logs upstream of each siphon barrel. MWRA is coordinating with BWSC on the feasibility and cost of this alternative.
FORT POINT CHANNEL					
BOS062	5	1.26	1	0.01	• Relieve interceptor connection. MWRA is coordinating with BWSC on the feasibility and cost of this alternative.
BOS065	1	0.62	1	0.06	• Raise the weir at the regulator. MWRA is coordinating with BWSC on the feasibility and cost of this alternative.
BOS070/DBC	7	6.14	3	2.19	• Add parallel relief pipe downstream of RE070/7-2. MWRA is coordinating with BWSC on the feasibility and cost of this alternative.
CHARLES RIVER					
MWR201 (Cottage Farm)	2	9.10	2	6.30	• Evaluated upstream sewer separation and targeted groundwater infiltration removal. • Further alternative development and evaluation with consideration of water quality benefits and cost to be considered beyond Dec. 2021.
CAM005	8	0.74	3	0.84	• Further coordination with CSO community to balance level of service needs against evaluated weir raising, cleaning of outfall, and separation of upstream areas. • Further alternative development and evaluation with consideration of water quality benefits and cost to be considered beyond Dec. 2021.
MWR018	2	1.12	0	0.00	• Evaluated alternatives including raising weirs, reducing head loss in the BMC; and redirecting upstream BWSC separate storm drains. • Further alternative development and evaluation with consideration of water quality benefits and cost to be considered beyond Dec. 2021.
MWR019	2	0.48	0	0.00	
MWR020	2	0.48	0	0.00	

1.4 CSO Data Collection and Analyses

In the period January 1, 2021 through June 30, 2021, MWRA continued to collect and analyze rainfall data from 20 gauges within the MWRA wastewater service area.

Comparison of storms in the first half of 2021 to the "Half-Typical Year" are shown in Table 1-8. To allow for a comparison of a half-year of data, the total rainfall statistics for the Typical Year were divided by two, to create "Half Typical Year" statistics. The comparison shows that the first half of 2021 was similar to the Half Typical Year rainfall. The first half of 2021 averaged 42 storm events, compared to 47 storm events for the Half Typical Year, while the total average rainfall depth for the first half of 2021 (22.82 inches) was relatively close to the Half Typical Year (23.40 inches) (Table 1-8).

The numbers of storms by rainfall depth categories for the first half of 2021 were relatively close to the values for the Half Typical Year. In terms of larger storms, the first half of 2021 had two storm events with a total rainfall depth greater than 2 inches compared to three for the Half Typical year. Among the Ward Street, Chelsea Creek and Columbus Park rain gauges, the largest storm in the first half of 2021 had 2.74 inches of rainfall, while the largest storm in the Typical Year had 3.89 inches of rainfall.

Table 1-8. Comparison of Rainfall January 1, 2021 – June 30, 2021

Rain Gauge	Total Rainfall (inches)	Total Number of Storms	Number of Storms by Depth				
			Depth < 0.25 inches	Depth 0.25 to 0.5 inches	Depth 0.5 to 1.0 inches	Depth 1.0 to 2.0 inches	Depth ≥2.0 inches
Jan. – June 2021	22.82	42	20	7	10	4	2
Half Typical Year[(1)]	23.40	47	25	7	8	4	3

(1) "Half Typical Year" values were calculated by dividing the full Typical Year statistics by two.

Permanent and temporary metering throughout the MWRA system provides a check of the model's ability to simulate system conditions as well as activation frequencies and volumes for remaining active CSO regulators. Meters can measure depth or depth and velocity. In locations where depth and velocity meters are installed the flows can be estimated. The MWRA monitors all active CSO outfalls that are owned and operated by MWRA.

Section 5.3 of this report presents a comparison of measured CSO activations and/or volumes for storms in the period January 1, 2021 through June 30, 2021 with the predictions of MWRA's hydraulic model as configured to represent system conditions that then existed, where MWRA meters were available. The model was able to replicate the storm responses for the majority of storm events in the Q1Q2-2021 period. However, it is not possible to match all of the modeled and metered activations for every meter and storm event due to rainfall data quality and rainfall spatial variation, unknown transient conditions in the collection system, and the accuracy of metering data (see Section 4.2 of Semiannual Report No. 5 *Model Calibration and Factors Affecting Model Results*). Table 5-9 in Section 5.3 presents the comparison of metered and modeled discharges. Locations of noted differences are summarized in Table 1-9.

Table 1-9. Notable Differences between Metered and Modeled CSO Discharges, January 1 – June 30, 2021

Location	Meter	Model	Comment
SOM007A/MWR205A	3 discharges 7.47 MG	1 discharge 6.68 MG	• The metered discharges occurred on 01/16/2021, 04/16/2021 and 05/28/2021. The model discharges only on the 05/282021 storm. • The model predicted discharge volume from the 01/16/2021 storm was very small, only 0.02 MG. This storm occurred in the winter, when the model can be less accurate due to winter conditions. • For the 04/16/2021 storm, the model predicted that the water level rose to within 8 inches of the discharge elevation for SOM007A/MWR205A. Thus, the model reacted to the storm but it was not enough to cause an activation. The discharge volume at this location is influenced by the discharge at the Somerville-Marginal CSO facility, the tide, and the stormwater coming in downstream of the facility. There is some uncertainty in the volume of stormwater entering the outfall downstream of the Somerville-Marginal CSO Facility, which could contribute to differences in metered versus modelled conditions.
Prison Point CSO Facility	4 discharges 74.1 MG	5 discharges 95.46 MG	• The metered discharges occurred on 01/16/2021, 04/16/2021, 05/29/2021, and 06/22/2021. The model correctly simulated discharges on these dates, but also predicted a discharge of 1.93 MG on 04/01/2021. This discharge, as well as the differences in discharge volume, are likely attributed to spatial variation in rainfall. In particular, the 06/22/2021 storm was highly variable across the region
BOS019	1 discharge 0.09 MG	0 discharges 0 MG	• The monitoring indicated there was one discharge at BOS019 (05/29/2021) while the model predicted zero. The model predicted that flow entered the storage tank for the 5/29/21 storm, but it was not enough to cause an overflow.
Union Park Facility	4 discharges 11.45 MG	5 discharges 18.25 MG	• The metered discharges occurred on 01/16/2021, 04/16/2021, 05/29/2021, and 06/22/2021. The model correctly simulated discharges on these dates, but also predicted a discharge of 1.35 MG on 02/02/2021. This discharge may be due to the model being less accurate during winter conditions. The differences in discharge volume are likely due to spatial variation in rainfall. The 06/22/2021 storm had significant spatial variation, as evidenced by the differences in peak intensity measured at the rain gages (See Table 5-7).

1.5 Conclusions and Remaining Work

This report builds on information previously presented in Semiannual Report No. 6, providing updates relevant to the Q1Q2-2021 system conditions. In terms of water quality impacts to the Variance waters (Charles River, Alewife Brook and Upper Mystic River), the findings of the previously-developed Water Quality Assessment are summarized. These key findings were that non-attainment of the water quality criteria for bacteria was driven primarily by non-CSO sources, and that further reduction in CSO bacterial loadings to these waters would not result in improvement in criteria attainment. The MWRA continues to evaluate bacterial loading reduction scenarios for the Variance waters, and these evaluations will be presented in a Water Quality Alternatives Report to be submitted to EPA and DEP in December 2021.

This report also presents an updated interim system performance assessment in terms of a comparison of Typical Year model results for current (Q1Q2-2021) system conditions compared with the LTCP activation and volume goals. The results have not changed significantly from Semiannual Report No. 6:

- 70 of the 86 CSO outfalls are projected to meet the LTCP goals by the end of the performance assessment in December 2021;
- 6 CSO outfalls will need additional time to implement defined projects;
- 10 CSO outfalls require further investigation to evaluate alternatives/projects and/or identify other efforts that would better serve improvements to water quality.

However, as documented in this report, for the six CSO outfalls identified as needing additional time to implement defined projects, significant advancements have been made in moving the defined projects forward to meet LTCP volume and activation goals, and these projects are expected to be fully implemented by December 2024. These projects include sewer separation work currently being constructed by BWSC with financial and technical support by MWRA to reduce CSO at BOS003 and BOS009 and design efforts underway by BWSC (BOS0014 regulator relief) and MWRA (CHE008 regulator relief, MWR205, & MWR205A/SOM007A upstream supplemental connection) to be followed by construction efforts. The report further documents additional activities performed to bring the 10 CSOs that require further investigation closer to LTCP volume and activation goals. Feasible plans have been developed for four of those CSO outfalls, and those plans are under review with the CSO communities. During the coming years, MWRA will evaluate the potential effectiveness of incorporating green infrastructure to reduce CSO activation frequency and volume at several locations that are not forecast to meet LTCP goals. The focus of these evaluations will be on outfalls located in Variance waters and Environmental Justice communities. However, the remaining six of these CSO outfalls for which feasible plans to meet LTCP goals have not been identified present significant challenges. These CSOs activate during large storm events and based on findings presented in this report would require significant and costly system modifications to achieve LTCP goals. When gauged against the minimal water quality improvements expected by further CSO reduction, consideration should be given to whether other non-CSO related efforts would better serve improvements to water quality.

2. Receiving Water Quality Modeling and Water Quality Assessments

2.1 Summary of Water Quality Assessment Report

As described in Semiannual Report No. 6, MWRA used hydrodynamic and water quality models for the Lower Charles River and Alewife Brook/Upper Mystic River to assess the water quality impacts of CSOs and other discharges to these water bodies. The modeling approach and results of the initial water quality assessment were presented in *Semiannual Report No. 6* (April 30, 2021) and documented in the *Task 5.3 Water Quality Assessment Report* (August 27, 2021), and are summarized briefly in this section below.

The Charles River model is two-dimensional (based on Delft3D) and the Alewife Brook/Upper Mystic River model is one-dimensional (based on InfoWorks Integrated Catchment Modelling (ICM). These models receive flows derived from USGS gauges and from separate collection system models. The two models were calibrated using extensive monitoring data primarily collected by MWRA from receiving waters, storm drains, and CSO outfalls.

The models were applied to the Typical Year annual rainfall series developed as part of previous CSO planning activities. and used throughout the LTCP development, implementation and now assessment to determine if the CSO volumes, activations and receiving water quality standards have been met. The Typical Year was based on the 1992 year with several storms replaced to improve the match with the long-term record. The Typical Year included the 1-year storm used for the previous assessments and a storm very similar to the 3-month storm previously used. The 1-year and 3-month storms were used in previous CSO planning (1997 FP/EIR, *2003 Final Variance Report for Alewife Brook/Upper Mystic River*) to estimate annual attainment with water quality criteria because the models used then were not capable of running an entire year. The models used in the present assessment are capable of running the entire Typical Year but some results for the 1-year and 3-month storms are also presented for completeness. The MWRA's collection system hydraulic model that was the basis of generating CSO flows was based on 2019 system conditions (see *Semiannual CSO Discharge Report No. 4*, April 30, 2020, for further details on 2019 system conditions).

The water quality parameters simulated by the models were *E. coli* and *Enterococcus,* with emphasis on the former. The model results, in terms of #/100 mL, were compared to the Single Sample Maximum water quality criteria for bacteria in the current Massachusetts Water Quality Standards. Since the model could generate significantly more data points than could reasonably be sampled in the real world, calculating a geometric mean from the model output was not considered to be consistent with the intent of the criteria. Use of the single sample maximum criterion was a more appropriate approach for assessing water quality impacts. The Massachusetts Department of Environmental Protection (MADEP) concurred that this was the preferred approach.

Model runs were conducted for the following *E. coli* and *Enterococcus* source loading conditions:

- All sources
- Non-CSO Sources only
- Stormwater only
- Dry weather discharges only
- Boundaries only; and
- CSO only

For each of these conditions, the number of hours of exceedance of the single sample maximum criterion during the Typical Year was calculated. These exceedance hours were calculated for each of the water bodies as a whole and also as a function of location within these water bodies. From these hours of exceedance, percent annual compliance with the criteria were calculated. Results were presented in tables and plots (2-dimensional contour plots for the Charles River and 1-dimensional plots for the Alewife Brook/Upper Mystic River).

For both the Charles River and the Alewife Brook/Upper Mystic River the following general observations were made (based on 2019 system conditions):

- Loadings due to stormwater and upstream boundaries were the two largest sources of *E. coli* and *Enterococcus* in both the 1-year and 3-month design storms and for the Typical Year.
- CSOs contribute loadings only during the larger storms, a maximum of eight times during the Typical Year for the Charles and 10 times for the Alewife/Upper Mystic.
- Single-sample maximum criterion compliance for *E. coli* for the different sources for the Typical Year over the entire water bodies are summarized in Table 2-1. In other words, for the computed percentages in Table 2-1, if any one location exceeds the criterion for a model timestep, that counts as non-compliance for the entire waterbody for that timestep. At fixed points in the waterbodies, the percent compliance would be greater than the entire water body values given in this table, but this approach allows comparison with previous assessments. These numbers are consistent with those predicted during the previous CSO planning as presented in the 1997 FP/EIR for the Charles River, and in the 2003 Final Variance Report for Alewife Brook/Upper Mystic River.
- For the "CSOs Only" condition, the annual compliance percentage is greater in the Alewife Brook than in the Mystic River, although there are no direct untreated CSO discharges to the Mystic River. The reason for this apparent discrepancy is that the elevated bacterial counts due to the CSO discharges to the Alewife Brook quickly move to the Mystic River where they take some time to decay below the standard.

Table 2-1. Summary of Annual Compliance with *E. coli* Single Sample Maximum Criterion, Typical Year, 2019 System Conditions

Waterbody	Annual Compliance with the 235 #/100 mL *E. coli* Single-Sample Maximum Criterion for the Typical Year					
	All Sources	Non-CSO Sources Only	Stormwater Only	Dry Weather Sources Only	Boundaries Only	CSOs Only
Charles River	48%	48%	64%	100%	59%	99.6%
Alewife Brook	45%	45%	47%	100%	100%	98.6%
Upper Mystic River	55%	55%	57%	100%	89%	96.9%

Note. The numbers above for Alewife Brook and Upper Mystic River are slightly different than those presented in Semiannual Report No. 6. During the evaluation of alternatives it was identified that a portion of the Alewife Brook was configured in the model to be wider than field conditions to simulate a flood plain. Since the application of this model is to evaluate Typical Year storms, the width was adjusted to more closely match field conditions. This change had only a small impact to the model results and did not change any of the conclusions. Also, for the Boundaries Only in the Mystic the percent compliance changed from 89% to 91% when only the points downstream of monitoring station 083 are considered. The points upstream of station 083 were considered to be beyond the upstream calibrated boundary of the model.

Sensitivity analyses were conducted in which the stormwater loadings were decreased by factors of 2 and 5 and CSO loadings were increased by a factor of two. The stormwater loading reductions increased the percent compliance with the criteria, but considerable non-compliance remained (approximately 1,500 hours for the Charles River, and 4,000 hours for the Alewife Brook/Upper Mystic River). The doubled CSO loadings only marginally decreased compliance with the criteria (the Charles River remained above 99%, while Alewife Brook/Upper Mystic River remained in the 95-96% range).

2.2 Comparison of Water Quality Baseline Results for 2019 and Q1-2021 Conditions

Following completion of the initial baseline water quality assessment, the next step was to use the water quality models to assess the impacts of various alternatives for reducing the *E. coli* and *Enterococcus* loadings to the Charles River and Alewife Brook/Upper Mystic River. The first step in the alternatives evaluation, however, was to establish an updated baseline condition based on more recent (Q1-2021) system conditions. The Q1-2021 collection system conditions incorporated a number of CSO reduction projects completed since 2019 as well as model updates based on new system investigations and information developed since 2019. The main collection system improvements and model updates implemented from 2019 to Q1-2021 are:

For the Charles River:

- The City of Cambridge completed the Cambridgeport partial sewer separation project, and the associated changes were incorporated into the model. This project reduced treated discharge activation frequency at Cottage Farm from four to two, and reduced the volume from 12.6 MG to 8.95 MG.
- The model configuration of outfalls MWR018-020 was updated based on field investigations. These updates reduced the total CSO volume at these outfalls by 0.58 MG, with no change to activation frequency.
- Overall, the changes reduced the total untreated CSO volume in the Typical Year from 4.1 MG to 3.5 MG.

For Alewife Brook/Upper Mystic River:

- The City of Cambridge completed a project to remove sediment in the combined sewers downstream of the CAM401A regulator. This project reduced the activation frequency at CAM401A from 10 to five, and reduced the volume from 3.59 MG to 0.66 MG.
- Model refinements and calibration adjustments at SOM001A resulted in an increase in the activation frequency from six to eight, and an increase in volume from 3.60 to 4.47 MG.
- MWRA implemented a revised operating procedure at Alewife Brook Pump Station. This change was incorporated into the model but did not substantially affect CSO volumes or activations.
- Overall, the changes reduced the total untreated CSO volume in the Typical Year from 9.5 MG to 6.3 MG.

The Q1-2021 collection system model was run with a sanitary wastewater tracer (to allow calculation of the CSO *E. coli* counts) and the model results were used to specify the CSO inputs to the water quality models for the Q1-2021 Conditions water quality runs.

Table 2-2 presents a comparison of the percent annual compliance with the *E. coli* single-sample maximum criterion for the 2019 Conditions and Q1-2021 Conditions water quality runs for the Charles River, Alewife Brook and Upper Mystic River. Results are presented for the same range of source loading conditions as presented above in Table 2-1. The following observations can be made:

- For the Charles River, the percent annual compliance remained unchanged relative to 2019 conditions for all of the loading conditions except for the CSO Only case, where the percent compliance increased from 99.6% to 99.9%.
- For the Alewife Brook, the percent annual compliance remained unchanged relative to 2019 conditions for all of the loading conditions except for the CSO Only case, where compliance increased from 98.7% to 99.6%.
- For the Upper Mystic River, the percent annual compliance remained unchanged relative to 2019 conditions for all of the loading conditions except for the CSO Only case, where the percent compliance increased from 96.9% to 97.9%.

In summary, the system improvements and model updates implemented between the 2019 and Q1-2021 system conditions versions of the model further reduced the impacts of CSOs on attainment of the single-sample maximum criterion when considering CSO loads, only. The impacts of other individual sources on attainment of the criterion did not change, nor did the level of attainment change when considering all sources together. In comparing the All Sources and Non-CSO Sources Only columns, it is clear that further reduction in CSOs would not affect the overall percent attainment with the single-sample maximum criterion when non-CSO sources are considered.

Table 2-2. Compliance Statistics for 2019 and Q1-2021 Conditions

Condition	Percent Annual Compliance with *E. coli* Single-Sample Maximum Criterion (235#/100mL)					
	All Sources	Non-CSO Sources Only	Stormwater Only	Dry Weather Sources Only	Boundaries Only	CSOs Only
Charles River						
2019	48%	48%	64%	100%	59%	99.6%
Q1-2021	48%	48%	64%	100%	59%	99.9%
Alewife Brook						
2019	45%	45%	47%	100%	100%	98.7%
Q1-2021	45%	45%	47%	100%	100%	99.6%
Upper Mystic River						
2019	55%	55%	57%	100%	100%	96.9%
Q1-2021	55%	55%	57%	100%	100%	97.9%

2.3 Next Steps: Alternatives Analysis

The water quality models are currently being used to assess the impact of a range of other load reduction scenarios on attainment with the water quality criteria. These scenarios include the following:

- Non-CSO sources capped at 100% of water quality criterion: For this run, the bacterial counts for the non-CSO sources were set to the value of the single-sample maximum criterion, unless the values of the counts currently used in the modeling were less than the single-sample maximum criterion, in which case the current values were used.
- Non-CSO sources capped at 50% of the water quality criterion: For this run, the bacterial counts for the non-CSO sources were set to one half of the value of the single-sample maximum criterion, unless the values of the counts currently used in the modeling were less than half of the single-sample maximum criterion, in which case the current values were used.
- Q1-2021 Conditions but with all outfalls meeting the CSO Long-Term Control Plan (LTCP) goals: For this run, the discharge characteristics of all CSOs that did not meet the LTCP goals for activation frequency and volume under Q1-2021 Conditions were adjusted so that each of those outfalls matched its respective LTCP goals. For outfalls that already met the LTCP goals under Q1-2021 Conditions, no changes were made.

- Stormwater capture scenario: This run approximated the impact of implementing stormwater management projects that would control the first one inch of rainfall throughout the separate stormwater areas tributary to the Charles River, Alewife Brook and Upper Mystic River. This scenario was approximated in the model by eliminating the rainfall assigned to separate stormwater areas for all rain events less than 1 inch from the modeled Typical Year. Rainfall assigned to combined sewer areas for all rain events less than 1 inch was not removed. For storms greater than one inch, no adjustments were made to the rainfall assigned to the separate stormwater or combined sewer areas. Trying to eliminate the first inch of rainfall from storms that had more than 1 inch of rainfall in the separate stormwater areas would have greatly complicated the modeling and was not considered necessary for this sensitivity analysis.

The results of these evaluations will be presented in a Water Quality Alternatives Report to be submitted in December 2021.

2.4 Non-Variance Water Quality – Report Card Method

As described in sections 2.1-2.3, water quality models developed for this assessment evaluate compliance with state indicator bacteria standards in regions with CSO variances, the Charles River and Alewife Brook/Upper Mystic River. In addition, MWRA conducts routine monitoring where CSO discharges remain to Class SB_{CSO} designated waters, including the Mystic River mouth, Chelsea Creek, Inner Harbor, Reserved Channel, and Fort Point Channel. To provide an assessment of water quality in those regions, MWRA has adapted the methodology used to develop annual report cards for Boston Harbor's tributary watersheds. Originally developed by Mystic River Watershed Association in 2014, the report cards summarize compliance with state bacteria standards by subregion.[2] Beginning in 2020, EPA publicized report cards for the Mystic, Charles, and Neponset River watersheds centered on this methodology.

The grades are calculated from an average compliance rate with primary and secondary contact standards, weighted based on antecedent rainfall, and calculated on a three year rolling basis. Per Massachusetts Surface Water Quality Standards 314 CMR 4.00, Class SB marine waters have a single sample maximum standard of 104 *Enterococcus* #/100mL, often referred to as a swimming standard. Class SC marine waters, designated to support secondary contact recreation like boating, fishing and sailing have a criterion of 350 *Enterococcus* #/100mL, often referred to as a boating standard (NOTE: water quality assessments in marine waters use *Enterococcus* as the indicator, while freshwater assessments preferentially use *E. coli* (per communication with DEP)). The weighting of wet and dry weather is designed to approximate that roughly 75% of the year falls into dry weather. This is supported by the fact that the Typical Year for the LTCP has about 90 storms in 365 days. Wet weather is defined as >0.25" of rain at Logan Airport in the two days preceding sampling and the day of sampling. Calculating the grades on a three year rolling basis balances year-to-year variability for a more accurate depiction of long term trends.

The three year compliance rate for a given station is calculated and converted to a letter grade based on EPA report card publications.[3]

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[2] "Water Quality Grade: EPA." Mystic River Watershed Association. Accessed October 8, 2021. https://mysticriver.org/epa-grade

[3] "2020 Mystic River Watershed Report Card Frequently Asked Questions". Environmental Protection Agency. Accessed October 8, 2021. https://www.epa.gov/mysticriver/2020-mystic-river-watershed-report-card-frequently-asked-questions

Table 2-3 below shows grades for MWRA monitoring stations in non-variance regions that still receive CSO discharges in the Typical Year. Data from 2010-2020 was used to calculate grades for 2012-2020. With the exception of station 075 at the head of Fort Point Channel, all stations have B to A range grades since 2012.

Table 2-3. Report Card Grades for MWRA Monitoring Stations in Non-Variance Regions, 2018-2020. Color Shading Follows Existing EPA Report Card Publications

Station	Description	2018	2019	2020
075	Fort Point (Head)	C-	D-	D-
018	Fort Point (Mid)	A-	B+	B
178	Fort Point (Mouth)	A	A-	B+
019	Fort Point (Inner Harbor)	A+	A+	A
022	Reserved Channel	A+	A+	A
138	Inner Harbor (Aquarium)	A+	A+	A+
014	Inner Harbor (Charles mouth)	A+	A+	A+
052	Mystic mouth (@MWR205)	A-	B	B
069	Mystic mouth (@BOS017)	A-	A-	B+
137	Mystic mouth (mid-channel)	A+	A+	A+
027	Chelsea Creek	A+	A+	A+
015	Inner Harbor (Tobin Br)	A+	A+	A
024	Inner Harbor (Airport)	A+	A+	A+

3. Typical Year Discharges: Updated System Performance Assessment and Comparison with LTCP Levels of Control

3.1 Description, Purpose and Use of the Hydraulic Model

MWRA's hydraulic model is the primary tool used to evaluate the performance of the MWRA system and MWRA and community CSOs against the LTCP Typical Year levels of control. Environmental variables such as rainfall, tide, and evaporation serve as inputs to the model. These inputs are used by the model to estimate the flow entering the sewer system, as well as the hydraulic performance of the system at CSO regulators. The hydraulic model includes the entire MWRA regional collection and transport system, broken into the north system (flows to Deer Island via the Columbus Park, Ward Street, Chelsea Creek and Winthrop Terminal Headworks) and the south system (flows to Deer Island via the Nut Island Headworks). The CSO system is part of the north system model and includes many of the local sewers within the four CSO communities of Boston, Cambridge, Chelsea, and Somerville. Therefore, the north system model, as shown in Figure 3-1 is used in model predictions of CSO performance. The north system model includes approximately 8,670 links, 8,930 nodes, and 2,500 subcatchments.

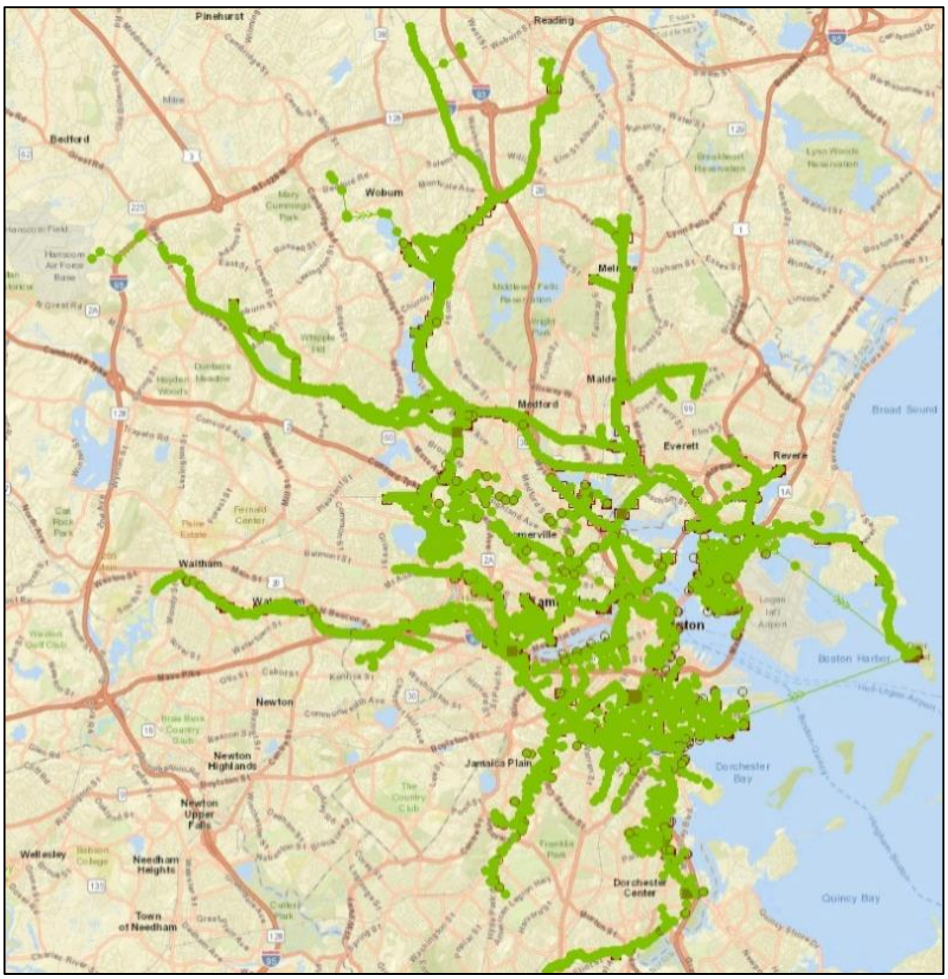

Figure 3-1. MWRA InfoWorks ICM North System Model

Hydraulic modeling has historically served as the basis for evaluating performance of the CSO system. The hydraulic model was first established in 1992 during early development of the LTCP using the U.S. Environmental Protection Agency (EPA) Storm Water Management Model software. It was then updated and converted to InfoWorks CS in the early 2000's to improve the simulation of hydraulic conditions and better serve MWRA's needs during LTCP implementation. The InfoWorks CS model was converted to

InfoWorks ICM, the successor modeling software to InfoWorks CS, for this post-construction assessment. The MWRA and CSO community wastewater collection systems are continuously improving, and even routine inspections can yield details of these systems that were lost over time - parts of these systems were constructed as early as the mid-1800s. As a result, the model continues to be updated to reflect completed improvements and inspection results.

In 2019 through early 2020, MWRA upgraded and calibrated its 2017 system conditions model with extensive inspection information and meter data collected in 2018, as described in Semiannual Progress Reports Nos. 4, 5 and 6 (https://www.mwra.com/cso/pcmapa.html). Subsequent to this extensive calibration effort, additional modifications have been made to the model based on new information.

3.2 Hydraulic Model Updates

Updates to MWRA's hydraulic model are necessary to estimate CSO discharges as improvements are made to the MWRA and community sewer systems; to compare or verify model predictions against meter data; and to update Typical Year CSO performance for comparison with the LTCP activation and volume goals. The following text describes recent updates to MWRA's Q1-2021 system conditions model to predict CSO discharges during the storms that occurred in the period January 1, 2021 through June 30, 2021 (the "Q1Q2-2021 system conditions model"). This same model will be used to assess the Typical Year CSO performance for current system conditions.

Table 3-1 documents the changes made to the Q1-2021 system conditions model to create the Q1Q2-2021 system conditions model. The table provides the **Location** of the part of the model that was modified. The **Summary of Change** provides information on what was changed in the model. **Supporting Information** provides additional context on the justification/source of information about the modification that was made to the model.

Table 3-1. Model Changes from Q1-2021 to Q1Q2-2021 System Conditions

Location	Summary of Change	Supporting Information
Full Model-CSO Facilities	Updated the Real Time Control (RTC) to include the storm-by-storm operation of the facilities based on facility operation data provided by MWRA.	The updated RTC was added for the January 1 – June 30, 2021 period based on MWRA-provided data.
Charlestown (BOS017)	Removed leaky tide gate and removed 4 acres of stormwater upstream of BOS017.	Updated the model based on system changes provided by BWSC.
Somerville Marginal CSO Facility	Added 42-inch storm drain tributary to the 85" x 90" combined sewer upstream of Somerville Marginal CSO Facility and re-delineated its tributary area.	The stormwater areas tributary to the pipe were in the model but were redirected to the 42-inch drain as appropriate.
Boston Marginal Conduit (BMC)	Revised the categorization of manholes along the BMC as sealed vs. unsealed	Adjusted manhole configurations along the BMC based on recent field information.
	Updated the model to include DCR catch basins tributary to the Boston Marginal Conduit BMC.	Catch basins were added based on review of DCR storm water drawings.
	Updated the model to include an interconnection between the Old Stony Brook Conduit (OSBC) and the Stony Brook Conduit (SBC)	Added an interconnection between the Old Stony Brook Conduit (OSBC) and the Stony Brook Conduit (SBC) based on field investigations conducted by BWSC.
	Made adjustments to headloss parameters at locations along the BMC.	Removed modeling losses at the manholes along the BMC identified during the alternative evaluation process to better reflect the structural configuration of the BMC and to improve the match between modeled and measured depths in the BMC

Location	Summary of Change	Supporting Information
BOS046, Boston Gate House #1	The model RTC was updated to reflect the actual gate conditions at Gate House #1 during the January 1, 2021 – June 30, 2021 period. The Typical Year version of the model will open the gates for rainfall events greater than 1-inch. The gate opening height was changed from 13 feet to 4 feet based on field information from Boston Water and Sewer Commission (BWSC).	BWSC opens the gates in Gate House #1 for each storm predicted to be 1 inch or greater over less than 24 hrs Gate opening dates from Jan 1 to June 30, 2021 were provided by BWSC.
BOS046, Boston Gate House #2	Added overflow at Boston Gate House #2, at El. 13 BCB (El. 112.97 MDC)	This overflow location was added based on new field information provided by BWSC.
North Metropolitan Branch Sewer Downstream of Alewife Brook Pump Station	Made adjustments to headloss parameters at locations along the interceptor.	Updated headloss parameters in the North Metropolitan Branch sewer downstream of the Alewife Brook Pump Station based on a review of pipe configurations.
Cottage Farm/Willard Street	Updated the model to include local subcatchment areas and piping tributary to the MWRA interceptor at Willard Street.	Added 28 acres at 50% impervious and associated piping, based on information provided by the City of Cambridge.
Alewife/ CAM401A	Added 6 inches of sediment to the combined sewer downstream of the CAM401A regulator to reflect 6-inches of standing water observed during the field inspection.	The City of Cambridge reported observing 6 inches of water downstream of the CAM401A regulator as part of post cleaning measurements on April 13, 2021.
CHE004	Updated the weir elevation based on field investigations.	The weir in the Q1-2021 Conditions model was set at El. 109.83. Due to construction issues and based on field observations, the weir elevation was reduced by 5 inches to El. 109.41.

3.3 Updated Interim CSO Performance Assessment Relative to Attainment of LTCP Goals

The performance objectives of MWRA's approved LTCP include annual frequency and volume of CSO discharge at each outfall based on "Typical Year" rainfall. The Court Order - specifically Exhibit B to the Second Stipulation - defines the LTCP levels of control by outfall and by receiving water segment. The sources of these levels of control are included in the historical MWRA reports that documented the various CSO control planning efforts MWRA conducted from 1992 to 2008. These source documents, all submitted to and accepted by MADEP and MADEP, are listed in Exhibit A to the Second Stipulation and presented in Semiannual Report No. 4 (April 30,2020), Table 4-1.

MWRA used the Q1Q2-2021 System Conditions Model to simulate current system performance under Typical Year rainfall and produce an updated interim performance assessment compared to the LTCP goals. These results are presented in Table 3-2 on the following pages, along with the LTCP Typical Year levels of control and previously modeled CSO discharge levels for 1992 system conditions when MWRA commenced planning for the LTCP. In Table 3-2, Q1Q2-2021 System Conditions activations or volumes that exceed the LTCP goals are shaded in grey.

3.3.1 Closed CSO Outfalls

Table 3-2 presents a full accounting of the status and Typical Year overflow activity for all discharge locations addressed by MWRA's CSO planning efforts and projects since MWRA assumed responsibility for system-wide CSO control in the mid-1980s. A few CSO outfalls listed in Table 3-2 were closed prior to the Federal Court's integration of LTCP levels of control into the Court Order in 2006 and are not listed in Exhibit B to the Second Stipulation. Table 3-2 shows that 35 outfalls active in the 1980s are now "closed," i.e., CSO discharges are eliminated. The closed outfalls include all 28 outfalls required to be closed by the approved LTCP and the Court Order and several additional outfalls. These additional closed outfalls include:

- SOM002, SOM002A and SOM003 on Alewife Brook and SOM006 on the Upper Mystic River, closed by the City of Somerville in the 1980s and 1990s;
- CHE002 on the Inner Harbor, closed by the City of Chelsea in 2014;
- BOS006 and BOS007 in East Boston, closed by BWSC in 2008;
- BOS072 on Fort Point Channel, closed by BWSC in 2014;
- BOS083 on the South Boston beaches, closed by MWRA in 2008 with construction of the South Boston CSO storage tunnel; and
- CAM009 and CAM011 on the Charles River, which are tentatively closed by the City of Cambridge pending additional hydraulic evaluations of upstream flooding risk.

3.3.2 Outfalls along the South Boston Beaches

MWRA has "effectively eliminated" CSO discharges at the remaining five outfalls along the South Boston beaches: BOS081, BOS082, BOS084, BOS085 and BOS086. Since May 2011, when MWRA brought the South Boston CSO Storage Tunnel and related facilities online, no CSO has discharged to the beaches, compared with an average of 20 CSO discharges per year prior to tunnel completion.

The tunnel also captures separate stormwater that prior to tunnel completion discharged to the beaches through the CSO outfalls every time it rained - 90 to 100 storms a year. Over the 10 years of tunnel operation through Q2-2021, stormwater has discharged to the beaches in only three large storms, including Hurricane Irene in August 2011, the December 9, 2014 storm (4.47 inches of rain), and the March 2, 2018 storm surge and coastal flooding event. The tunnel has prevented more than 2 billion gallons of CSO and stormwater from discharging to the beaches since May 2011.

3.3.4 Updated CSO Typical Year Performance at Remaining Active CSO Outfalls

The Typical Year CSO performance based on Q1Q2-2021 System Conditions in Table 3-2 indicate substantial improvements over 1992 conditions at remaining active outfalls as a result of implementing the MWRA's LTCP projects and other actions taken by MWRA and the CSO communities to further control CSOs. A full discussion of the LTCP, its 35 projects (all completed by 2015), and other CSO abatement actions is presented in Semiannual Report No. 1. A similar version of Table 3-2 was previously presented as Table 3-2 in Semiannual Report No. 6 based on Q1-2021 system conditions, for comparison. As noted in Section 3.2, the MWRA's hydraulic model is continually being updated to reflect ongoing system as well as model improvements. At some locations, system improvements and/or model updates have resulted in changes in the Typical Year performance between the Q1-2021 and current (Q1Q2-2021) system conditions, as summarized above in Table 3-1.

3.4 Forecasted CSO Performance

3.4.1 Current Attainment of the LTCP Goals at Remaining Active Outfalls

In Table 3-2 below the outfalls are color-coded based on status of attainment with the LTCP goals, as follows:

- Dark blue indicates outfalls that currently achieve the LTCP goals under the Q1Q2-2021 conditions
- Medium blue indicates outfalls that are anticipated to achieve the LTCP goals by the end of December 2021.
- Light blue indicates outfalls that are forecast to achieve the LTCP goals after December 2021.
- No color indicates outfall for which investigations continue to assess the potential to achieve the LTCP goals.

