MASSACHUSETTS WATER RESOURCES AUTHORITY
Charlestown Navy Yard
100 First Avenue, Building 39
Boston, MA 02129

Frederick A. Laskey
Executive Director

Telephone: (617) 242-6000
Fax: (617) 788-4899
TTY: (617) 788-4971

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Kevin Brander, P.E.
Section Chief, Municipal Services Section
DEP Northeast Region Office
205B Lowell Street
Wilmington, MA 01887

Todd J. Borci
Office of Environmental Stewardship
US EPA New England
5 Post Office Square Suite 100 (OES 04-4)
Boston, MA 02109-3912

Subject: CSO Discharge Estimates and Rainfall Analyses for Calendar Year 2019 and Supplemental Discharge Information for Calendar Year 2018

Dear Mr. Brander and Mr. Borci:

The purpose of this letter report is to document and report the Massachusetts Water Resources Authority's (MWRA) estimates of combined sewer overflow (CSO) discharges in its service area during calendar year 2019. Variances to Massachusetts Water Quality Standards for CSO discharges to the Alewife Brook/Upper Mystic River and the Lower Charles River/Charles Basin, issued by the Massachusetts Department of Environmental Protection on August 30, 2019, require MWRA to submit an annual report which documents MWRA's estimates of CSO activations and volumes to these waters during the previous calendar year. The variances authorize limited CSO discharges to these waters in conjunction with National Pollutant Discharge Elimination System (NPDES) permits MA0103284, MA0101982 and MA0101974 issued to MWRA, the City of Cambridge and the City of Somerville, respectively.

The CSO discharge estimates in this report include activation frequency, total discharge duration and total discharge volume in 2019 from all outfalls addressed in MWRA's approved CSO Long-Term Control Plan (LTCP), including but not limited to the outfalls discharging to the Alewife Brook/Upper Mystic River and the Lower Charles River/Charles Basin. This letter report also includes information that supplements MWRA's April 30, 2019 letter report that presented estimates of CSO discharges during calendar year 2018. Specifically, it provides recently calibrated MWRA model predictions of CSO activations and volumes for each discharge location along with the discharge estimates MWRA presented a year ago, which were primarily from meter data supplemented with MWRA and City of Cambridge model results where meter data was not available.

CSO Post-Construction Monitoring and Performance Assessment

In compliance with the Federal District Court Order in the Boston Harbor Case (U.S. v. M.D.C. et al, No. 85-0489 MA) and milestones in the Court's Schedule Seven, MWRA is undertaking an

extensive program of CSO inspections, overflow metering, rainfall analyses, hydraulic model improvements and calibration, site-specific CSO performance investigations and water quality impact assessments. These activities, which MWRA commenced in November 2017, will culminate in a report to the U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection in December 2021, in compliance with Schedule Seven.[1]

MWRA issues semiannual reports on the progress of this work. The first four semiannual reports, including the most recent report issued on April 30, 2020, are posted to MWRA's website at http://www.mwra.com/cso/pcmapa.html. These progress reports document rainfall data and analyses, overflow meter data and analyses, CSO activity investigations, and hydraulic modeling efforts. The April 30, 2020 report also includes updates on MWRA's progress in the development of receiving water models for the Lower Charles River/Charles Basin and the Alewife Brook/Upper Mystic River.

The semiannual progress reports also document CSO abatement investigations for the regulators and outfalls where meter generated and/or model predicted CSO discharge estimates indicate higher CSO activity than the LTCP goals. MWRA has closely coordinated these investigations with its CSO communities: Boston Water and Sewer Commission (BWSC) and the cities of Cambridge, Chelsea and Somerville. The investigations include identifying the current site-specific wastewater system conditions that may be contributing to higher activity, and evaluating and recommending maintenance protocols or system adjustments that can reduce CSO discharges. From these investigations, certain maintenance and system adjustments have already been implemented and incorporated into MWRA's hydraulic model. Other recommended system adjustments may be implemented by MWRA and the CSO communities during the performance assessment if determined to be effective without causing adverse impacts (e.g., unacceptable wastewater levels in upstream or downstream systems).

CSO Metering

On April 15, 2018, as part of its CSO post-construction monitoring program and performance assessment, MWRA began collecting data from temporary metering equipment it installed at 57 potentially active CSO regulators. The instrumentation included 81 meters collecting data from 106 depth and velocity sensors, 20 level sensors and 16 tide gate inclinometers. The temporary meters supplemented the permanent overflow meters that are operated by the cities of Cambridge, Chelsea and Somerville in accordance with their NPDES permits and temporary meters that are operated by BWSC at several of its outfalls. In addition, MWRA operates several permanent CSO meters: at its CSO treatment facilities (Cottage Farm, Prison Point, Somerville-Marginal and Union Park); at Outfall MWR003 on Alewife Brook; at its CSO storage facility for Outfall BOS019 in Charlestown; bracketing three CSOs discharging to the Charles Basin (MWR018, 019 & 020); and at the CSO outfalls associated with the South Boston storage tunnel.

[1] On July 19, 2019, the Federal District Court approved an extension of the Schedule Seven milestone for submission of a final report on the CSO Performance Assessment from December 2020 to December 2021. MWRA had requested this one-year extension with the agreement and support of EPA and DEP to provide time for MWRA to develop receiving water models for the Charles River Basin and the Alewife Brook/Upper Mystic River and use the models to perform water quality impact assessments.

The MWRA's temporary metering program had the primary objectives of providing extensive overflow and system data to support improved calibration of its hydraulic model, measuring CSO activations and volumes at outfalls and comparing them with what MWRA's model had previously predicted, and measuring flow depths to confirm activation frequency. These objectives would support the use of the model for CSO predictions to determine whether the LTCP goals are being met.

The temporary meter installations at most of the 57 locations collected data that enabled quantification of discharge volume in addition to the start and end of an activation. At some less active regulators, the temporary meter installations measured depth only, for the purposes of confirming low overflow activity and for supporting calibration of MWRA's model. All of the temporary meters remained in place and operational through February 2019. With a determination that it had collected ample data since April 2018 to characterize CSO discharges and improve the calibration of the hydraulic model, MWRA took temporary meters out of service at 21 of the 57 CSO regulators.