As indicated in Table 3-2, of the 46 outfalls that remain active (i.e. are not physically closed or associated with the North Dorchester Bay CSO Storage Tunnel), 28 currently meet the LTCP goals and two more are anticipated to meet the LTCP goals by the end of December 2021, bringing the total achieving by the end of 2021 to 30. Of the remaining outfalls, six are projected to meet the LTCP goals after December 2021, and ten outfalls continue to be investigated.

3.4.2 Additional Outfalls Forecast to Attain LTCP Activation and Volume Goals by December 2021

Outfalls CHE004 and BOS010 are identified in Table 3-2 as not currently meeting the LTCP goals, but they are anticipated to meet the goals by the end of 2021.

At outfall CHE004, the City of Chelsea had planned to raise the overflow weir by 1.5 feet early in 2021. However, due to construction issues, the weir could not initially be raised the full 1.5 feet, so the Q1Q2-2021 Conditions results reflect the lower weir elevation. In August 2021, the City of Chelsea successfully raised the weir by the full 1.5 feet, and the projected performance with the weir raised the full height (3 activations and 0.30 MG) meets the LTCP goals. This will be reflected in the final report.

BWSC is expected to complete sewer separation Contract 2 in East Boston by the end of 2021. The projected performance of Outfall BOS010 upon completion of Contract 2 separation work (1 activation, 0.07 MG) meets the LTCP goals. More information about the BWSC sewer separation contracts and their predicted CSO benefits is presented in Section 4.1.

Table 3-2. Typical Year Performance: Baseline 1992, Current (Q1Q2-2021 Conditions) and LTCP (1 of 3)

Outfall currently achieves LTCP activation and volume goals.	Outfall is projected to achieve LTCP activation and volume goals by Dec 2021.	Outfall is forecast to achieve LTCP goals after Dec 2021.
Outfall investigations continue for forecast of LTCP attainment potential.	Model prediction is greater than LTCP value.	

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q1Q2-2021 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
ALEWIFE BROOK						
CAM001	5	0.15	1	0.02	5	0.19
CAM002	11	2.73	0	0.00	4	0.69
MWR003	6	0.67	3	0.61	5	0.98
CAM004	20	8.19	Closed	N/A	Closed	N/A
CAM400	13	0.93	Closed	N/A	Closed	N/A
CAM401A	18	2.12	5	0.66	5	1.61
CAM401B			4	0.50	7	2.15
SOM001A(8)	10	11.93	8	4.47	3	1.67
SOM001	0	0.00	Closed	N/A	Closed	N/A
SOM002	0	0.00	Closed	N/A	N/I(3)	N/I(3)
SOM002A	0	0.00	Closed	N/A	Closed	N/A
SOM003	0	0.00	Closed	N/A	Closed	N/A
SOM004	5	0.09	Closed	N/A	Closed	N/A
TOTAL		**26.81**		**6.26**		**7.29**
UPPER MYSTIC RIVER						
SOM007A/MWR205A(7)	9	7.61	5	4.50	3	3.48
SOM006	0	0.00	Closed	N/A	N/I(3)	N/I(3)
SOM007	3	0.06	Closed	N/A	Closed	N/A
TOTAL		**7.67**		**4.50**		**3.48**
MYSTIC/CHELSEA CONFLUENCE						
MWR205(7) (Somerville-Marginal CSO Facility)	33	120.37	30	99.66	39	60.58
BOS013*	36	4.40	8	0.27	4	0.54
BOS014(7)	20	4.91	8	1.45	0	0.00
BOS015	76	2.76	Closed	N/A	Closed	N/A
BOS017(8)	49	7.16	6	0.34	1	0.02
CHE002	49	2.51	Closed	N/A	4	0.22
CHE003	39	3.39	0	0.00	3	0.04
CHE004**	44	18.11	6	0.41	3	0.32
CHE008(7)	35	22.35	6	1.94	0	0.00
TOTAL		**185.96**		**104.06**		**61.72**
UPPER INNER HARBOR						
BOS009(7)	34	3.60	10	0.73	5	0.59
BOS010**	48	11.83	7	0.44	4	0.72
BOS012	41	7.90	0	0.00	5	0.72
BOS019	107	4.48	1	0.07	2	0.58
BOS050	No Data		Closed	N/A	N/A	N/A
BOS052	0	0.00	Closed	N/A	Closed	N/A
BOS057*	33	14.71	2	1.33	1	0.43
BOS058	17	0.29	Closed	N/A	Closed	N/A
BOS060*	64	2.90	2	0.47	0	0.00
MWR203 (Prison Point Facility)*	28	261.85	17	248.23	17	243.00
TOTAL		**307.56**		**251.27**		**246.04**

Table 3-2. Typical Year Performance: Baseline 1992, Current (Q1Q2-2021 Conditions) and LTCP (2 of 3)

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q1Q2-2021 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
LOWER INNER HARBOR						
BOS003(7)	28	18.09	9	6.40	4	2.87
BOS004	34	3.43	2	0.06	5	1.84
BOS005	4	10.23	0	0.00	1	0.01
BOS006	17	1.21	Closed	N/A	4	0.24
BOS007	34	3.93	Closed	N/A	6	1.05
TOTAL		**36.89**		**6.46**		**6.01**
CONSTITUTION BEACH						
MWR207	24	4.00	Closed	N/A	Closed	N/A
TOTAL		4.00		N/A		N/A
FORT POINT CHANNEL						
BOS062(8)	8	4.15	5	1.26	1	0.01
BOS064*	14	0.99	1	0.01	0	0.00
BOS065(8)	11	3.08	1	0.62	1	0.06
BOS068	4	0.62	0	0.00	0	0.00
BOS070	4	281.62				
BOS070/DBC(8)			7	6.18	3	2.19
MWR215 (Union Park Facility)			10	26.73	17	71.37
BOS070/RCC			0	0.00	2	0.26
BOS072	21	3.62	Closed	N/A	0	0.00
BOS073	23	4.73	0	0.00	0	0.00
TOTAL		**298.81**		**34.80**		**73.89**
RESERVED CHANNEL						
BOS076	65	65.94	1	0.10	3	0.91
BOS078	41	14.84	0	0.00	3	0.28
BOS079	18	2.10	0	0.00	1	0.04
BOS080	33	6.21	0	0.00	3	0.25
TOTAL		**89.09**		**0.10**		**1.48**
NORTHERN DORCHESTER BAY						
BOS081	13	0.32	0 / 25 year	N/A	0 / 25 year	N/A
BOS082	28	3.75	0 / 25 year	N/A	0 / 25 year	N/A
BOS083	14	1.05	Closed	N/A	0 / 25 year	N/A
BOS084	15	3.22	0 / 25 year	N/A	0 / 25 year	N/A
BOS085	12	1.31	0 / 25 year	N/A	0 / 25 year	N/A
BOS086	80	3.31	0 / 25 year	N/A	0 / 25 year	N/A
BOS087	9	1.27	Closed	N/A	Closed	N/A
TOTAL		**14.23**		**0.00**		**0.00**
SOUTHERN DORCHESTER BAY						
BOS088	0	0.00	Closed	N/A	Closed	N/A
BOS089 (Fox Pt.)	31	87.11	Closed	N/A	Closed	N/A
BOS090 (Commercial Pt.)	19	10.16	Closed	N/A	Closed	N/A
TOTAL		**97.27**		**0.00**		**0.00**
UPPER CHARLES						
BOS032	4	3.17	Closed	N/A	Closed	N/A
BOS033	7	0.26	Closed	N/A	Closed	N/A
CAM005(8)	6	41.56	8	0.74	3	0.84
CAM007*	1	0.81	1	0.50	1	0.03
CAM009(4)	19	0.19	Closed	N/A	2	0.01
CAM011(4)	1	0.07	Closed	N/A	0	0.00
TOTAL		**46.06**		**1.24**		**0.88**

Table 3-2. Typical Year Performance: Baseline 1992, Current (Q1Q2-2021 Conditions) and LTCP (3 of 3)

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q1Q2-2021 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
LOWER CHARLES						
BOS028	4	0.02	Closed	N/A	Closed	N/A
BOS042	0	0.00	Closed	N/A	Closed	N/A
BOS049	1	0.01	Closed	N/A	Closed	N/A
CAM017	6	4.72	0	0.00	1	0.45
MWR010	16	0.08	0	0.00	0	0.00
MWR018(8)	2	3.18	2	1.12	0	0.00
MWR019(8)	2	1.32	2	0.48	0	0.00
MWR020(8)	2	0.64	2	0.48	0	0.00
MWR021	2	0.50	Closed	N/A	Closed	N/A
MWR022	2	0.43	Closed	N/A	Closed	N/A
MWR201(8) (Cottage Farm Facility)	18	214.10	2	9.10	2	6.30
MWR023(5)	39	114.60	1	0.04	2	0.13
SOM010	18	3.38	Closed	N/A	Closed	N/A
TOTAL		**342.98**		**11.22**		**6.88**
NEPONSET RIVER						
BOS093	72	1.61	Closed	N/A	Closed	N/A
BOS095	11	5.37	Closed	N/A	Closed	N/A
TOTAL		**6.98**		**0.00**		**0.00**
BACK BAY FENS						
BOS046 – Boston GH1(5)	2	5.25	1	0.10	2	5.38
BOS046 – Boston GH2(6)			0	0.00		
TOTAL		**5.25**		**0.10**		**5.38**
Total Treated		**698**		**384**		**381**
Total Untreated		**759**		**32**		**23**
GRAND TOTAL		**1457**		**416**		**404**

*Model predicted activation and volume for Q1Q2-2021 System Conditions has decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to meet such goals at these locations is considered immaterial.
** The City of Chelsea raised the weir at the regulator associated with outfall CHE004 on August 16, 2021. With the weir raised an additional 3 inches the predicted activation frequency is 3 and the volume is 0.30 MG allowing CHE004 to achieve its LTCP goals. The BWSC is anticipated to complete Contract 2 sewer separation in East Boston by the end of 2021. That work is projected to reduce the activation frequency at outfall BOS010 to 1 and the volume to 0.07 MG, and forecasting achieving the LTCP goals.

(1) 1992 System Conditions include completion of Deer Island Fast-Track Improvements, upgrades to headworks, and new Caruso and DeLauri pumping stations. Estimated 1988 Grand Total Typical Year CSO volume (prior to these improvements) is 3,300 million gallons.
(2) From Exhibit B to Second Stipulation of the United States and the Massachusetts Water Resources Authority on Responsibility and Legal Liability for Combined Sewer Overflows, as amended by the Federal District Court on May 7, 2008 (the "Second CSO Stipulation").
(3) N/I: Outfall was closed prior to 2006 and is not included in Exhibit B to the Second CSO Stipulation.
(4) Tentatively closed pending additional hydraulic evaluation by City of Cambridge.
(5) BOS046 (Gatehouse 1) is primarily a stormwater discharge but may contain CSO if the upstream regulators overflow. The upstream regulators are monitored directly. Gatehouse 1 is normally closed but may be opened for flood mitigation. Flow can discharge at the Gatehouse if either the gate is opened or if water overtops the gate. Based on model tracer studies, when a discharge occurs during model simulations at BOS046 it was estimated that 25% of the CSO from the upstream regulators discharges at the MWR023 outfall (Charles River) and 75% discharges at BOS046 (Back Bay Fens).
(6) BOS046 (Gatehouse 2) contains a gate which may also be overtopped in extreme wet weather; this gate was added to the model after the Q1-2021 system conditions model run per new field information.
(7) See Table 3-3 below for outfalls forecast to attain LTCP after 2021.
(8) See Table 3-4 below for site-specific investigations underway where attainment of LTCP goals cannot yet be forecast.

3.4.3 Outfalls Forecast to Attain LTCP Activation and Volume Goals after December 2021

The site-specific investigations described in Chapter 4 have identified system improvement recommendations that are predicted by MWRA's hydraulic model to result in attainment of the LTCP goals but are scheduled or expected to be implemented by MWRA and the CSO communities after 2021. These outfalls and the recommended improvements are listed in Table 3-3.

Table 3-3. Outfalls Forecast to Attain LTCP Goals After 2021

OUTFALL	LOCATION	SYSTEM IMPROVEMENT(S)	TO BE IMPLEMENTED BY	SCHEDULED COMPLETION
MWR205	Somerville-Marginal CSO Facility	Add new dry weather flow (DWF) connection to the interceptor; redirect separate stormwater; and replace tide gate	MWRA	2024
SOM007A/ MWR205A				
BOS003	East Boston	Complete BWSC Sewer Separation Contract 3, including upgrade interceptor connection at regulator RE003-12.	BWSC	2023
BOS009				
BOS014		Add interceptor connection		
CHE008	Chelsea Creek	Replace/upgrade interceptor connection	MWRA	2022

3.4.4 Outfalls Currently Not Forecast to Attain LTCP Activation and/or Volume Goal

MWRA has continued to track CSO performance and the causes of higher overflow activity at locations where Typical Year CSO activation and/or volume exceed the LTCP goals and no system improvement has yet been recommended. MWRA has identified candidate projects or system adjustments that may further mitigate CSO discharges to bring activations and volumes to or closer to the LTCP goals. Table 3-4 lists these locations and potential mitigation alternatives identified so far. Information on the progress of these evaluations is presented in Chapter 4.

Table 3-4. Investigations Where Attainment of LTCP Goals Cannot Yet be Forecast

OUTFALL	Q1Q2-2021 SYSTEM CONDITIONS MODEL		LONG TERM CONTROL PLAN		POTENTIAL ACTION PLAN
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	
ALEWIFE BROOK					
SOM001A	8	4.47	3	1.67	• Potential modifications to the regulator structure including raising the weir and interceptor connection relief, relining portions of the Alewife Brook Conduit (ABC) and Alewife Brook Branch Sewer (ABBS,) and upstream flow controls have been evaluated but a feasible plan to meet the LTCP goals has not yet been identified. MWRA is coordinating with City of Somerville to investigate whether flood control measures being considered by the City of Somerville may provide CSO reduction benefit.
MYSTIC/CHELSEA CONFLUENCE					
BOS017	6	0.34	1	0.02	• Concept design has been developed to construct modifications to the Sullivan Square siphon structure including adjustable stop logs upstream of each siphon barrel. MWRA is coordinating with BWSC on the feasibility and cost of this alternative.
FORT POINT CHANNEL					
BOS062	5	1.26	1	0.01	• Relieve interceptor connection. MWRA is coordinating with BWSC on the feasibility and cost of this alternative.
BOS065	1	0.62	1	0.06	• Raise the weir at the regulator. MWRA is coordinating with BWSC on the feasibility and cost of this alternative.
BOS070/DBC	7	6.14	3	2.19	• Add parallel relief pipe downstream of RE070/7-2. MWRA is coordinating with BWSC on the feasibility and cost of this alternative.
CHARLES RIVER					
MWR201 (Cottage Farm)	2	9.10	2	6.30	• Evaluated upstream sewer separation and targeted groundwater infiltration removal. • Further alternative development and evaluation with consideration of water quality benefits and cost to be considered beyond Dec. 2021.
CAM005	8	0.74	3	0.84	• Further coordination with CSO community to balance level of service needs against evaluated weir raising, cleaning of outfall, and separation of upstream areas. • Further alternative development and evaluation with consideration of water quality benefits and cost to be considered beyond Dec. 2021.
MWR018	2	1.12	0	0.00	• Evaluated alternatives including raising weirs, reducing head loss in the BMC; and redirecting upstream BWSC separate storm drains. • Further alternative development and evaluation with consideration of water quality benefits and cost to be considered beyond Dec. 2021.
MWR019	2	0.48	0	0.00	
MWR020	2	0.48	0	0.00	

4. Recommendations and Continuing Work for Outfalls not Currently Attaining LTCP Activation and Volume Goals

The following sections provide recommendations and continuing work for outfalls which are currently not attaining LTCP levels of control.

4.1 East Boston Outfalls

Eight CSO outfalls (BOS003, BOS004, BOS005, BOS009, BOS010, BOS012, BOS013, and BOS014) are included in the East Boston subsystem and discharge to either the Inner Harbor or Mystic/Chelsea Confluence. The dry weather flows from the regulators associated with these CSO outfalls discharge to either the Condor Street Interceptor or the East Boston Branch Sewer. Dry weather flow is carried by the two interceptors to the Caruso Pump Station. When the hydraulic grade line exceeds the elevation of the overflow points in the regulators along the Condor St. Interceptor and East Boston Branch Sewer, excess flow is discharged to the Inner Harbor and/or the Mystic/Chelsea Confluence. A schematic of the East Boston sub-system is shown in Figure 4-1.

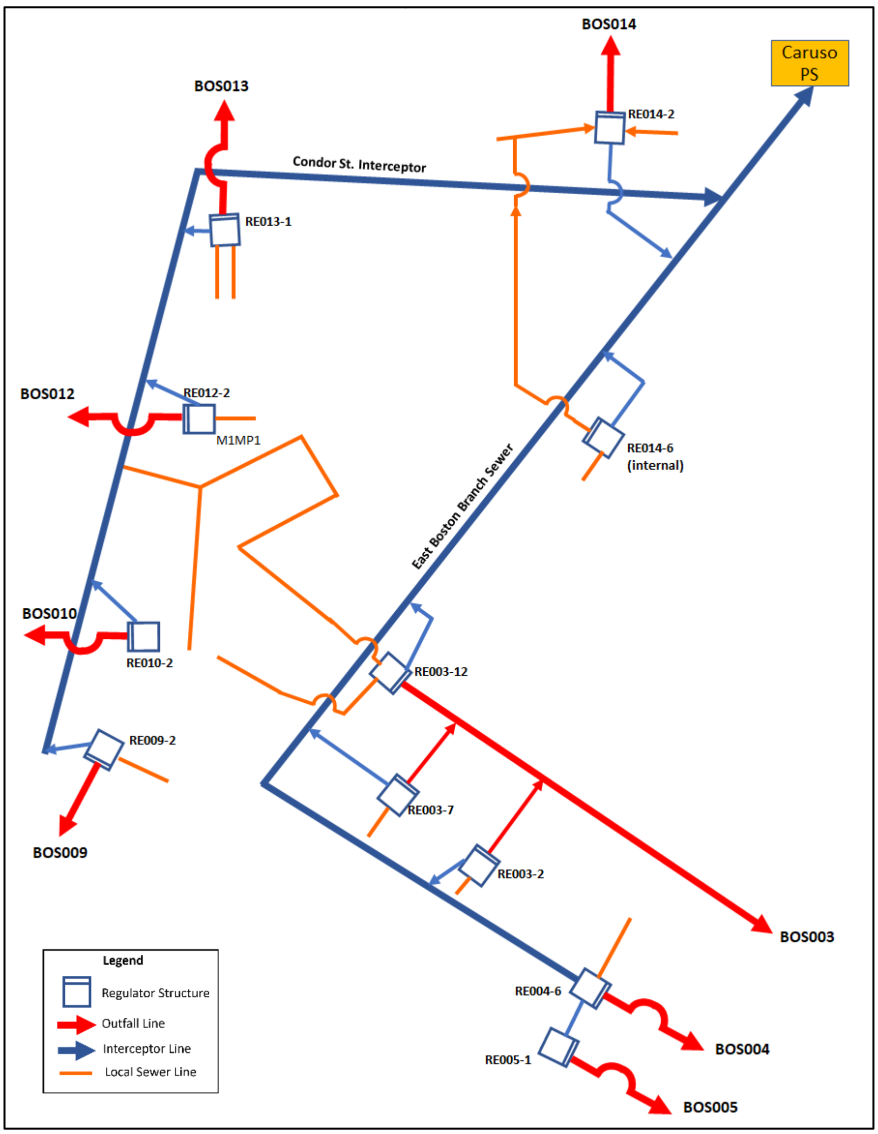

Figure 4-1. East Boston System Schematic

Table 4-1 presents the Q1Q2-2021 Typical Year model results compared to the LTCP goals for East Boston. These results are the same as the Q1-2021 model results presented in Semiannual Report No. 6 because there were no system changes in the East Boston area for the second quarter of 2021. For the Q1Q2-2021 conditions, five of the eight outfalls in East Boston do not meet the LTCP goals for either activation frequency, volume, or both.

Table 4-1. Comparison of Q1Q2-2021 System Conditions to LTCP

Outfall	Regulator	Q1Q2-2021 System(1) Conditions		Long Term Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
BOS013	RE013-1	8	0.27	4	0.54
BOS014	RE014-2	8	1.45	0	0
BOS009	RE009-2	10	0.73	5	0.59
BOS010	RE010-2	7	0.44	4	0.72
BOS012	RE012-2	0	0.00	5	0.72
BOS003 (2)	RE003-2	1	0.02	4	2.87
	RE003-7	8	1.71		
	RE003-12	9	4.67		
BOS004	RE004-6	2	0.06	5	1.84
BOS005	RE005-1	0	0.00	1	0.01
Total (3)		**10 (Max.)**	**9.35**	**5 (Max.)**	**7.29**

(1) Grey shading indicates model prediction is greater than LTCP value.
(2) For outfall BOS003, activation frequency shown is the maximum among its three regulators. Volume is the sum of the regulator volumes.
(3) Activation frequency shown is the maximum among East Boston regulators. Volume is the total summed volume.

4.1.1 Update on BWSC East Boston Sewer Separation Contracts and System Improvements

BWSC has been implementing a multi-phased sewer separation project in East Boston as well as other system modifications in an effort to make further progress in meeting LTCP goals. Below is a list of the improvements BWSC is currently implementing. These modifications are included in the Future Conditions model run as discussed further below.

- Sewer separation Contract 1: BWSC completed Contract 1 of sewer separation in 2020. This work mostly affected flows at regulator RE0012-2 (outfall BOS012), which now meets LTCP levels of control in the Typical Year. Contract 1 separation work was included in the Q1-2021 model results presented in Semiannual Report No. 6.
- Sewer separation Contract 2: This contract will separate certain areas tributary to outfalls BOS010 and BOS005. Construction is currently in progress.
- Sewer separation Contract 3: This contract will separate certain areas tributary to outfalls BOS012, BOS009, and BOS003. The construction contract was awarded in late spring of 2021, with an estimated completion date of 2023. The following improvements are also included with Contract 3:
  - Reconstructing regulators RE003-2 and RE003-7 to provide relief only in extreme events; following completion of sewer separation these regulators will not activate in the Typical Year; and
  - Constructing a new dry weather flow connection between the combined sewer tributary to regulator RE014-2 from Eagle Square and an existing manhole on the Condor Street Interceptor along East Eagle Street;

A more detailed description of these improvements as well as previous work in East Boston is provided in Semiannual Report No. 6. Note that the report indicated that RE003-2 and RE003-7 would be closed under Future Conditions. However, after further investigations BWSC decided to reconstruct those regulators with higher overflow elevations so that they would be available to provide relief in storms larger than the Typical Year.

The completion of BWSC's three sewer separation contracts in East Boston and constructing modifications to RE003-2, RE003-7, and RE0014-2 are predicted to significantly reduce CSO activations and volumes at the CSO outfalls within the sewer separation project areas. Table 4-2 presents a comparison of the Typical Year model results for the Q1Q2-2021 conditions, the "Future Conditions" which includes all of the improvements listed above, and the LTCP goals. As indicated in Table 4-2, under Future Conditions all outfalls are predicted to meet LTCP levels of control for activation frequency and volume with the exception of the activation frequency at BOS013. As indicated in Table 4-2 the activation frequency at BOS013 is eight compared to the LTCP goal of four. However, the volume discharged at outfall BOS013 is 0.27 MG in a Typical Year which is less than the LTCP goal of 0.54 MG. Therefore, the volume associated with the four additional activations in the Typical Year is very small and considered to be immaterial, making this location consistent with LTCP goals.

Table 4-2. East Boston Existing and Future Conditions for Proposed Modifications Compared to the LTCP Goals

Outfall	Regulator	Q1Q2-2021 System Conditions (1)		Future Conditions		Long Term Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
BOS013	RE013-1	8	0.27	8	0.27	4	0.54
BOS014	RE014-2	8	1.45	0	0.00	0	0
BOS009	RE009-2	10	0.73	5	0.15	5	0.59
BOS010	RE010-2	7	0.44	1	0.06	4	0.72
BOS012	RE012-2	0	0.00	0	0.00	5	0.72
BOS003	RE003-2	1	0.02	0	0.00	4(2)	2.87(2)
	RE003-7	8	1.71	0	0.00		
	RE003-12	9	4.67	4	0.89		
BOS004	RE004-6	2	0.06	2	0.09	5	1.84
BOS005	RE005-1	0	0.00	0	0.00	1	0.01
Total (3)		**10 (max)**	**9.35**	**8 (max)**	**1.30**	**5 (max)**	**7.29**

(1) Grey shading indicates model prediction is greater than LTCP value

(2) For the LTCP goals for outfall BOS003, activation frequency shown is the maximum among its three regulators. Volume is the sum of the regulator volumes.

(3) Activation frequency shown is the maximum among East Boston regulators. Volume is the total summed volume.

4.2 Somerville-Marginal CSO Facility Discharges

Outfall MWR205 is located in tidal waters of the Mystic River immediately downstream of the Amelia Earhart Dam, and discharges treated CSO from the Somerville-Marginal Facility along with separate stormwater that enters the Somerville-Marginal Conduit downstream of the CSO facility. Outfall SOM007A/MWR205A is a relief outfall off of the Somerville Marginal Conduit that discharges to the freshwater reach of the Mystic River upstream of the Amelia Earhart Dam when the Somerville-Marginal CSO Facility activates during high tide (see Figure 4-2).

Typical Year model results presented in Semiannual Report No. 6 showed that the Somerville-Marginal CSO Facility's activation frequency is consistent with the LTCP level of control, but the treated discharge volume (100.5 MG) exceeds the LTCP level (61 MG). Meter data collected in 2018 and 2019 indicate that stormwater flows entering the combined sewer system upstream of the facility are higher than those simulated with prior models. In accordance with a condition in the Alewife Brook/Upper Mystic River CSO Variance, MWRA has commenced evaluations of specific projects that may reduce overflows to the Somerville-Marginal CSO Facility and discharges from outfalls MWR205 and MWR205A/SOM007A. The evaluations included:

1) The benefit and feasibility of increasing the capacity of the connection to the Somerville-Medford Branch Sewer.

2) The benefit and feasibility of removing stormwater including the Ten Hills and/or Mystic Avenue/I-93 stormwater flows from the Massachusetts Dept. of Transportation 72-inch drain that enters the combined sewer system upstream of the Somerville Marginal CSO Facility.

A more detailed description of these evaluations is provided in Semiannual Report No. 6.

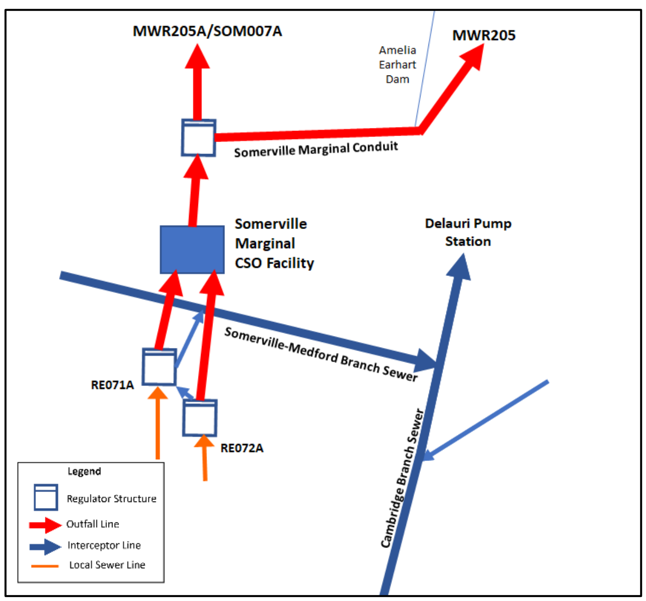

Figure 4-2. Schematic of Somerville-Marginal CSO Facility, MWR205A/SOM007A and MWR205

As noted in Semiannual Report No. 6, increasing the capacity of the connection to the Somerville-Medford Branch Sewer showed promise in terms of reducing activation frequency and volume at the Somerville-Marginal CSO Facility during the Typical Year. However, the initial modeling of this modification resulted in adverse impacts on the peak hydraulic grade line in the Somerville-Medford Branch Sewer in larger storms. In addition, this alternative increased discharge volumes at Prison Point because of the hydraulic connectivity between that facility and the interceptor network downstream of the Somerville-Medford Branch Sewer. Separating the stormwater upstream of the Somerville Marginal CSO

Facility had much less of an impact on the discharge frequency and volume at the facility. As a result of these findings, subsequent evaluations focused on the configuration and control strategy for a gated connection to the Somerville Medford Branch Sewer. The intent of the gated connection was to maximize performance during the Typical Year without adversely affecting the hydraulic grade line in the interceptor and minimizing the increase in volume at Prison Point.

4.2.1 Preliminary Results of Modeling Evaluations

After the initial model evaluations, the alternatives were further refined, and the following two options were identified (Figure 4-3):

- **Option 1**: Construction of a 36-inch connection between the 85 x 90-inch influent combined sewer to the Somerville Marginal Facility and the 42-inch Somerville-Medford Branch Sewer with a control gate on the 36-inch connection at the invert of the 85 x 90-inch combined sewer.
- **Option 2**: Construction of a gated connection between an existing 42-inch storm drain that ties into the 85” x 90” influent combined sewer to the Somerville Marginal Facility and a manhole on the 42-inch Somerville-Medford Branch Sewer.

Option 1 was modeled as a 36-inch piped connection with a 36-inch control gate. For Option 2, the length of the connection was relatively short (Figure 4-4) and was modeled as a 100-square foot chamber with the control gate within the chamber. For this option, the gate was modeled as either a 36-inch or 42-inch gate. The 42-inch storm drain was not originally included in the model and was added for this alternative. The stormwater tributary area delineation was adjusted to allocate runoff area to the 42-inch pipe based on available information.

For each alternative, the gate would be controlled based on set points at the following three locations:

1. Somerville-Medford Branch Sewer at new connection: Gate closes at 105.0 and opens at 102.0
2. Upstream Critical Low Point along Somerville-Medford Branch Sewer: Closes at 108.5 and opens at 107.5
3. Prison Point influent chamber: Closes at 103.0 and opens at 100.0

The first two locations were intended to protect the downstream and upstream hydraulic grade line in the Somerville-Medford Branch Sewer. The third location was intended to limit the increase in discharge volume at Prison Point.

Table 4-3 presents the CSO discharge activation frequency and volume for the Typical Year for the baseline condition, Option 1, the two variations of Option 2, and the LTCP goals. As indicated in Table 4-3, all three alternatives would result in a significant reduction in activation frequency and volume at the Somerville-Marginal CSO Facility. Discharge volume at the Prison Point CSO Facility would increase, but the net discharge from the system would decrease. The differences in performance among the three alternatives are relatively nominal. All three would reduce the activation frequency at Somerville Marginal by about 40 percent, well below the LTCP target, and bring the activation volume to within 3 to 5 percent of the LTCP target.

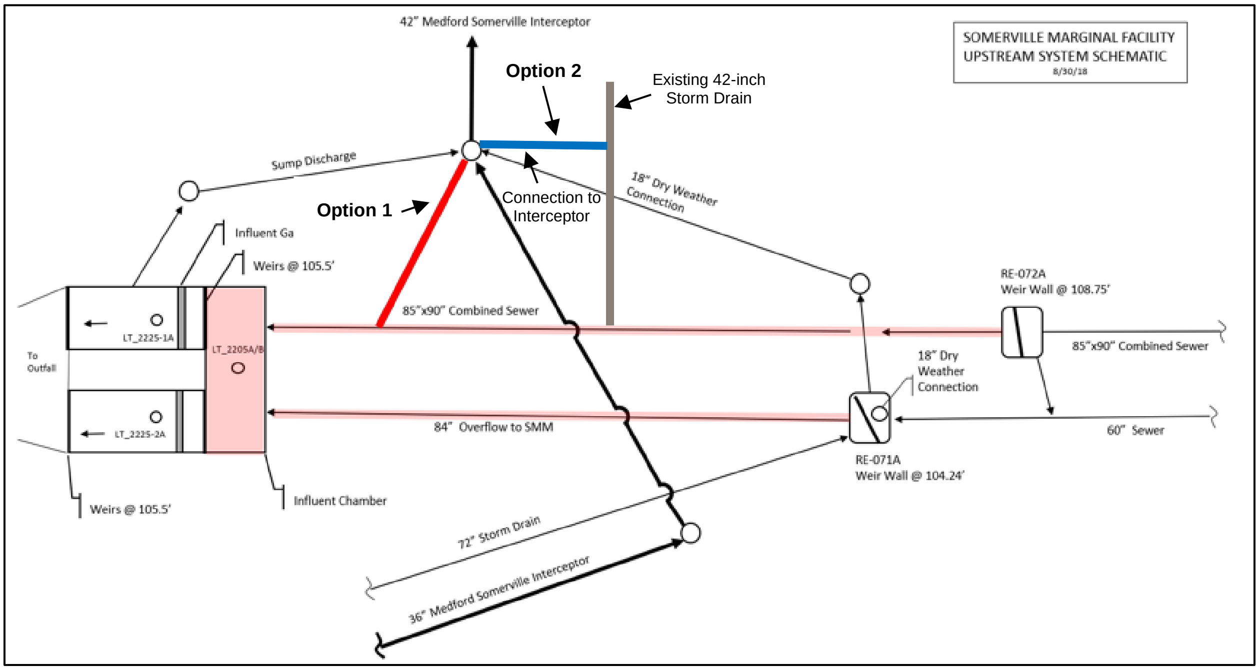

Figure 4-3. Somerville Marginal CSO Facility Upstream System Schematic

Table 4-3. Preliminary Results for Alternatives at Somerville Marginal CSO Facility

Outfall	Regulator ID	Baseline(1)(2)		Option 1		Option 2 – 36 -inch gate		Option 2 – 42-inch gate		Typical-Year Rainfall w/ Long Term CSO Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
SOM007A/MWR205A		5	4.50	3	3.65	3	3.59	3	3.63	3	3.48
MWR205 (Somerville Marginal Facility)		30	100.5	18	62.85	17	63.34	17	62.43	39	60.58
BOS017(3)	RE017-2	6	0.34	4	0.45	4	0.45	4	0.45	1	0.02
MWR203 (Prison Point)		17	254	17	263	17	263	17	264	17	243
Total of Above Outfalls			359		330		330		330		307
Net Change From Baseline					-29		-29		-29		

(1) Grey shading indicates model prediction is greater than LTCP value.
(2) Baseline for this evaluation was Q1-2021 conditions.
(3) MWRA has developed a concept design that is predicted to me the LTCP goal at this location. Additional detail is provided below.

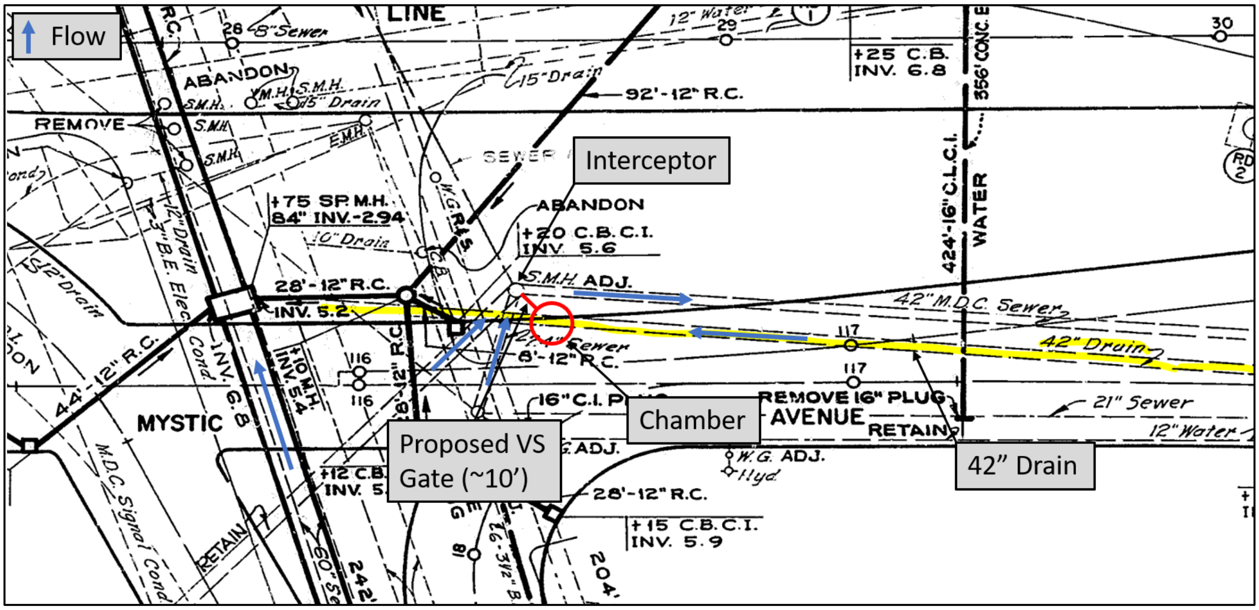

Figure 4-4. Proposed Option 2 Configuration

The model was run for the Typical Year and 5-year storm events to assess impacts to the hydraulic gradeline (HGL) for Options 1 and 2. After several iterations, the gate set points (as indicated above) were configured so that the options would not negatively impact the HGL in the surrounding areas.

Figures 4-5 and 4-6 show the plan and profile for the baseline and Option 1 alternative for the Typical Year for the portion of the Somerville-Medford Branch Sewer affected by the increased flow. These results indicate the peak HGL is not predicted to be affected by Option 1 because of the operation of the gate.

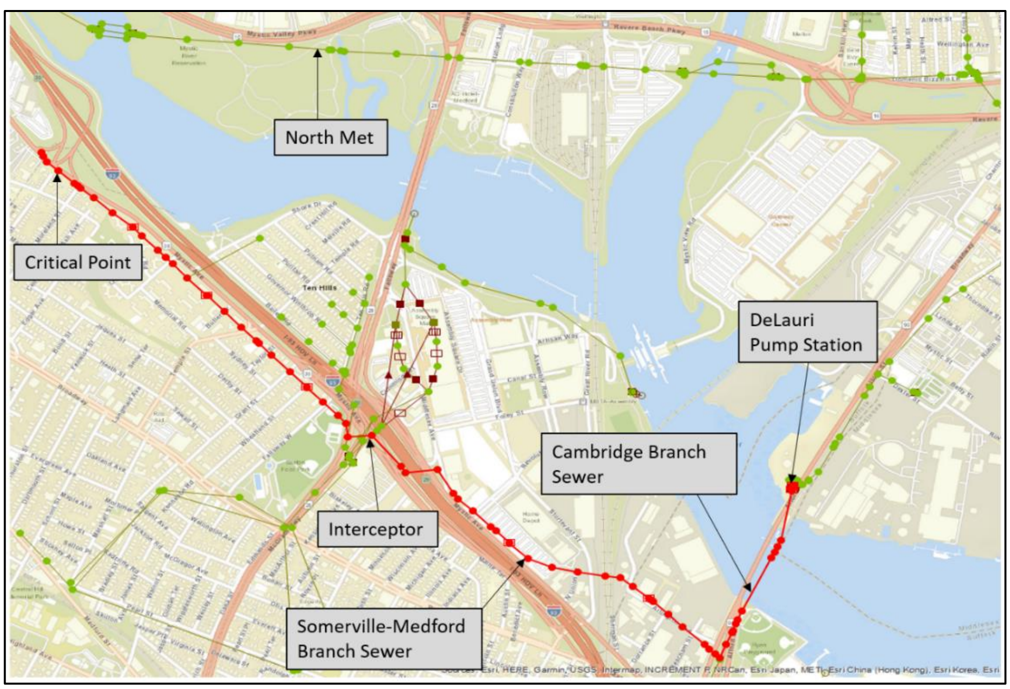

Figure 4-5. Location of Somerville-Medford Branch Sewer Hydraulic Profile Shown in Figure 4-6

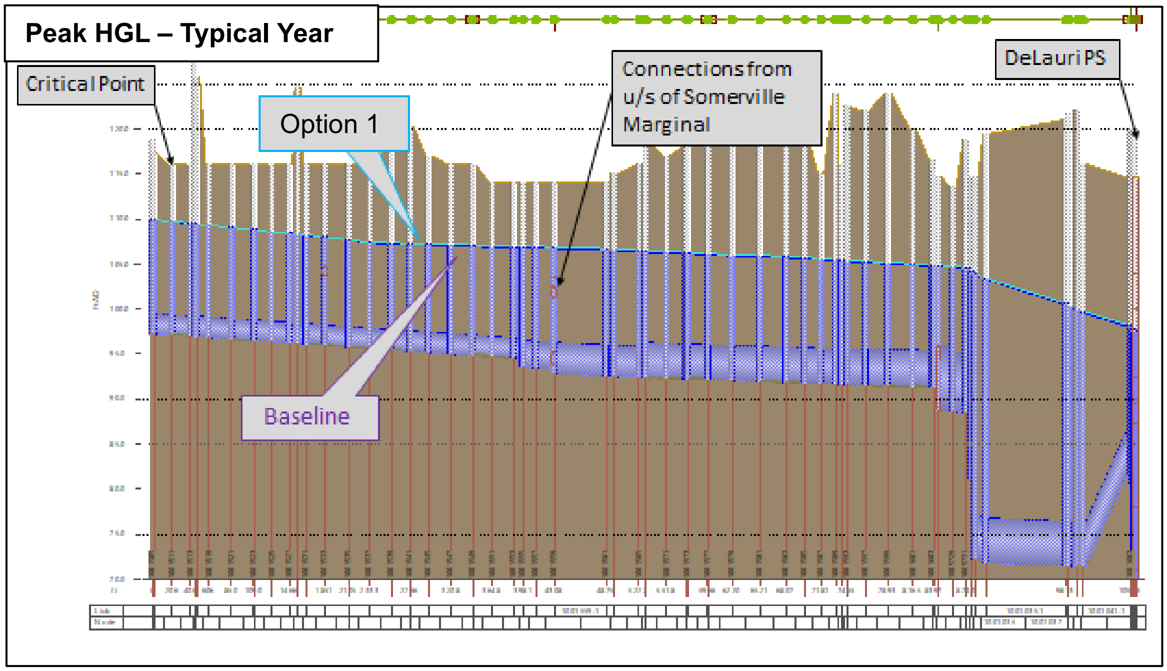

Figure 4-6. Somerville-Medford Branch Sewer Typical Year Hydraulic Profile with Option 1

Figure 4-7 presents the profile for the baseline and Option 2 alternative (42-inch gate) for the Typical Year for the portion of the Somerville-Medford Branch Sewer affected by the increased flow. Similar to Option 1, these results indicate the peak hydraulic grade line is not predicted to be impacted by Option 2 because of the operation of the gate.

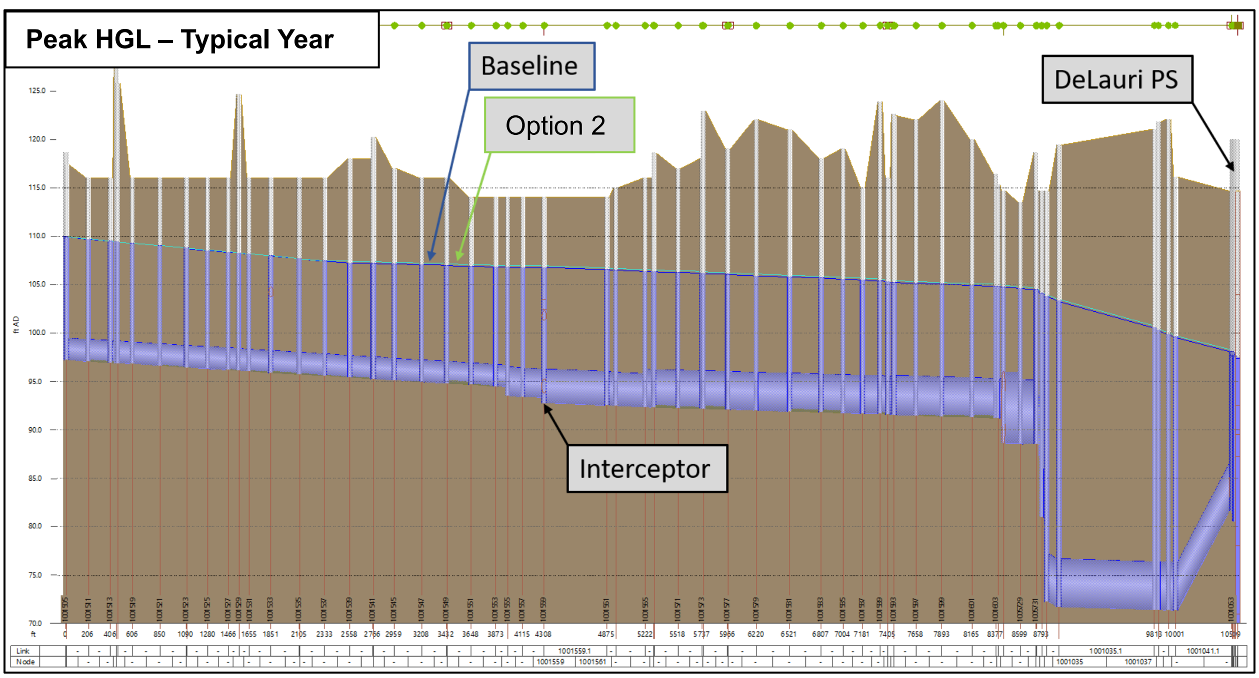

Figure 4-7. Somerville-Medford Branch Sewer Peak Hydraulic Profile for Typical Year with Option 2

Similar plots were prepared for the 5-year storm for both Option 1 and Option 2. These results indicate the peak hydraulic grade line is not predicted to be impacted by either option because of the operation of the gate.

MWRA is moving forward with selecting Option 1 or 2 depending on the viability of using the existing 42-inch storm drain and will then prepare a detailed design for construction of the new connection and control gate.

4.3 Cottage Farm CSO Facility Discharges

Under Q1Q2-2021 system conditions, the Cottage Farm CSO facility is currently meeting the LTCP goal for activation frequency with two activations predicted in the Typical Year. However, the CSO discharge volume is currently predicted to be 9.06 MG and the LTCP goal is 6.30 MG. The current model prediction includes the benefit realized from completion of the partial sewer separation effort in the Cambridgeport area which was completed in August 2020. The partial sewer separation project allows a portion of the stormwater from the Cambridgeport area to continue to be conveyed to the MWRA's interceptor to allow Cambridge to meet phosphorus discharge limits for the Charles River, while providing for some of the stormwater, especially in larger storm events, to be discharged to the Charles River, thereby reducing peak wet weather flows to the MWRA's interceptor and reducing Cottage Farm CSO Facility treated discharges. The volume increased slightly from the Q1-2020 conditions reported in Semiannual Report No. 6 due to the model updates made for the Willard Street area as described below in Section 4.4.2 (Outfall CAM005). Figure 4-8 below presents a schematic of the interceptors tributary to the facility.

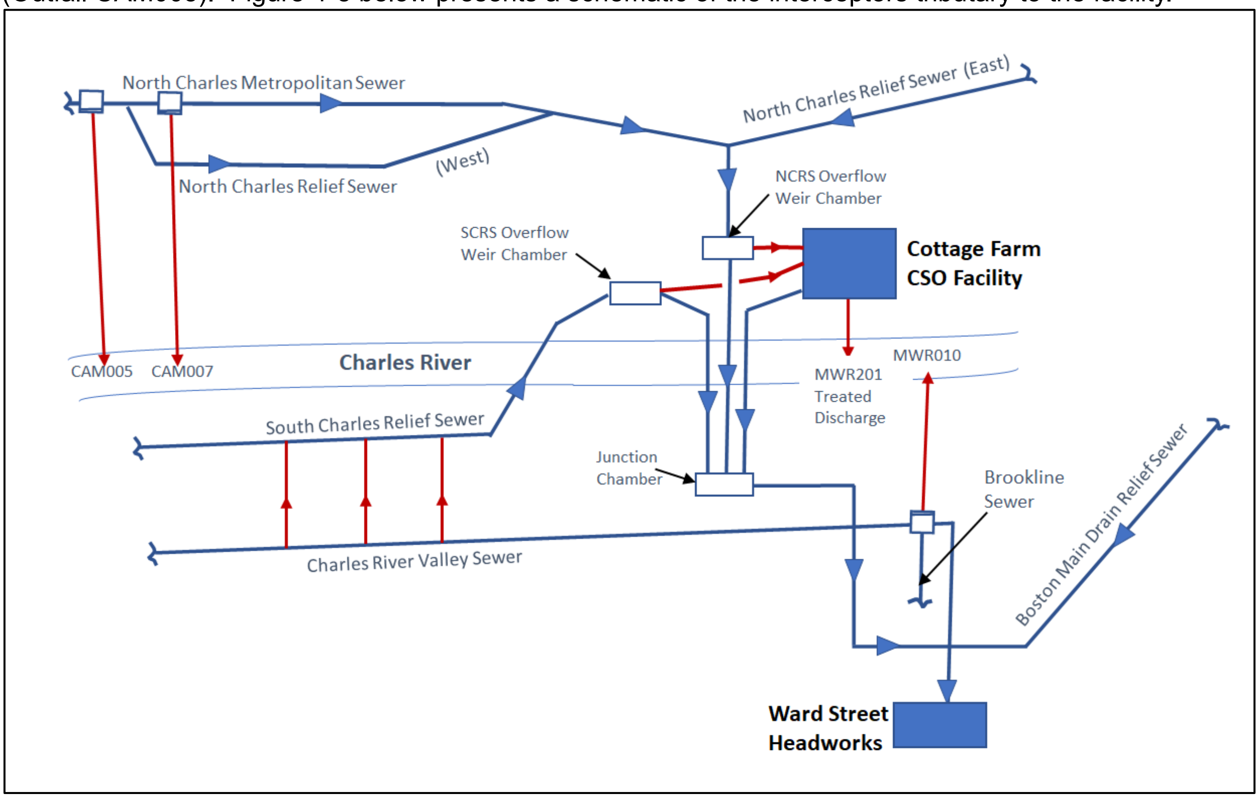

Figure 4-8. Cottage Farm CSO Facility Area Schematic

A number of alternatives were evaluated to decrease the volume discharged from the facility during the Typical Year including:

- facility operation changes;
- groundwater infiltration removal from catchments tributary to Cottage Farm; and
- sewer separation upstream of CAM011.

A combination of substantial groundwater removal and sewer separation upstream of CAM011 would be necessary to reduce the CSO discharge volume enough to meet the LTCP goal. The groundwater volume to be removed and the areas to be separated are significant, however, and the feasibility of implementing projects to achieve the needed groundwater removal and sewer separation has not yet been established. This alternative is still being evaluated based on constructability, cost, and benefits considering the limited water quality improvements to the Charles River that would be achieved by reducing this treated discharge by the small amount needed to achieve LTCP goals. In addition, the water quality impacts of the additional stormwater loadings due to sewer separation have not yet been evaluated. The MWRA and its member CSO communities continue to work to identify and investigate other alternative to meet the LTCP goal.

Evaluations and adjustment to facility activation and deactivation procedures at Cottage Farm, do not appear to provide additional benefit in reducing the CSO discharge volume. Facility optimization efforts in the past have already been undertaken.

4.4 Other Charles River Outfalls

In addition to the Cottage Farm CSO Facility, four other outfalls to the Charles River are currently projected to exceed the LTCP goals for annual activations and/or volume (MWR018, MWR019, MWR020, and CAM005). The following section identifies efforts that are underway at these outfalls to meet LTCP levels of control.

4.4.1 Outfalls MWR018, MWR019, and MWR020

Outfalls MWR018, MWR019 and MWR020 are located along the Boston Marginal Conduit (BMC) upstream of the Prison Point CSO Facility (Figure 4-9). These outfalls overflow to the Charles River when the hydraulic grade line in the BMC exceeds the controlling weir elevations at each structure.

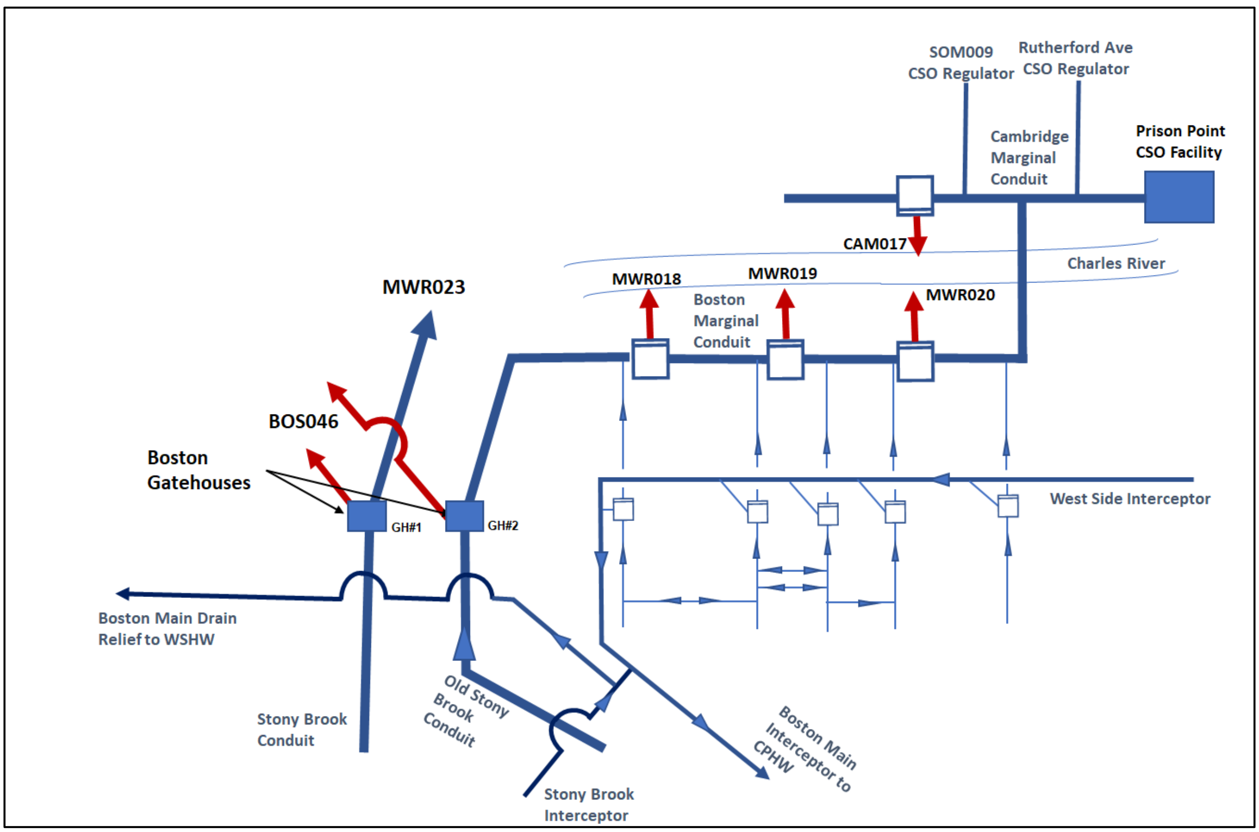

Figure 4-9. MWR018, MWR019, MWR020 System Schematic

The LTCP goal for these outfalls is to have no discharges in the Typical Year. Table 4-4 presents the Typical Year activation frequency and volumes for all the outfalls to the Charles River as well as for Prison Point for Q1-2021 system conditions, Q1Q2-2021 system conditions, and the LTCP goals. As indicated in

Table 4-4, the LTCP goals for activation frequency and volume are projected to be exceeded for the Q1Q2-2021 conditions at outfalls MWR018, MWR019 and MWR020.

The differences between the Q1-2021 and the Q1Q2-2021 system conditions for outfalls MWR018 to MWR020 reflect updates to the model based on newly available information. These updates include the following:

1. Updated several manholes to be unsealed based on field investigations conducted by MWRA.
2. Added catch basins in the area of Back Street which are hydraulically connected to the BMC based on a review of DCR stormwater drawings.
3. Removed modeling losses at the manholes along the BMC.
4. Added Boston Gate House #2 overflow at El. 13 (Boston City Base datum; El. 112.97 MDC datum in the model) based on field investigations conducted by BWSC.
5. Added an interconnection between the Old Stony Brook Conduit (OSBC) and the Stony Brook Conduit (SBC) based on field investigations conducted by BWSC.

These updates were incorporated into the model and the model calibration was checked by comparing the modeled HGL to measured levels in the BMC, activation frequencies at MWR018-020 and Prison Point, and discharge volume at Prison Point for the 2019 calibration period. The updates showed a slight decrease in the HGL in the BMC resulting in a small decrease in CSO discharge volumes at MWR018, MWR019, MWR020 and Prison Point CSO Facility compared to Q1-2021 Conditions as presented Table 4-4.

Table 4-4. Comparison of Q1-2021 and Q1Q2-2021 System Conditions to LTCP

Outfall	Q1-2021 System Conditions (1)		Q1Q2-2021 System Conditions (1)		Long Term Control Plan	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
Lower Charles						
CAM017	0	0	0	0	1	0.45
MWR010	0	0	0	0	0	0
MWR018	2	1.14	2	1.12	0	0
MWR019	2	0.51	2	0.48	0	0
MWR020	2	0.57	2	0.48	0	0
MWR201 (Cottage Farm CSO Facility)	2	8.95	2	9.10	2	6.3
MWR023	1	0.14	1	0.04	2	0.13
BOS046 – Boston GH1 (3)	0	0.00	1	0.10	2	5.38
BOS046 – Boston GH2 (4)	(3)	(3)	0	0.00		
Total (2)	**2 (Max.)**	**11.31**	**2 (Max.)**	**11.31**	**2 (Max.)**	**6.88**
MWR203 (Prison Point CSO Facility)	17	253.66	17	248.23	17	243.0

(1) Grey shading indicates model prediction is greater than LTCP value.
(2) Activation frequency shown is the maximum among Lower Charles regulators. Volume is the total summed volume.
(3) BOS046 (Gatehouse 1) is primarily a stormwater discharge but may contain CSO if the upstream regulators overflow. The upstream regulators are monitored directly. Gatehouse 1 is normally closed but may be opened for flood mitigation. Flow can discharge at the Gatehouse if either the gate is opened or if water overtops the gate. Based on model tracer studies, when a discharge occurs during model simulations at BOS046 it was estimated that 25% of the CSO from the upstream regulators discharges at the MWR023 outfall (Charles River) and 75% discharges at BOS046 (Back Bay Fens). The reported volumes for the model at MWR023 are based on 25% of the CSO volume upstream and BOS046 are based on 75% of the predicted CSO volume upstream. BOS046(Gatehouse 2) contains a gate which may also be overtopped in very wet weather; this gate was added to the model after the Q1-2021 system conditions model run per new field information.
(4) BOS046 (Gatehouse 2) contains a gate which may also be overtopped in very wet weather; this gate was added to the model after the Q1-2021 system conditions model run per new field information. Gatehouse 2 was added to the model after the Q1-2021 system conditions model run per new field information.

4.4.1.2 Investigations / Regulator Modifications/System Hydraulics/Stormwater

A number of alternatives were evaluated in an effort to bring MWR018, MWR019 and MWR020 into attainment with LTCP goals. These alternatives focused on ways to reduce the HGL in the BMC and are summarized below:

1. Shifting flow from the BMI to Union Park CSO Facility: The intent of this alternative was to reduce flows into the BMC from the Westside Interceptor system by lowering the HGL in the BMI downstream of the connection from the Westside Interceptor. However, modeling indicated that this alternative had no impact on overflows at MWR018, MWR019, or MWR020.

2. Operating Prison Point more aggressively: This alternative tried opening the influent gate to Prison Point earlier in the storm event compared to the current operating protocol. This alternative did reduce the HGL in the BMC slightly, with nominal reductions in the discharge volume at MWR018, MWR019, and MWR020, but increased the volume discharged at Prison Point by about 18 MG.

3. Installing gates on MWR018/019/020 that would only open in storms larger than the Typical Year: The intent of this alternative was to use gates to eliminate the discharges in the Typical Year, but allow the gates to open to provide relief in storms larger than the Typical Year storms. However, this alternative created adverse HGL impacts in the BMC during the Typical Year.

4. Removing stormwater tributary to the OSBC: The intent of this alternative was to see how much separate stormwater tributary to the OSBC would need to be relocated to the SBC in order to mitigate the adverse HGL impacts in the Typical Year associated with Alternative 3 above. Preliminary modeling indicated that a substantial area of separate stormwater would need to be relocated, and the feasibility of relocating that stormwater has not been established. Therefore, the alternative which includes installing gates and relocating stormwater is still being evaluated for constructability and cost. Further consideration will need to be given to the additional hydraulic load placed on the SBC as well as additional pollutant load tributary to the Charles River resulting from additional storm water flows.

5. Increasing the size of the connection from the OSBC to the Boston Main Drain Relief Sewer ("Boston Main Drain"): The intent of this alternative was to reduce the HGL in the BMC by shifting flows from the OSBC towards Ward Street Headworks (WSHW) via the Boston Main Drain Initial modeling of this alternative showed some beneficial results in terms of reducing the peak HGL in the BMC in conjunction with relocating upstream stormwater. However, the alternative did increase the activation frequency and discharge volume at Cottage Farm from 2 and 8.95 MG to 4 and 13.25 MG. Additional field investigations are needed to check that the model properly reflects existing conditions before this alternative can be further investigated. BWSC is moving forward with these field investigations.

MWRA and its member CSO communities continue to identify and investigate options for reducing the CSO activations and volumes at outfalls MWR018, MWR019 and MWR020.

4.4.2 Outfall CAM005

As reported in Semiannual Report No. 6, the annual volume at CAM005 is predicted to meet the LTCP level of control, but the annual activation frequency still exceeds the target. Evaluations including raising the weir 6 inches and 12 inches and cleaning the outfall pipe were also presented in Semiannual Report No. 6. While these alternatives were predicted to further reduce activations and volume, they did not allow CAM005 to attain LTCP goals for activation frequency. In addition, Cambridge has raised concerns about the potential impacts to upstream HGLs. Following those evaluations, MWRA continued to evaluate alternatives to allow CAM005 to meet LTCP goals for activation frequency. First the model was updated to provide additional detail on the 28-acre area near Willard Street that the City of Cambridge is planning to separate. When this area was updated the activation frequency at CAM005 increased from 7 to 8 activations and the volume increased from 0.65 MG 0.74 MG. At Cottage Farm the activation frequency did not change, and the discharge volume increased slightly from 8.95 to 9.10 MG. The model was then run with the 28-acre area separated and the CAM005 activation frequency was reduced back to 7 and the volume down to 0.64 MG. At Cottage Farm the activation frequency remained the same and the discharge volume was reduced to 8.92 MG.

After the model was updated it was used to estimate the number of acres of combined area upstream of CAM005 that would need to be separated to bring the CAM005 activation frequency into attainment, assuming Cambridge completed the Willard Street separation work. The combined sewer areas tributary to CAM005 are presented in Figure 4-10. Model runs were conducted to incrementally increase the area of sewer separation, starting from the areas closest to the Charles River and then moving further upstream.

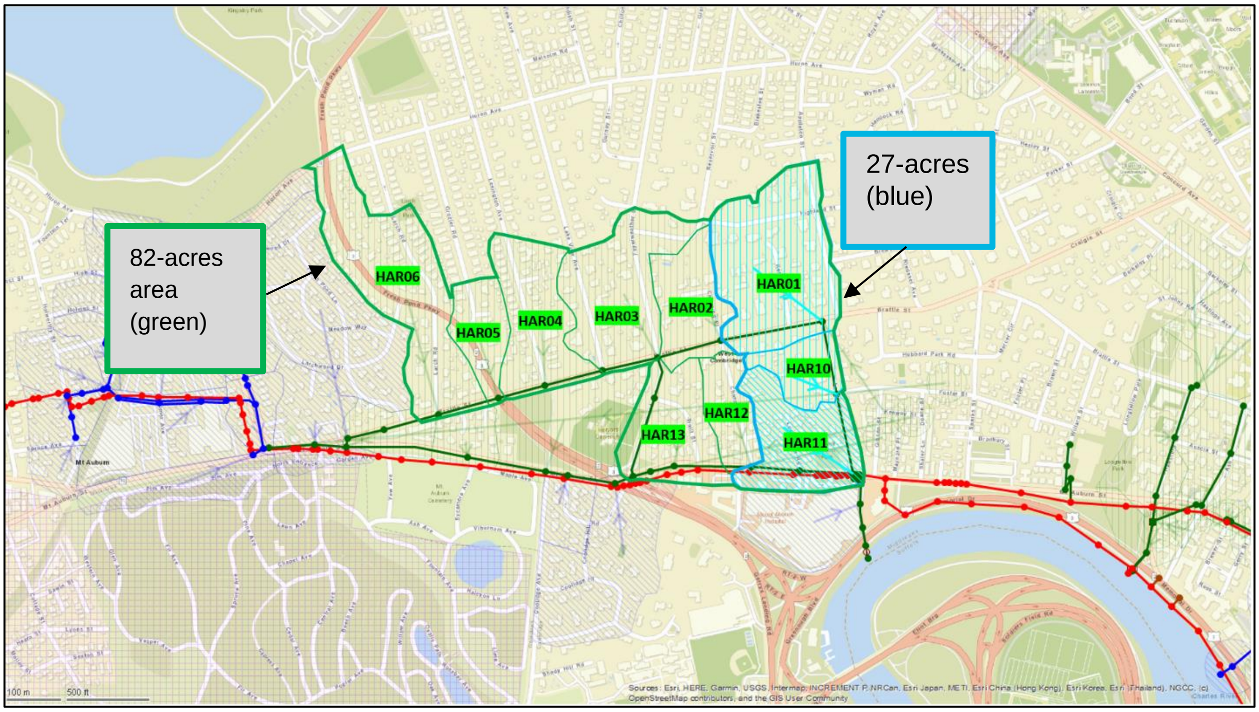

Figure 4-10. Combined Area Tributary to CAM005

Various combinations of acreage of tributary area to be separated were run for the Typical Year with and without the CAM005 outfall cleaned and the weir raised 6 inches and 12 inches. For this evaluation it was assumed that the areas would be 75% separated. Table 4-5presents the results of the evaluations for the Typical Year for the Q1-2021 conditions, Q1-2021 conditions with the Willard Street area updated, and Q1-2021 conditions with the Willard Street area separated. That last run then became the new baseline used to evaluate separation of the area upstream of CAM005. Results are presented for raising the weir 6 inches and 12 inches and cleaning the outfall at CAM005. The model was also run with additional separation, 12 acres of separation with the outfall cleaned and the weir raised 12 inches, 27 acres of separation with the outfall cleaned and the weir raised 12 inches and then 82 acres separated with no changes to the outfall or weir. Separating the 12 acres (areas HAR10 and HAR11 in Figure 4-10) with raising the weir 12-inches and cleaning the outfall reduced the activation frequency to within one low-volume activation of the LTCP. Separating 27 acres (areas HAR10, HAR11 and HAR01 in Figure 4-10) with raising the weir 12-inches and cleaning the outfall reduce the activation frequency to 2 which is less than the LTCP goal. To meet the LTPC goal for activations without cleaning the outfall and raising the weir would require separating a total of 82 acres (all 10 areas highlighted in green in Figure 4-10). The sewer separation evaluations focused on the reduction of CSO activation frequency and volume, however, the water quality impacts of increasing the stormwater loads as a result of sewer separation have not been evaluated.

MWRA is continuing to coordinate with the City of Cambridge regarding the feasibility and hydraulic impacts of alternatives for outfall CAM005. The City of Cambridge is planning to have the CAM005 outfall cleaned by the end of the year. Improvements to CSO control must be balanced against the need for improved level of service to address flooding experienced in this tributary system during large storm events.

Table 4-5. Prelminary Model Results of Sensitivity Analyis at CAM005

Outfall	Regulator ID	Q1-2021 System Conditions(1)		Q1-2021(Updated Willard St)		Q1-2021Updated Willard St Areas 90% Separation (New Baseline)		New Baseline with Weir Raised 6 inches and Outfall Cleaned		New Baseline with Weir Raised 12 inches and Outfall Cleaned		New Baseline with 12 acres of Separation (HAR011/HAR10) Weir Raised12 inches/Outfall Cleaned		New Baseline with 27 acres of Separation (HAR011/HAR10/HAR01) /Weir Raised 12 inches/Outfall Cleaned		New Baseline with 82 acres of Separation (HAR01 to HAR06 and HAR010 to HAR13)		Long Term CSO Control Plan	
		Act Freq	Volume (MG)	Act Freq	Volume (MG)	Act Freq	Volume (MG)	Volume (MG)	Volume (MG)	Act Freq	Volume (MG)	Act Freq	Volume (MG)	Act Freq	Volume (MG)	Act Freq	Volume (MG)	Act Freq	Volume (MG)
CAM005	**RE-051**	7	0.66	8	0.74	7	0.64	5	0.66	5	0.52	4	0.40	2	0.33	3	0.30	3	0.84
CAM007	**RE-071**	2	0.45	1	0.48	2	0.43	2	0.29	2	0.35	2	0.34	2	0.31	1	0.18	1	0.03
MWR201	**Cottage Farm**	2	8.95	2	9.07	2	8.92	2	8.91	2	8.93	2	8.90	2	8.84	2	8.52	2	6.3

(1) Grey shading indicates model prediction is greater than LTCP value.

4.5 Fort Point Channel Outfalls

4.5.1 Outfall BOS070

4.5.1.1 Existing System Improvement

Figure 4-131 presents a schematic of the South Boston interceptor system which includes the BOS070 regulators and outfall. As presented in Semiannual Report No. 6, BWSC completed a program to remove sediment in South Boston sewers and removed a temporary weir. These improvements, however, were not sufficient to meet the LTCP goals for the BOS070/DBC regulators. MWRA then evaluated the CSO benefits of BWSC's planned multi-phased "South Boston Sewer Separation Project" that involves the removal of stormwater from combined sewers serving approximately 400 acres of area tributary to the BOS070 system. The South Boston Sewer Separation Project includes five construction contracts that BWSC plans to phase over a 20-year period. BWSC completed the design and awarded the construction contract for Contract 1 in May 2021. Contract 1 is scheduled to be completed in May 2023. The design of Contract 2 is progressing and BWSC expects construction to begin in 2022 and be completed in 2024. BWSC has not yet commenced design of the remaining three contracts.

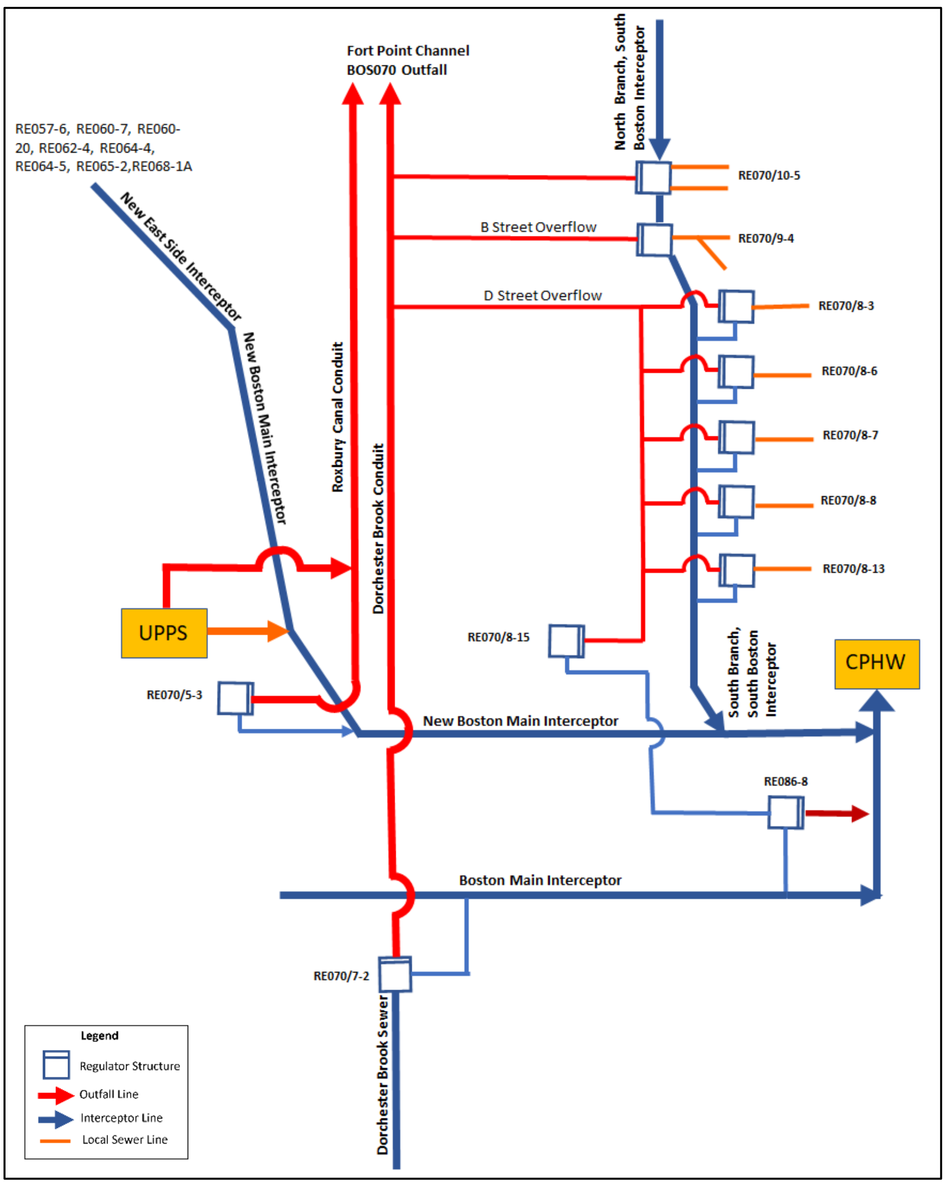

Figure 4-11. Schematic of the South Boston Interceptor System

MWRA evaluated the potential CSO control benefits of Contracts 1 and 2 using its hydraulic model. The Typical Year model results are presented in Table 4-6 for each of the BOS070/DBC regulators, and the BOS070/DBC regulator volumes are totaled for comparison with the LTCP activation and volume goals. As shown in Table 4-6, the LTCP activation and volume goals at all of the BOS070/DBC regulators except for regulator RE070/7-2 can be attained with sewer separation Contracts 1 and 2.

Table 4-6. Typical Year Model Simulations of South Boston Sewer Separation Contracts 1 & 2

Outfall	Regulator	Interim Q3Q4-2020 System Conditions(1)		Interim Q3Q4-2020 System Conditions w/Contract 1 (Completion 2023)(1)		Interim Q3Q4-2020 System Conditions w/Contracts 1 & 2 (Completion 2024)(1)		Long Term CSO Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
Fort Point Channel									
BOS070/ DBC	RE070/8-3	7	1.31	6	0.79	1	0.02	3	2.19
	RE070/8-6	0	0.00	0	0.00	0	0.00		
	RE070/8-7	2	0.05	2	0.05	0	0.00		
	RE070/8-8	0	0.00	0	0.00	0	0.00		
	RE070/8-13	0	0.00	0	0.00	0	0.00		
	RE070/8-15	0	0.00	0	0.00	0	0.00		
	RE070/9-4	6	1.93	3	0.40	1	0.05		
	RE070/10-5	1	0.04	0	0.00	0	0.00		
	RE070/7-2	2	2.77	2	2.66	2	2.41		
SUM BOS070/DBC		**7 Max**	**6.10**	**6 Max**	**3.90**	**2 Max**	**2.48**	**3 Max**	**2.19**

(1) Grey shading indicates model prediction is greater than LTCP value.