Since March 1, 2019, MWRA has maintained the temporary meters and continued to collect data at the other 36 CSO regulators. Temporary meters remain in place to support ongoing site-specific investigations of CSO activity and evaluations of potential system modifications that may improve CSO performance. Temporary meters also remain in place at all CSO regulators associated with outfalls along the Charles River, the Alewife Brook and the Upper Mystic River to support water quality assessments required by the CSO variances.

MWRA's Hydraulic Model

MWRA updated the model beginning in the spring of 2019 to incorporate new information it had collected from the CSO inspections it conducted in 2018 and other information it obtained through its coordination efforts with the CSO communities. With the model updated to 2018 system conditions, MWRA recalibrated the model against temporary and permanent meter data collected from April 15, 2018 through September 30, 2018.

Calibration of the model was substantially complete by November 2019, and the 2018 conditions model was updated to 2019 conditions by incorporating adjustments to the wastewater system made in 2019, including regulator modifications performed by MWRA and the City of Cambridge to lower CSO discharges at Alewife Brook outfalls SOM001A and CAM002 in the spring of 2019. MWRA then compared CSO discharge activations and volumes predicted by the 2018 and 2019 models to meter data collected from April 15, 2018 through most of 2019 and concluded that the model and meter results were not sufficiently or consistently close at 10 of the 40 active CSO outfalls. To improve the calibration, MWRA conducted detailed investigations for each of the 10 locations, which resulted in additional model adjustments.

In January 2020, MWRA determined the model to be well calibrated, despite continuing to investigate minor model vs. meter CSO discrepancies at Alewife Brook outfall MWR003. Additional adjustments to the model's hydraulic parameters have since been made to better predict CSO discharges at MWR003. MWRA will continue to make adjustments to the model as it obtains new information about system conditions and wet weather performance. As part of its site-specific investigations into locations of higher CSO activity compared to LTCP levels of control, further inspections and evaluations continue to be conducted by MWRA and the CSO communities.

A recent example involved MWRA's adjustment of the model calibration for East Boston in response to new field information from BWSC. BWSC field crew conducted a more rigorous inspection of regulator RE003-12 in August 2019 in response to measured higher overflow activity. The field crew discovered and removed a significant blockage from the dry weather flow connection. While BWSC and MWRA continued to discuss and evaluate approaches that might reduce CSO discharges at RE003-12 and other East Boston regulators, the August 2019 field report and maintenance record was not submitted to MWRA until February 2020. Earlier regulator inspections conducted by BWSC and MWRA did not reveal a problem, as the small amount of flow observed during the inspections typically conducted during dry weather was able to pass through the partial blockage. BWSC is refining its inspection protocol for this and similar regulators.

Once it received the August 2019 maintenance report, MWRA compared calibrated model predictions to meter data collected after the removal of the partial blockage, which led MWRA to lower the model's head loss coefficient for the RE003-12 connection to bring the model results in line with the measurements. Once recalibrated, the updated model results compared well with meter data collected after the 2019 cleaning, and the results showed that removing the partial blockage significantly lowered CSO discharges at BOS003. With the recalibration, Typical Year model activations and volume at BOS003 dropped from 25 activations and 17.41 million gallons (MG) to 9 activations and 6.13 MG.

MWRA has since run the calibrated 2018 and 2019 models for all storms in those years, and has also run the 2019 model for Typical Year rainfall. Results are discussed and presented in later sections of this report.

Coordination with CSO Communities

MWRA has worked closely with its CSO communities during the CSO post-construction monitoring and performance assessment. BWSC and the cities of Cambridge, Chelsea and Somerville have joined MWRA in field inspections, modeling, and the reevaluation of system conditions to explain and attempt to mitigate higher CSO activity locations. Each of these communities are also making progress with their own wastewater plans and programs, such as the development or improvement of GIS maps and hydraulic models of their systems, preparation of master plans, enhancements to their inspection and maintenance protocols, and continuing progress with the design and construction of sewer separation projects. MWRA has received the hydraulic models developed by all four communities, and has used these models to confirm or improve MWRA's model. MWRA will continue to track the communities' efforts for their potential beneficial impact on CSO performance.

Like MWRA, all four CSO communities are preparing reports of their estimates of CSO discharges in 2019. Cambridge plans to report its own meter and model results. Chelsea and Somerville plan to report the discharges measured by their meters, as required by their NPDES CSO discharge permits. BWSC plans to report the MWRA's estimates while it continues to develop its metering program and hydraulic model.

MWRA will continue to evaluate the model's capability to predict CSO discharges across a range of rainfall characteristics, thereby being capable of providing an assessment of the system's Typical Year performance relative to the LTCP levels of control. Also important to MWRA has

been the review of the CSO discharges it reports compared to the discharges reported by the communities. Over the past few months, MWRA and the CSO communities have worked together to understand and compare their meter results and Cambridge's and MWRA's model results, with the objectives of reporting similar estimates and being able to explain any remaining differences. This coordination will continue in the year ahead.

2018 CSO Discharge Estimates

Table 1: Summary of 2018 CSO Discharge Estimates from Meter Data and Hydraulic Model Simulations

When MWRA issued its report of CSO discharge estimates for 2018 on April 30, 2019, it had not completed calibration of its hydraulic model. Last year's report presented estimated CSO activations and volumes from the data MWRA had collected from its temporary and permanent CSO meters during the many storms that occurred in 2018. As mentioned above, the temporary meters were operational beginning April 15, 2018. MWRA utilized its 2017 system condition model to predict CSO discharges for the few rainfall events that occurred from January 1, 2018 through April 14, 2018.

The temporary meters at some of the regulators measured flow depth relative to overflow elevation, but not discharge volume. MWRA was unable to provide discharge volume estimates for these locations. With respect to the CSO outfalls that discharge to the variance waters, MWRA did not have volume estimates for Outfall SOM007A/ MWR205A, which discharges to the Upper Mystic River, and for outfalls MWR018, MWR019, MWR020 and MWR023 (the latter, at certain regulators only), which discharge to the Lower Charles River/Charles Basin. MWRA utilized the City of Cambridge's hydraulic model results for estimated volumes at outfalls CAM001, CAM002, and CAM401A.