As indicated in Table 4-6, regulator RE070/7-2 is meeting the LTCP goal for activation frequency, however, by itself it still exceeds the total discharge volume goal for BOS070/DBC even with sewer separation Contracts 1 and 2. MWRA continued to work towards meeting the LTCP goal for CSO discharge volume for BOS070/DBC by evaluating alternatives to reduce discharges at regulator RE070/7-2. These investigations included weir raising and interceptor connection relief. After evaluating many alternatives and coordinating with BWSC, MWRA identified that enlarging approximate 540 linear feet of 60 inch the Boston Main Interceptor (BMI) downstream of the RE070/7-2 regulator would provide the additional capacity needed to reduce the CSO discharge volume at RE070/7-2 to 2.06 MG, which would bring the total BOS070/DBC CSO discharge volume within the LTCP goals. A comparison of the Typical Year model results for the Interim Q3Q4-2020 model conditions with sewer separation contracts 1 and 2 with and without the proposed 72-inch enlarged BMI is presented in Table 4-7.

Table 4-7. Comparison of Typical Year Model Simulations of South Boston Sewer Separation Contracts 1 & 2 with and without the Enlarged 72-Inch BMI

Outfall	Regulator	Interim Q3Q4-2020 System Conditions w/Contracts 1 & 2 (Completion 2024)(1)		Interim Q3Q4-2020 System Conditions w/Contracts 1 & 2 and 72-inch Enlarged BMI (Completion 2024)(1)		Long Term CSO Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
BOS070/ DBC	RE070/8-3	1	0.02	2	0.05	3	2.19
	RE070/8-6	0	0.00	0	0.00		
	RE070/8-7	0	0.00	0	0.00		
	RE070/8-8	0	0.00	0	0.00		
	RE070/8-13	0	0.00	0	0.00		
	RE070/8-15	0	0.00	0	0.00		
	RE070/9-4	1	0.05	1	0.06		
	RE070/10-5	0	0.00	0	0.00		
	RE070/7-2	2	2.41	2	2.06		
SUM BOS070/DBC		**2 Max**	**2.48**	**2 Max**	**2.17**	**3 Max**	**2.19**

(1) Grey shading indicates model prediction is greater than LTCP value.

After further discussion with BWSC, a relief pipe parallel to the existing 60 inch BMI was proposed. The proposed relief pipe would extend approximately 540 linear feet along Massachusetts Avenue between the RE070/7-2 regulator connection to the BMI and Enterprise Street as shown schematically in Figure 4-12. This alternative is still being evaluated. The MWRA and BWSC continue to work to identify and investigate other alternatives to meet the LTCP goal.

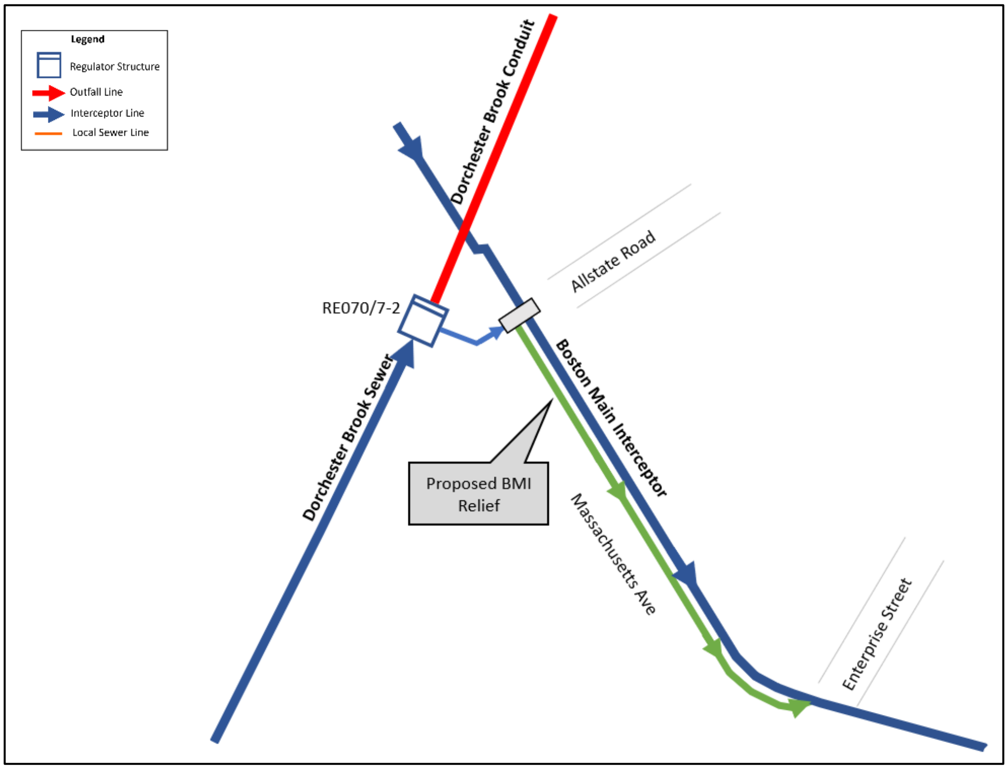

Figure 4-12. Schematic of Proposed BMI Relief Pipe along Massachusetts Avenue

4.5.2 Outfalls BOS062 and BOS065

4.5.2.1 Hydraulic Model Updates

Figure 4-13 presents a schematic of the upstream end of the New East Side Interceptor (NESI) system. Semiannual Report No. 6 presented a description of minor adjustments made to the physical configuration of the regulators tributary to outfalls BOS060, BOS062, BOS064, and BOS065. MWRA used the updated model to identify and evaluate system modifications that may further lower CSO discharges toward attainment of the LTCP activation and volume goals at outfalls BOS062 and BOS065.

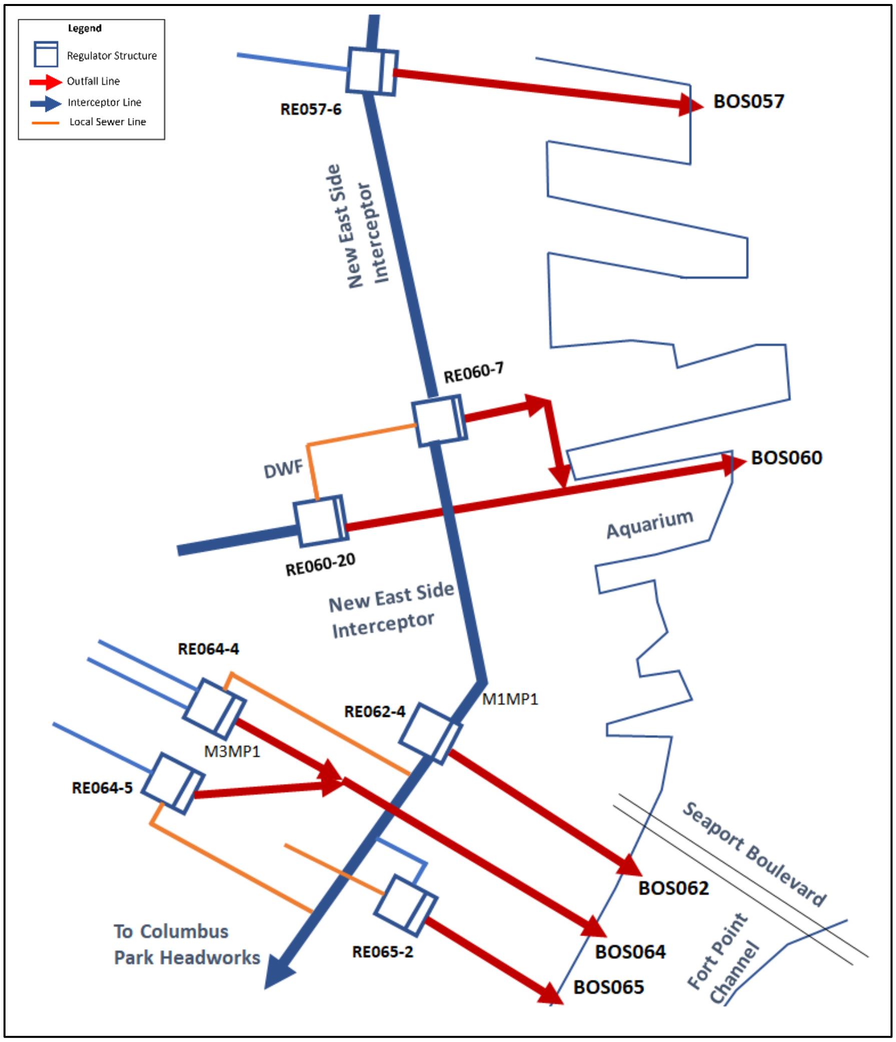

Figure 4-13. Schematic of New East Side Interceptor System

Potentially beneficial alternatives that MWRA initially considered included raising the overflow weirs and upgrading interceptor connection capacities at the BOS62 and BOS65 regulators. The results for the initial weir and interceptor connection modifications MWRA modeled were presented in Semiannual Report No. 6.

Following that report MWRA updated the model to include Contracts 1 and 2 of the South Boston Sewer Separation project as described above and continued evaluating alternatives.

Table 4-8 presents the Interim Q3Q4-2020 results as presented in Semiannual Report No. 6, Interim Q3Q4-2020 Conditions with South Boston sewer separation Contracts 1 and 2, and the LTCP goals for outfalls BOS062 to BOS068. As indicated in Table 4-9, Contracts 1 and 2 provided a nominal benefit on Typical Year CSO volume at Fort Point Channel regulators along the NESI due to a reduction in the downstream hydraulic grade line. Notably, however, the sewer separation was predicted to eliminate the one activation at regulator RE064-5, allowing outfall BOS064 to meet the LTCP goals.

Table 4-8 Typical Year Model Simulations of Proposed Regulator Modifications at BOS062 and BOS065

Outfall	Regulator	Current Weir Elevation	Interim Q3Q4-2020(1)		Interim Q3Q4-2020 System Conditions w/Contracts 1 & 2 (Completion 2024)		Long-Term Control Plan	
			Activations	Volume (MG)	Activations	Volume (MG)	Activations	Volume (MG)
BOS062	RE062-4	106.69	5	1.25	5	1.23	1	0.01
BOS065	RE065-2	102.83	1	0.60	1	0.40	1	0.06
BOS064	RE064-4	107.73	0	0.00	0	0.00	0	0.00
	RE064-5	104.32	1	0.01	0	0.00		
BOS068	RE068-1A	105.97	0	0.00	0	0.00	0	0.00

(1) Grey shading indicates model prediction is greater than LTCP value.

With the updated model MWRA continued to analyze the alternatives to bring RE062-4 and RE065-2 into attainment with LTCP goals. The investigations were coordinated with BWSC, in part to confirm that system changes, including increasing or adding interceptor connection capacity at RE062-4 and raising the weir at RE065-2 are feasible and are not anticipated to cause adverse downstream or upstream hydraulic impacts.

The evaluations identified an alternative referred to as the "BOS062/BOS065 Alternative" with the following components:

- Constructing a second DWF connection at regulator RE062-4
- Raising the weir at regulator RE064-5 by 3 inches from El. 104.32 to El.104.57
- Raising the weir at regulator RE065-2 by 2.8 feet (approximate 6 inches over the NESI) Peak HGL) from El. 102.83 to El.105.60

Table 4-9 presents a comparison of the Typical Year model results for the new baseline (that includes Contracts 1 and 2) and the BOS062/BOS065 Alternative.

Table 4-9 Typical Year Model Simulations of Regulator Modifications at BOS062 and BOS065

Outfall	Regulator	Current Weir Elevation	Interim Q3Q4-2020		Interim Q3Q4-2020 System Conditions w/Contracts 1 & 2 (Completion 2024)(1)		Interim Q3Q4-2020 System Conditions w/Contracts 1 & 2 (Completion 2024) BOS062&BOS065 Alternative		Long-Term Control Plan	
			Activations	Volume (MG)	Activations	Volume (MG)	Activations	Volume (MG)	Activations	Volume (MG)
BOS062	RE062-4	106.69	5	1.25	5	1.23	0	0.00	1	0.01
BOS065	RE065-2	102.83	1	0.60	1	0.40	1	0.03	1	0.06
BOS064	RE064-4	107.73	0	0.00	0	0.00	0	0.00	0	0.00
	RE064-5	104.32	1	0.01	0	0.00	1	0.03		
BOS068	RE068-1A	105.97	0	0.00	0	0.00	0	0.00	0	0.00

(1) Grey shading indicates model prediction is greater than LTCP value.

The model results show that adding a second interceptor connection at RE062-4 would bring CSO discharges at BOS062 into attainment with the LTCP goals and result in no activation in the Typical Year. The increased flow to the NESI required that the weir at RE065-2 be raised as described above. The model results showed, however, that allowing more flow to enter the NESI at RE062-4 would not affect overflows at other hydraulically related regulators except at regulator RE064-5, where one very small-volume activation is predicted to reappear. While this one activation would theoretically put outfall BOS064 slightly over the LTCP goal, the one predicted small-volume activation is considered to be immaterial.

This alternative is still being evaluated based on constructability and cost. The MWRA and BWSC continue to work to identify and investigate other alternatives to meet the LTCP goal.

4.6 Alewife Brook Outfalls

MWRA has continued to make progress with the evaluation of the Alewife Brook outfalls. A schematic of the Alewife Brook system is shown in Figure 4-14. In Semiannual Report No. 6, it was reported that outfalls CAM001, CAM002, MWR003, CAM401A, and CAM401B were meeting the LTCP goals for activation frequency and discharge volume. Outfall SOM001A is the only outfall reported not to be meeting the LTCP goals (Table 4-10). Investigations into alternatives that could reduce the activation frequency and volume at outfall SOM001A are underway and are also discussed below.

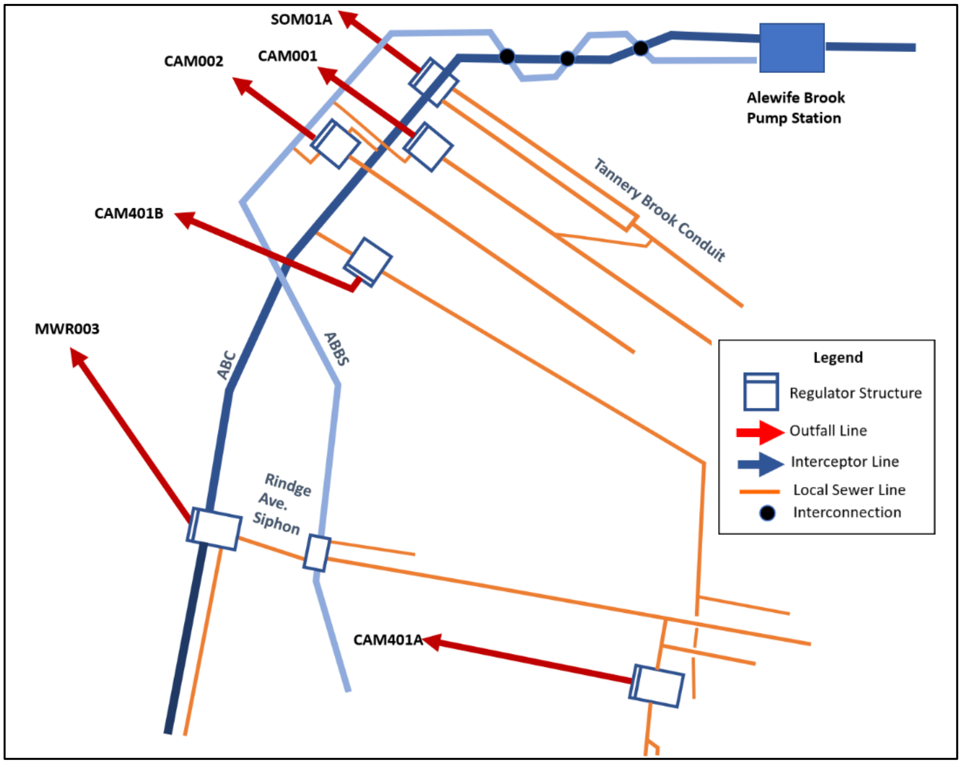

Figure 4-14. Schematic of Alewife Sub-System

4.6.1 CAM401A Sediment Removal Update

In Semiannual Report No. 6, it was reported that the model was updated with the removal of the sediment in the combined sewer downstream of regulator RE401A (outfall CAM401A) per field investigations undertaken at that time. Additional field measurements taken on April 13, 2020 identified 6 inches of sediment in the combined sewer. As a result, the model was updated to include the 6 inches of sediment. This update did not result in a change in the model activation frequency of 5 or the discharge volume of 0.66 MG reported in Semiannual Report No. 6. Therefore, CAM401A is still meeting the LTCP goal.

Table 4-10. Comparison of Q1-2021 and Q1Q2-2021System Conditions to LTCP

Outfall	Q1-2021 System Conditions(1)		Q1Q2-2021 System Conditions(1)		Long Term Control Plan	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)

Alewife Brook						
CAM001	1	0.02	1	0.02	5	0.19
CAM002	0	0.00	0	0.00	4	0.69
MWR003	3	0.61	3	0.61	5	0.98
CAM401A	5	0.66	5	0.66	5	1.61
CAM401B	4	0.50	4	0.50	7	2.15
SOM001A	8	4.47	8	4.47	3	1.67
Total	**8 (max)**	**6.26**	**8 (max)**	**6.26**	**7 (max)**	**7.29**

(1) Grey shading indicates model prediction is greater than LTCP value.

4.6.2 Outfall SOM001A

As indicated above in Table 4-10 (Section 4.6.1), outfall SOM001A is currently not meeting the LTCP goal of 3 activations and 1.67 MG of CSO discharge in the Typical Year. MWRA has been investigating a range of alternatives to potentially reduce the activation frequency and volume and work towards achieving the LTCP goals. These alternatives included:

- Raising the weir in the SOM001A regulator;
- increasing the conveyance of flow between the SOM001A regulator and the interceptor system;
- diverting upstream flows away from the Tannery Brook Drain, towards regulator SOM009 and the Prison Point system; and
- utilizing in-system storage within the Tannery Brook Drain to attenuate peak flows to the regulator.

After evaluating many different variations of the alternatives listed above, an alternative was identified which was predicted to meet the LTCP goals in the Typical Year. This alternative included:

- raising the weir in the SOM001A regulator 3 inches;
- increasing the size of the DWF orifice to the Alewife Brook Conduit (ABC) from 2’8”x2’8” to 4’8”x2’8”; and
- relining the ABC and Alewife Brook Branch Sewer (ABBS) from approximately the location of SOM001A to the Alewife Brook Pump Station.

The model predicted that in the Typical Year this alternative would reduce the CSO activation frequency and CSO discharge volume at SOM001A to 3 activations and 1.23 MG, meeting the LTCP goal of 3 activations and 1.67 MG. This alternative did not have adverse impacts to the HGL during the Typical Year. However, during a 5-year storm the alternative was predicted to have adverse impacts at a critical location just downstream of the SOM001A regulator. Several additional model runs were conducted with modifications to operations at MWR003 as well as making small reductions to the dry weather flow connection to attempt to mitigate the HGL impacts, but the adverse impacts remained.

MWRA is currently working with the City of Somerville to see if flood mitigation efforts that the city is currently investigating will reduce and/or attenuate the stormwater tributary to SOM001A and mitigate the adverse impact the alternative described above has in the 5-year storm. The City of Somerville is also working to assess if these potential flood mitigation efforts may have an overall benefit on CSO control. MWRA and Somerville continue to work together to identify and investigate alternatives as well as the appropriate combination of flood mitigation and system modification for CSO control that will meet the dual objectives, considering overall cost, constructability, and overall receiving water benefits.

4.7 Mystic/Chelsea Confluence Outfalls

4.7.1 Update on Raising the Overflow Weir at CHE004

Figure 4-15 shows the location of outfall CHE004. Flows from the area tributary to regulator RE041 are conveyed into the Chelsea Trunk Sewer. The Chelsea Trunk Sewer ties into the MWRA's Metropolitan Sewer which ultimately conveys flow to the Chelsea Screen House (Figure 4-15).

In Semiannual Report No. 6 it was reported that outfall CHE004 was predicted to activate seven times in the Typical Year under Mid-2020 conditions, with an annual overflow volume of 1.01 MG. This level of performance exceeds the LTCP goal for outfall CHE004 of three activations and 0.32 MG in the Typical Year.

Evaluations by MWRA and Chelsea showed that raising the weir at regulator RE041 by 1.5 feet was predicted to result in three activations and 0.30 MG at outfall CHE004 in the Typical Year, which would meet the LTCP goals of three activations and 0.32 MG.

As a result of the evaluations, the City of Chelsea was able to implement the weir raising at regulator RE041, increasing the height by 1.5 feet to elevation 109.83 on December 1, 2020. However, due to construction issues the weir had to be adjusted after it was constructed resulting in a weir elevation of 109.41. On August 16, 2021, the City of Chelsea raised the weir the additional 5 inches to elevation 109.83 which will bring outfall CHE004 back to meeting LTCP goals.

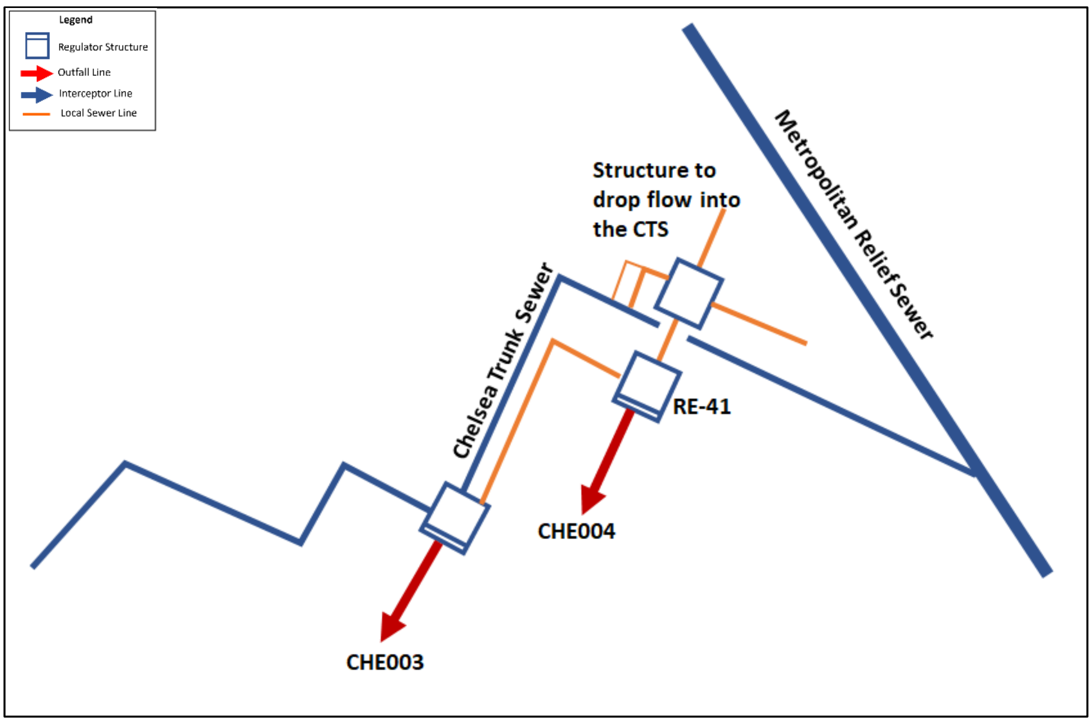

Figure 4-15. Schematic of CHE004 Model Configuration

4.7.2 Update on Upgrading the Interceptor Connection at Outfall CHE008

Under Q1Q2-2021 Conditions, outfall CHE008 is predicted to activate 6 times with a total volume of 1.93 MG, while the LTCP goal is zero activations in the Typical Year. Semiannual Report No. 6 included a description of an alternative to increase the capacity of the dry weather flow connection between regulator RE-081 (outfall CHE008) and the MWRA interceptor system at Structure C. Since then, MWRA completed preliminary design activities and commenced final design of this project in March 2021. The project schedule calls for the completion of design in Fall 2021, commencement of construction in early 2022, and completion of construction in the summer of 2022.

4.7.3 Outfall BOS017

Outfall BOS017 is currently not meeting the LTCP goal of 1 activation and 0.02 MG of CSO discharge in the Typical Year. As indicated in Semiannual Report No. 6, MWRA has updated and recalibrated its model to incorporate the results of recent BWSC inspections in the Charlestown/BOS017 area. MWRA then began the process of identifying and evaluating potential CSO reduction alternatives such as removing sources of tidal inflow, raising the weir, and improving interceptor connection capacity using the recalibrated model. MWRA also conducted system inspections to attempt to locate sources of tidal inflow.

Through the inspections and a review of meter data, MWRA identified a leaky tidegate that was allowing tidal inflow to enter RE017-3. In addition, a separate stormwater area was found to be connected to the combined sewer at Rutherford Ave. near Middlesex St. upstream of BOS017. BWSC replaced the tide gate and relocated the stormwater area to an adjacent separate storm drain. These changes have been updated in the model for the Q1Q2-2021 conditions.

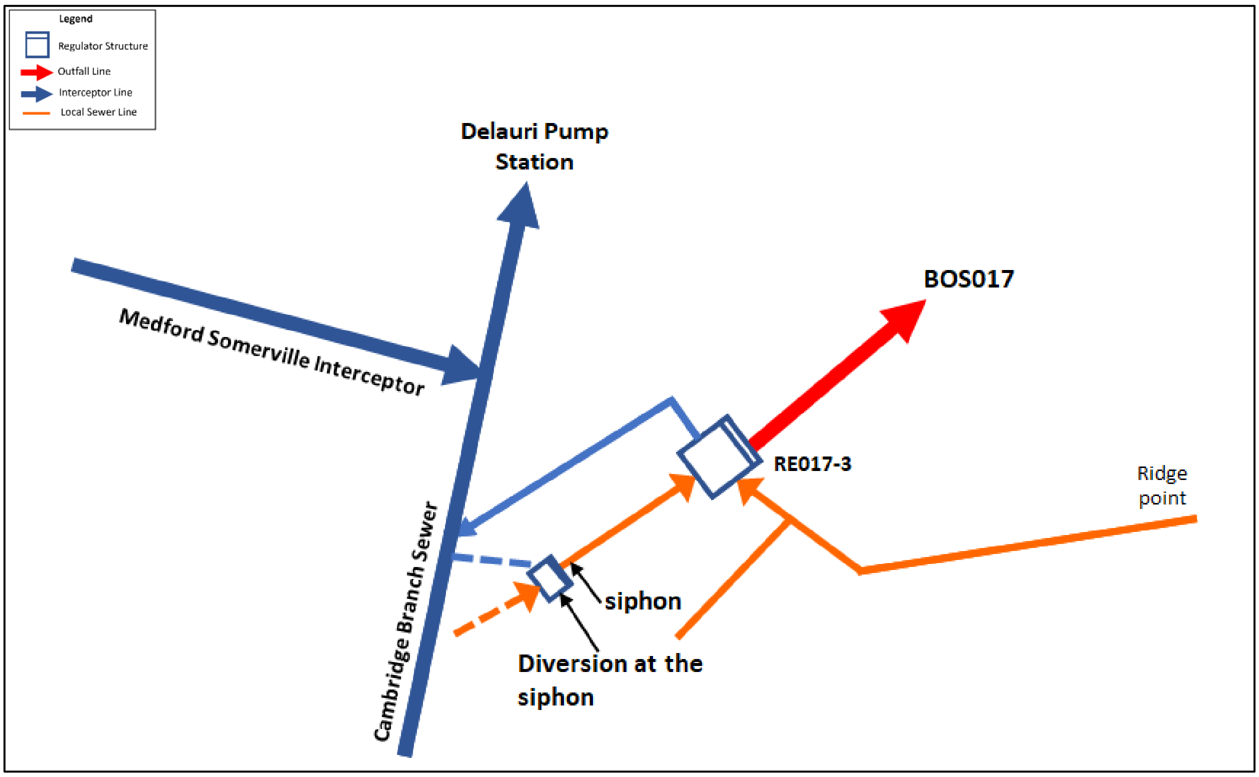

Figure 4-16. Schematic of BOS017 System Showing Locations of Flow Meters

The Sullivan Square Siphon is located upstream of BOS017 as shown in the model schematic in Figure 4-16 above. A section view of the record drawing of the structure is presented below in Figure 4-17. The siphon has two 24-inch barrels each with adjustable weir plates and guides set directly against the openings in the 24-inch siphon barrels. The current configuration within the siphon chamber has one weir set to completely block flow into one of the siphon barrels, with the second weir set at elevation 107.3, at approximately the springline of the second siphon barrel. During dry weather the weirs direct flow to the Cambridge Branch Sewer, and at higher flows the one weir set at elevation 107.3 can be overtopped allowing flow towards the BOS017 regulator structure.

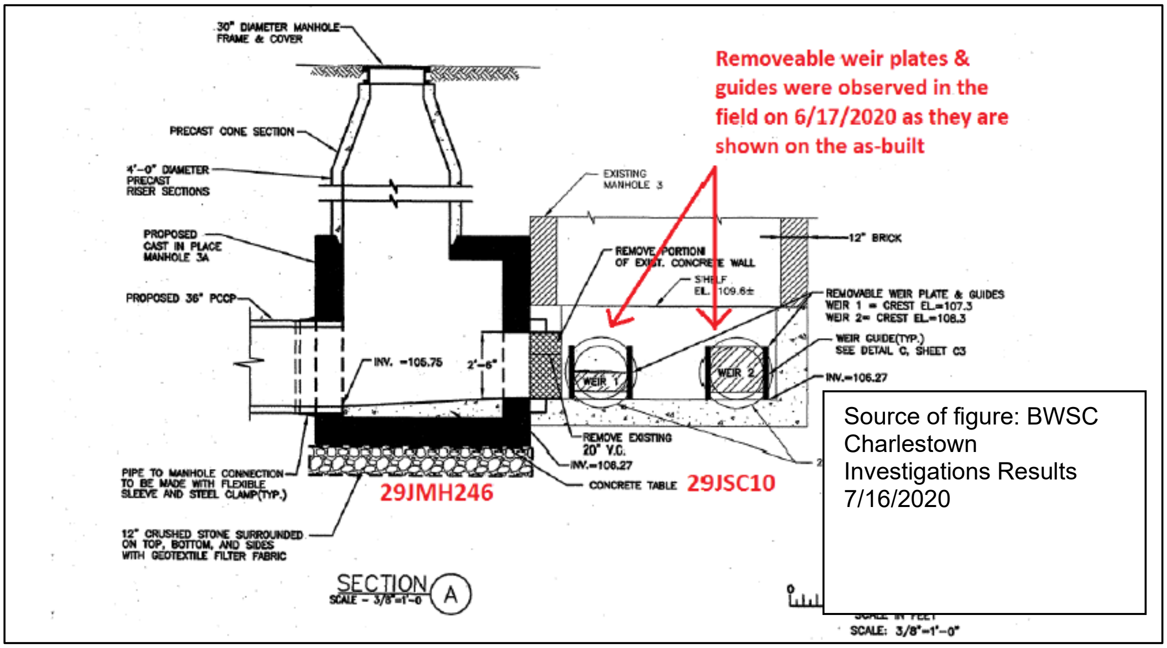

Figure 4-17. Siphon Barrel Configuration at Sullivan Square

Hydraulic modeling indicated that removing the leaky tide gate, removing the small stormwater area, and closing the siphon would achieve the LTCP goals at outfall BOS017 for the Typical Year. However, initial modeling indicated this configuration would cause adverse upstream HGL impacts from closing the siphon in the 5-year storm. The next step was to use the model to evaluate the elevation of the weirs upstream of the siphon barrels needed to eliminate overflows in the Typical Year but not adversely affect the HGLs in the surrounding areas in the 5-year storm.

To model options for raising the weirs in the siphon structure, it was assumed that the existing weirs would be removed and new weirs would be constructed offset from the ends of the siphon barrels as shown in Figures 4-18 and 4-19. This configuration would allow water to flow over the weirs without creating a restriction in the openings to the siphon barrels, thus providing a reduction in headloss during larger storm events compared to the current configuration. The model was configured with the weir for one of the siphon barrels set to El. 109.27 (3 inches above the peak HGL in the Typical Year) while the other weir was set to El. 113.45 (3 inches over the peak HGL during a 5-year storm. This arrangement would allow no flow to go through the siphons during the Typical Year but would allow the siphon to be used as a relief during storms larger than the Typical Year storms. Table 4-11 presents a comparison of the Q1-2021 System Conditions, Q1Q2-2021 System Conditions, and Q1Q2-2021 System Conditions with Siphon Structure Modification to the LTCP. As indicated in Table 4-11, the siphon structure modifications were predicted to bring outfall BOS017 to meet the LTCP goals.

Table 4-11. Comparison of Q1-2021, Q1Q2-2021, Q1Q2-2021 with Siphon Structure Modification to LTCP

Outfall	Regulator	Q1-2021 System Conditions (1)		Q1Q2-2021 System Conditions (1)		Q1Q2-2021 System Conditions with Siphon Structure Modification (1)		Long Term Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
BOS017	RE017-2	6	0.34	6	0.34	0	0	1	0.02

(1) Grey shading indicates model prediction is greater than LTCP value.

(2) Q1Q2 includes relocating 4 acres of stormwater and repairing the tide gate at BOS017

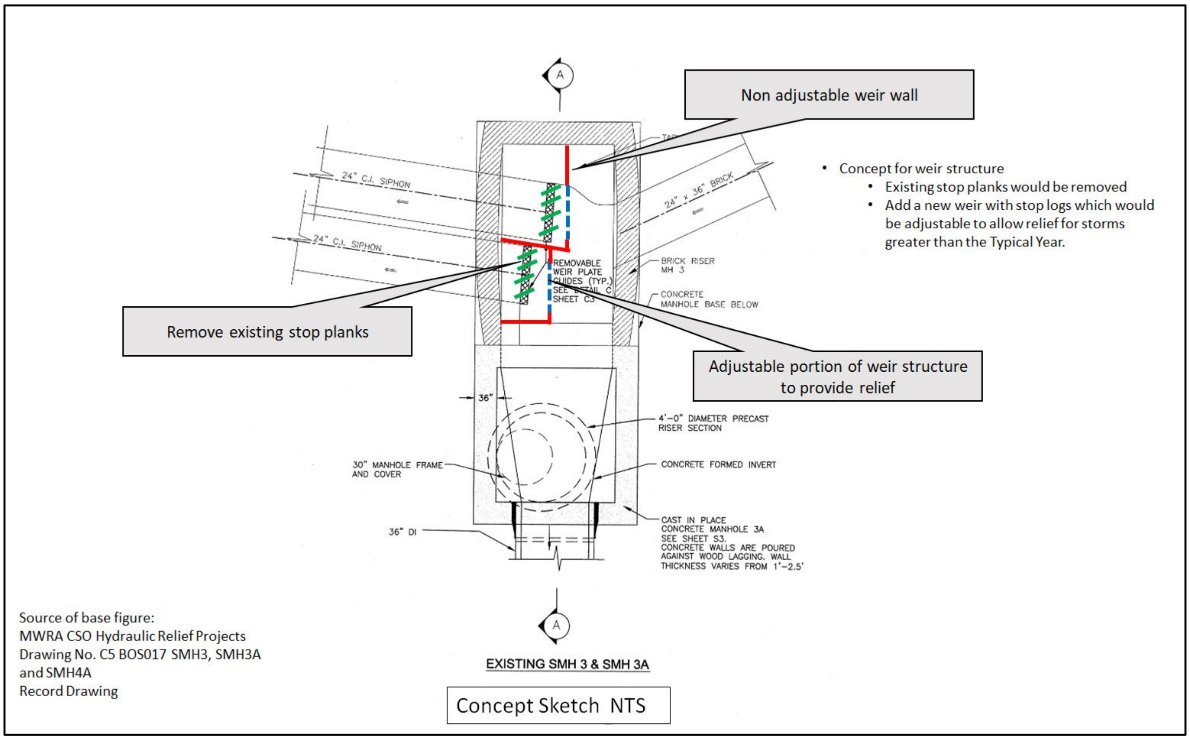

Figure 4-18. BOS017 – Concept Sketch of Sullivan Square Siphon Structure Modifications – Plan View- Option 1

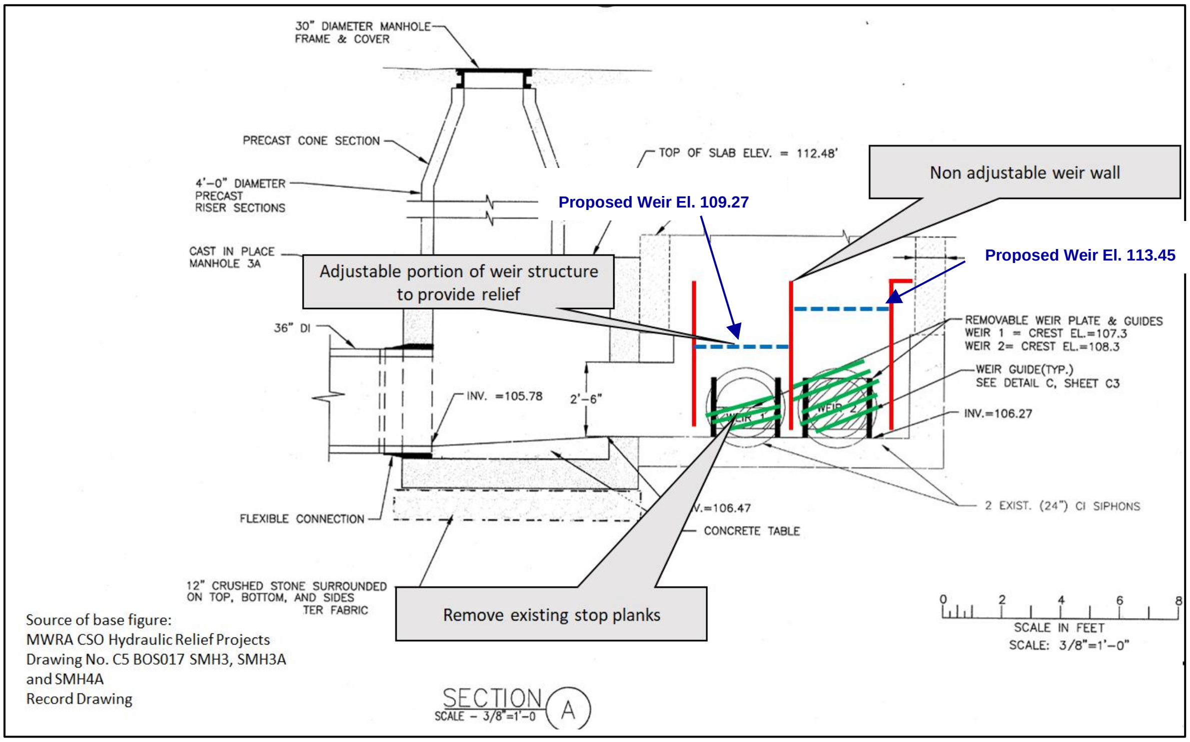

Figure 4-19. BOS017 – Concept Sketch of Sullivan Square Siphon Structure Modifications – Section View- Option 1

Figure 4-20 shows a comparison of the peak HGL in the siphon structure upstream of the weir for the 5-year storm for the Q1-2021 condition and the Q1Q2-2021 model with the modifications at the siphon structure. Even though the weir elevation has been raised the peak HGL is reduced due to the new configuration with the weirs offset from the openings to the siphon barrels in the siphon structure.

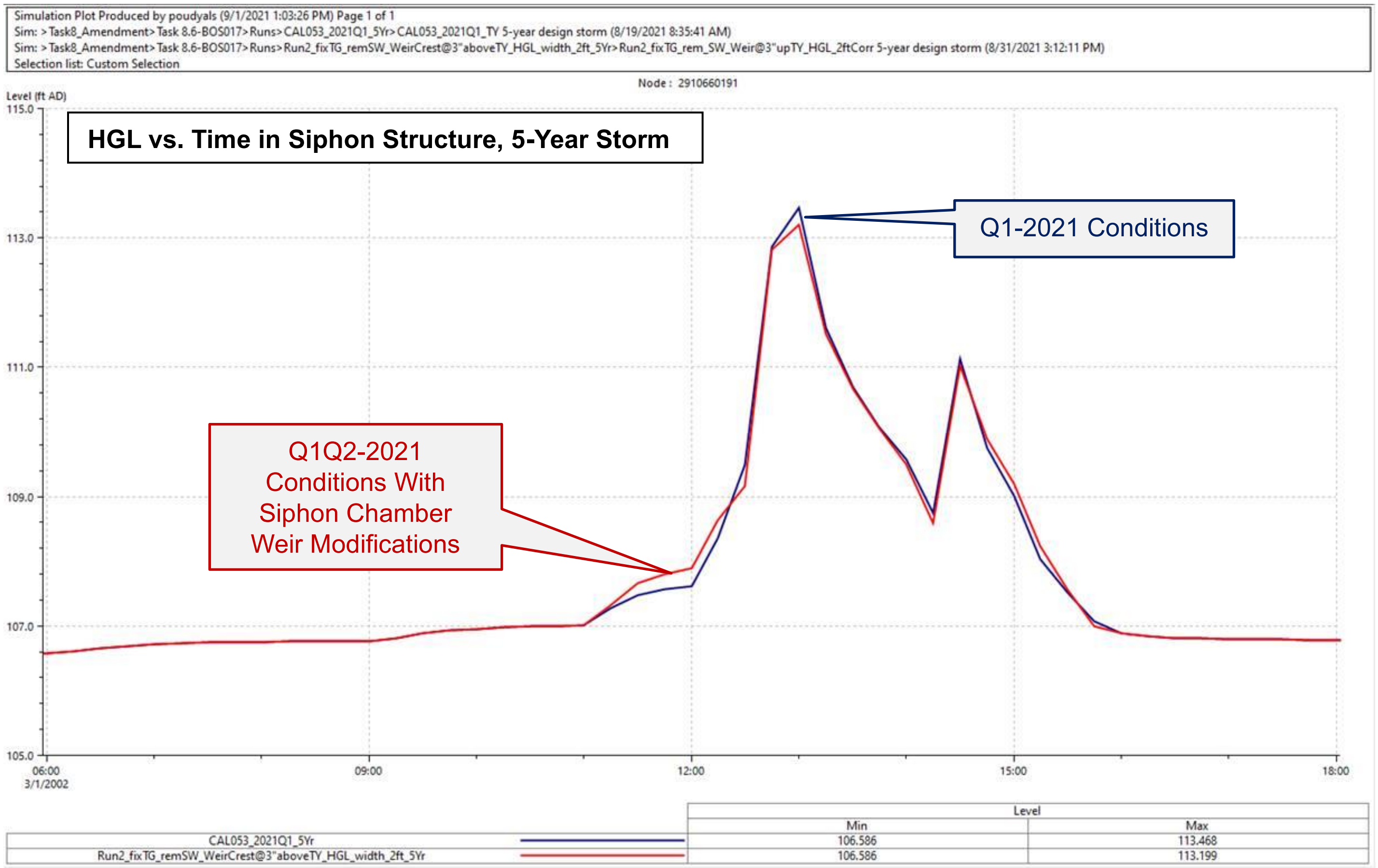

Figure 4-20. Comparison of the Peak HGL in the Typical Year for Q1-2021 and the Q1Q2-2021 with Modifications to Siphon Structure

MWRA and BWSC are coordinating on the constructability of the proposed alternative. However, this alternative to meet LTCP goals at BOS017 appears to be amenable and will likely move forward into design.

5. Data Collection and Analyses January 1, 2021 - June 30, 2021

5.1. Rainfall Analyses

Rainfall is a driving factor in the analysis of CSOs, as the occurrence of overflows within the MWRA sewer system is dependent on rainfall intensity and/or depth. This section presents the rainfall data measured during the period of January 1, 2021 through June 30, 2021. It also describes the analysis of the rainfall data used to characterize the return period of each storm event and a comparison of measured rainfall for the Q1Q2-2021 period to the rainfall included in the Typical Year.

5.1.1 Rainfall Data Collection and Processing

Rainfall has been quantified for this analysis using 15-minute rainfall data collected at rain gauges distributed over the MWRA system. Rain gauges are listed in Table 5-1 and the locations are shown in Figure 5-1, on the following page.

Table 5-1. Rain Gauges

Gauge Code	Name	Owner
BO-DI-1	Ward St.	MWRA
BO-DI-2	Columbus Park	MWRA
BWSC001	Union Park Pump Sta.	BWSC
BWSC002	Roslindale	BWSC
BWSC003	Dorchester Adams St.	BWSC
BWSC004	Allston	BWSC
BWSC007	Charlestown	BWSC
EB	East Boston	BWSC
BWSC008	Longwood Medical	BWSC
BWSC005	Hyde Park	BWSC

Gauge Code	Name	Owner
BWSC006	Dorchester -Talbot	BWSC
Rox	Roxbury	BWSC
CH-BO-1	Chelsea Ck.	MWRA
FRESH_POND	USGS Fresh Pond	USGS
HF-1C	Hanscom AFB	MWRA
RG-WF-1	Hayes Pump Sta.	MWRA
SOM	Somerville Remote	MWRA
Lex	Lexington Farm	Project (1)
SP	Spot Pond	Project (1)
WF	Waltham Farm	Project (1)

(1) Project gauges were removed as of July 1, 2020. Project gauge data has been replaced with the nearest rain gauge, following the QA/QC procedures and closest rain gauges substitution table.

Quality assurance and quality control are provided by reviewing the data based on geographic location, comparing total rainfall depth and rainfall intensity values by month and for individual storm events. The shape of rainfall hyetographs is reviewed for irregularities. Rain gauges with significantly higher or lower total rainfall depths than other gauges, and unusual hyetograph shapes, are flagged as suspect and further reviewed.

Suspect or missing rain gauge data were replaced with data from the rain gauge in closest linear proximity. If the closest gauge also had suspect data, the second closest rain gauge was used. Table 5-2 identifies the two closest rain gauges to each of the rain gauges. Replacement of suspect data was recorded in Table 5-3. Rainfall data used for the analysis are provided in Appendix A.

Intensity-Duration-Frequency (IDF) analysis was used to characterize the return periods of the storm events in the January 1 through June 30, 2021 metering period. Storm recurrence intervals for 1-hour, 24-hour, and 48-hour durations were identified for each storm event based on the IDF analysis. Storm recurrence intervals were based on Technical Paper 40, Rainfall Frequency Atlas of the United States (TP-40), and Technical Paper 49, Two-To Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States (TP-49), with values extrapolated for the 3- and 6-month storms.

Additional information on the methodologies for rainfall data collection and processing can be found in Semiannual Report Nos. 1 and 2.

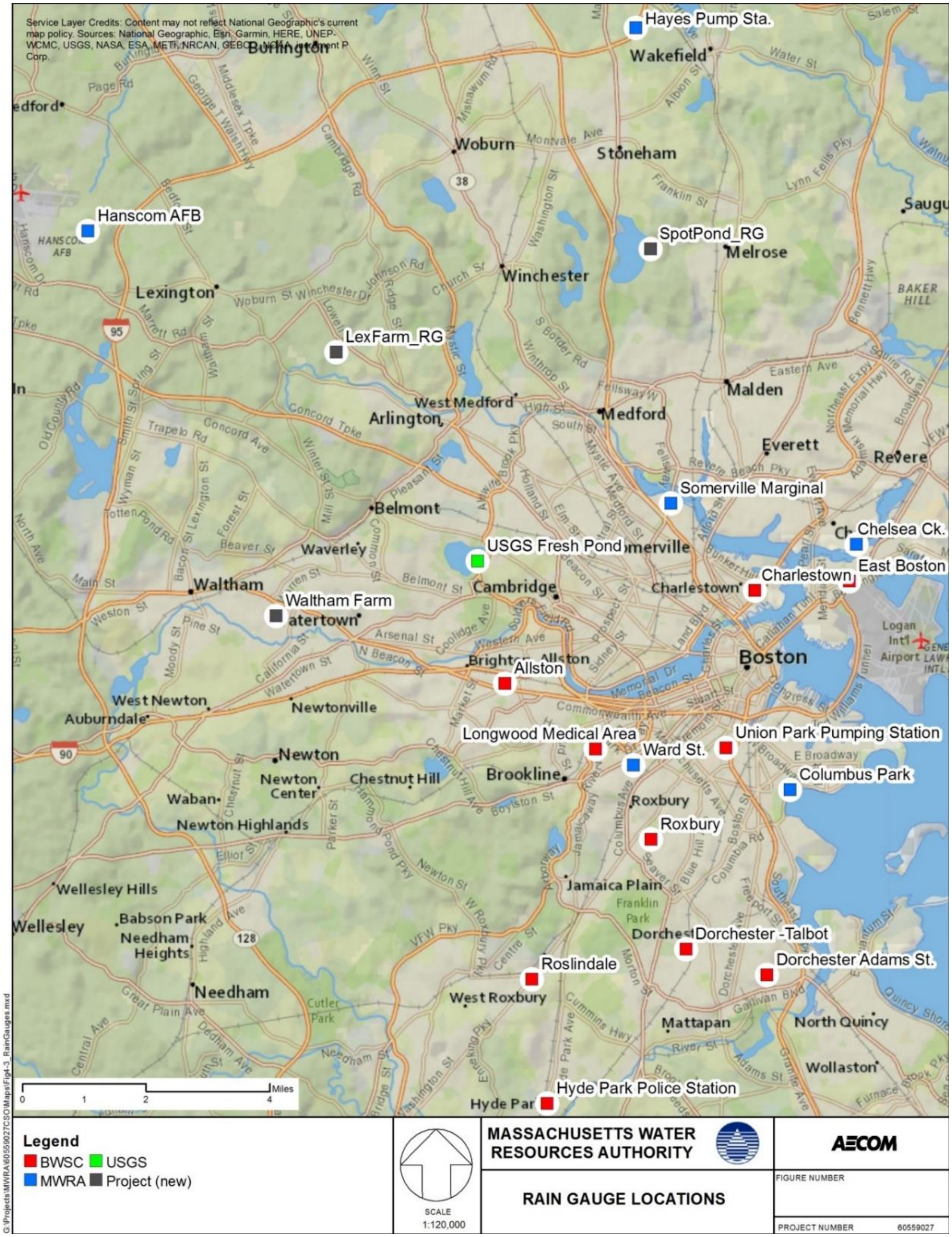

Figure 5-1. Rain Gauge Location Plan

Table 5-2. Closest Rain Gauges for Data Substitution

Origin Gauge		Closest Gauge		Second Closest Gauge	
Gauge Name	**Gauge Code**	**Gauge Code**	**Distance (mi)**	**Gauge Code**	**Distance (mi)**
Ward Street	BO-DI-1	BWSC008	0.66	Rox	1.23
Columbus Park	BO-DI-2	BWSC001	1.24	Rox	2.39
Union Park Pumping Station	BWSC001	BO-DI-2	1.24	BO-DI-1	1.52
Roslindale	BWSC002	BWSC005	2.02	BWSC006	2.54
Dorchester Adams St.	BWSC003	BWSC006	1.37	Rox	2.88
Allston	BWSC004	BWSC008	1.81	FRESH_POND	2.03
Hyde Park Police Station	BWSC005	BWSC002	2.02	BWSC006	3.36
Dorchester -Talbot	BWSC006	BWSC003	1.37	Rox	1.86
Charlestown	BWSC007	EB	1.53	CH-BO-1	1.80
Longwood Medical Area	BWSC008	BO-DI-1	0.67	Roxbury	1.71
Chelsea Creek	CH-BO-1	EB	0.60	BWSC007	1.80
East Boston	EB	CH-BO-1	0.60	BWSC007	1.53
USGS Fresh Pond	FRESH_POND	BWSC004	2.21	SOM	3.26
Hanscom AFB	HF-1C	Lex	4.47	WF	6.92
Lexington Farm	Lex	FRESH_POND	4.08	WF	4.37
Hayes Pump Sta.	RG-WF-1	SP	3.58	Lex	7.13
Roxbury	Rox	BO-DI-1	1.23	BWSC008	1.71
Somerville	SOM	BWSC007	1.95	CH-BO-1	3.07
Spot Pond	SP	SOM	4.12	Lex	5.34
Waltham Farm	WF	FRESH_POND	3.37	BWSC004	3.86

Table 5-3. Summary of Rainfall Data Replacement, January - June 2021 (Page 1 of 2)

Rain Gauge	Replacement Data Start Time	Replacement Data End Time	Replacement Rain Gauge
Ward Street (BO-DI-1)	02/18/2021 10:15	02/18/2021 10:15	Columbus Park (BO-DI-2)
	03/11/2021 9:00	03/11/2021 9:15	Columbus Park (BO-DI-2)
	05/24/2021 8:30	05/24/2021 8:30	Columbus Park (BO-DI-2)
Columbus Park (BO-DI-2)	02/18/2021 9:45	02/18/2021 9:45	Ward Street (BO-DI-1)
	03/11/2021 9:45	03/11/2021 10:15	Ward Street (BO-DI-1)
	03/12/2021 8:45	03/12/2021 8:45	Ward Street (BO-DI-1)
	05/25/2021 8:45	05/25/2021 8:45	Ward Street (BO-DI-1)
Union Park Pumping Station (BWSC001)	01/26/2021 18:45	01/27/2021 18:00	Columbus Park (BO-DI-2)
	02/18/2021 16:30	02/21/2021 16:30	Columbus Park (BO-DI-2)
Roslindale (BWSC002)	01/26/2021 17:45	01/27/2021 18:00	Ward Street (BO-DI-1)
	02/18/2021 16:30	02/21/2021 16:30	Ward Street (BO-DI-1)
	06/29/2021 16:15	06/29/2021 19:00	Ward Street (BO-DI-1)
Dorchester Adams St. (BWSC003)	01/01/2021 0:00	01/03/2021 0:00	Roxbury (ROX)
	01/03/2021 0:00	01/31/2021 23:45	Ward Street (BO-DI-1)
	02/01/2021 0:00	04/30/2021 6:00	Dorchester Talbot (BWSC006)
	4/30/2021 6:00	06/30/2021 23:45	Roslindale (BWSC002)
Allston (BWSC004)	01/26/2021 17:45	01/27/2021 18:00	Ward Street (BO-DI-1)
	02/18/2021 16:30	02/21/2021 16:30	Ward Street (BO-DI-1)

Table 5-3. Summary of Rainfall Data Replacement, January-June 2021 (Page 2 of 2)

Rain Gauge	Replacement Data Start Time	Replacement Data End Time	Replacement Rain Gauge
Hyde Park Police Station (BWSC005)	01/26/2021 17:45	01/27/2021 18:00	Ward Street (BO-DI-1)
	02/18/2021 16:30	02/21/2021 16:30	Ward Street (BO-DI-1)
Dorchester -Talbot (BWSC006)	01/01/2021 0:00	01/03/2021 0:00	Roxbury (ROX)
	01/03/2021 0:00	01/31/2021 23:45	Ward Street (BO-DI-1)
	02/18/2021 16:30	02/21/2021 16:30	Columbus Park (BO-DI-2)
	4/30/2021 6:00	06/30/2021 23:45	Roslindale (BWSC002)
Charlestown (BWSC007)	01/01/2021 0:00	06/30/2021 23:45	East Boston (EB)
Longwood Medical Area (BWSC008)	01/01/2021 0:00	06/30/2021 23:45	Ward Street (BO-DI-1)
Chelsea Creek (CH-BO-1)	01/26/2021 18:45	01/27/2021 18:00	Columbus Park (BO-DI-2)
	02/18/2021 16:30	02/21/2021 16:30	Columbus Park (BO-DI-2)
East Boston (EB)	01/26/2021 18:45	01/27/2021 18:00	Columbus Park (BO-DI-2)
	02/18/2021 16:30	02/21/2021 16:30	Columbus Park (BO-DI-2)
USGS Fresh Pond (FRESH_POND)	02/18/2021 16:30	02/21/2021 16:30	Ward Street (BO-DI-1)
	05/30/2021 9:15	05/31/2021 7:30	Somerville (SOM)
Hanscom AFB (HF-1C)	01/01/2021 0:00	06/30/2021 23:45	Fresh Pond (FRESH_POND)
Lexington Farm (Lex)	01/01/2021 0:00	06/30/2021 23:45	Fresh Pond (FRESH_POND)
Hayes Pump Sta. (RG-WF-1)	01/26/2021 18:45	01/27/2021 18:00	Fresh Pond (FRESH_POND)
	02/18/2021 16:30	02/21/2021 16:30	Ward Street (BO-DI-1)
	06/29/2021 15:30	06/29/2021 15:45	Fresh Pond (FRESH_POND)
Roxbury (ROX)	01/03/2021 0:30	06/30/2021 23:45	Ward Street (BO-DI-1)
Somerville (SOM)	01/16/2021 20:00	1/27/2021 18:00	Chelsea Creek (CH-BO-1)
	02/18/2021 16:30	02/21/2021 16:30	Ward Street (BO-DI-1)
Spot Pond (SP)	01/01/2021 0:00	06/30/2021 23:45	Somerville (SOM)
Waltham Farm (WF)	01/01/2021 0:00	06/30/2021 23:45	Fresh Pond (FRESH_POND)

5.1.2 Monitored Storms and Comparison with Typical Year

For the period of January 1 to June 30, 2021, the rainfall data at each rain gauge were analyzed and summarized, providing the date and time, duration, volume, average intensity, peak 1-hour, 24-hour, and 48-hour intensities and storm recurrence intervals for each storm. The storm recurrence intervals were assigned values of <3 months, 3 months, 3-6 months, 6 months, 1 year, or the nearest year, based on comparison to the IDF values from TP-40/TP-49. Table 5-4Table 5-4 presents the summary of storm events for Ward Street Headworks for the period of January to June 2021. These data show that 45 storm events occurred in the 6-month period January to June 2021 at the Ward Street Headworks rain gauge (BO-DI-1). The majority of events had less than 3-month recurrence intervals at 1-hour or 24-hour durations. Three storm events had a 24-hour recurrence interval of 3 months or greater (April 15, 2021, and May 28, 2021). Tables summarizing the storm events from January to June 2021 for the other rain gauges are provided in Appendix B.

Table 5-4. Summary of Storm Events at Ward Street Headworks Rain Gauge (BO-DI-1) for January to June 2021 (Page 1 of 2)

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:15	12	0.56	0.05	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:00	2.75	0.06	0.02	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:30	6.25	0.09	0.01	0.03	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 3:45	9.25	1.42	0.15	0.34	0.06	N/A	<3m	<3m	N/A
5	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 5:00	10	0.07	0.01	0.02	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 14:15	20	1.12	0.06	0.14	0.05	N/A	<3m	<3m	N/A
8	2/6/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/7/2021 12:15	25.5	0.37	0.01	0.07	0.01	0.01	<3m	<3m	<3m
10	2/9/2021 12:30	24.75	0.11	0.00	0.03	0.00	0.0	<3m	<3m	<3m
11	2/15/2021 12:00	27	0.67	0.02	0.17	0.03	0.02	<3m	<3m	<3m
12	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
13	2/22/2021 15:45	4.25	0.16	0.04	0.08	0.01	N/A	<3m	<3m	N/A
14	2/27/2021 9:00	7.25	0.17	0.02	0.07	0.01	N/A	<3m	<3m	N/A
15	3/1/2021 0:15	18.25	0.18	0.01	0.07	0.01	N/A	<3m	<3m	N/A
16	3/11/2021 14:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
17	3/18/2021 14:15	9	0.75	0.08	0.13	0.03	N/A	<3m	<3m	N/A
18	3/25/2021 0:00	6	0.12	0.02	0.04	0.01	N/A	<3m	<3m	N/A
19	3/26/2021 4:15	5	0.02	0.00	0.01	0.00	N/A	<3m	<3m	N/A
20	3/28/2021 12:00	12	0.85	0.07	0.35	0.04	N/A	<3m	<3m	N/A
21	3/31/2021 21:30	13.25	1.06	0.08	0.27	0.04	N/A	<3m	<3m	N/A
22	4/12/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
23	4/15/2021 17:30	41.5	2.74	0.07	0.24	0.11	0.06	<3m	6m-1yr	1yr
24	4/20/2021 12:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
25	4/21/2021 13:00	4.75	0.29	0.06	0.11	0.01	N/A	<3m	<3m	N/A
26	4/25/2021 8:15	2.5	0.1	0.04	0.05	0.00	N/A	<3m	<3m	N/A
27	4/28/2021 1:15	2.25	0.22	0.10	0.14	0.01	N/A	<3m	<3m	N/A
28	4/28/2021 19:45	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
29	4/29/2021 10:00	16	0.85	0.05	0.21	0.03	N/A	<3m	<3m	N/A
30	4/30/2021 22:15	3	0.15	0.05	0.07	0.00	N/A	<3m	<3m	N/A
31	5/2/2021 2:15	2	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
32	5/4/2021 0:15	11.5	0.87	0.08	0.17	0.04	N/A	<3m	<3m	N/A
33	5/5/2021 1:15	21.75	0.6	0.03	0.26	0.03	N/A	<3m	<3m	N/A
34	5/10/2021 0:45	4.5	0.35	0.08	0.13	0.01	N/A	<3m	<3m	N/A
35	5/16/2021 15:30	0.5	0.05	0.10	0.05	0.00	N/A	<3m	<3m	N/A
36	5/26/2021 20:00	11.5	0.33	0.03	0.17	0.01	N/A	<3m	<3m	N/A

Table 5-4. Summary of Storm Events at Ward Street Headworks Rain Gauge (BO-DI-1) for January to June 2021 (Page 2 of 2)

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
37	5/28/2021 18:30	20	2.38	0.12	0.29	0.10	N/A	<3m	6m	N/A
38	5/30/2021 8:45	23	1	0.04	0.12	0.04	N/A	<3m	<3m	N/A
39	6/9/2021 0:00	2	0.04	0.02	0.03	0.00	N/A	<3m	<3m	N/A
40	6/11/2021 21:45	13.25	0.74	0.06	0.17	0.03	N/A	<3m	<3m	N/A
41	6/14/2021 8:30	21	0.62	0.03	0.22	0.03	N/A	<3m	<3m	N/A
42	6/15/2021 18:15	0.25	0.03	0.12	0.03	0.00	N/A	<3m	<3m	N/A
43	6/22/2021 14:00	8.25	1.75	0.21	1.23	0.07	N/A	2yr	<3m	N/A
44	6/25/2021 1:30	4.25	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
45	6/30/2021 17:15	4.5	0.4	0.09	0.24	0.02	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1year (6m-1yr) or the nearest year.

The characteristics of the rain events that occurred in the January 1 through June 30, 2021 monitoring period were compared to rainfall characteristics from the Typical Year to help interpret the measured CSO activations and volumes in comparison to Typical Year performance. To allow for a comparison of a half-year of data, the total rainfall statistics for the Typical Year were divided by two, to create "Half Typical Year" statistics.

The total rainfall and number of storms at each rain gauge were identified for the period of January 1 through June 30, 2021, and the number of storms by depth identified. These values were then compared to the values from the Half Typical Year. Table 5-5 presents this comparison. As indicated in Table 5-5, during the first half of 2021, rain gauges measured an average of 42 storms with total rainfall volume of 22.82 inches, compared with 47 storms and 23.4 inches in Half Typical Year. Storm frequencies for the 0.25 to 0.5-inch and 1.0 to 2.0-inch ranges were equal to the Half Typical Year, while the numbers of storms in less than 0.25-inch and greater than 2-inch ranges were less than the Half Typical Year. The number of storms in the 0.5 to 1.0-inch range were higher than the Half Typical Year. In general, the breakdown of numbers of storms by rainfall depth categories for the first half of 2021 were relatively close to the values for the Half Typical Year.

Storms with greater than 2 inches of total rainfall at the Ward Street, Columbus Park, Chelsea Creek Headworks, and USGS Fresh Pond rain gauges were identified and compared to storms with greater than 2 inches of total rainfall in the full Typical Year (Table 5-6). Experience has shown that large storms often account for a disproportionate volume of CSO. Table 5-6Table 5-6 indicates that two storm events (April 15, 2021, and May 28, 2021) had rainfall depths at Ward Street, Columbus Park, Chelsea Creek and/or USGS Fresh Pond of greater than 2 inches. At the USGS Fresh Pond rain gauge, the April 15 storm had greater than 2 inches, while the May 28 storm had 1.92 inches (see Appendix B). Thus, these two storms appeared to have relatively uniform rainfall across the service area. Referring to Table 5-5, the first half of the 2021 monitoring period had a lower frequency of 2-inch or greater storm events compared to the Half Typical Year. In addition, while the largest storm for the rain gauges presented below recorded 2.74 inches of rainfall, the Typical Year storm with greatest depth had 3.89 inches of rainfall.

Table 5-5. Frequency of Events within Selected Ranges of Total Rainfall for January 1 to June 30, 2021

Rain Gauge	Total Rainfall (inches)	Total Number of Storms	Number of Storms by Depth				
			Depth < 0.25 inches	Depth 0.25 to 0.5 inches	Depth 0.5 to 1.0 inches	Depth 1.0 to 2.0 inches	Depth ≥2.0 inches
Half Typical Year(1)	23.40	47	25	7	8	4	3
January - June 2021 Metering Data							
Average of Rain Gauges							
Average	22.82	42	20	7	10	4	2
MWRA Rain Gauges							
Ward Street	22.09	45	22	7	9	5	2
Columbus Park	23.17	45	20	6	11	6	2
Chelsea Creek	20.81	46	24	5	11	4	2
Hanscom Air	17.12	36	14	9	10	2	1
Hayes PS	19.47	41	19	6	12	3	1
BWSC Rain Gauges							
Allston	20.73	46	23	7	12	2	2
Charlestown	22.02	42	21	4	9	6	2
Dorchester-Adams	23.98	42	20	4	12	4	2
Dorchester-Talbot	23.97	42	20	4	12	4	2
Hyde Park	23.11	44	22	8	8	3	3
East Boston	22.02	42	21	4	9	6	2
Longwood	22.09	45	22	7	9	5	2
Roslindale	22.98	45	24	6	10	3	2
Roxbury	22.04	44	21	7	9	5	2
Union Park	22.26	48	24	8	9	5	2
USGS Rain Gauge							
Fresh Pond	17.12	36	14	9	10	2	1
MWRA Rain Gauges							
Lexington Farm	17.12	36	14	9	10	2	1
Spot Pond	18.55	40	17	8	11	3	1
Somerville	18.55	40	17	8	11	3	1
Waltham Farm	17.12	36	14	9	10	2	1

(1) "Half Typical Year" values were calculated by dividing the full Typical Year statistics by two.

Table 5-6. Comparison of Storms Between January 1 and June 30, 2021 and Typical Year with Greater Than 2 Inches of Total Rainfall

Rain Gauge	Date	Duration (hr)	Total Rainfall (in)	Average Intensity (in/hr)	Peak Intensity (in/hr)	Storm Recurrence Interval (24-hr)
Typical Year	12/11/1992	50	3.89	0.08	0.20	1y
	8/15/1992	72	2.91	0.04	0.66	3m
	9/22/1992	23	2.76	0.12	0.65	1y
	11/21/1992	84	2.39	0.03	0.31	3m
	5/31/1992	30	2.24	0.07	0.37	3m-6m
	10/9/1992	65	2.04	0.03	0.42	< 3m
January-June 2021 Rain Gauge Data						
Ward Street	4/15/2021	41.5	2.74	0.07	0.24	6m-1yr
	5/28/2021	20	2.38	0.12	0.29	6m
Columbus Park	4/15/2021	39	2.29	0.06	0.27	3m-6m
	5/28/2021	19.25	2.55	0.13	0.31	6m-1yr
Chelsea Creek	4/15/2021	39.5	2.20	0.06	0.24	3m-6m
	5/28/2021	19.25	2.28	0.12	0.28	3m-6m
Fresh Pond (USGS)	4/15/2021	23.5	2.35	0.10	0.22	6m

Storms with peak rainfall intensities greater than 0.40 in/hr at the Ward Street, Columbus Park, Chelsea Creek Headworks, and USGS Fresh Pond rain gauges were identified and compared to storms with greater than 0.40 in/hr of peak intensity in the Typical Year (Table 5-7). Storms with intensities greater than 0.40 in/hr are of importance because higher intensity storms have been found to produce more CSO activations and volumes than lower intensity storms. The full Typical Year has nine storm events with intensities greater than 0.40 inches per hour, while the first half of the 2021 monitoring period had one storm event (June 22, 2021) in which the peak intensities ranged from 0.46 to 1.23 inches per hour at three gages (Ward Street, Columbus Park, and Chelsea Creek). The peak intensity at Fresh Pond was less than 0.40 inches per hour. This suggests that the June 22, 2021 storm had high spatial variability which is common in summer thunderstorms.

For storms with peak rainfall intensities greater than 0.4 in/hr at Ward Street Headworks, Columbus Park Headworks, and Chelsea Creek Headworks rain gauges, hyetographs were developed. These hyetographs show the 15-minute rainfall intensities and show the distribution of rainfall during the storm. Rainfall distribution during a storm can impact the behavior of system hydraulics due to soil saturation. For example, a storm where the peak rainfall occurs towards the end of the event will generally create more CSO than a storm with similar total rainfall and peak intensity, where the peak occurs at the beginning of the storm. An example hyetograph is shown in Figure 5-2, with the remaining hyetographs in Appendix C.

Table 5-7. Comparison of Storms Between January 1 and June 30, 2021 and the Typical Year with Peak Intensities Greater than 0.40 inches/hour

Rain Gauge	Date	Duration (hours)	Total Rainfall (inches)	Average Intensity (inch/hour)	Peak Hourly Intensity (inch/hour)	Storm Recurrence Interval (1-hour)
Typical Year	10/23/1992	4	1.18	0.29	1.08	1-2y
	8/11/1992	11	0.87	0.08	0.75	6m-1y
	8/15/1992	72	2.91	0.04	0.66	3m-6m
	9/22/1992	23	2.76	0.12	0.65	3m-6m
	5/2/1992	7	1.14	0.16	0.63	3m-6m
	9/9/1992	1	0.57	0.57	0.57	3m
	9/3/1992	13	1.19	0.09	0.51	< 3m
	6/5/1992	18	1.34	0.07	0.44	< 3m
	10/9/1992	65	2.04	0.03	0.42	< 3m
January-June 2021 Rain Gauge Data						
Ward Street Headworks (BO-DI-1)	6/22/2021	8.25	1.75	0.21	1.23	2yr
Columbus Park Headworks (BO-DI-2)	6/22/2021	6.25	1.09	0.17	0.46	< 3m
Chelsea Creek Headworks (CH-BO-1)	6/22/2021	6.5	1.70	0.26	1.02	1y-2y
Fresh Pond (USGS)	No storm events > 0.4 in/hr					

In summary, comparisons of the first half 2021 monitoring period to the Half Typical Year suggest that Q1Q2 of 2021 was similar, but slightly drier than the Half Typical Year rainfall and had fewer larger storms. The following is a summary of the rainfall comparison of January to June 2021 to the Half Typical Year:

- The first half of 2021 averaged 42 storm events, compared to 47 storm events for the Half Typical Year (Table 5-5).
- The total average rainfall depth for the first half of 2021 (22.82 inches) was similar to but slightly less than the Half Typical Year (23.40 inches) (Table 5-5).
- In general, the breakdown of numbers of storms by rainfall depth categories for the first half of 2021 were relatively close to the values for the Half Typical Year (Table 5-5Table 5-5).
- In terms of larger storms, the first half of 2021 had two storm events with a total rainfall depth greater than 2 inches compared to three for the Half Typical year. The largest storm in the first half of 2021 for the rain gauges presented in Table 5-6 had 2.74 inches of rainfall, while the largest storm in the Typical Year had 3.89 inches of rainfall.
- The first half of 2021 had one storm (June 22, 2021) with a peak intensity greater than 0.40 inches per hour compared to four to five for the Half Typical Year (nine for the full Typical Year; Table 5-7). The peak intensities for the June 22, 2021 storm ranged from less than 0.40 to 1.23 inches per hour across different rain gauges, suggesting the storm exhibited high spatial variability typical of summer storms.

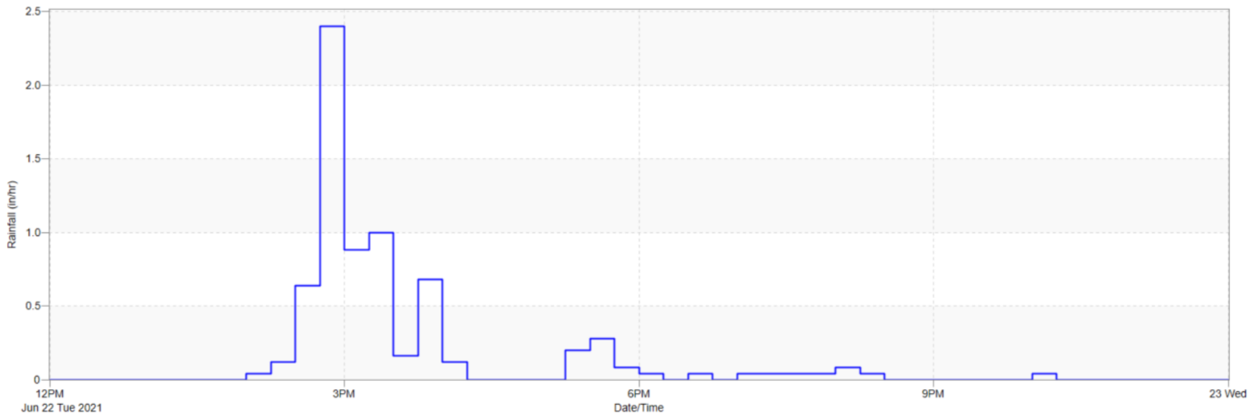

Figure 5-2. Hyetograph from the Ward Street Headworks Gauge for June 22, 2021

5.2. CSO Data Collection and Analyses

Permanent and temporary metering throughout the MWRA system provides a check of the model's ability to simulate system conditions as well as activation frequencies and volumes for remaining active CSO regulators. Meters can measure depth or depth and velocity. In locations where depth and velocity meters are installed the flows can be estimated.

5.2.1 Meter Locations and Purposes

Two types of metering were conducted within the MWRA system during January 1 – June 30, 2021: (1) interceptor metering; and (2) CSO overflow monitoring.

Interceptor meters provide measurement of the water levels and/or computation of flows within the MWRA's interceptors. MWRA has a number of interceptor meters throughout the system that identify flows and water levels through major pipes.

CSO overflow metering is configured to identify the CSO activation frequency, duration, and in some cases volumes.

The MWRA monitors all active CSO outfalls that are owned and operated by MWRA. In mid-2020, the MWRA successfully initiated the CSO public notification program. This program provides notification of active CSO regulators within four hours of a regulator activating, informing the public of the location, frequency, and duration of CSO activations. The notification program provides subscribers with text and/or email notifications of CSO activations. Table 5-8 identifies the CSO outfalls that MWRA monitors and are part of the CSO notification program. An example of the CSO notification website is shown in Figure 5-3 with the locations monitored (See Table 5-8 for letter key). Table 5-9 summarizes the results of the CSO monitoring.