In the April 30, 2019 report, MWRA committed to supplementing the 2018 CSO discharge estimates with full-year model predictions at every regulator and outfall following completion of model calibration. Table 1 presents the calibrated model predictions of CSO discharge frequency, total duration and total volume in 2018, alongside the discharge estimates presented in last year's report.

2019 CSO Discharge Estimates

Table 2: Summary of 2019 CSO Discharge Estimates from Meter Data and Hydraulic Model Simulations

Table 2 presents estimated CSO activations, total discharge duration and total discharge volume at each CSO outfall and regulator during calendar year 2019, as quantified from meter data and as predicted by MWRA's calibrated 2019 system condition model.

MWRA's collection and treatment systems had no significant operational or performance problems in 2019. The year saw a significantly higher number of storms and many storms with short but high peak rainfall intensities. When there was a forecast of an impending intense storm, MWRA facility operators would then monitor upstream levels and open the influent gates at CSO treatment facilities at an elevation below the facility's standard operating level, especially in response to a sudden rise of water in the influent chamber. Although this may have contributed to

nominally higher treated discharge volumes, MWRA believes that the unpredictability of these events and the potential for upstream flooding or higher untreated CSO discharges justifies an earlier response when an intense storm warning is issued.

Comparison of MWRA and Community CSO Discharge Estimates for 2019

Table 3: Comparison of CSO Discharge Estimates Reported by the Communities and by MWRA

As noted previously, MWRA and its CSO communities coordinated closely as they prepared their respective annual CSO discharge reports for 2019. These interactions included review and comparison of MWRA and community meter installations and their methodologies for quantifying CSO discharge activations and volumes from the data. Because MWRA and the City of Cambridge also report model results, they compared model configurations, real-time (operational) controls in their storm-by-storm model simulations, and model platforms, which can also affect results. This months-long coordination has brought MWRA and community discharge estimates closer together. Table 3 compares the discharge estimates reported by each community for 2019 rainfall with the discharges estimated by MWRA. BWSC outfalls are not included in Table 3 because BWSC reports MWRA's estimates as it continues to develop its metering program and hydraulic model.

2019 Rainfall Analyses

Table R-1: Comparison of Frequency of Rain Events within Selected Ranges of Total Rainfall, Typical Year vs. 2019

Table R-2: Comparison of Rain Events with Greater than 2 Inches of Total Rain, Typical Year vs. 2019

Table R-3: Comparison of Rain Events with Peak Intensities Greater than 0.40 Inch/Hour, Typical Year vs. 2019

Figure R-1: Rainfall Intensity Distribution Comparison, Typical Year vs. 2019

These rainfall comparisons help to explain the magnitude of the estimated CSO discharges caused by 2019 rainfall relative to the model predicted discharges for the Typical Year with 2019 system conditions. The comparisons help to understand whether actual CSO discharges and their associated impacts are in line with the predictions that supported regulatory approvals of MWRA's LTCP.

In 2019, as in 2018, Metropolitan Boston experienced a significantly greater number of rainfall events, a greater total rainfall amount, and more storms with relatively high peak intensity compared to the Typical Year. The impact of this heavier wet weather is evident in comparing the metered and modeled discharge estimates for 2019 rainfall in Table 2 with the model predicted discharges for Typical Year 2019 system conditions and the LTCP in Table 4. Table 2 shows a total modeled CSO discharge volume from all outfalls of 543 MG, while Table 4 shows a Typical Year total discharge volume of 430 MG for the same (2019) system conditions.

Table R-1 shows that 20 area rain gauges recorded an average of 112 storms in 2019 with total rainfall volume of approximately 49 inches compared with 93 storms and rainfall volume of 46.8 inches in the Typical Year. Table R-1 shows that the larger number of storms in 2019 compared with the Typical Year were storms of less than 1 inch depth, and mostly storms of less than 0.5 inch depth. Table R-2 shows that there were fewer storms with rainfall depths greater than 2 inches in 2019 compared with the Typical Year. However, CSO discharges are also influenced by peak rainfall intensity and not just by total rainfall volume. At most of the CSO outfalls, activations can be caused by high rainfall intensity that even over a very short duration can cause sewer system flows to exceed pipe capacities or exceed the capacities of connections between collection sewers and interceptors.

Generally, peak intensities of greater than 0.4 inch/hour can cause activations at many of the CSO outfalls. Table R-3 shows that area rain gauges recorded more storms in 2019 with peak hourly intensities of greater than 0.4 inch/hour compared with the Typical Year (up to 13 storms in 2019 vs. 9 storms in the Typical Year). Figure R-1 shows probability distributions of peak intensities from rainfall measurements in 2019 compared with the Typical Year. For most percentiles, 2019 peak intensity is greater than Typical Year peak intensity (where the Ward Street, Columbus Park and Chelsea Creek headworks graphed lines lie above the Typical Year line). While approximately 9% of the storms in the Typical Year had peak intensities of greater than 0.4 inch/hour, approximately 12% of the storms in 2019 exceeded 0.4 inch/hour.

Typical Year Performance

Table 4: Summary of Typical Year CSO Discharges for 2019 System Conditions and Comparison with Long-Term Control Plan Levels of Control

Table 4 presents the results of the MWRA's calibrated 2019 system conditions model's simulation of Typical Year rainfall and compares the results to the LTCP levels of control. Activations and volumes that exceed the LTCP levels are shaded.

MWRA, in consultation with BWSC, Cambridge, Chelsea and Somerville, has been carefully studying the locations where the current model predicts higher Typical Year activations and/or volume compared with the LTCP. Efforts are underway to assess measures that may improve CSO performance. MWRA will perform additional model investigations to determine whether CSO performance will improve with ongoing maintenance activities (e.g., sediment removal) and planned changes to the collection system (e.g., sewer separation and partial sewer separation projects). For instance, BWSC is nearing completion of an extensive sediment cleaning contract involving the South Boston Interceptor - North Branch (SBI-NB) and tributary connecting sewers. Once complete, MWRA will use post-cleaning meter data and the hydraulic model to evaluate how removal of the sediments has affected CSO discharges from the SBI-NB system to the Dorchester Brook Conduit, which discharges to the Fort Point Channel at Outfall BOS070.