Table 5-8. MWRA Monitored CSOs in the MWRA Notification Program

CSO Outfall	Outfall Location	Potentially Affected Area	Location (Figure 5-3)
SOM007A/ MWR205A	Baxter Park/Assembly Row, just downstream of Rte. 28 Bridge	Mystic River	A
MWR205	Draw Seven Park	Lower Mystic River (marine)	B
BOS019	Charlestown, near mouth of Little Mystic Channel	Little Mystic Channel and confluence of Mystic and Chelsea Rivers	C
MWR203	Upper Inner Harbor, upstream of N. Washington St. bridge	Boston Inner Harbor	D
MWR215	Head of Fort Point Channel near the Broadway Street Bridge	Fort Point Channel	E
BOS081-086	South Boston beaches along Day Boulevard	South Boston beaches, North Dorchester Bay	F
MWR020	Downstream end of Charles R. Esplanade	Charles River between Esplanade and Science Museum	G
MWR019	Middle of Charles River Esplanade	Charles River between Esplanade and Science Museum	H
MWR018	Upstream end of Charles R. Esplanade	Charles River between Esplanade and Science Museum	I
MWR023	Boston side of river, near Fenway exit from Storrow Drive	Charles River from just upstream of Harvard Bridge (Mass. Ave.) to Science Museum	J
MWR010	Charles River near Boston University	Charles River between the Boston University Bridge and Science Museum	K
MWR201	Cottage Farm CSO Storage and Treatment Facility, Between Magazine Park and BU Bridge	Charles River from just upstream of the Boston University Bridge to Science Museum	L
MWR003	Alewife Brook Reservation near Alewife T station	Little River and Alewife Brook	M

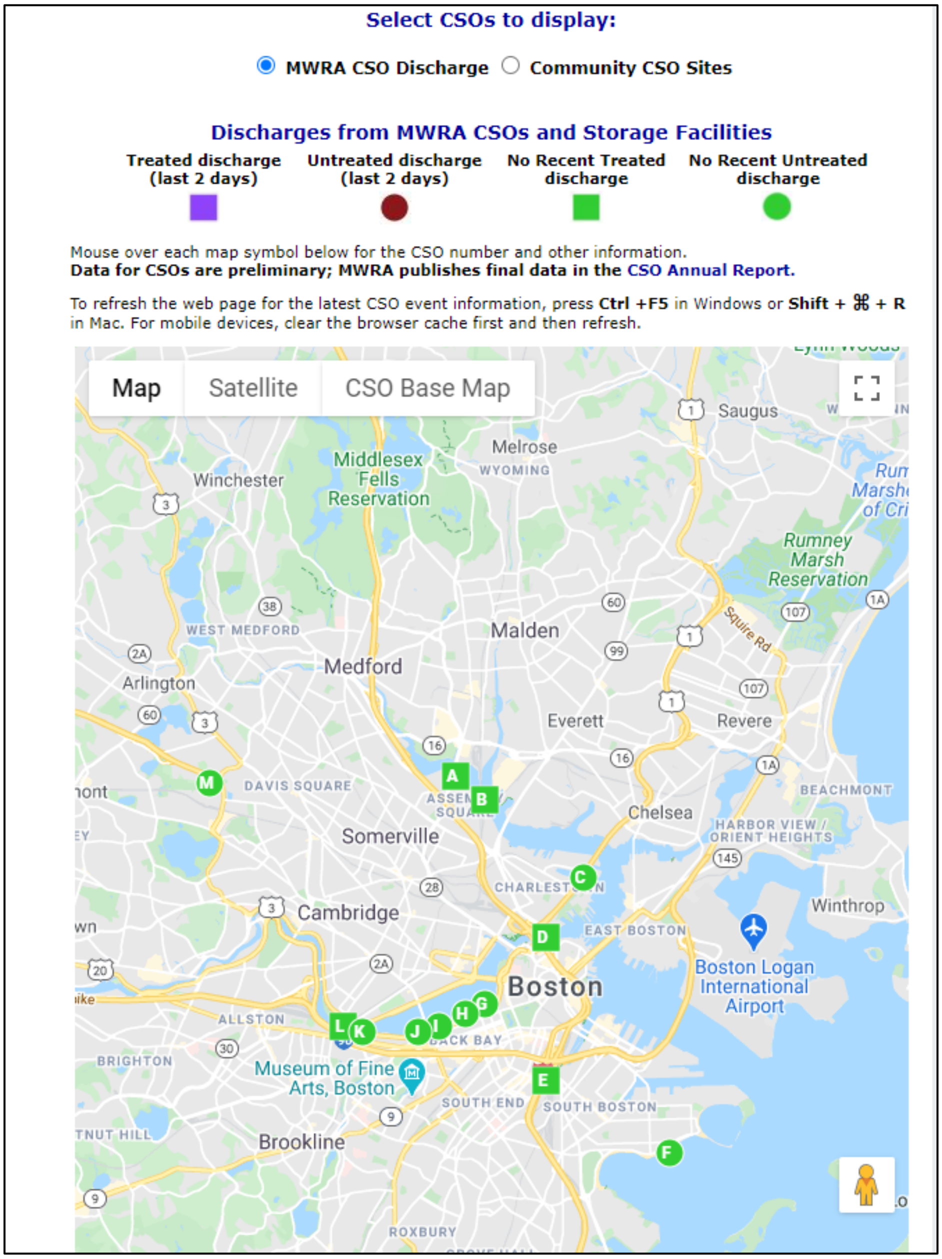

Figure 5-3. MWRA CSO Notification Reporting

5.3. Modeled Estimates of CSO Discharges January 1, 2021 – June 30, 2021

MWRA's recently calibrated model, updated to the Q1Q2-2021 system conditions, was used to simulate the storm events from January 1, 2021 to June 30, 2021. The comparison of metered and modeled CSO discharges from January 1, 2021 to June 30, 2021 is presented in Table 5-9. The model was able to replicate the storm responses for the majority of storm events in the Q1Q2-2021 period. However, it is not possible to match all of the modeled and metered activations for every meter and storm event due to rainfall data quality and rainfall spatial variation, unknown transient conditions in the collection system, and the accuracy of metering data (see Section 4.2 of Semiannual Report No. 5 *Model Calibration and Factors Affecting Model Results*).

Table 5-9. Summary of January 1- June 30, 2021 Modeled and Metered CSO Discharges (1 of 2)

Outfall	Regulator	January 1- June 30, 2021			
		Meter(1)		Model	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
Alewife Brook					
CAM001	RE-011	-	-	0	0.00
CAM002	RE-021	-	-	0	0.00
MWR003	RE-031	0	0.00	0	0.00
CAM401A	RE-401	-	-	0	0.00
CAM401B	RE-401B	-	-	0	0.00
SOM001A	RE-01A	-	-	0	0.00
Upper Mystic River					
SOM007A/MWR205A		3	7.47	1	6.68
Mystic/Chelsea Confluence					
MWR205 (Somerville-Marginal CSO Facility)		9	31.74	10	27.39
BOS013	RE013-1	-	-	1	0.07
BOS014	RE014-2	-	-	6	0.40
BOS017	RE017-3	-	-	1	0.06
CHE003	RE-031	-	-	0	0.00
CHE004	RE-041	-	-	1	0.29
CHE008	RE-081	-	-	4	0.88
Upper Inner Harbor					
BOS009	RE009-2	-	-	9	0.16
BOS010	RE010-2	-	-	1	0.11
BOS012	RE012-2	-	-	0	0.00
BOS019	RE019-2	1	0.09	0	0.00
BOS057	RE057-6	-	-	2	0.37
BOS060	RE060-7	-	-	1	0.18
	RE060-20	-	-	2	0.07
MWR203 (Prison Point)		4	74.1	5	95.46
Lower Inner Harbor					
BOS003	RE003-2	-	-	0	0.00
	RE003-7	-	-	3	0.67
	RE003-12	-	-	2	1.04
BOS004	RE004-6	-	-	1	0.03
BOS005	RE005-1	-	-	0	0.00
Fort Point Channel					
BOS062	RE062-4	-	-	1	0.62
BOS064	RE064-4	-	-	1	0.00
	RE064-5	-	-	1	0.01
BOS065	RE065-2	-	-	4	0.25
BOS068	RE068-1A	-	-	0	0.00
BOS070/DBC	RE070/8-3	-	-	1	0.07
	RE070/8-6	-	-	0	0.00
	RE070/8-7	-	-	0	0.00

Table 5-9. Summary of January 1- June 30, 2021 Modeled and Metered CSO Discharges (2 of 2)

Outfall	Regulator	January 1- June 30, 2021			
		Meter(1)		Model	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
Fort Point Channel (cont.)					
BOS070/DBC (*cont.)*	RE070/8-8	-	-	0	0.00
	RE070/8-13	-	-	0	0.00
	RE070/8-15	-	-	0	0.00
	RE070/9-4	-	-	1	0.07
	RE070/10-5	-	-	1	0.01
	RE070/7-2	-	-	7	1.81
MWR215 (Union Park)		4	11.45	5	18.26
BOS070/RCC	RE070/5-3	-	-	1	0.15
BOS073	RE073-4	-	-	0	0.00
Reserved Channel					
BOS076	RE076/2-3	-	-	0	0.00
	RE076/4-3	-	-	1	0.00
BOS078	RE078-1 RE078-2	-	-	0	0.00
BOS079	RE079-3	-	-	0	0.00
BOS080	RE080-2B	-	-	0	0.00
Upper Charles					
CAM005	RE-051	-	-	0	0.00
CAM007	RE-071	-	-	0	0.00
Lower Charles					
CAM017	CAM017	-	-	0	0.00
MWR010	RE036-9	-	-	0	0.00
	RE037	-	-	0	0.00
MWR018		1	0.46	1	0.71
MWR019		1	0.18	1	0.44
MWR020		1	0.16	1	0.74
MWR201 (Cottage Farm)		0	0.00	0	0.00
MWR023	RE046-19	1	0.12	0	0.00
	RE046-30			0	0.00
	RE046-50			0	0.00
	RE046-54			0	0.00
	RE046-55			0	0.00
	RE046-62A			0	0.00
	RE046-90			1	0.00
	RE046-100			1	0.11
	RE046-105			1	0.07
	RE046-381			1	0.19
	RE046-192			0	0.00
MWR023 Total(2)				1	0.09
Back Bay Fens					
BOS046	Boston Gatehouse #1(2)	-	-	1	0.28
	Boston Gatehouse #2(3)	-	-	1	0.65
GRAND TOTAL			**-**	10 (max)	158.02

(1) Meter volume only reported for MWRA-metered outfalls.
(2) BOS046 (Gatehouse 1) is primarily a stormwater discharge but may discharge CSO if the upstream regulators overflow. The upstream regulators are monitored by BWSC. The gatehouse is normally closed but may be opened for flood mitigation. Flow can discharge at Gatehouse 1 if the gate is opened or if water overtops the closed gate. Based on model tracer studies, when a discharge occurs during model simulations at BOS046 and one or more of the upstream regulators in the Stony Brook system are predicted to activate, it was estimated that 25% of the CSO from the upstream regulators discharges at the MWR023 outfall (Charles River) and 75% discharges at

BOS046 (Back Bay Fens). Therefore, the reported CSO volumes for the model at MWR023 are based on 25% of the CSO volume from the upstream regulators and the CSO volumes at BOS046 are based on 75% of the predicted CSO volume from the upstream regulators. For Q1Q2-2021 BWSC opened the gates 6 times, however, upstream CSOs only occurred during one of those instances.

(3) BOS046(Gatehouse 2) contains a gate which may also be overtopped in larger storm events; this gate was added to the model after the Q1-2021 system conditions model run per new field information.

As indicated in Table 5-9, the metered and modeled discharges were reasonably close at most locations. Locations where the differences were greater are discussed in Table 5-10.

Table 5-10. Notable Differences between Metered and Modeled CSO Discharges, July 1 -December 31, 2020

Location	Meter	Model	Comment
SOM007A/MWR205A	3 discharges 7.47 MG	1 discharge 6.68 MG	• The metered discharges occurred on 01/16/2021, 04/16/2021 and 05/28/2021. The model discharges only on the 05/28/2021 storm. • The 01/16/2021 storm volume was very small, only 0.02 MG. This storm occurred in the winter, when the model can be less accurate due to winter conditions. • For the 04/16/2021 storm, the model predicted that the water level rose to within 8 inches of the discharge elevation for SOM007A/MWR205A. Thus, the model reacted to the storm but it was not enough to cause an activation. The discharge volume at this location is influenced by the discharge at the Somerville-Marginal CSO facility, the tide, and the stormwater coming in downstream of the facility. There is some uncertainty in the volume of stormwater entering the outfall downstream of the Somerville-Marginal CSO Facility, which could contribute to differences in metered versus modeled conditions.
Prison Point CSO Facility	4 discharges 74.1 MG	5 discharges 95.46 MG	• The metered discharges occurred on 01/16/2021, 04/16/2021, 05/29/2021, and 06/22/2021. The model correctly simulated discharges on these dates, but also predicted a discharge of 1.93 MG on 04/01/2021. This discharge, as well as the differences in discharge volume, are likely attributed to spatial variation in rainfall. In particular, the 06/22/2021 storm was highly variable across the region
BOS019	1 discharge 0.09 MG	0 discharges 0 MG	• The monitoring indicated there was one discharge at BOS019 (05/29/2021) while the model predicted zero. The model predicted that flow entered the storage tank for the 5/29/21 storm, but it was not enough to exceed the storage volume and discharge through BOS019.
Union Park Facility	4 discharges 11.45 MG	5 discharges 18.25 MG	• The metered discharges occurred on 01/16/2021, 04/16/2021, 05/29/2021, and 06/22/2021. The model correctly simulated discharges on these dates, but also predicted a discharge of 1.35 MG on 02/02/2021. This discharge may be due to the model being less accurate during winter conditions. The differences in discharge volume are likely due to spatial variation in rainfall. The 06/22/2021 storm had significant spatial variation, as evidenced by the differences in peak intensity measured at the rain gages (See Table 5-7).

6. Remaining Work and Assessments

6.1 Investigations at Outfalls Not Forecast to Attain LTCP Activation and Volume Goals

MWRA continues to work at alternative development and site-specific investigations that are intended to identify and develop additional CSO mitigation measures at outfalls which are not forecast to attain LTCP activation and volume goals by December 2021. These include outfalls where MWRA is further developing or implementing specific measures previously recommended (Table 6-1) as well as outfalls where additional investigations continue to identify and evaluate potential CSO reduction alternatives (Table 6-2). More information on these investigations, along with recommended or potential CSO control measures and their estimated CSO reduction benefits, was presented in Chapter 4. In addition, to the specific actions described below, MWRA will evaluate the potential effectiveness of incorporating green infrastructure to reduce CSO activation frequency and volume during the period beyond 2021. The focus of these evaluations will be on outfalls located in the Variance waters and in Environmental Justice communities.

Table 6-1. Implementation of Recommended Additional CSO Control Measures

<table>
<tr><th>OUTFALL</th><th>CSO CONTROL MEASURE</th><th>IMPLEMENTATION SCHEDULE</th></tr>
<tr><td colspan="3">Somerville Marginal*</td></tr>
<tr><td>MWR205
(Somerville Marginal CSO Facility)</td><td rowspan="2">• Construct new connection to the interceptor; redirect separate stormwater; and replace tide gate</td><td rowspan="2">MWRA had identified 2 options to construct a new connection to the interceptor. MWRA is moving forward with selecting one of the options and then will develop a design for construction. MWRA and City of Somerville also continue to coordinate investigations into the feasibility of removing separate stormwater connections to the sewer system. MWRA awarded the construction contract to replace the tide gate in the MWR205 outfall in July 2021 and expect to complete the work by February 2022.</td></tr>
<tr><td>SOM007A/MWR205A</td></tr>
<tr><td colspan="3">MYSTIC/CHELSEA CONFLUENCE</td></tr>
<tr><td>BOS003</td><td>• Replace/upsize restricted interceptor connection at regulator RE003-12; leave high-outlet relief at regulators RE003-2 and RE003-7 which will not activate in the Typical Year.</td><td rowspan="2">BWSC has added the CSO control measures at BOS003 to Contract 3 Sewer Separation. BWSC awarded Contract 3 in June 2021 and the work is scheduled to be completed by June 2023.</td></tr>
<tr><td>BOS009</td><td>• BWSC Contract 3 Sewer Separation</td></tr>
<tr><td>BOS014</td><td>• Construct new interceptor connection</td><td>MWRA and BWSC are coordinating on the design which will divert flow to an MWRA interceptor with available capacity. This work is expected to be completed as part of Contract 3.</td></tr>
<tr><td colspan="3">Chelsea</td></tr>
<tr><td>CHE008</td><td>• Replace/upsize interceptor connection</td><td>MWRA completed preliminary design and issued notice to proceed with final design in March 2021. MWRA plans to commence construction in 2022 and complete construction in Summer 2022.</td></tr>
</table>

* Outfall SOM007A/MWR205A, discharging to the Upper Mystic River, is the subject of CSO optimization evaluations required by conditions in the CSO Variances.

Table 6-2. Continuing CSO Control Investigations and Evaluations

OUTFALL	POTENTIAL CSO CONTROLS	PROGRESS AND REMAINING WORK
ALEWIFE BROOK*		
SOM001A	• Modifications to the regulator structure including raising the weir and interceptor connection relief • Relining the ABC and ABBS • Upstream flow controls	MWRA has evaluated the potential CSO controls listed. An alternative that would allow attainment of the LTCP goals was predicted to have adverse HGL impacts in the 5-year storm. MWRA is coordinating with City of Somerville regarding flood mitigation efforts that the City of Somerville is currently investigating that may reduce the stormwater tributary to SOM001A and mitigate the adverse impact the alternative noted above has in the 5-year storm. The City of Somerville is also working to assess if these potential flood mitigation efforts may have an overall benefit on CSO control.
MYSTIC/CHELSEA CONFLUENCE		
BOS017	• Construct modifications to the Sullivan Square siphon structure including adjustable stop logs upstream of each siphon.	MWRA updated and recalibrated the hydraulic model to incorporate the results of recent BWSC activities including the repair of a leaky tide gate and the relocation of a stormwater area tributary to the regulator. MWRA evaluated potential CSO reduction alternatives using the recalibrated model and has identified an alternative that includes modifications to the Sullivan Square siphon structure including adjustable stop logs upstream of each siphon. BWSC & MWRA continue to evaluate the constructability and cost of this alternative.
FORT POINT CHANNEL		
BOS062	• Construct a second 36-inch DWF connection at regulator RE062-4 • Raise the weir at regulator RE064-5 by 3 inches from El. 104.32 to El.104.57	MWRA has completed the evaluation of several alternatives and is recommending moving forward with concept design to construct a second dry weather flow connection at RE062-4 and raise the weir at RE065-2. As part of the recommendation, the weir at RE064-5 would also be raised because of the increased HGL in the New East Side Interceptor which would result from more flow coming in from RE062-4. The MWRA and BWSC continue to evaluate this alternative for constructability and cost.
BOS065	• Raise the weir at regulator RE065-2 by 2.8 feet from El. 102.83 to El.105.60	
BOS070/DBC (all regulators except RE070/7-2)	• BWSC South Boston Sewer Separation Contract 1 and Contract 2	BWSC recently awarded Contract 1 and expects to complete the work in 2023. BWSC is making progress with design of Contract 2 and plans to award the contract in 2022 and complete the work in 2024. MWRA has performed preliminary modeling of the CSO impacts of completing Contracts 1 & 2 and predicts LTCP goals will be met at all of the regulators tributary to BOS070/DBC with the exception of RE070/7-2.
BOS070/DBC (regulator RE070/7-2)	• Construct relief pipe parallel to the BMI	MWRA conducted evaluations and found that adding a relief pipe parallel to the Boston Main Interceptor (BMI) would provide the additional capacity needed to reduce the CSO discharge volume at RE070/7-2. The MWRA and BWSC continue to evaluate this alternative for sizing, constructability and cost. Further alternative evaluations are being considered.

Table 6-2. Continuing CSO Control Investigations and Evaluations

OUTFALL	• POTENTIAL CSO CONTROLS	PROGRESS AND REMAINING WORK
CHARLES RIVER*		
MWR201 (Cottage Farm)	• Additional sewer separation • Targeted reduction in upstream groundwater infiltration	Following Cambridge's completion of its partial sewer separation improvements (and gaining related CSO benefits) in August 2020, MWRA is working with the City of Cambridge to evaluate the potential CSO benefits of city-planned and other sewer separation projects in tributary areas. The water quality impacts of the additional stormwater loads resulting from sewer separation have not yet been evaluated. The potential benefits of reducing groundwater infiltration in certain areas tributary to Cottage Farm is also being evaluated. MWRA and Cambridge continue to evaluate these alternatives for constructability, cost and water quality benefit.
CAM005	• Raise weir/clean outfall • Separate upstream areas	Recent MWRA modeling shows some benefit by raising the overflow weir, and MWRA is evaluating the results and feasibility with Cambridge. In particular Cambridge has raised concerns about the potential impacts to upstream HGLs. MWRA is also assessing the extent of additional sewer separation that would be needed to allow the activation frequency at CAM005 to meet the LTCP goal (the annual volume at CAM005 is meeting the LTCP goal). The water quality impacts of the additional stormwater loads resulting from sewer separation have not yet been evaluated. MWRA and Cambridge continue to evaluate these alternatives for constructability, cost and water quality benefit.
MWR018 MWR019 MWR020	• Raise weirs • Lower localized BMC head loss • Redirect upstream BWSC separate storm drains	MWRA updated and recalibrated its hydraulic model with information from field inspections and new information provided by BWSC. MWRA is working with BWSC to identify the feasibility of removing certain upstream separate storm drain connections.

*The listed outfalls and all other active outfalls discharging to these waterbodies are the subject of CSO optimization evaluations required by conditions in the CSO Variances.

6.2 Water Quality Monitoring, Receiving Water Modeling, and Water Quality Assessments

MWRA continues to collect water quality data in each of the receiving waters. This data will continue to be analyzed to assess the water quality in the receiving waters.

As discussed in Chapter 2, MWRA submitted the final Water Quality Assessment Report on September 9, 2021 to MADEP and EPA. This report incorporated comments provided by the CSO communities, MADEP, and EPA, and MWRA held meetings with all parties to provide an overview of the report and an opportunity for comments. These meetings also provided an opportunity to suggest additional water quality model runs to be conducted for sensitivity analyses and to assess the impact of additional CSO control measures.

The water quality models are now being applied to assess the potential benefits of additional bacterial load reduction alternatives in terms of improvement in attainment of water quality criteria. Alternatives based on specific system improvements are being simulated, and additional sensitivity runs may be conducted. MWRA also held a meeting with MADEP and EPA to identify the additional evaluations to be conducted as part of the alternatives evaluations. The alternative evaluations are in progress and will be documented in the Alternatives Simulation Report which will be submitted in draft form to MADEP and EPA in November 2021 for review. Similar to the Water Quality Assessment, the CSO communities will also have the opportunity to review the draft submittal in parallel with MADEP and EPA. The Final Alternatives Simulation Report will be submitted to MADEP and EPA in December 2021.

6.3 Other Efforts and Projects Expected to Improve CSO Performance

In addition to the projects and system adjustments that have been implemented or recommended or continue to be identified and evaluated within the scope of MWRA's CSO performance assessment, MWRA is tracking other system improvements that may also contribute to CSO reduction. These system improvements, while beyond the scope of the performance assessment, nonetheless are the subject of regular discussion and coordination with the CSO communities. MWRA intends to evaluate the potential CSO benefits of these system improvements when sufficient information regarding design and operational criteria and construction schedule is available.

The City of Somerville expects to complete over the next few years a large stormwater conduit along Somerville Avenue and Union Square and a related pumping station on Poplar Street that will allow the City to remove large quantities of stormwater from its combined sewer system. The separated stormwater will be pumped into a storm drain recently constructed by the MBTA to serve portions of the Green Line Extension. The extension drain conveys stormwater to the Charles River Basin via the Millers River. While this city project is intended to lower the risk of flooding in the Union Square area and offset the impacts of major planned development projects, it will also reduce wet weather burden on MWRA's Cambridge Branch Sewer, thereby reducing overflows from the Somerville system to MWRA's Prison Point CSO facility and potentially reducing Prison Point's treated discharges.

BWSC will be moving forward with Phase 4 sewer separation design in East Boston. The request for proposals for design services is expected to be released in late 2021. This project is anticipated to further reduce CSO discharges in the East Boston area, however, MWRA has not yet modeled the project.

The City of Chelsea has begun to implement a sewer separation master plan that among its long-term goals includes the closing of its three CSO outfalls: CHE003, CHE004 and CHE008. The City is focusing its efforts first in areas tributary to CHE004, and initial construction projects in the master plan are already underway.

MWRA also tracks the efforts by the CSO communities (as well as efforts by its other communities) to remove infiltration and inflow (I/I) from their sewer systems, which communities must do to comply with I/I mitigation requirements in MADEP regulations. The requirements are intended to offset the potential wastewater impacts, including potential CSO impacts, of new wastewater flows from larger development projects. In the CSO communities, I/I mitigation is often accomplished with sewer separation. When significant I/I removal work is planned or completed, MWRA incorporates the flow reduction as an update to its hydraulic model.

All of the CSO communities Boston Cambridge, Chelsea and Somerville - are continuing with substantial efforts at great cost to improve their sewer system records, maps and models. New information from their efforts are a regular topic of discussion during MWRA and community CSO coordination meetings. The communities' sewer system investigations and improved modeling capabilities have supported new maintenance and capital improvements that reduce wet weather burdens on their and MWRA's sewer systems.

6.4 Progress Updates and Related Reports

Table 6-3 identifies remaining progress updates on the CSO performance assessment, as well as scheduled MWRA reports directly or indirectly related to the performance assessment.

Table 6-3. Scheduled Progress Updates and Related Reports

<table>
<tr><th>Report/Progress Update</th><th>Date</th></tr>
<tr><td>Draft Alternatives Simulation Report</td><td>November, 2021</td></tr>
<tr><td>Final Alternatives Simulation Report</td><td>December 2021</td></tr>
<tr><td>Final Water Quality Impact Report</td><td rowspan="2">December 2021</td></tr>
<tr><td>Final CSO Post-Construction Monitoring and Performance Assessment</td></tr>
</table>

6.5 Progress Toward Final Post-Construction Monitoring and Performance Report December 2021 and Next Steps

MWRA plans to issue the Post Construction Monitoring and Performance (PCCMP) final report in December 2021. The MWRA acknowledges that more work remains to be done, as to meeting the LTCP goals for the 16 CSOs not forecast to meet by December 2021. Therefore, MWRA has recommended the following next steps (1) submit the performance assessment report in December pursuant to the final Schedule Seven Compliance Milestone; (2) request three years of additional time for the Authority to focus its efforts on the 16 outfalls; (3) provide annual reporting beginning in April 2022; (4) hold periodic meetings with EPA, MADEP and others on progress and future CSO issues; (5) submit a supplemental report at the conclusion of the three year period on the 16 remaining outfalls not forecast to meet LTCP goals by December 2021.

Appendix A Rainfall Data January 1, 2021 to June 30, 2021

Appendix B Storm Event Tables for January 1, 2021 to June 30, 2021

Appendix B Storm Event Tables for January 1, 2021 to June 30, 2021

Rain Gauge 1: Allston

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [1]		
								1-hr	24-hr	48-hr
1	1/1/2021 22:45	11.5	0.57	0.05	0.14	0.02	N/A	<3m	<3m	NA
2	1/3/2021 17:30	16.5	0.05	0.00	0.02	0.00	N/A	<3m	<3m	NA
3	1/14/2021 15:00	6.25	0.11	0.02	0.03	0.00	N/A	<3m	<3m	NA
4	1/16/2021 3:45	9.5	1.5	0.16	0.35	0.06	N/A	<3m	<3m	NA
5	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	NA
6	2/1/2021 14:00	25.5	0.85	0.03	0.12	0.04	0.00	<3m	<3m	<3m
7	2/3/2021 10:00	1.5	0.03	0.02	0.02	0.00	N/A	<3m	<3m	N/A
8	2/5/2021 13:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/8/2021 14:45	0.75	0.03	0.04	0.03	0.00	N/A	<3m	<3m	N/A
10	2/10/2021 13:00	2.25	0.06	0.03	0.16	0.00	N/A	<3m	<3m	N/A
11	2/11/2021 12:15	2.5	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
12	2/14/2021 12:00	1	0.02	0.02	0.02	0.00	N/A	<3m	<3m	N/A
13	2/15/2021 12:00	1	0.02	0.02	0.02	0.00	N/A	<3m	<3m	N/A
14	2/16/2021 1:45	15.25	0.69	0.05	0.16	0.03	N/A	<3m	<3m	N/A
15	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
16	2/22/2021 12:00	8	0.29	0.04	0.09	0.01	N/A	<3m	<3m	N/A
17	2/27/2021 9:00	7.25	0.18	0.02	0.05	0.01	N/A	<3m	<3m	N/A
18	2/28/2021 23:45	13.25	0.18	0.01	0.07	0.01	N/A	<3m	<3m	N/A
19	3/18/2021 14:15	9.25	0.68	0.07	0.13	0.03	N/A	<3m	<3m	N/A
20	3/25/2021 0:00	6	0.14	0.02	0.06	0.01	N/A	<3m	<3m	N/A
21	3/26/2021 4:15	0.25	0.05	0.20	0.05	0.00	N/A	<3m	<3m	N/A
22	3/28/2021 12:00	12.25	0.78	0.06	0	0.03	N/A	<3m	<3m	N/A
23	3/31/2021 21:45	10.75	0.96	0.09	0.26	0.04	N/A	<3m	<3m	N/A
24	4/12/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
25	4/15/2021 17:15	41.75	2.63	0.06	0.3	0.11	0.05	<3m	6m-1yr	6m
26	4/21/2021 12:45	5	0.31	0.06	0.2	0.01	N/A	<3m	<3m	N/A
27	4/25/2021 8:15	2.5	0.09	0.04	0.3	0.00	N/A	<3m	<3m	N/A
28	4/28/2021 1:15	3.75	0.24	0.06	0.15	0.01	N/A	<3m	<3m	N/A
29	4/28/2021 19:45	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
30	4/29/2021 9:45	17	0.96	0.06	0.19	0.04	N/A	<3m	<3m	N/A
31	4/30/2021 22:00	3.25	0.13	0.04	0.05	0.00	N/A	<3m	<3m	N/A
32	5/2/2021 2:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
33	5/4/2021 0:15	10.75	0.72	0.07	0.18	0.03	N/A	<3m	<3m	N/A
34	5/5/2021 1:15	21.25	0.55	0.03	0.24	0.03	N/A	<3m	<3m	N/A
35	5/10/2021 0:45	4.5	0.34	0.08	0.3	0.01	N/A	<3m	<3m	N/A
36	5/16/2021 15:30	0.5	0.07	0.14	0.07	0.00	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
37	5/26/2021 20:15	8.5	0.36	0.04	0.15	0.02	N/A	<3m	<3m	N/A
38	5/28/2021 18:30	20	2.51	0.13	0.3	0.10	N/A	<3m	6m-1yr	N/A
39	5/30/2021 9:15	22.25	0.9	0.04	0.11	0.04	N/A	<3m	<3m	N/A
40	6/4/2021 15:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
41	6/9/2021 0:15	3.25	0.05	0.02	0.03	0.00	N/A	<3m	<3m	N/A
42	6/11/2021 22:00	8.25	0.78	0.09	0.19	0.03	N/A	<3m	<3m	N/A
43	6/14/2021 8:45	9.25	0.69	0.07	0.21	0.03	N/A	<3m	<3m	N/A
44	6/22/2021 14:15	6.75	1.1	0.16	0.73	0.05	N/A	6m	<3m	N/A
45	6/25/2021 1:30	4	0.04	0.01	0.02	0.00	N/A	<3m	<3m	N/A
46	6/30/2021 17:30	4.25	0.34	0.08	0.16	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 2: Ward Street

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:15	12	0.56	0.05	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:00	2.75	0.06	0.02	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:30	6.25	0.09	0.01	0.03	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 3:45	9.25	1.42	0.15	0.34	0.06	N/A	<3m	<3m	N/A
5	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 5:00	10	0.07	0.01	0.02	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 14:15	20	1.12	0.06	0.14	0.05	N/A	<3m	<3m	N/A
8	2/6/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/7/2021 12:15	25.5	0.37	0.01	0.07	0.01	0.01	<3m	<3m	<3m
10	2/9/2021 12:30	24.75	0.11	0.00	0.03	0.00	0.0	<3m	<3m	<3m
11	2/15/2021 12:00	27	0.67	0.02	0.17	0.03	0.02	<3m	<3m	<3m
12	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
13	2/22/2021 15:45	4.25	0.16	0.04	0.08	0.01	N/A	<3m	<3m	N/A
14	2/27/2021 9:00	7.25	0.17	0.02	0.07	0.01	N/A	<3m	<3m	N/A
15	3/1/2021 0:15	18.25	0.18	0.01	0.07	0.01	N/A	<3m	<3m	N/A
16	3/11/2021 14:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
17	3/18/2021 14:15	9	0.75	0.08	0.13	0.03	N/A	<3m	<3m	N/A
18	3/25/2021 0:00	6	0.12	0.02	0.04	0.01	N/A	<3m	<3m	N/A
19	3/26/2021 4:15	5	0.02	0.00	0.01	0.00	N/A	<3m	<3m	N/A
20	3/28/2021 12:00	12	0.85	0.07	0.35	0.04	N/A	<3m	<3m	N/A
21	3/31/2021 21:30	13.25	1.06	0.08	0.27	0.04	N/A	<3m	<3m	N/A
22	4/12/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
23	4/15/2021 17:30	41.5	2.74	0.07	0.24	0.11	0.06	<3m	6m-1yr	1yr
24	4/20/2021 12:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
25	4/21/2021 13:00	4.75	0.29	0.06	0.11	0.01	N/A	<3m	<3m	N/A
26	4/25/2021 8:15	2.5	0.1	0.04	0.05	0.00	N/A	<3m	<3m	N/A
27	4/28/2021 1:15	2.25	0.22	0.10	0.14	0.01	N/A	<3m	<3m	N/A
28	4/28/2021 19:45	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
29	4/29/2021 10:00	16	0.85	0.05	0.21	0.03	N/A	<3m	<3m	N/A
30	4/30/2021 22:15	3	0.15	0.05	0.07	0.00	N/A	<3m	<3m	N/A
31	5/2/2021 2:15	2	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
32	5/4/2021 0:15	11.5	0.87	0.08	0.17	0.04	N/A	<3m	<3m	N/A
33	5/5/2021 1:15	21.75	0.6	0.03	0.26	0.03	N/A	<3m	<3m	N/A
34	5/10/2021 0:45	4.5	0.35	0.08	0.13	0.01	N/A	<3m	<3m	N/A
35	5/16/2021 15:30	0.5	0.05	0.10	0.05	0.00	N/A	<3m	<3m	N/A
36	5/26/2021 20:00	11.5	0.33	0.03	0.17	0.01	N/A	<3m	<3m	N/A
37	5/28/2021 18:30	20	2.38	0.12	0.29	0.10	N/A	<3m	6m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
38	5/30/2021 8:45	23	1	0.04	0.12	0.04	N/A	<3m	<3m	N/A
39	6/9/2021 0:00	2	0.04	0.02	0.03	0.00	N/A	<3m	<3m	N/A
40	6/11/2021 21:45	13.25	0.74	0.06	0.17	0.03	N/A	<3m	<3m	N/A
41	6/14/2021 8:30	21	0.62	0.03	0.22	0.03	N/A	<3m	<3m	N/A
42	6/15/2021 18:15	0.25	0.03	0.12	0.03	0.00	N/A	<3m	<3m	N/A
43	6/22/2021 14:00	8.25	1.75	0.21	1.23	0.07	N/A	2yr	<3m	N/A
44	6/25/2021 1:30	4.25	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
45	6/30/2021 17:15	4.5	0.4	0.09	0.24	0.02	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

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Rain Gauge 3: Columbus Park

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [1]		
								1-hr	24-hr	48-hr
1	1/1/2021 22:15	20.5	0.5	0.02	0.09	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 18:00	1.75	0.04	0.02	0.03	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 13:15	7.5	0.1	0.01	0.03	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 3:30	9.5	1.11	0.12	0.25	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	15.5	0.29	0.02	0.09	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 5:15	7.5	0.02	0.00	0.01	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 14:15	20.5	1.65	0.08	0.17	0.07	N/A	<3m	<3m	N/A
8	2/7/2021 11:45	12.5	0.5	0.04	0.09	0.02	N/A	<3m	<3m	N/A
9	2/9/2021 12:30	10.25	0.18	0.02	0.04	0.01	N/A	<3m	<3m	N/A
10	2/10/2021 12:00	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
11	2/15/2021 12:15	27.25	0.66	0.02	0.19	0.03	0.01	<3m	<3m	<3m
12	2/18/2021 16:30	43	0.61	0.01	0.05	0.02	0.01	<3m	<3m	<3m
13	2/22/2021 16:15	4.25	0.11	0.03	0.06	0.00	N/A	<3m	<3m	N/A
14	2/27/2021 9:00	7.5	0.11	0.01	0.03	0.00	N/A	<3m	<3m	N/A
15	3/1/2021 0:15	13	0.17	0.01	0.08	0.01	N/A	<3m	<3m	N/A
16	3/18/2021 14:30	8	0.79	0.10	0.15	0.03	N/A	<3m	<3m	N/A
17	3/25/2021 0:00	6.75	0.14	0.02	0.05	0.01	N/A	<3m	<3m	N/A
18	3/28/2021 12:00	12.25	0.72	0.06	0.3	0.03	N/A	<3m	<3m	N/A
19	3/31/2021 21:45	11	1.23	0.11	0.34	0.05	N/A	<3m	<3m	N/A
20	4/12/2021 3:00	11	0.02	0.00	0.01	0.00	N/A	<3m	<3m	N/A
21	4/15/2021 19:30	39	2.29	0.06	0.27	0.09	0.05	<3m	3-6m	6m
22	4/19/2021 18:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
23	4/21/2021 13:45	7.5	0.27	0.04	0.15	0.01	N/A	<3m	<3m	N/A
24	4/25/2021 8:15	2.75	0.12	0.04	0.08	0.01	N/A	<3m	<3m	N/A
25	4/28/2021 1:15	3.5	0.24	0.07	0.15	0.01	N/A	<3m	<3m	N/A
26	4/29/2021 10:00	16.5	0.93	0.06	0.23	0.04	N/A	<3m	<3m	N/A
27	4/30/2021 22:30	2.5	0.11	0.04	0.06	0.00	N/A	<3m	<3m	N/A
28	5/2/2021 2:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
29	5/3/2021 22:45	13	0.91	0.07	0.2	0.04	N/A	<3m	<3m	N/A
30	5/5/2021 1:15	22	0.59	0.03	0.24	0.03	N/A	<3m	<3m	N/A
31	5/10/2021 0:45	4.5	0.37	0.08	0.13	0.02	N/A	<3m	<3m	N/A
32	5/16/2021 15:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
33	5/26/2021 20:15	7.75	0.29	0.04	0.18	0.01	N/A	<3m	<3m	N/A
34	5/28/2021 18:15	19.25	2.55	0.13	0.31	0.11	N/A	<3m	6m-1yr	N/A
35	5/30/2021 8:15	23.25	1.14	0.05	0.17	0.05	N/A	<3m	<3m	N/A
36	6/9/2021 0:15	3.25	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
37	6/11/2021 21:45	9	0.69	0.08	0.15	0.03	N/A	<3m	<3m	N/A
38	6/14/2021 8:45	8	0.5	0.06	0.17	0.02	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	6/15/2021 18:15	0.5	0.05	0.10	0.05	0.00	N/A	<3m	<3m	N/A
40	6/22/2021 14:15	6.25	1.09	0.17	0.46	0.05	N/A	<3m	<3m	N/A
41	6/25/2021 1:00	5.25	0.11	0.02	0.03	0.00	N/A	<3m	<3m	N/A
42	6/30/2021 17:30	4	0.36	0.09	0.2	0.02	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 4: Charlestown

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:45	11.5	0.54	0.05	0.09	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:00	4.25	0.06	0.01	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:45	8.25	0.12	0.01	0.03	0.01	N/A	<3m	<3m	N/A
4	1/16/2021 4:15	9.25	1.18	0.13	0.29	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	15.5	0.29	0.02	0.09	0.01	N/A	<3m	<3m	N/A
6	2/1/2021 14:00	27.25	1.48	0.05	0.15	0.06	0.00	<3m	<3m	<3m
7	2/3/2021 10:00	3.25	0.11	0.03	0.04	0.01	N/A	<3m	<3m	N/A
8	2/5/2021 10:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/7/2021 13:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
10	2/8/2021 10:30	5	0.07	0.01	0.03	0.00	N/A	<3m	<3m	N/A
11	2/10/2021 11:00	2	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
12	2/14/2021 11:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
13	2/15/2021 12:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
14	2/16/2021 0:30	10	0.7	0.07	0.17	0.03	N/A	<3m	<3m	N/A
15	2/18/2021 16:30	43	0.61	0.01	0.05	0.02	0.01	<3m	<3m	<3m
16	2/22/2021 12:15	7.75	0.36	0.05	0.09	0.02	N/A	<3m	<3m	N/A
17	2/27/2021 9:00	7.25	0.16	0.02	0.07	0.01	N/A	<3m	<3m	N/A
18	2/28/2021 23:15	14.25	0.21	0.01	0.08	0.01	0.00	<3m	<3m	N/A
19	3/18/2021 14:15	9	0.71	0.08	0.13	0.03	0.01	<3m	<3m	N/A
20	3/25/2021 0:00	6.5	0.13	0.02	0.04	0.01	0.00	<3m	<3m	N/A
21	3/26/2021 4:15	0.5	0.02	0.04	0.03	0.00	0.00	<3m	<3m	N/A
22	3/28/2021 12:00	11.75	0.77	0.07	0.31	0.03	0.02	<3m	<3m	N/A
23	3/31/2021 21:45	10.5	1.1	0.10	0.3	0.05	N/A	<3m	<3m	N/A
24	4/15/2021 19:45	39	2.42	0.06	0.24	0.10	0.05	<3m	3-6m	6m
25	4/21/2021 14:15	3.75	0.23	0.06	0.11	0.01	N/A	<3m	<3m	N/A
26	4/25/2021 8:15	2.25	0.09	0.04	0.05	0.00	N/A	<3m	<3m	N/A
27	4/28/2021 1:15	7.75	0.23	0.03	0.16	0.01	N/A	<3m	<3m	N/A
28	4/29/2021 9:45	15.25	1.12	0.07	0.24	0.05	N/A	<3m	<3m	N/A
29	4/30/2021 22:00	3.25	0.17	0.05	0.09	0.00	N/A	<3m	<3m	N/A
30	5/3/2021 21:45	13.75	0.85	0.06	0.22	0.04	N/A	<3m	<3m	N/A
31	5/5/2021 1:15	21.75	0.64	0.03	0.31	0.03	N/A	<3m	<3m	N/A
32	5/10/2021 0:30	4.75	0.36	0.08	0.12	0.02	N/A	<3m	<3m	N/A
33	5/12/2021 16:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
34	5/26/2021 20:00	4.25	0.41	0.10	0.18	0.02	N/A	<3m	<3m	N/A
35	5/28/2021 18:15	19.5	2.5	0.13	0.29	0.10	N/A	<3m	6m-1yr	N/A
36	5/30/2021 8:45	23	1.12	0.05	0.15	0.05	N/A	<3m	<3m	N/A
37	6/9/2021 0:15	3	0.03	0.01	0.01	0.00	N/A	<3m	<3m	N/A
38	6/11/2021 21:45	8.5	0.85	0.10	0.23	0.04	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	6/14/2021 9:00	20.5	0.53	0.03	0.21	0.02	N/A	<3m	<3m	N/A
40	6/22/2021 14:15	6.25	1.45	0.23	0.86	0.06	N/A	6m-1yr	<3m	N/A
41	6/25/2021 1:30	4.75	0.09	0.02	0.03	0.00	N/A	<3m	<3m	N/A
42	6/30/2021 17:15	4.5	0.24	0.05	0.12	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 5: Chelsea Creek

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:30	11.75	0.5	0.04	0.09	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:45	3.5	0.05	0.01	0.03	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:30	7.75	0.12	0.02	0.03	0.01	N/A	<3m	<3m	N/A
4	1/16/2021 4:00	9.25	1.05	0.11	0.26	0.04	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	15.5	0.29	0.02	0.09	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 4:15	1.5	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 16:00	18.75	0.91	0.05	0.1	0.04	N/A	<3m	<3m	N/A
8	2/5/2021 10:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/7/2021 15:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
10	2/10/2021 14:15	0.75	0.02	0.03	0.02	0.00	N/A	<3m	<3m	N/A
11	2/11/2021 8:45	5	0.11	0.02	0.04	0.01	N/A	<3m	<3m	N/A
12	2/13/2021 13:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
13	2/14/2021 11:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
14	2/15/2021 12:00	22.75	0.66	0.03	0.16	0.03	N/A	<3m	<3m	N/A
15	2/18/2021 16:30	43	0.61	0.01	0.05	0.02	0.01	<3m	<3m	<3m
16	2/22/2021 11:45	8.25	0.38	0.05	0.09	0.02	N/A	<3m	<3m	N/A
17	2/27/2021 9:15	7.75	0.17	0.02	0.06	0.01	N/A	<3m	<3m	N/A
18	3/1/2021 0:15	13	0.2	0.02	0.08	0.01	N/A	<3m	<3m	N/A
19	3/18/2021 14:15	18	0.71	0.04	0.13	0.03	N/A	<3m	<3m	N/A
20	3/25/2021 0:00	7	0.13	0.02	0.04	0.01	N/A	<3m	<3m	N/A
21	3/26/2021 4:15	5.25	0.04	0.01	0.03	0.00	N/A	<3m	<3m	N/A
22	3/28/2021 12:00	12.25	0.75	0.06	0.31	0.03	N/A	<3m	<3m	N/A
23	3/31/2021 21:45	10.5	1.01	0.10	0.3	0.04	N/A	<3m	<3m	N/A
24	4/10/2021 18:00	0.25	0.02	0.08	0.02	0.00	N/A	<3m	<3m	N/A
25	4/15/2021 19:45	39.5	2.2	0.06	0.24	0.09	0.05	<3m	3-6m	6m
26	4/21/2021 14:30	3.5	0.22	0.06	0.13	0.01	N/A	<3m	<3m	N/A
27	4/25/2021 8:15	3	0.1	0.03	0.05	0.00	N/A	<3m	<3m	N/A
28	4/28/2021 1:15	5.5	0.21	0.04	0.15	0.01	N/A	<3m	<3m	N/A
29	4/29/2021 7:30	25.5	1.07	0.04	0.24	0.04	0.03	<3m	<3m	<3m
30	4/30/2021 22:00	3.5	0.16	0.05	0.09	0.00	N/A	<3m	<3m	N/A
31	5/3/2021 1:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
32	5/3/2021 21:45	13.75	0.71	0.05	0.22	0.03	N/A	<3m	<3m	N/A
33	5/5/2021 1:15	22	0.62	0.03	0.33	0.03	N/A	<3m	<3m	N/A
34	5/10/2021 0:45	4.75	0.36	0.08	0.12	0.02	N/A	<3m	<3m	N/A
35	5/12/2021 15:45	0.5	0.05	0.10	0.05	0.00	N/A	<3m	<3m	N/A
36	5/26/2021 20:00	7.75	0.46	0.06	0.25	0.02	N/A	<3m	<3m	N/A
37	5/28/2021 18:15	19.25	2.28	0.12	0.28	0.09	N/A	<3m	3-6m	N/A
38	5/30/2021 7:00	24.75	0.96	0.04	0.15	0.04	0.01	<3m	<3m	<3m

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	6/4/2021 12:15	0.25	0.05	0.20	0.05	0.00	N/A	<3m	<3m	N/A
40	6/9/2021 0:15	1.75	0.03	0.02	0.02	0.00	N/A	<3m	<3m	N/A
41	6/11/2021 21:45	8.25	0.87	0.11	0.21	0.04	N/A	<3m	<3m	N/A
42	6/14/2021 9:00	20.75	0.55	0.03	0.2	0.02	N/A	<3m	<3m	N/A
43	6/21/2021 5:15	0.25	0.02	0.08	0.02	0.00	N/A	<3m	<3m	N/A
44	6/22/2021 14:15	6.5	1.7	0.26	1.02	0.07	N/A	1y-2y	<3m	N/A
45	6/25/2021 1:30	5	0.07	0.01	0.03	0.00	N/A	<3m	<3m	N/A
46	6/30/2021 17:15	4.5	0.32	0.07	0.15	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 6: Dorchester-Adams

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [1]		
								1-hr	24-hr	48-hr
1	1/1/2021 22:45	11.5	0.52	0.05	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:00	2.75	0.06	0.02	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:30	6.25	0.09	0.01	0.03	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 3:45	9.25	1.42	0.15	0.34	0.06	N/A	<3m	<3m	N/A
5	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 5:00	10	0.07	0.01	0.02	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 13:45	21.75	1.69	0.08	0.23	0.07	N/A	<3m	<3m	N/A
8	2/7/2021 11:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/8/2021 10:45	3.75	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
10	2/10/2021 11:45	2.75	0.13	0.05	0.08	0.01	N/A	<3m	<3m	N/A
11	2/11/2021 11:15	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
12	2/15/2021 12:45	22.5	0.79	0.04	0.26	0.03	N/A	<3m	<3m	N/A
13	2/18/2021 16:30	43	0.61	0.01	0.05	0.02	0.01	<3m	<3m	<3m
14	2/22/2021 12:00	8.25	0.5	0.06	0.1	0.02	N/A	<3m	<3m	N/A
15	2/27/2021 9:00	7.5	0.18	0.02	0.05	0.01	N/A	<3m	<3m	N/A
16	2/28/2021 23:45	13.5	0.17	0.01	0.06	0.01	N/A	<3m	<3m	N/A
17	3/18/2021 14:15	9	0.78	0.09	0.15	0.03	N/A	<3m	<3m	N/A
18	3/25/2021 0:15	5.75	0.11	0.02	0.06	0.00	N/A	<3m	<3m	N/A
19	3/26/2021 4:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
20	3/28/2021 11:45	12.25	0.78	0.06	0.28	0.03	N/A	<3m	<3m	N/A
21	3/31/2021 21:45	11	1.23	0.11	0.3	0.04	N/A	<3m	<3m	N/A
22	4/12/2021 3:00	10.75	0.04	0.00	0	0.00	N/A	<3m	<3m	N/A
23	4/15/2021 19:15	40	2.7	0.07	0.24	0.09	0.05	<3m	3-6m	6m
24	4/21/2021 13:30	4.25	0.37	0.09	0.13	0.01	N/A	<3m	<3m	N/A
25	4/25/2021 8:00	2.75	0.14	0.05	0.05	0.00	N/A	<3m	<3m	N/A
26	4/28/2021 1:00	2.25	0.17	0.08	0.15	0.01	N/A	<3m	<3m	N/A
27	4/29/2021 10:00	16	0.74	0.05	0.24	0.04	N/A	<3m	<3m	N/A
28	4/30/2021 22:30	3	0.15	0.05	0.06	0.00	N/A	<3m	<3m	N/A
29	5/2/2021 2:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
30	5/3/2021 23:45	12.75	0.99	0.08	0.2	0.04	N/A	<3m	<3m	N/A
31	5/5/2021 1:15	22	0.55	0.03	0.21	0.04	N/A	<3m	<3m	N/A
32	5/10/2021 0:45	4.75	0.42	0.09	0.15	0.02	N/A	<3m	<3m	N/A
33	5/26/2021 20:30	8.5	0.29	0.03	0.16	0.01	N/A	<3m	<3m	N/A
34	5/28/2021 18:45	19.5	2.74	0.14	0.32	0.11	N/A	<3m	6m-1y	N/A
35	5/30/2021 8:45	27.75	1.07	0.04	0.13	0.04	0.02	<3m	<3m	<3m
36	6/4/2021 15:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
37	6/5/2021 5:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
38	6/8/2021 16:00	12.25	0.07	0.01	0.04	0.00	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [1]		
								1-hr	24-hr	48-hr
39	6/11/2021 22:00	9.5	0.66	0.07	0.13	0.03	N/A	<3m	<3m	N/A
40	6/14/2021 8:45	20.75	0.6	0.03	0.16	0.03	N/A	<3m	<3m	N/A
41	6/22/2021 14:15	7.25	1.96	0.27	1.34	0.08	N/A	2yr	3m	N/A
42	6/25/2021 1:30	4.75	0.08	0.02	0.03	0.00	N/A	<3m	<3m	N/A
43	6/30/2021 17:30	4.25	0.77	0.18	0.57	0.03	N/A	3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 7: Dorchester-Talbot

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:45	11.5	0.52	0.05	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:00	2.75	0.06	0.02	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:30	6.25	0.09	0.01	0.03	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 3:45	9.25	1.42	0.15	0.34	0.06	N/A	<3m	<3m	N/A
5	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 5:00	10	0.07	0.01	0.02	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 13:45	21.75	1.69	0.08	0.23	0.07	N/A	<3m	<3m	N/A
8	2/7/2021 11:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/8/2021 10:45	3.75	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
10	2/10/2021 11:45	2.75	0.13	0.05	0.08	0.01	N/A	<3m	<3m	N/A
11	2/11/2021 11:15	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
12	2/15/2021 12:45	22.5	0.79	0.04	0.26	0.03	N/A	<3m	<3m	N/A
13	2/18/2021 16:30	43	0.61	0.01	0.05	0.02	0.01	<3m	<3m	<3m
14	2/22/2021 12:00	8.25	0.5	0.06	0.1	0.02	N/A	<3m	<3m	N/A
15	2/27/2021 9:00	7.5	0.18	0.02	0.05	0.01	N/A	<3m	<3m	N/A
16	2/28/2021 23:45	13.5	0.17	0.01	0.06	0.01	N/A	<3m	<3m	N/A
17	3/18/2021 14:15	9	0.78	0.09	0.15	0.03	N/A	<3m	<3m	N/A
18	3/25/2021 0:15	5.75	0.11	0.02	0.06	0.00	N/A	<3m	<3m	N/A
19	3/26/2021 4:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
20	2/28/2021 23:45	13.5	0.17	0.01	0.28	0.03	N/A	<3m	<3m	N/A
21	3/31/2021 21:45	11	1.23	0.11	0.31	0.05	N/A	<3m	<3m	N/A
22	4/12/2021 3:00	10.75	0.04	0.00	0.02	0.00	N/A	<3m	<3m	N/A
23	4/15/2021 19:15	40	2.7	0.07	0.31	0.11	0.06	<3m	6m-1yr	1yr
24	4/21/2021 13:30	4.25	0.37	0.09	0.2	0.02	N/A	<3m	<3m	N/A
25	4/25/2021 8:00	2.75	0.14	0.05	0.09	0.01	N/A	<3m	<3m	N/A
26	4/28/2021 1:00	2.25	0.17	0.08	0.12	0.01	N/A	<3m	<3m	N/A
27	4/29/2021 10:00	16	0.74	0.05	0.16	0.03	N/A	<3m	<3m	N/A
28	4/30/2021 22:30	3	0.14	0.05	0.06	0.00	N/A	<3m	<3m	N/A
29	5/2/2021 2:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
30	5/3/2021 23:45	12.75	0.99	0.08	0.2	0.04	N/A	<3m	<3m	N/A
31	5/5/2021 1:15	22	0.55	0.03	0.21	0.04	N/A	<3m	<3m	N/A
32	5/10/2021 0:45	4.75	0.42	0.09	0.15	0.02	N/A	<3m	<3m	N/A
33	5/26/2021 20:30	8.5	0.29	0.03	0.16	0.01	N/A	<3m	<3m	N/A
34	5/28/2021 18:45	19.5	2.74	0.14	0.32	0.11	N/A	<3m	6m-1y	N/A
35	5/30/2021 8:45	27.75	1.07	0.04	0.13	0.04	0.02	<3m	<3m	<3m
36	6/4/2021 15:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
37	6/5/2021 5:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
38	6/8/2021 16:00	12.25	0.07	0.01	0.04	0.00	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	6/11/2021 22:00	9.5	0.66	0.07	0.13	0.03	N/A	<3m	<3m	N/A
40	6/14/2021 8:45	20.75	0.6	0.03	0.16	0.03	N/A	<3m	<3m	N/A
41	6/22/2021 14:15	7.25	1.96	0.27	1.34	0.08	N/A	2yr	3m	N/A
42	6/25/2021 1:30	4.75	0.08	0.02	0.03	0.00	N/A	<3m	<3m	N/A
43	6/30/2021 17:30	4.25	0.77	0.18	0.57	0.03	N/A	3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 8: East Boston

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:45	11.5	0.54	0.05	0.09	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:00	4.25	0.06	0.01	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:45	8.25	0.12	0.01	0.03	0.01	N/A	<3m	<3m	N/A
4	1/16/2021 4:15	9.25	1.18	0.13	0.29	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	15.5	0.29	0.02	0.09	0.01	N/A	<3m	<3m	N/A
6	2/1/2021 14:00	27.25	1.48	0.05	0.15	0.06	0.00	<3m	<3m	<3m
7	2/3/2021 10:00	3.25	0.11	0.03	0.04	0.01	N/A	<3m	<3m	N/A
8	2/5/2021 10:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/7/2021 13:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
10	2/8/2021 10:30	5	0.07	0.01	0.03	0.00	N/A	<3m	<3m	N/A
11	2/10/2021 11:00	2	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
12	2/14/2021 11:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
13	2/15/2021 12:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
14	2/16/2021 0:30	10	0.7	0.07	0.17	0.03	N/A	<3m	<3m	N/A
15	2/18/2021 16:30	43	0.61	0.01	0.05	0.02	0.01	<3m	<3m	<3m
16	2/22/2021 12:15	7.75	0.36	0.05	0.09	0.02	N/A	<3m	<3m	N/A
17	2/27/2021 9:00	7.25	0.16	0.02	0.07	0.01	N/A	<3m	<3m	N/A
18	2/28/2021 23:15	14.25	0.21	0.01	0.08	0.01	N/A	<3m	<3m	N/A
19	3/18/2021 14:15	9	0.71	0.08	0.13	0.03	N/A	<3m	<3m	N/A
20	3/25/2021 0:00	6.5	0.13	0.02	0.04	0.01	N/A	<3m	<3m	N/A
21	3/26/2021 4:15	0.5	0.02	0.04	0.02	0.00	N/A	<3m	<3m	N/A
22	3/28/2021 12:00	11.75	0.77	0.07	0.32	0.03	N/A	<3m	<3m	N/A
23	3/31/2021 21:45	10.5	1.1	0.10	0.3	0.05	N/A	<3m	<3m	N/A
24	4/15/2021 19:45	39	2.42	0.06	0.24	0.10	0.05	<3m	3-6m	6m
25	4/21/2021 14:15	3.75	0.23	0.06	0.11	0.01	N/A	<3m	<3m	N/A
26	4/25/2021 8:15	2.25	0.09	0.04	0.05	0.00	N/A	<3m	<3m	N/A
27	4/28/2021 1:15	7.75	0.23	0.03	0.16	0.01	N/A	<3m	<3m	N/A
28	4/29/2021 9:45	15.25	1.12	0.07	0.24	0.05	N/A	<3m	<3m	N/A
29	4/30/2021 22:00	3.25	0.17	0.05	0.09	0.00	N/A	<3m	<3m	N/A
30	5/3/2021 21:45	13.75	0.85	0.06	0.22	0.04	N/A	<3m	<3m	N/A
31	5/5/2021 1:15	21.75	0.64	0.03	0.31	0.03	N/A	<3m	<3m	N/A
32	5/10/2021 0:30	4.75	0.36	0.08	0.12	0.02	N/A	<3m	<3m	N/A
33	5/12/2021 16:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
34	5/26/2021 20:00	4.25	0.41	0.10	0.18	0.02	N/A	<3m	<3m	N/A
35	5/28/2021 18:15	19.5	2.5	0.13	0.29	0.10	N/A	<3m	6m-1yr	N/A
36	5/30/2021 8:45	23	1.12	0.05	0.15	0.05	N/A	<3m	<3m	N/A
37	6/9/2021 0:15	3	0.03	0.01	0.01	0.00	N/A	<3m	<3m	N/A
38	6/11/2021 21:45	8.5	0.85	0.10	0.23	0.04	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	6/14/2021 9:00	20.5	0.53	0.03	0.21	0.02	N/A	<3m	<3m	N/A
40	6/22/2021 14:15	6.25	1.45	0.23	0.86	0.06	N/A	6m-1yr	<3m	N/A
41	6/25/2021 1:30	4.75	0.09	0.02	0.03	0.00	N/A	<3m	<3m	N/A
42	6/30/2021 17:15	4.5	0.24	0.05	0.12	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 9: Hanscom AFB

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 23:00	11	0.46	0.04	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 19:45	1	0.03	0.03	0.03	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 15:15	2.25	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 4:15	8.75	1.25	0.14	0.3	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	2.75	0.18	0.07	0.09	0.01	N/A	<3m	<3m	N/A
6	2/1/2021 16:15	14.5	0.95	0.07	0.16	0.04	N/A	<3m	<3m	N/A
7	2/7/2021 12:30	7.25	0.28	0.04	0.07	0.01	N/A	<3m	<3m	N/A
8	2/9/2021 12:45	3	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
9	2/16/2021 4:00	6.5	0.56	0.09	0.16	0.02	N/A	<3m	<3m	N/A
10	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
11	2/22/2021 16:30	2	0.13	0.07	0.09	0.01	N/A	<3m	<3m	N/A
12	2/27/2021 9:15	7	0.11	0.02	0.04	0.00	N/A	<3m	<3m	N/A
13	3/1/2021 4:30	2.75	0.11	0.04	0.08	0.00	N/A	<3m	<3m	N/A
14	3/18/2021 15:45	8.5	0.61	0.07	0.11	0.03	N/A	<3m	<3m	N/A
15	3/25/2021 1:15	5.75	0.06	0.01	0.04	0.01	N/A	<3m	<3m	N/A
16	3/26/2021 5:30	0.25	0.03	0.12	0.03	0.00	N/A	<3m	<3m	N/A
17	3/28/2021 13:15	11.75	0.63	0.05	0.29	0.03	N/A	<3m	<3m	N/A
18	3/31/2021 21:30	10.25	0.88	0.09	0.26	0.04	N/A	<3m	<3m	N/A
19	4/15/2021 19:30	23.5	2.35	0.10	0.22	0.10	N/A	<3m	6m	N/A
20	4/21/2021 14:30	3	0.25	0.08	0.18	0.01	N/A	<3m	<3m	N/A
21	4/25/2021 8:00	2.25	0.07	0.03	0.03	0.00	N/A	<3m	<3m	N/A
22	4/28/2021 1:00	2	0.21	0.11	0.13	0.01	N/A	<3m	<3m	N/A
23	4/29/2021 10:00	13.5	0.82	0.06	0.22	0.03	N/A	<3m	<3m	N/A
24	4/30/2021 23:30	1.5	0.1	0.07	0.08	0.00	N/A	<3m	<3m	N/A
25	5/3/2021 2:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
26	5/3/2021 23:30	11.75	0.46	0.04	0.12	0.02	N/A	<3m	<3m	N/A
27	5/5/2021 2:30	16	0.47	0.03	0.28	0.03	N/A	<3m	<3m	N/A
28	5/10/2021 1:45	4.75	0.34	0.07	0.11	0.01	N/A	<3m	<3m	N/A
29	5/26/2021 20:15	3.75	0.47	0.13	0.24	0.02	N/A	<3m	<3m	N/A
30	5/28/2021 18:45	25.5	1.92	0.08	0.12	0.08	0.04	<3m	3m	<3m
31	5/30/2021 9:15	22.5	0.85	0.04	0.1	0.04	N/A	<3m	<3m	N/A
32	6/11/2021 22:00	8.25	0.62	0.08	0.15	0.03	N/A	<3m	<3m	N/A
33	6/14/2021 8:45	20.75	0.53	0.03	0.2	0.02	N/A	<3m	<3m	N/A
34	6/22/2021 12:15	6.25	0.55	0.09	0.32	0.02	N/A	<3m	<3m	N/A
35	6/25/2021 4:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
36	6/30/2021 15:30	4.25	0.31	0.07	0.15	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 10: Hyde Park

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:30	11.5	0.44	0.04	0.11	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 15:30	6	0.1	0.02	0.04	0.00	N/A	<3m	<3m	N/A
3	1/5/2021 9:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
4	1/14/2021 11:30	9.75	0.13	0.01	0.03	0.01	N/A	<3m	<3m	N/A
5	1/16/2021 3:30	9.5	1.33	0.14	0.32	0.06	N/A	<3m	<3m	N/A
6	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	N/A
7	1/28/2021 12:15	1.75	0.03	0.02	0.02	0.00	N/A	<3m	<3m	N/A
8	2/1/2021 14:00	21	2.16	0.10	0.25	0.09	N/A	<3m	3-6m	N/A
9	2/4/2021 8:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
10	2/5/2021 10:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
11	2/7/2021 11:45	3.75	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
12	2/8/2021 9:00	6.5	0.41	0.06	0.08	0.02	N/A	<3m	<3m	N/A
13	2/10/2021 12:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
14	2/15/2021 14:30	20	0.81	0.04	0.24	0.03	N/A	<3m	<3m	N/A
15	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
16	2/22/2021 14:15	6.25	0.24	0.04	0.09	0.01	N/A	<3m	<3m	N/A
17	2/27/2021 8:45	8.25	0.2	0.02	0.06	0.01	N/A	<3m	<3m	N/A
18	3/1/2021 0:00	13.25	0.19	0.01	0.08	0.01	N/A	<3m	<3m	N/A
19	3/18/2021 14:15	8.75	0.85	0.10	0.14	0.04	N/A	<3m	<3m	N/A
20	3/25/2021 0:00	6	0.11	0.02	0.07	0.00	N/A	<3m	<3m	N/A
21	3/26/2021 4:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
22	3/28/2021 11:45	12.25	0.78	0.06	0.31	0.03	N/A	<3m	<3m	N/A
23	3/31/2021 21:30	11.25	1.23	0.11	0.28	0.05	N/A	<3m	<3m	N/A
24	4/12/2021 3:45	11	0.06	0.01	0.02	0.00	N/A	<3m	<3m	N/A
25	4/15/2021 19:15	39.5	2.92	0.07	0.35	0.12	0.06	<3m	1yr	1yr
26	4/21/2021 13:00	4.75	0.42	0.09	0.23	0.02	N/A	<3m	<3m	N/A
27	4/25/2021 7:45	2.75	0.15	0.05	0.09	0.01	N/A	<3m	<3m	N/A
28	4/28/2021 1:45	2.25	0.13	0.06	0.1	0.01	N/A	<3m	<3m	N/A
29	4/29/2021 10:15	16	0.58	0.04	0.14	0.02	N/A	<3m	<3m	N/A
30	4/30/2021 22:30	3.5	0.15	0.04	0.06	0.00	N/A	<3m	<3m	N/A
31	5/2/2021 2:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
32	5/3/2021 1:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
33	5/3/2021 23:15	13	0.87	0.07	0.19	0.04	N/A	<3m	<3m	N/A
34	5/5/2021 1:15	22.25	0.49	0.02	0.17	0.03	N/A	<3m	<3m	N/A
35	5/10/2021 0:45	4.75	0.42	0.09	0.14	0.02	N/A	<3m	<3m	N/A
36	5/26/2021 20:30	7.5	0.27	0.04	0.16	0.01	N/A	<3m	<3m	N/A
37	5/28/2021 18:45	19.5	2.53	0.13	0.31	0.11	N/A	<3m	6m-1yr	N/A
38	5/30/2021	30.25	1.08	0.04	0.13	0.04	0.02	<3m	<3m	<3m

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	6/4/2021 15:00	0.75	0.03	0.04	0.03	0.00	N/A	<3m	<3m	N/A
40	6/8/2021 16:00	12	0.06	0.01	0.03	0.00	N/A	<3m	<3m	N/A
41	6/11/2021 22:00	9	0.56	0.06	0.12	0.02	N/A	<3m	<3m	N/A
42	6/14/2021 8:45	8.5	0.61	0.07	0.22	0.03	N/A	<3m	<3m	N/A
43	6/22/2021 14:15	8.5	1.21	0.14	0.56	0.05	N/A	3m	<3m	N/A
44	6/25/2021 1:30	4.75	0.09	0.02	0.03	0.00	N/A	<3m	<3m	N/A
45	6/30/2021 17:45	4	0.67	0.17	0.48	0.03	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 11: Lexington Farm

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 23:00	11	0.46	0.04	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 19:45	1	0.03	0.03	0.03	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 15:15	2.25	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 4:15	8.75	1.25	0.14	0.3	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	2.75	0.18	0.07	0.09	0.01	N/A	<3m	<3m	N/A
6	2/1/2021 16:15	14.5	0.95	0.07	0.16	0.04	N/A	<3m	<3m	N/A
7	2/7/2021 12:30	7.25	0.28	0.04	0.07	0.01	N/A	<3m	<3m	N/A
8	2/9/2021 12:45	3	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
9	2/16/2021 4:00	6.5	0.56	0.09	0.16	0.02	N/A	<3m	<3m	N/A
10	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
11	2/22/2021 16:30	2	0.13	0.07	0.09	0.01	N/A	<3m	<3m	N/A
12	2/27/2021 9:15	7	0.11	0.02	0.04	0.00	N/A	<3m	<3m	N/A
13	3/1/2021 4:30	2.75	0.11	0.04	0.08	0.00	N/A	<3m	<3m	N/A
14	3/18/2021 15:45	8.5	0.61	0.07	0.11	0.03	N/A	<3m	<3m	N/A
15	3/25/2021 1:15	5.75	0.06	0.01	0.03	0.00	N/A	<3m	<3m	N/A
16	3/26/2021 5:30	0.25	0.03	0.12	0.03	0.00	N/A	<3m	<3m	N/A
17	3/28/2021 13:15	11.75	0.63	0.05	0.29	0.03	N/A	<3m	<3m	N/A
18	3/31/2021 21:30	10.25	0.88	0.09	0.26	0.04	N/A	<3m	<3m	N/A
19	4/15/2021 19:30	23.5	2.35	0.10	0.22	0.10	N/A	<3m	6m	N/A
20	4/21/2021 14:30	3	0.25	0.08	0.18	0.01	N/A	<3m	<3m	N/A
21	4/25/2021 8:00	2.25	0.07	0.03	0.03	0.00	N/A	<3m	<3m	N/A
22	4/28/2021 1:00	2	0.21	0.11	0.13	0.01	N/A	<3m	<3m	N/A
23	4/29/2021 10:00	13.5	0.82	0.06	0.22	0.03	N/A	<3m	<3m	N/A
24	4/30/2021 23:30	1.5	0.1	0.07	0.08	0.00	N/A	<3m	<3m	N/A
25	5/3/2021 2:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
26	5/3/2021 23:30	11.75	0.46	0.04	0.12	0.02	N/A	<3m	<3m	N/A
27	5/5/2021 2:30	16	0.47	0.03	0.28	0.03	N/A	<3m	<3m	N/A
28	5/10/2021 1:45	4.75	0.34	0.07	0.11	0.01	N/A	<3m	<3m	N/A
29	5/26/2021 20:15	3.75	0.47	0.13	0.24	0.02	N/A	<3m	<3m	N/A
30	5/28/2021 18:45	25.5	1.92	0.08	0.12	0.08	0.04	<3m	3m	3m
31	5/30/2021 9:15	22.5	0.85	0.04	0.1	0.04	N/A	<3m	<3m	N/A
32	6/11/2021 22:00	8.25	0.62	0.08	0.15	0.03	N/A	<3m	<3m	N/A
33	6/14/2021 8:45	20.75	0.53	0.03	0.2	0.02	N/A	<3m	<3m	N/A
34	6/22/2021 12:15	6.25	0.55	0.09	0.32	0.02	N/A	<3m	<3m	N/A
35	6/25/2021 4:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
36	6/30/2021 15:30	4.25	0.31	0.07	0.15	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 12: Longwood

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:15	12	0.56	0.05	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:00	2.75	0.06	0.02	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:30	6.25	0.09	0.01	0.03	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 3:45	9.25	1.42	0.15	0.34	0.06	N/A	<3m	<3m	N/A
5	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 5:00	10	0.07	0.01	0.02	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 14:15	20	1.12	0.06	0.14	0.05	N/A	<3m	<3m	N/A
8	2/6/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/7/2021 12:15	25.5	0.37	0.01	0.07	0.01	0.01	<3m	<3m	<3m
10	2/9/2021 12:30	24.75	0.11	0.00	0.03	0.00	0.0	<3m	<3m	<3m
11	2/15/2021 12:00	27	0.67	0.02	0.17	0.03	0.02	<3m	<3m	<3m
12	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
13	2/22/2021 15:45	4.25	0.16	0.04	0.08	0.01	N/A	<3m	<3m	N/A
14	2/27/2021 9:00	7.25	0.17	0.02	0.07	0.01	N/A	<3m	<3m	N/A
15	3/1/2021 0:15	18.25	0.18	0.01	0.07	0.01	N/A	<3m	<3m	N/A
16	3/11/2021 14:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
17	3/18/2021 14:15	9	0.75	0.08	0.13	0.03	N/A	<3m	<3m	N/A
18	3/25/2021 0:00	6	0.12	0.02	0.04	0.01	N/A	<3m	<3m	N/A
19	3/26/2021 4:15	5	0.02	0.00	0.01	0.00	N/A	<3m	<3m	N/A
20	3/28/2021 12:00	12	0.85	0.07	0.35	0.04	N/A	<3m	<3m	N/A
21	3/31/2021 21:30	13.25	1.06	0.08	0.27	0.04	N/A	<3m	<3m	N/A
22	4/12/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
23	4/15/2021 17:30	41.5	2.74	0.07	0.24	0.11	0.06	<3m	6m-1yr	1yr
24	4/20/2021 12:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
25	4/21/2021 13:00	4.75	0.29	0.06	0.11	0.01	N/A	<3m	<3m	N/A
26	4/25/2021 8:15	2.5	0.1	0.04	0.05	0.00	N/A	<3m	<3m	N/A
27	4/28/2021 1:15	2.25	0.22	0.10	0.14	0.01	N/A	<3m	<3m	N/A
28	4/28/2021 19:45	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
29	4/29/2021 10:00	16	0.85	0.05	0.21	0.03	N/A	<3m	<3m	N/A
30	4/30/2021 22:15	3	0.15	0.05	0.07	0.00	N/A	<3m	<3m	N/A
31	5/2/2021 2:15	2	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
32	5/4/2021 0:15	11.5	0.87	0.08	0.17	0.04	N/A	<3m	<3m	N/A
33	5/5/2021 1:15	21.75	0.6	0.03	0.26	0.03	N/A	<3m	<3m	N/A
34	5/10/2021 0:45	4.5	0.35	0.08	0.13	0.01	N/A	<3m	<3m	N/A
35	5/16/2021 15:30	0.5	0.05	0.10	0.05	0.00	N/A	<3m	<3m	N/A
36	5/26/2021 20:00	11.5	0.33	0.03	0.17	0.01	N/A	<3m	<3m	N/A
37	5/28/2021 18:30	20	2.38	0.12	0.29	0.10	N/A	<3m	6m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
38	5/30/2021 8:45	23	1	0.04	0.12	0.04	N/A	<3m	<3m	N/A
39	6/9/2021 0:00	2	0.04	0.02	0.03	0.00	N/A	<3m	<3m	N/A
40	6/11/2021 21:45	13.25	0.74	0.06	0.17	0.03	N/A	<3m	<3m	N/A
41	6/14/2021 8:30	21	0.62	0.03	0.22	0.03	N/A	<3m	<3m	N/A
42	6/15/2021 18:15	0.25	0.03	0.12	0.03	0.00	N/A	<3m	<3m	N/A
43	6/22/2021 14:00	8.25	1.75	0.21	1.23	0.07	N/A	2yr	<3m	N/A
44	6/25/2021 1:30	4.25	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
45	6/30/2021 17:15	4.5	0.4	0.09	0.24	0.02	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 13: Hayes Pump Station