Further modeling analyses will also be performed to determine if raising weir elevations can improve CSO performance without causing adverse impacts to the upstream systems. In advance of submitting the December 2021 final report on the performance assessment, MWRA intends to

implement additional system adjustments (potentially, weir changes, flow shifting, modifications to facility operations, etc.) aimed at improving CSO performance.

Areas of particular immediate focus include East Boston (Inner Harbor and Chelsea Creek), the Cottage Farm Facility (Lower Charles River) and the Somerville Marginal Facility (Upper Mystic River and Mystic/Chelsea Confluence). For more information about these investigations, see MWRA's April 30, 2020 Semiannual CSO Progress Report No. 4, at http://www.mwra.com/cso/pcmapa.html.

Notwithstanding the need for and value of these investigations, the 2019 Typical Year calibrated model validates the accomplishment of MWRA and its member communities with their CSO control efforts and investments over the past three decades. The Typical Year results show that region-wide average annual CSO discharge volume has been reduced from 1.5 billion gallons in 1992 (and from 3.3 billion gallons in the late 1980's prior to Fast Track pumping and reliability improvements at the Deer Island Treatment Plant) to 430 million gallons today. CSO discharges have been permanently eliminated at all of the outfalls required to be closed in the LTCP, and several more outfalls have also been closed. MWRA's South Boston CSO storage tunnel has prevented any CSO discharge to the beaches since it was brought on-line in May 2011.

MWRA is confident that it will continue to make and show further improvement as its CSO performance assessment and related mitigation efforts continue. MWRA, with the support of the CSO communities, continues to make important progress in evaluating and implementing system adjustments that may improve CSO performance.

Should you have questions about MWRA's CSO discharge estimates or MWRA's continued efforts implementing the LTCP, please feel free to contact me, at 617-788-4359, or Brian Kubaska at 617-756-8464.

Very truly yours,

David W. Coppes
Chief Operating Officer

TABLE 1: SUMMARY OF 2018 METER AND MODEL CSO DISCHARGE ESTIMATES

		JANUARY 1, 2018 - DECEMBER 31, 2018 RAINFALL 2018 SYSTEM CONDITIONS					
		FROM MWRA APRIL 30, 2019 LETTER REPORT [1]			CALIBRATED MODEL PREDICTIONS		
Outfall	**Regulator**	**Activation Frequency**	**Duration (hrs)**	**Volume (MG)**	**Activation Frequency**	**Duration (hrs)**	**Volume (MG)**
ALEWIFE BROOK							
CAM001	RE-011	3	0.75	**0.02**	2	0.46	0.01
CAM002	RE-021	4	1.25	**1.43**	4	2.17	0.63
MWR003	RE-031	0	0.00	0.00	2	2.25	0.46
CAM004	Closed	-	-	-	-	-	-
CAM400	Closed	-	-	-	-	-	-
CAM401A	RE-401	18	20.75	**5.01**	17	15.79	5.30
CAM401B	RE-401B	3	2.25	0.00	3	2.87	0.22
SOM001A	RE-01A	14	9.25	14.64	14	8.03	9.23
SOM001	Closed	-	-	-	-	-	-
SOM002A	Closed	-	-	-	-	-	-
SOM003	Closed	-	-	-	-	-	-
SOM004	Closed	-	-	-	-	-	-
TOTAL				**21.10**			**15.85**
UPPER MYSTIC RIVER							
SOM007A/MWR205A [2]		21	48.87	N/A	17	53.72	43.78
SOM007	Closed	-	-	-	-	-	-
TOTAL				**N/A**			**43.78**
MYSTIC / CHELSEA CONFLUENCE							
MWR205 (Somerville Marginal Facility) [3]		35	131.33	121.44	32	N/A[4]	121.22
BOS013	RE013-1	14	6.75	0.51	24	28.38	1.07
BOS014	RE014-2	11	9.00	2.25	24	20.04	2.23
BOS015	Closed	-	-	-	-	-	-
BOS017	RE017-3	8[5]	5.6[5]	1.15[5]	13	25.31	0.59
CHE002	Closed	-	-	-	-	-	-
CHE003	RE-031	0	0.00	0.00	0	0.00	0.00
CHE004	RE-041	17	12.50	1.79	10	8.47	1.62
CHE008	RE-081	19	32.25	3.46	23	35.60	5.11
TOTAL				**129.45**			**131.84**
UPPER INNER HARBOR							
BOS009	RE009-2	14	18.50	0.40	34	58.78	0.80
BOS010	RE010-2	7	7.75	1.35	11	14.68	1.88
BOS012	RE012-2	12	4.00	1.15	21	12.47	2.01
BOS019	RE019-2	5	22.91	N/A	2	2.48	0.21
BOS050	Closed	-	-	-	-	-	-
BOS052	Closed	-	-	-	-	-	-
BOS057	RE057-6	4	4.25	2.98	5	5.42	1.58
BOS058	Closed	-	-	-	-	-	-
BOS060	RE060-7	9	11.00	1.33	6	3.03	0.68
	RE060-20	4	1.25	N/A	11	9.31	0.42
MWR203 (Prison Point) [6]		21	90.09	343.13	17	N/A[4]	288.62
TOTAL				**>350.34**			**296.20**
LOWER INNER HARBOR							
BOS003	RE003-2	3	0.75	0.00	2	0.16	0.05
	RE003-7	6	6.50	0.52	9	22.04	1.91
	RE003-12	34	130.02	20.87	38	114.96	21.15
BOS004	RE004-6	6	5.25	0.10	7	7.28	0.01
BOS005	RE005-1	0	0.00	0.00	0	0.00	0.00
BOS006	Closed	-	-	-	-	-	-
BOS007	Closed	-	-	-	-	-	-
TOTAL				**21.49**			**23.12**

TABLE 1: SUMMARY OF 2018 METER AND MODEL CSO DISCHARGE ESTIMATES

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		FROM MWRA APRIL 30, 2019 LETTER REPORT [1]			CALIBRATED MODEL PREDICTIONS		
Outfall	**Regulator**	**Activation Frequency**	**Duration (hrs)**	**Volume (MG)**	**Activation Frequency**	**Duration (hrs)**	**Volume (MG)**
CONSTITUTION BEACH							
MWR207	Closed	-	-	-	-	-	-
TOTAL					-	-	-
FORT POINT CHANNEL							
BOS062	RE062-4	11	10.25	0.11	17	29.84	1.23
BOS064	RE064-4	2	2.50	0.20	2	2.15	0.01
	RE064-5	5	2.25	N/A	8	3.87	0.06
BOS065	RE065-2	10	16.00	N/A	15	26.76	0.46
BOS068	RE068-1A	1	0.50	N/A	1	0.83	0.00
BOS070							
BOS070/DBC	RE070/8-3	10	8.50	2.14	12	17.20	1.71
	RE070/8-6	1	1.00	N/A	1	1.05	0.00
	RE070/8-7	7	4.25	N/A	10	3.48	0.20
	RE070/8-8	1	0.25	N/A	1	0.45	0.00
	RE070/8-13	0	0.00	0.00	1	0.47	0.00
	RE070/8-15	2	1.25	N/A	2	1.53	0.00
	RE070/9-4	12	10.00	2.25	12	17.04	1.47
	RE070/10-5	2	0.50	0.31	3	2.30	0.20
	RE070/7-2	25	23.00	1.81	30	56.57	2.13
MWR215 (Union Park) [6]		10	32.71	34.09	14	N/A[4]	43.29
BOS070/RCC	RE070/5-3	2	0.50	N/A	4	1.33	0.17
	RE070/6-1	Closed	-	-	-	-	-
BOS072	Closed	-	-	-	-	-	-
BOS073	RE073-4	1	2.50	0.04	3	1.83	0.01
TOTAL				**>40.95**			**50.94**
RESERVED CHANNEL							
BOS076	RE076/2-3	0	0.00	0.00	4	8.85	0.06
	RE076/4-3	1	2.50	0.12	6	16.52	0.41
BOS078	RE078-1 & RE078-2	1	0.75	0.11	3	3.83	0.08
BOS079	RE079-3	0	0.00	0.00	1	0.40	0.00
BOS080	RE080-2B	1	0.75	N/A	1	0.07	0.00
TOTAL				**>0.23**			**0.55**
NORTHERN DORCHESTER BAY							
BOS081	RE081-2	0	0.00	0.00	0	0.00	0.00
BOS082	RE082-2	0	0.00	0.00	0	0.00	0.00
BOS083	Closed	-	-	-	-	-	-
BOS084	RE084-3 & RE084-6	0	0.00	0.00	0	0.00	0.00
BOS085	RE085-4	0	0.00	0.00	0	0.00	0.00
BOS086	RE086-1	0	0.00	0.00	0	0.00	0.00
BOS087	Closed	-	-	-	-	-	-
TOTAL		**0**	**0.00**	**0.00**	**0**	**0.00**	**0.00**
SOUTHERN DORCHESTER BAY							
BOS088/BOS089 (Fox Pt.)	Closed	-	-	-	-	-	-
BOS090 (Commercial Pt.)	Closed	-	-	-	-	-	-
TOTAL							
UPPER CHARLES							
BOS032	Closed	-	-	-	-	-	-
BOS033	Closed	-	-	-	-	-	-
CAM005	RE-051	15	11.50	4.97	14	7.58	1.08
CAM007	RE-071	2	4.50	0.14	3	2.25	0.99
CAM009	Closed	-	-	-	-	-	-
CAM011	Closed	-	-	-	-	-	-
TOTAL				**5.11**			**2.07**

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		FROM MWRA APRIL 30, 2019 LETTER REPORT [1]			CALIBRATED MODEL PREDICTIONS		
Outfall	**Regulator**	**Activation Frequency**	**Duration (hrs)**	**Volume (MG)**	**Activation Frequency**	**Duration (hrs)**	**Volume (MG)**
LOWER CHARLES							
BOS028	Closed	-	-	-	-	-	-
BOS042	Closed	-	-	-	-	-	-
BOS049	Closed	-	-	-	-	-	-
CAM017	CAM017	0	0.00	0.00	2	1.72	0.20
MWR010	RE37	0	0.00	0.00	0	0.00	0.00
	RE036-9	No meter data available			0	0.00	0.00
MWR018		2	1.75	N/A	4	5.07	4.81
MWR019		2	1.75	N/A	4	3.65	1.94
MWR020		2	2.00	N/A	4	3.20	1.39
MWR021	Closed	-	-	-	-	-	-
MWR022	Closed	-	-	-	-	-	-
MWR201 (Cottage Farm) [6]		4	10.26	30.14	4	14.01	27.72
MWR023	RE046-19	0	0.00	0.00	0	0.00	0.00
	RE046-30	0	0.00	0.00	0	0.00	0.00
	RE046-50	0	0.00	0.00	0	0.00	0.00
	RE046-54	0	0.00	0.00	0	0.00	0.00
	RE046-55	3	15.00	N/A	0	0.00	0.00
	RE046-62A	0	0.00	0.00	0	0.00	0.00
	RE046-90	1	0.25	N/A	0	0.00	0.00
	RE046-100	6	2.00	0.02	4	2.15	0.16
	RE046-105	1	0.50	0.03	4	1.05	0.07
	RE046-381	2	1.00	N/A	2	0.74	0.14
	RE046-192	0	0.00	0.00	1	0.02	0.02
SOM010	Closed	-	-	-	-	-	-
TOTAL				**>30.19**			**36.45**
NEPONSET RIVER							
BOS093	Closed	-	-	-	-	-	-
BOS095	Closed	-	-	-	-	-	-
TOTAL							
BACK BAY FENS							
BOS046 [7]	Fens Gatehouse #1	7	16.00	N/A	4	2.15	0.29
TOTAL				**N/A**			**0.29**
Total Treated				**528.80**			**480.85**
Total Untreated				**>71.21**			**76.17**
GRAND TOTAL				**>600.01**			**557.02**

N/A: Level sensor, only. No volume measurement.