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/2/2021 2:00	13.75	0.69	0.05	0.21	0.03	N/A	<3m	<3m	N/A
2	1/14/2021 13:45	8	0.13	0.02	0.04	0.01	N/A	<3m	<3m	N/A
3	1/16/2021 4:00	9.25	1.36	0.15	0.31	0.06	N/A	<3m	<3m	N/A
4	1/26/2021 18:15	2.75	0.18	0.07	0.09	0.01	N/A	<3m	<3m	N/A
5	1/28/2021 13:45	1.25	0.04	0.03	0.03	0.00	N/A	<3m	<3m	N/A
6	2/1/2021 16:15	47.5	0.89	0.02	0.08	0.03	N/A	<3m	<3m	<3m
7	2/4/2021 11:00	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
8	2/8/2021 12:00	3	0.22	0.07	0.1	0.01	N/A	<3m	<3m	N/A
9	2/9/2021 15:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
10	2/10/2021 10:00	7.5	0.15	0.02	0.06	0.01	N/A	<3m	<3m	N/A
11	2/11/2021 11:00	4	0.07	0.02	0.03	0.01	N/A	<3m	<3m	N/A
12	2/13/2021 12:30	2.25	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
13	2/15/2021 16:00	18.5	0.81	0.04	0.17	0.03	N/A	<3m	<3m	N/A
14	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
15	2/22/2021 15:45	4.5	0.18	0.04	0.08	0.01	N/A	<3m	<3m	N/A
16	2/23/2021 8:15	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
17	2/27/2021 9:00	7.75	0.25	0.03	0.08	0.01	N/A	<3m	<3m	N/A
18	2/28/2021 23:45	13.75	0.31	0.02	0.15	0.01	N/A	<3m	<3m	N/A
19	3/18/2021 14:30	12.5	0.63	0.05	0.13	0.03	N/A	<3m	<3m	N/A
20	3/25/2021 2:30	3.5	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
21	3/26/2021 3:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
22	3/28/2021 12:00	11.75	0.76	0.06	0.33	0.03	N/A	<3m	<3m	N/A
23	3/31/2021 22:15	10.25	0.71	0.07	0.17	0.03	N/A	<3m	<3m	N/A
24	4/15/2021 19:45	40.5	1.99	0.05	0.25	0.08	0.04	<3m	3m	3m
25	4/21/2021 16:30	1.75	0.1	0.06	0.08	0.00	N/A	<3m	<3m	N/A
26	4/25/2021 9:15	1.5	0.03	0.02	0.02	0.00	N/A	<3m	<3m	N/A
27	4/28/2021 1:30	1.75	0.18	0.10	0.14	0.01	N/A	<3m	<3m	N/A
28	4/29/2021 9:15	15	1.92	0.13	0.36	0.08	N/A	<3m	3m	N/A
29	4/30/2021 22:00	3.25	0.11	0.03	0.05	0.00	N/A	<3m	<3m	N/A
30	5/2/2021 2:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
31	5/3/2021 21:15	13	0.54	0.04	0.12	0.02	N/A	<3m	<3m	N/A
32	5/5/2021 1:15	27.75	0.75	0.03	0.3	0.03	0.03	<3m	<3m	<3m
33	5/10/2021 0:45	4.75	0.38	0.08	0.1	0.02	N/A	<3m	<3m	N/A
34	5/26/2021 20:00	8.25	0.45	0.05	0.23	0.02	N/A	<3m	<3m	N/A
35	5/28/2021 18:15	19.75	2.25	0.11	0.32	0.09	N/A	<3m	3-6m	N/A
36	5/30/2021 8:30	20.5	0.8	0.04	0.1	0.03	N/A	<3m	<3m	N/A
37	6/11/2021 22:00	8.5	0.56	0.07	0.19	0.02	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
38	6/14/2021 8:45	20.75	0.51	0.02	0.18	0.02	N/A	<3m	<3m	N/A
39	6/22/2021 14:15	6.5	0.36	0.06	0.13	0.02	N/A	<3m	<3m	N/A
40	6/25/2021 4:45	2	0.04	0.02	0.02	0.00	N/A	<3m	<3m	N/A
41	6/30/2021 17:00	5.25	0.6	0.11	0.42	0.03	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 14: Roslindale

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 23:45	10.5	0.5	0.05	0.15	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 16:15	7.75	0.1	0.01	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 12:15	11	0.13	0.01	0.03	0.01	N/A	<3m	<3m	N/A
4	1/16/2021 3:45	9.75	1.56	0.16	0.38	0.06	N/A	<3m	<3m	N/A
5	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	N/A
6	1/29/2021 5:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
7	2/2/2021 7:30	29.75	0.2	0.01	0.04	0.01	0.00	<3m	<3m	<3m
8	2/5/2021 10:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/7/2021 12:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
10	2/8/2021 10:00	5.25	0.16	0.03	0.08	0.01	N/A	<3m	<3m	N/A
11	2/10/2021 10:15	1.25	0.05	0.04	0.04	0.00	N/A	<3m	<3m	N/A
12	2/11/2021 11:30	2	0.04	0.02	0.02	0.00	N/A	<3m	<3m	N/A
13	2/15/2021 12:00	28.25	0.77	0.03	0.19	0.03	0.02	<3m	<3m	<3m
14	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
15	2/22/2021 11:15	9	0.46	0.05	0.09	0.02	N/A	<3m	<3m	N/A
16	2/27/2021 9:15	10.75	0.19	0.02	0.07	0.01	N/A	<3m	<3m	N/A
17	2/28/2021 23:45	13.5	0.18	0.01	0.06	0.01	N/A	<3m	<3m	N/A
18	3/18/2021 14:15	8.75	0.85	0.10	0.16	0.04	N/A	<3m	<3m	N/A
19	3/25/2021 0:15	6.75	0.12	0.02	0.06	0.01	N/A	<3m	<3m	N/A
20	3/26/2021 4:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
21	3/28/2021 12:00	11.75	0.92	0.08	0.37	0.04	N/A	<3m	<3m	N/A
22	3/31/2021 21:30	13	1.19	0.09	0.3	0.05	N/A	<3m	<3m	N/A
23	4/12/2021 2:45	12	0.05	0.00	0.02	0.00	N/A	<3m	<3m	N/A
24	4/15/2021 17:15	41.25	3.03	0.07	0.34	0.12	0.06	<3m	1yr	1yr
25	4/19/2021 17:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
26	4/20/2021 12:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
27	4/21/2021 13:30	4.5	0.36	0.08	0.16	0.02	N/A	<3m	<3m	N/A
28	4/25/2021 8:00	2.75	0.13	0.05	0.07	0.01	N/A	<3m	<3m	N/A
29	4/28/2021 0:45	4.5	0.18	0.04	0.12	0.01	N/A	<3m	<3m	N/A
30	4/29/2021 10:00	17	0.71	0.04	0.15	0.03	N/A	<3m	<3m	N/A
31	4/30/2021 22:30	3	0.15	0.05	0.06	0.00	N/A	<3m	<3m	N/A
32	5/2/2021 2:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
33	5/3/2021 23:45	12.75	0.99	0.08	0.2	0.04	N/A	<3m	<3m	N/A
34	5/5/2021 1:15	22	0.55	0.03	0.21	0.04	N/A	<3m	<3m	N/A
35	5/10/2021 0:45	4.75	0.42	0.09	0.15	0.02	N/A	<3m	<3m	N/A
36	5/26/2021 20:30	8.5	0.29	0.03	0.16	0.01	N/A	<3m	<3m	N/A
37	5/28/2021 18:45	19.5	2.74	0.14	0.32	0.11	N/A	<3m	6m-1y	N/A
38	5/30/2021 8:45	27.75	1.07	0.04	0.13	0.04	0.02	<3m	<3m	<3m

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [(1)]		
								1-hr	24-hr	48-hr
39	6/4/2021 15:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
40	6/5/2021 5:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
41	6/8/2021 16:00	12.25	0.07	0.01	0.04	0.00	N/A	<3m	<3m	N/A
42	6/11/2021 22:00	9.5	0.66	0.07	0.13	0.03	N/A	<3m	<3m	N/A
43	6/14/2021 8:45	20.75	0.6	0.03	0.16	0.03	N/A	<3m	<3m	N/A
44	6/22/2021 14:15	7.25	1.96	0.27	1.34	0.08	N/A	2yr	3m	N/A
45	6/25/2021 1:30	4.75	0.08	0.02	0.03	0.00	N/A	<3m	<3m	N/A
46	6/30/2021 17:30	4.25	0.77	0.18	0.57	0.03	N/A	3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

AECOM Imagine it. Delivered.

Rain Gauge 15: Roxbury

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [1]		
								1-hr	24-hr	48-hr
1	1/1/2021 22:45	11.5	0.52	0.05	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 17:00	2.75	0.06	0.02	0.04	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:30	6.25	0.09	0.01	0.03	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 3:45	9.25	1.42	0.15	0.34	0.06	N/A	<3m	<3m	N/A
5	1/26/2021 17:45	15	0.25	0.02	0.06	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 5:00	10	0.07	0.01	0.02	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 14:15	20	1.12	0.06	0.14	0.05	N/A	<3m	<3m	N/A
8	2/6/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
9	2/7/2021 12:15	25.5	0.37	0.01	0.07	0.01	0.01	<3m	<3m	<3m
10	2/9/2021 12:30	24.75	0.11	0.00	0.03	0.00	0.0	<3m	<3m	<3m
11	2/15/2021 12:00	27	0.67	0.02	0.17	0.03	0.02	<3m	<3m	<3m
12	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
13	2/22/2021 15:45	4.25	0.16	0.04	0.08	0.01	N/A	<3m	<3m	N/A
14	2/27/2021 9:00	7.25	0.17	0.02	0.07	0.01	N/A	<3m	<3m	N/A
15	3/1/2021 0:15	18.25	0.18	0.01	0.07	0.01	N/A	<3m	<3m	N/A
16	3/11/2021 14:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
17	3/18/2021 14:15	9	0.75	0.08	0.13	0.03	N/A	<3m	<3m	N/A
18	3/25/2021 0:00	6	0.12	0.02	0.04	0.01	N/A	<3m	<3m	N/A
19	3/26/2021 4:15	5	0.02	0.00	0.01	0.00	N/A	<3m	<3m	N/A
20	3/28/2021 12:00	12	0.85	0.07	0.35	0.04	N/A	<3m	<3m	N/A
21	3/31/2021 21:30	13.25	1.06	0.08	0.27	0.04	N/A	<3m	<3m	N/A
22	4/12/2021 10:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
23	4/15/2021 17:30	41.5	2.74	0.07	0.24	0.11	0.06	<3m	6m-1yr	1yr
24	4/21/2021 13:00	4.75	0.29	0.06	0.11	0.01	N/A	<3m	<3m	N/A
25	4/25/2021 8:15	2.5	0.1	0.04	0.05	0.00	N/A	<3m	<3m	N/A
26	4/28/2021 1:15	2.25	0.22	0.10	0.14	0.01	N/A	<3m	<3m	N/A
27	4/28/2021 19:45	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
28	4/29/2021 10:00	16	0.85	0.05	0.21	0.03	N/A	<3m	<3m	N/A
29	4/30/2021 22:15	3	0.15	0.05	0.07	0.00	N/A	<3m	<3m	N/A
30	5/2/2021 2:15	2	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
31	5/4/2021 0:15	11.5	0.87	0.08	0.17	0.04	N/A	<3m	<3m	N/A
32	5/5/2021 1:15	21.75	0.6	0.03	0.26	0.03	N/A	<3m	<3m	N/A
33	5/10/2021 0:45	4.5	0.35	0.08	0.13	0.01	N/A	<3m	<3m	N/A
34	5/16/2021 15:30	0.5	0.05	0.10	0.05	0.00	N/A	<3m	<3m	N/A
35	5/26/2021 20:00	11.5	0.33	0.03	0.17	0.01	N/A	<3m	<3m	N/A
36	5/28/2021 18:30	20	2.38	0.12	0.29	0.10	N/A	<3m	6m	N/A
37	5/30/2021 8:45	23	1	0.04	0.12	0.04	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [1]		
								1-hr	24-hr	48-hr
38	6/9/2021 0:00	2	0.04	0.02	0.03	0.00	N/A	<3m	<3m	N/A
39	6/11/2021 21:45	13.25	0.74	0.06	0.17	0.03	N/A	<3m	<3m	N/A
40	6/14/2021 8:30	21	0.62	0.03	0.22	0.03	N/A	<3m	<3m	N/A
41	6/15/2021 18:15	0.25	0.03	0.12	0.03	0.00	N/A	<3m	<3m	N/A
42	6/22/2021 14:00	8.25	1.75	0.21	1.23	0.07	N/A	2yr	<3m	N/A
43	6/25/2021 1:30	4.25	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
44	6/30/2021 17:15	4.5	0.4	0.09	0.24	0.02	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 16: Somerville

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:30	11.5	0.48	0.04	0.03	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 18:00	2	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:45	6.5	0.09	0.01	0.01	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 4:00	9	1.16	0.13	0.08	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	15.5	0.29	0.02	0.03	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 9:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 16:30	15.25	0.36	0.02	0.02	0.02	N/A	<3m	<3m	N/A
8	2/7/2021 12:30	9.25	0.31	0.03	0.02	0.01	N/A	<3m	<3m	N/A
9	2/9/2021 12:15	6.25	0.1	0.02	0.01	0.00	N/A	<3m	<3m	N/A
10	2/15/2021 12:00	22.25	0.57	0.03	0.07	0.02	N/A	<3m	<3m	N/A
11	2/18/2021 16:30	43	0.61	0.01	0.02	0.02	0.01	<3m	<3m	<3m
12	2/22/2021 15:45	4.25	0.15	0.04	0.03	0.01	N/A	<3m	<3m	N/A
13	2/27/2021 9:00	7.75	0.16	0.02	0.02	0.01	N/A	<3m	<3m	N/A
14	3/1/2021 0:15	13.25	0.17	0.01	0.06	0.01	N/A	<3m	<3m	N/A
15	3/18/2021 14:15	8.5	0.59	0.07	0.11	0.02	N/A	<3m	<3m	N/A
16	3/25/2021 0:00	6.25	0.13	0.02	0.05	0.01	N/A	<3m	<3m	N/A
17	3/26/2021 4:15	0.75	0.03	0.04	0.03	0.00	N/A	<3m	<3m	N/A
18	3/28/2021 12:00	11.75	0.69	0.06	0.31	0.03	N/A	<3m	<3m	N/A
19	3/31/2021 21:45	11	0.86	0.08	0.22	0.04	N/A	<3m	<3m	N/A
20	4/15/2021 19:30	39.5	1.93	0.05	0.23	0.08	0.04	<3m	3m	3m
21	4/21/2021 13:00	5	0.32	0.06	0.19	0.01	N/A	<3m	<3m	N/A
22	4/25/2021 8:15	2.75	0.08	0.03	0.04	0.00	N/A	<3m	<3m	N/A
23	4/28/2021 1:15	3.5	0.21	0.06	0.16	0.01	N/A	<3m	<3m	N/A
24	4/28/2021 19:15	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
25	4/29/2021 10:00	16.5	0.98	0.06	0.22	0.04	N/A	<3m	<3m	N/A
26	4/30/2021 22:00	3.5	0.16	0.05	0.09	0.00	N/A	<3m	<3m	N/A
27	5/2/2021 2:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
28	5/3/2021 22:15	13	0.59	0.05	0.18	0.02	N/A	<3m	<3m	N/A
29	5/5/2021 1:15	21	0.59	0.03	0.29	0.03	N/A	<3m	<3m	N/A
30	5/10/2021 0:30	4.75	0.34	0.07	0.11	0.01	N/A	<3m	<3m	N/A
31	5/12/2021 15:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
32	5/26/2021 20:00	7.75	0.44	0.06	0.2	0.02	N/A	<3m	<3m	N/A
33	5/28/2021 18:15	19.75	2.25	0.11	0.26	0.09	N/A	<3m	3-6m	N/A
34	5/30/2021 9:15	22.5	0.85	0.04	0.1	0.04	N/A	<3m	<3m	N/A
35	6/9/2021 3:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
36	6/11/2021 21:45	8.25	0.78	0.09	0.07	0.03	N/A	<3m	<3m	N/A
37	6/14/2021 8:45	18	0.74	0.04	0.2	0.03	N/A	<3m	<3m	N/A
38	6/22/2021 14:15	7	1.15	0.16	0.32	0.05	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	6/25/2021 1:30	4.5	0.05	0.01	0.01	0.00	N/A	<3m	<3m	N/A
40	6/30/2021 17:15	4.75	0.27	0.06	0.08	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 17: Spot Pond

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [1]		
								1-hr	24-hr	48-hr
1	1/1/2021 22:30	11.5	0.48	0.04	0.1	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 18:00	2	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 14:45	6.5	0.09	0.01	0.03	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 4:00	9	1.16	0.13	0.29	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	15.5	0.29	0.02	0.09	0.01	N/A	<3m	<3m	N/A
6	1/28/2021 9:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
7	2/1/2021 16:30	15.25	0.36	0.02	0.05	0.02	N/A	<3m	<3m	N/A
8	2/7/2021 12:30	9.25	0.31	0.03	0.06	0.01	N/A	<3m	<3m	N/A
9	2/9/2021 12:15	6.25	0.1	0.02	0.03	0.00	N/A	<3m	<3m	N/A
10	2/15/2021 12:00	22.25	0.57	0.03	0.16	0.02	N/A	<3m	<3m	N/A
11	2/18/2021 16:30	43	0.61	0.01	0.05	0.02	0.01	<3m	<3m	<3m
12	2/22/2021 15:45	4.25	0.15	0.04	0.08	0.01	N/A	<3m	<3m	N/A
13	2/27/2021 9:00	7.75	0.16	0.02	0.05	0.01	N/A	<3m	<3m	N/A
14	3/1/2021 0:15	13.25	0.17	0.01	0.06	0.01	N/A	<3m	<3m	N/A
15	3/18/2021 14:15	8.5	0.59	0.07	0.11	0.02	N/A	<3m	<3m	N/A
16	3/25/2021 0:00	6.25	0.13	0.02	0.05	0.01	N/A	<3m	<3m	N/A
17	3/26/2021 4:15	0.75	0.03	0.04	0.03	0.00	N/A	<3m	<3m	N/A
18	3/28/2021 12:00	11.75	0.69	0.06	0.31	0.03	N/A	<3m	<3m	N/A
19	3/31/2021 21:45	11	0.86	0.08	0.22	0.04	N/A	<3m	<3m	N/A
20	4/15/2021 19:30	39.5	1.93	0.05	0.23	0.08	0.04	<3m	3m	3m
21	4/21/2021 13:00	5	0.32	0.06	0.19	0.01	N/A	<3m	<3m	N/A
22	4/25/2021 8:15	2.75	0.08	0.03	0.04	0.00	N/A	<3m	<3m	N/A
23	4/28/2021 1:15	3.5	0.21	0.06	0.16	0.01	N/A	<3m	<3m	N/A
24	4/28/2021 19:15	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
25	4/29/2021 10:00	16.5	0.98	0.06	0.22	0.04	N/A	<3m	<3m	N/A
26	4/30/2021 22:00	3.5	0.16	0.05	0.09	0.00	N/A	<3m	<3m	N/A
27	5/2/2021 2:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
28	5/3/2021 22:15	13	0.59	0.05	0.18	0.02	N/A	<3m	<3m	N/A
29	5/5/2021 1:15	21	0.59	0.03	0.29	0.03	N/A	<3m	<3m	N/A
30	5/10/2021 0:30	4.75	0.34	0.07	0.11	0.01	N/A	<3m	<3m	N/A
31	5/12/2021 15:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
32	5/26/2021 20:00	7.75	0.44	0.06	0.2	0.02	N/A	<3m	<3m	N/A
33	5/28/2021 18:15	19.75	2.25	0.11	0.26	0.09	N/A	<3m	3-6m	N/A
34	5/30/2021 9:15	22.5	0.85	0.04	0.1	0.04	N/A	<3m	<3m	N/A
35	6/9/2021 3:15	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
36	6/11/2021 21:45	8.25	0.78	0.09	0.07	0.03	N/A	<3m	<3m	N/A
37	6/14/2021 8:45	18	0.74	0.04	0.2	0.03	N/A	<3m	<3m	N/A
38	6/22/2021 14:15	7	1.15	0.16	0.32	0.05	N/A	<3m	<3m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	6/25/2021 1:30	4.5	0.05	0.01	0.01	0.00	N/A	<3m	<3m	N/A
40	6/30/2021 17:15	4.75	0.27	0.06	0.08	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 18: Union Park

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 22:45	11.5	0.54	0.05	0.09	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 16:15	4.5	0.09	0.02	0.04	0.00	N/A	<3m	<3m	N/A
3	1/5/2021 16:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
4	1/14/2021 14:15	6.75	0.1	0.01	0.03	0.00	N/A	<3m	<3m	N/A
5	1/15/2021 13:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
6	1/16/2021 4:15	9.25	1.3	0.14	0.3	0.05	N/A	<3m	<3m	N/A
7	1/26/2021 18:15	15.5	0.29	0.02	0.09	0.01	N/A	<3m	<3m	N/A
8	1/28/2021 12:45	3.25	0.06	0.02	0.03	0.00	N/A	<3m	<3m	N/A
9	2/1/2021 14:00	21.25	1.68	0.08	0.2	0.07	N/A	<3m	<3m	N/A
10	2/7/2021 11:45	1	0.03	0.03	0.03	0.00	N/A	<3m	<3m	N/A
11	2/8/2021 8:45	7.25	0.22	0.03	0.07	0.01	N/A	<3m	<3m	N/A
12	2/10/2021 8:30	7	0.27	0.04	0.09	0.01	N/A	<3m	<3m	N/A
13	2/11/2021 10:45	10.75	0.05	0.00	0.02	0.01	N/A	<3m	<3m	N/A
14	2/15/2021 12:30	26.5	0.68	0.03	0.16	0.03	0.01	<3m	<3m	<3m
15	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
16	2/22/2021 11:00	9	0.28	0.03	0.1	0.01	N/A	<3m	<3m	N/A
17	2/27/2021 9:00	12.5	0.18	0.01	0.07	0.01	N/A	<3m	<3m	N/A
18	2/28/2021 23:45	13.5	0.19	0.01	0.07	0.01	N/A	<3m	<3m	N/A
19	3/18/2021 14:15	9.25	0.71	0.08	0.13	0.03	N/A	<3m	<3m	N/A
20	3/25/2021 0:00	6.25	0.12	0.02	0.04	0.01	N/A	<3m	<3m	N/A
21	3/26/2021 4:30	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
22	3/28/2021 12:00	15.75	0.78	0.05	0.32	0.03	N/A	<3m	<3m	N/A
23	3/31/2021 21:30	11	1.08	0.10	0.3	0.05	N/A	<3m	<3m	N/A
24	4/12/2021 3:00	11	0.02	0.00	0.01	0.00	N/A	<3m	<3m	N/A
25	4/15/2021 19:30	39.25	2.57	0.07	0.26	0.10	0.05	<3m	6m	6m
26	4/21/2021 13:45	6.25	0.26	0.04	0.12	0.01	N/A	<3m	<3m	N/A
27	4/25/2021 8:15	3	0.11	0.04	0.06	0.00	N/A	<3m	<3m	N/A
28	4/28/2021 1:15	4	0.24	0.06	0.15	0.01	N/A	<3m	<3m	N/A
29	4/28/2021 19:45	0.25	0.01	0.04	0.01	0.01	N/A	<3m	<3m	N/A
30	4/29/2021 10:00	16	0.87	0.05	0.21	0.04	N/A	<3m	<3m	N/A
31	4/30/2021 22:15	3.5	0.17	0.05	0.08	0.00	N/A	<3m	<3m	N/A
32	5/2/2021 2:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
33	5/4/2021 0:30	11.25	0.82	0.07	0.16	0.03	N/A	<3m	<3m	N/A
34	5/5/2021 1:30	21.5	0.53	0.02	0.2	0.03	N/A	<3m	<3m	N/A
35	5/10/2021 1:00	4.5	0.34	0.08	0.13	0.01	N/A	<3m	<3m	N/A
36	5/16/2021 15:45	1.25	0.06	0.05	0.05	0.00	N/A	<3m	<3m	N/A
37	5/26/2021 20:15	7.75	0.32	0.04	0.17	0.01	N/A	<3m	<3m	N/A
38	5/28/2021 18:30	19.75	2.38	0.12	0.29	0.10	N/A	<3m	6m	N/A

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
39	5/30/2021 8:30	27.25	1.04	0.04	0.15	0.04	0.02	<3m	<3m	<3m
40	6/4/2021 14:15	1.5	0.02	0.01	0.01	0.00	N/A	<3m	<3m	N/A
41	6/9/2021 0:30	1.75	0.08	0.05	0.07	0.00	N/A	<3m	<3m	N/A
42	6/11/2021 22:00	8.25	0.64	0.08	0.14	0.03	N/A	<3m	<3m	N/A
43	6/14/2021 9:00	8.5	0.59	0.07	0.24	0.02	N/A	<3m	<3m	N/A
44	6/15/2021 5:30	0.25	0.01	0.04	0.01	0.03	N/A	<3m	<3m	N/A
45	6/15/2021 18:30	0.5	0.04	0.08	0.04	0.00	N/A	<3m	<3m	N/A
46	6/22/2021 14:15	6.75	1.63	0.24	0.98	0.07	N/A	1yr-2yr	<3m	N/A
47	6/25/2021 1:45	5	0.1	0.02	0.03	0.00	N/A	<3m	<3m	N/A
48	6/30/2021 17:30	4.25	0.31	0.07	0.16	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 19: USGS Fresh Pond

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval (1)		
								1-hr	24-hr	48-hr
1	1/1/2021 23:00	11	0.46	0.04	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 19:45	1	0.03	0.03	0.03	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 15:15	2.25	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 4:15	8.75	1.25	0.14	0.3	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	2.75	0.18	0.07	0.09	0.01	N/A	<3m	<3m	N/A
6	2/1/2021 16:15	14.5	0.95	0.07	0.16	0.04	N/A	<3m	<3m	N/A
7	2/7/2021 12:30	7.25	0.28	0.04	0.07	0.01	N/A	<3m	<3m	N/A
8	2/9/2021 12:45	3	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
9	2/16/2021 4:00	6.5	0.56	0.09	0.16	0.02	N/A	<3m	<3m	N/A
10	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
11	2/22/2021 16:30	2	0.13	0.07	0.09	0.01	N/A	<3m	<3m	N/A
12	2/27/2021 9:15	7	0.11	0.02	0.04	0.00	N/A	<3m	<3m	N/A
13	3/1/2021 4:30	2.75	0.11	0.04	0.08	0.00	N/A	<3m	<3m	N/A
14	3/18/2021 15:45	8.5	0.61	0.07	0.11	0.03	N/A	<3m	<3m	N/A
15	3/25/2021 1:15	5.75	0.06	0.01	0.03	0.00	N/A	<3m	<3m	N/A
16	3/26/2021 5:30	0.25	0.03	0.12	0.03	0.00	N/A	<3m	<3m	N/A
17	3/28/2021 13:15	11.75	0.63	0.05	0.29	0.03	N/A	<3m	<3m	N/A
18	3/31/2021 21:30	10.25	0.88	0.09	0.26	0.04	N/A	<3m	<3m	N/A
19	4/15/2021 19:30	23.5	2.35	0.10	0.22	0.10	N/A	<3m	6m	N/A
20	4/21/2021 14:30	3	0.25	0.08	0.18	0.01	N/A	<3m	<3m	N/A
21	4/25/2021 8:00	2.25	0.07	0.03	0.03	0.00	N/A	<3m	<3m	N/A
22	4/28/2021 1:00	2	0.21	0.11	0.13	0.01	N/A	<3m	<3m	N/A
23	4/29/2021 10:00	13.5	0.82	0.06	0.22	0.03	N/A	<3m	<3m	N/A
24	4/30/2021 23:30	1.5	0.1	0.07	0.08	0.00	N/A	<3m	<3m	N/A
25	5/3/2021 2:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
26	5/3/2021 23:30	11.75	0.46	0.04	0.12	0.02	N/A	<3m	<3m	N/A
27	5/5/2021 2:30	16	0.47	0.03	0.28	0.03	N/A	<3m	<3m	N/A
28	5/10/2021 1:45	4.75	0.34	0.07	0.11	0.01	N/A	<3m	<3m	N/A
29	5/26/2021 20:15	3.75	0.47	0.13	0.24	0.02	N/A	<3m	<3m	N/A
30	5/28/2021 18:45	25.5	1.92	0.08	0.12	0.08	0.04	<3m	3m	3m
31	5/30/2021 9:15	22.5	0.85	0.04	0.1	0.04	N/A	<3m	<3m	N/A
32	6/11/2021 22:00	8.25	0.62	0.08	0.15	0.03	N/A	<3m	<3m	N/A
33	6/14/2021 8:45	20.75	0.53	0.03	0.2	0.02	N/A	<3m	<3m	N/A
34	6/22/2021 12:15	6.25	0.55	0.09	0.07	0.01	N/A	<3m	<3m	N/A
35	6/25/2021 4:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
36	6/30/2021 15:30	4.25	0.31	0.07	0.15	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Rain Gauge 20: Waltham Farm

Event	Date & Start Time	Duration (hr)	Volume (in)	Average Intensity (in/hr)	Peak 1-hr Intensity (in/hr)	Peak 24-hr Intensity (in/hr)	Peak 48-hr Intensity (in/hr)	Storm Recurrence Interval [1]		
								1-hr	24-hr	48-hr
1	1/1/2021 23:00	11	0.46	0.04	0.12	0.02	N/A	<3m	<3m	N/A
2	1/3/2021 19:45	1	0.03	0.03	0.03	0.00	N/A	<3m	<3m	N/A
3	1/14/2021 15:15	2.25	0.03	0.01	0.02	0.00	N/A	<3m	<3m	N/A
4	1/16/2021 4:15	8.75	1.25	0.14	0.3	0.05	N/A	<3m	<3m	N/A
5	1/26/2021 18:15	2.75	0.18	0.07	0.09	0.01	N/A	<3m	<3m	N/A
6	2/1/2021 16:15	14.5	0.95	0.07	0.16	0.04	N/A	<3m	<3m	N/A
7	2/7/2021 12:30	7.25	0.28	0.04	0.07	0.01	N/A	<3m	<3m	N/A
8	2/9/2021 12:45	3	0.07	0.02	0.03	0.00	N/A	<3m	<3m	N/A
9	2/16/2021 4:00	6.5	0.56	0.09	0.16	0.02	N/A	<3m	<3m	N/A
10	2/18/2021 16:45	41.25	0.41	0.01	0.04	0.01	0.01	<3m	<3m	<3m
11	2/22/2021 16:30	2	0.13	0.07	0.09	0.01	N/A	<3m	<3m	N/A
12	2/27/2021 9:15	7	0.11	0.02	0.04	0.00	N/A	<3m	<3m	N/A
13	3/1/2021 4:30	2.75	0.11	0.04	0.08	0.00	N/A	<3m	<3m	N/A
14	3/18/2021 15:45	8.5	0.61	0.07	0.11	0.03	N/A	<3m	<3m	N/A
15	3/25/2021 1:15	5.75	0.06	0.01	0.03	0.00	N/A	<3m	<3m	N/A
16	3/26/2021 5:30	0.25	0.03	0.12	0.03	0.00	N/A	<3m	<3m	N/A
17	3/28/2021 13:15	11.75	0.63	0.05	0.29	0.03	N/A	<3m	<3m	N/A
18	3/31/2021 21:30	10.25	0.88	0.09	0.26	0.04	N/A	<3m	<3m	N/A
19	4/15/2021 19:30	23.5	2.35	0.10	0.22	0.10	N/A	<3m	6m	N/A
20	4/21/2021 14:30	3	0.25	0.08	0.18	0.01	N/A	<3m	<3m	N/A
21	4/25/2021 8:00	2.25	0.07	0.03	0.03	0.00	N/A	<3m	<3m	N/A
22	4/28/2021 1:00	2	0.21	0.11	0.13	0.01	N/A	<3m	<3m	N/A
23	4/29/2021 10:00	13.5	0.82	0.06	0.22	0.03	N/A	<3m	<3m	N/A
24	4/30/2021 23:30	1.5	0.1	0.07	0.08	0.00	N/A	<3m	<3m	N/A
25	5/3/2021 2:45	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
26	5/3/2021 23:30	11.75	0.46	0.04	0.12	0.02	N/A	<3m	<3m	N/A
27	5/5/2021 2:30	16	0.47	0.03	0.28	0.03	N/A	<3m	<3m	N/A
28	5/10/2021 1:45	4.75	0.34	0.07	0.11	0.01	N/A	<3m	<3m	N/A
29	5/26/2021 20:15	3.75	0.47	0.13	0.24	0.02	N/A	<3m	<3m	N/A
30	5/28/2021 18:45	25.5	1.92	0.08	0.12	0.08	0.04	<3m	3m	3m
31	5/30/2021 9:15	22.5	0.85	0.04	0.1	0.04	N/A	<3m	<3m	N/A
32	6/11/2021 22:00	8.25	0.62	0.08	0.15	0.03	N/A	<3m	<3m	N/A
33	6/14/2021 8:45	20.75	0.53	0.03	0.2	0.02	N/A	<3m	<3m	N/A
34	6/22/2021 12:15	6.25	0.55	0.09	0.07	0.01	N/A	<3m	<3m	N/A
35	6/25/2021 4:00	0.25	0.01	0.04	0.01	0.00	N/A	<3m	<3m	N/A
36	6/30/2021 15:30	4.25	0.31	0.07	0.15	0.01	N/A	<3m	<3m	N/A

(1) Recurrence intervals given in ranges of less than 3 months (<3m), 3-months, (3m), 3-6 months (3-6m), 6 months (6m), 6 months-1 year (6m-1yr), 1 year (1yr), 1 year to 2 year (1yr-2yr), 2 year (2yr) or the nearest year.

Appendix C Hyetographs

All hyetographs are plotted using 15-minute peak intensities.

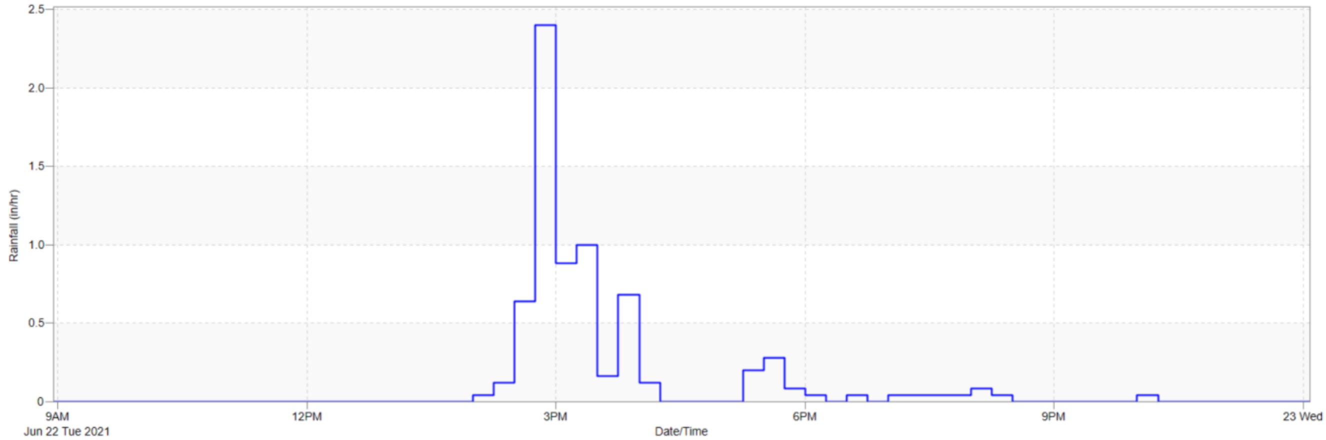

Figure 1. Ward Street June 22, 2021

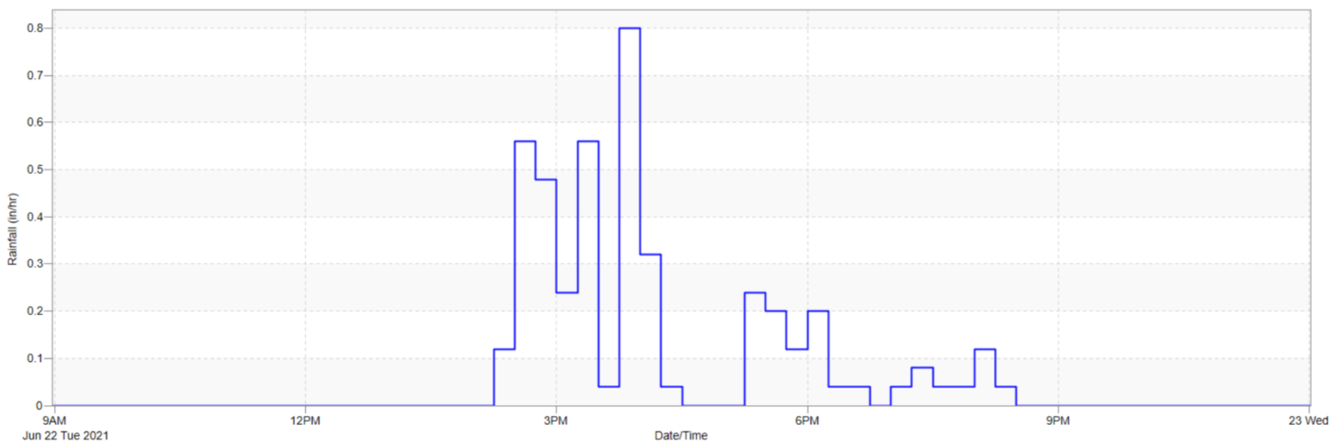

Figure 2. Columbus Park June 22, 2021

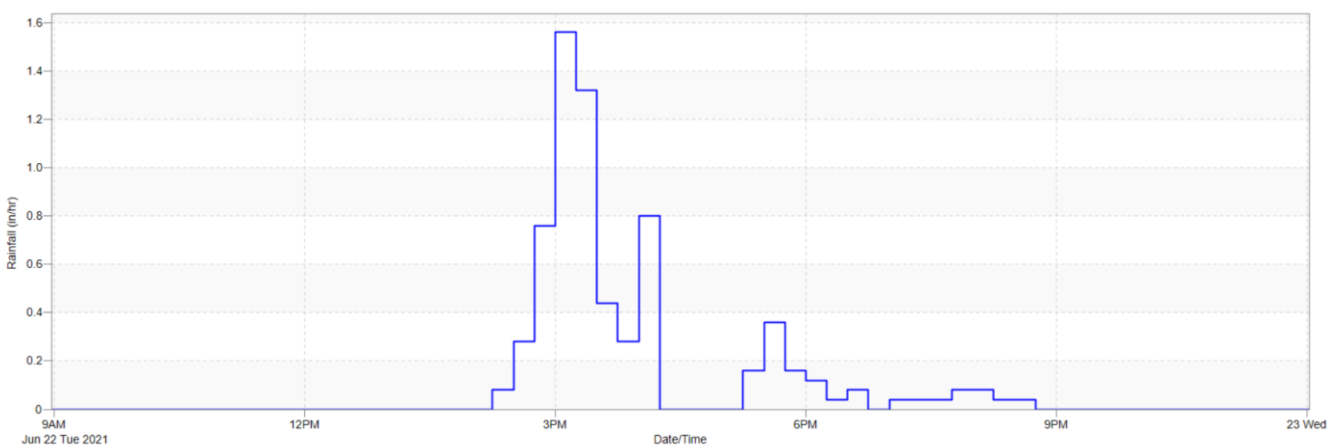

Figure 3. Chelsea Creek June 22, 2021