Where activations occurred and volume is reported as 0.00 MG, volumes are less than 0.005MG.

Alewife Brook: Shaded values for CAM001, CAM002 and CAM401A are CSO discharge volumes from Cambridge model results. Activation frequency and duration are from MWRA meters.

(1) For the regulators at untreated CSO outfalls, activation frequency, duration and volume for 2018 rainfall are from model results for the period January 1 - April 14, 2018, and are from meter measurements for the period April 15 - December 31, 2018. Only activation frequency and duration are available at locations with level-only meter.

(2) Includes portion of flow treated at Somerville Marginal facility and separate stormwater entering the Somerville Marginal Conduit (outfall) downstream of the facility.

(3) Volume represents all flow through the CSO treatment facility. Metered activation frequency and volume are from MWRA facility records.

(4) Modeled discharge duration is under review.

(5) Activation frequency, duration and volume are from model results for January 1 - April 14, 2018 period, and from meter measurements for July 19 - December 31, 2018 period. No meter measurements were available April 15 - July 18, 2018, the discharge frequency, duration and volumes are from MWRA extrapolation of meter results in the later period.

(6) Metered activation frequency and volume are from MWRA facility records.

(7) Modeled volume is the CSO component of discharge from Outfall BOS046 and does not include stormwater.

Table 2: Summary of January 1-December 31, 2019 Modeled and Metered CSO Discharges (1 of 2)

Outfall	Regulator	Level Only Meter[1]	Meter Removed 3/1/19[2]	January 1 - December 31, 2019					
				Meter[2]			Model		
				Activation Frequency	Duration (hrs)	Volume (MG)[3]	Activation Frequency	Duration (hrs)	Volume (MG)
Alewife Brook									
CAM001	RE-011	Y		7	6.06	N/A	3	3.16	0.16
CAM002	RE-021			1	0.19	N/A	2	1.72	0.20
MWR003	RE-031			3	3.01	2.99	3	5.74	5.34
CAM401A	RE-401			20	22.37	N/A	10	11.94	6.25
CAM401B	RE-401B			6	7.84	1.04	6	6.46	1.69
SOM001A	RE-01A			9	4.93	7.98	7	6.19	9.08
Upper Mystic River									
SOM007A/MWR205A [4]		Y		12	26.17	N/A	8	14.50	14.52
Mystic/Chelsea Confluence									
MWR205 (Somerville Marginal Facility)				27	89.38	96.41	26	N/A[5]	98.89
BOS013	RE013-1		Y	-	-	-	19	45.69	1.79
BOS014	RE014-2		Y	-	-	-	18	42.31	4.76
BOS017	RE017-3		Y	-	-	-	12	13.64	0.90
CHE003	RE-031	Y		0	0.00	0.00	0	0.00	0.00
CHE004	RE-041			28	29.33	1.44	12	8.88	2.70
CHE008	RE-081			18	21.04	3.34	17	52.47	8.01
Upper Inner Harbor									
BOS009	RE009-2		Y	-	-	-	22	70.70	1.39
BOS010	RE010-2		Y	-	-	-	15	22.38	3.31
BOS012	RE012-2		Y	-	-	-	22	37.43	3.25
BOS019	RE019-2	Y		3	6.39	N/A	1	2.05	0.14
BOS057	RE057-6			6	6.18	4.62	6	6.57	2.83
BOS060	RE060-7			4	3.28	0.58	7	8.36	1.13
	RE060-20			4	1.39	0.09	6	4.78	0.43
MWR203 (Prison Point)				17	70.23	276.63	15	N/A[5]	260.96
Lower Inner Harbor									
BOS003	RE003-2		Y	-	-	-	6	2.87	0.40
	RE003-7		Y	-	-	-	12	31.82	3.80
	RE003-12			29	124.86	19.46	21	59.70	16.54
BOS004	RE004-6		Y	-	-	-	12	15.99	0.13
BOS005	RE005-1	Y	Y	-	-	-	0	0.00	0.00
Fort Point Channel									
BOS062	RE062-4		Y	-	-	-	14	38.20	1.65
BOS064	RE064-4		Y	-	-	-	2	2.86	0.11
	RE064-5	Y	Y	-	-	-	8	4.00	0.09
BOS065	RE065-2	Y		15	18.79	N/A	8	18.46	1.69
BOS068	RE068-1A	Y	Y	-	-	-	2	1.24	0.00
BOS070/DBC	RE070/8-3			11	8.86	2.53	14	16.09	3.09
	RE070/8-6	Y		1	1.46	N/A	2	1.67	0.01
	RE070/8-7	Y		7	5.43	N/A	8	6.01	0.34
	RE070/8-8	Y		2	0.76	N/A	1	0.68	0.00
	RE070/8-13	Y		5	1.06	N/A	2	0.82	0.03
	RE070/8-15	Y		N/A [6]	N/A [6]	N/A [6]	4	3.06	0.10
	RE070/9-4			15	12.58	3.24	14	21.56	4.61
	RE070/10-5			4	2.02	0.24	3	3.12	0.33
	RE070/7-2			15	16.39	0.90	24	57.61	7.07
MWR215 (Union Park)				10	28.28	41.88	11	N/A[5]	31.01
BOS070/RCC	RE070/5-3	Y	Y	-	-	-	2	1.25	0.23
BOS073	RE073-4			2	3.84	0.55	2	2.14	0.01

Table 2: Summary of January 1-December 31, 2019 Modeled and Metered CSO Discharges (2 of 2)

Outfall	Regulator	Level Only Meter[1]	Meter Removed 3/1/19[2]	January 1 - December 31, 2019					
				Meter[2]			Model		
				Activation Frequency	Duration (hrs)	Volume (MG)[3]	Activation Frequency	Duration (hrs)	Volume (MG)
Reserved Channel									
BOS076	RE076/2-3			3	3.11	0.01	3	3.46	0.09
	RE076/4-3			3	4.44	0.26	6	10.65	1.84
BOS078	RE078-1 RE078-2		Y	-	-	-	3	2.81	0.15
BOS079	RE079-3	Y	Y	-	-	-	3	1.86	0.00
BOS080	RE080-2B	Y	Y	-	-	-	3	1.32	0.09
Upper Charles									
CAM005	RE-051			17	13.18	N/A	10	10.00	1.71
CAM007	RE-071			2	2.25	1.43	3	3.36	4.43
Lower Charles									
CAM017	CAM017			3	3.25	N/A	1	1.25	0.95
MWR010	RE036-9	Y		0	0.00	0.00	1	8.29	0.00
	RE037	Y		0	0.00	0.00	0	0.00	0.00
MWR018		Y		1	1.50	N/A	2	3.62	6.50
MWR019		Y		0	0.00	0.00	2	2.78	3.20
MWR020		Y		0	0.00	0.00	2	2.39	2.57
MWR201 (Cottage Farm)				6	12.14	41.50	5	18.49	37.00
MWR023 [7]	RE046-19	Y		1	0.41	N/A	0	0.00	0.00
	RE046-30			1	1.16	0.01	0	0.00	0.00
	RE046-50	Y		0	0.00	0.00	0	0.00	0.00
	RE046-54	Y		0	0.00	0.00	0	0.00	0.00
	RE046-55	Y		0	0.00	0.00	0	0.00	0.00
	RE046-62A	Y		0	0.00	0.00	0	0.00	0.00
	RE046-90	Y		0	0.00	0.00	0	0.00	0.00
	RE046-100			4	0.31	0.00	4	1.92	0.17
	RE046-105			1	0.21	0.00	3	0.74	0.06
	RE046-381	Y		2	1.56	N/A	2	0.97	0.26
	RE046-192	Y		0	0.00	0.00	0	0.00	0.00
Back Bay Fens									
BOS046 [7]	Boston Gatehouse #1			N/A	N/A	N/A	2	1.25	0.35
GRAND TOTAL						-			543.47

(1) For locations indicated with a "Y," the meter measured level/activation only; volume measurement is not available (N/A).

(2) For locations indicated with a "Y," in the "Meter Removed 3/1/19" column, the meter was removed on March 1, 2019, and no metered volume for 2019 is reported.

(3) Flow volume methodology varies depending on regulator configuration and other factors, and may be by direct measurement in the outfall pipe, use of weir equation, use of scattergraph, and other methods to estimate volumes. Where activations occurred and volume is reported as 0.00 MG, the estimated volume was less than 0.01 MG. In locations where no volume calculation methodology could be applied, such as the sites with level-only sensors, no volume was estimated (N/A).

(4) Outfall SOM007A/MWR205A, jointly permitted to the City of Somerville and MWRA, provides high tide relief to MWRA's Somerville-Marginal Conduit. The Somerville-Marginal Conduit conveys treated CSO from MWRA's Somerville-Marginal Facility and separate stormwater to the tidal portion of the Mystic River below the Amelia Earhart Dam, at Outfall MWR205. The reported discharge at MWR205 is the total treated CSO and does not include separate stormwater entering the Somerville-Marginal Conduit. The reported discharge at high tide Outfall SOM007A/MWR205A is total flow, both separate stormwater and CSO. Because the reported MWR205 discharge is the total amount of CSO, the SOM007A/MWR205A discharge is not counted in the "Grand Total."

(5) Modeled discharge duration is under review.

(6) BWSC pipe cleaning operations along and tributary to the South Boston Interceptor - North Branch in the summer/fall of 2019 prevented accurate meter readings at regulator RE070/8-15.

(7) Boston Gatehouse #1 (Outfall BOS046) provides hydraulic relief to BWSC's Stony Brook Conduit in very large storms. The Stony Brook Conduit conveys both separate stormwater and CSO to the Charles River Basin at Outfall MWR023. The reported discharge at MWR023 is total CSO entering the Stony Brook Conduit from all upstream regulators, and does not include separate stormwater. The reported discharge to the Back Bay Fens via BOS046 is the CSO component of discharge and does not include stormwater. Because the reported MWR023 discharge is the total amount of CSO, the BOS046 discharge is not counted in the "Grand Total."

Table 3: Comparison of 2019 CSO Discharge Estimates Reported by MWRA and the CSO Communities [1]

Outfall	MWRA[2]		Community		Remarks
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	
Cambridge's estimates are from its hydraulic model simulations, not overflow measurements					
CAM001	3	0.16	3	0.38	
CAM002	2	0.20	2	0.16	
CAM401A	10	6.25	14	7.74	
CAM401B	6	1.69	7	2.26	
CAM005	10	1.71	7	3.42	
CAM007	3	4.43	2	2.87	
CAM017	1	0.95	3	4.90	
Chelsea's estimates are from its meter data					
CHE003	0	0	1	0.028	
CHE004	12	2.70	9	1.446	
CHE008	17	8.01	16	3.343	
Somerville's estimates are from its meter data at SOM01A and from MWRA meter data at SOM007A					
SOM001A	7	9.08	9	7.98	
SOM007A/ MWR205A[3]	8	14.52	12	N/A[3]	

[1] BWSC continues to report MWRA's discharge estimates.

[2] MWRA's estimates in this table are calibrated model results.

[3] MWRA's measurements at SOM007A/MWR205A do not include volume.

Table R-1: Comparison of Frequency of Rain Events within Selected Ranges of Total Rainfall Typical Year vs. 2019[1]

Rain Gauge	Total Rainfall (inches)	Number of Storms	Number of Storms by Depth				
			Depth < 0.25 inch	Depth 0.25 to 0.5 inch	Depth 0.5 to 1.0 inch	Depth 1.0 to 2.0 inches	Depth ≥2.0 inches
Typical Year	46.8	93	49	14	16	8	6
January-December 2019 Rainfall Data							
Average of All 20 Rain Gauges							
Average	49.07	112	58	24	14	12	4
MWRA Rain Gauges							
Ward Street	50.14	113	56	25	18	11	3
Columbus Park	52.47	115	57	24	16	14	4
Chelsea Creek	49.18	116	63	26	9	17	1
Hanscom AFB	47.53	111	57	29	12	8	5
Hayes P.S.	45.78	110	55	28	11	15	1
BWSC Rain Gauges							
Allston	44.44	110	62	23	13	8	4
Charlestown	46.09	115	61	28	11	13	2
Dorchester – Adam [2]	51.12	112	58	22	15	13	4
Dorchester-Talbot [2]	51.12	112	58	22	15	13	4
Hyde Park	54.72	116	56	25	15	16	4
East Boston	50.42	116	62	26	12	13	3
Longwood	48.74	115	61	22	18	10	4
Roslindale	55.53	115	58	25	16	11	5
Roxbury	51.47	113	58	24	16	10	5
Union Park	49.57	113	55	25	19	10	4
USGS Rain Gauge							
Fresh Pond	45.43	108	60	19	15	10	4
Project Gauges							
Lexington Farm	45.44	110	58	29	13	8	4
Spot Pond	46.8	111	55	28	15	11	2
Somerville	46.54	111	56	27	13	14	1
Waltham Farm	51.18	116	63	23	13	12	5

(1) MWRA's rainfall data analyses for 2019 included replacement of suspect or missing rain gauge data with validated data from the closest rain gauge.

(2) No rainfall data were available from the Dorchester-Adams and Dorchester-Talbot gauges for all of 2019. For these locations, data from one or more nearby gauges were used.

Table R-2: Comparison of Rain Events with Greater than 2 Inches of Rain
Typical Year vs. 2019

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	0.2	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-December 2019 Rainfall Data						
Ward Street	4/22/2019	17.75	2.66	0.15	0.36	1-2yr
	8/7/2019	12.75	2.45	0.19	1.26	6m
Columbus Park	4/22/2019	17	2.59	0.15	0.4	6m-1yr
	7/22/2019	23.75	2.34	0.1	0.55	6m
	8/7/2019	13.25	2.05	0.15	0.87	3-6m
Chelsea Creek	4/22/2019	18.75	2.63	0.14	0.44	6m-1yr
Fresh Pond	4/22/2019	18.5	2.15	0.12	0.47	3-6m
	8/7/2019	13	2.98	0.23	1.41	1.5 yr
	10/16/2019	9	2.07	0.23	0.66	<3m
	12/29/2019	36.25	2.09	0.06	0.17	<3m

Table R-3: Comparison of Rain Events with Peak Intensities Greater than 0.40 inch/hour
Typical Year vs. 2019

Rain Gauge	Date	Duration (hours)	Total Rainfall (inches)	Average Intensity (inch/hour)	Peak 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-December 2019 Rainfall Data						
Ward Street Headworks (BO-DI-1)	4/14/2019	17.75	0.93	0.05	0.65	3-6m
	4/26/2019	27.75	1.66	0.06	0.48	<3m
	6/21/2019	13.25	0.83	0.06	0.64	3-6m
	7/6/2019	3.5	1.13	0.32	0.84	6m-1yr
	7/17/2019	17	1.07	0.06	0.46	<3m
	7/22/2019	22.25	2	0.09	0.41	<3m
	8/7/2019	12.75	2.45	0.19	1.26	2.5 yr
	8/28/2019	11.75	1.2	0.1	0.61	3-6m
	9/2/2019	2	0.74	0.37	0.67	3-6m
	10/16/2019	11.75	1.85	0.16	0.7	6m
	10/27/2019	10.75	1.69	0.16	0.54	3m
Columbus Park Headworks (BO-DI-2)	4/14/2019	17.5	0.77	0.04	0.54	3m
	4/22/2019	17	2.59	0.15	0.4	<3m
	6/21/2019	13	1.03	0.08	0.79	6m-1yr
	7/6/2019	3.5	1.42	0.41	1.14	2 yr
	7/17/2019	18.5	1.28	0.07	0.52	<3m
	7/22/2019	23.75	2.34	0.1	0.55	3m
	7/31/2019	2.25	1.69	0.75	1.61	6 yr
	8/7/2019	13.25	2.05	0.15	0.87	6m-1yr
	8/28/2019	10.5	1.26	0.12	0.48	<3m
	9/2/2019	1.5	0.58	0.39	0.53	3m
	10/16/2019	8.5	1.91	0.22	0.84	6m-1yr
	10/27/2019	11.75	1.48	0.13	0.48	<3m
	11/24/2019	17.5	1.84	0.11	0.53	3m
Rain Gauge	**Date**	**Duration (hours)**	**Total Rainfall (inches)**	**Average Intensity (inch/hour)**	**Peak Intensity (inch/hour)**	**Storm Recurrence Interval (1-hour)**

Chelsea Creek Headworks (CH-BO-1)	4/14/2019	16.75	0.78	0.05	0.55	3m
	4/22/2019	18.75	2.63	0.14	0.44	<3m
	4/26/2019	21.75	1.47	0.07	0.48	<3m
	6/20/2019	33.5	1.28	0.04	0.68	3-6m
	6/29/2019	11.5	1.82	0.16	1.67	7 yr
	7/6/2019	4	1.69	0.42	1.26	2.5 yr
	7/17/2019	5.75	0.71	0.12	0.63	3-6m
	8/7/2019	13.5	1.92	0.14	0.88	6m-1yr
	8/28/2019	13	1.02	0.08	0.42	<3m
	9/2/2019	1.75	0.93	0.53	0.8	6m-1yr
	10/16/2019	9	1.62	0.18	0.69	6m
	10/27/2019	11.75	1.34	0.11	0.47	<3m
	11/24/2019	17.25	1.54	0.09	0.44	<3m
Fresh Pond (USGS)	4/15/2019	17.25	0.86	0.05	0.65	3-6m
	4/22/2019	18.5	2.15	0.12	0.47	<3m
	6/20/2019	33	1.02	0.03	0.44	<3m
	7/6/2019	3.75	1.09	0.29	0.82	6m-1yr
	7/12/2019	20.25	1.05	0.05	0.41	<3m
	7/17/2019	9	0.75	0.08	0.67	3-6m
	7/31/2019	1.5	0.64	0.43	0.62	3-6m
	8/7/2019	13	2.98	0.23	1.41	3.5 yr
	8/28/2019	10.25	1.37	0.13	0.6	3m
	9/2/2019	6.5	1.41	0.22	1.25	2.5 yr
	10/16/2019	9	2.07	0.23	0.66	3-6m

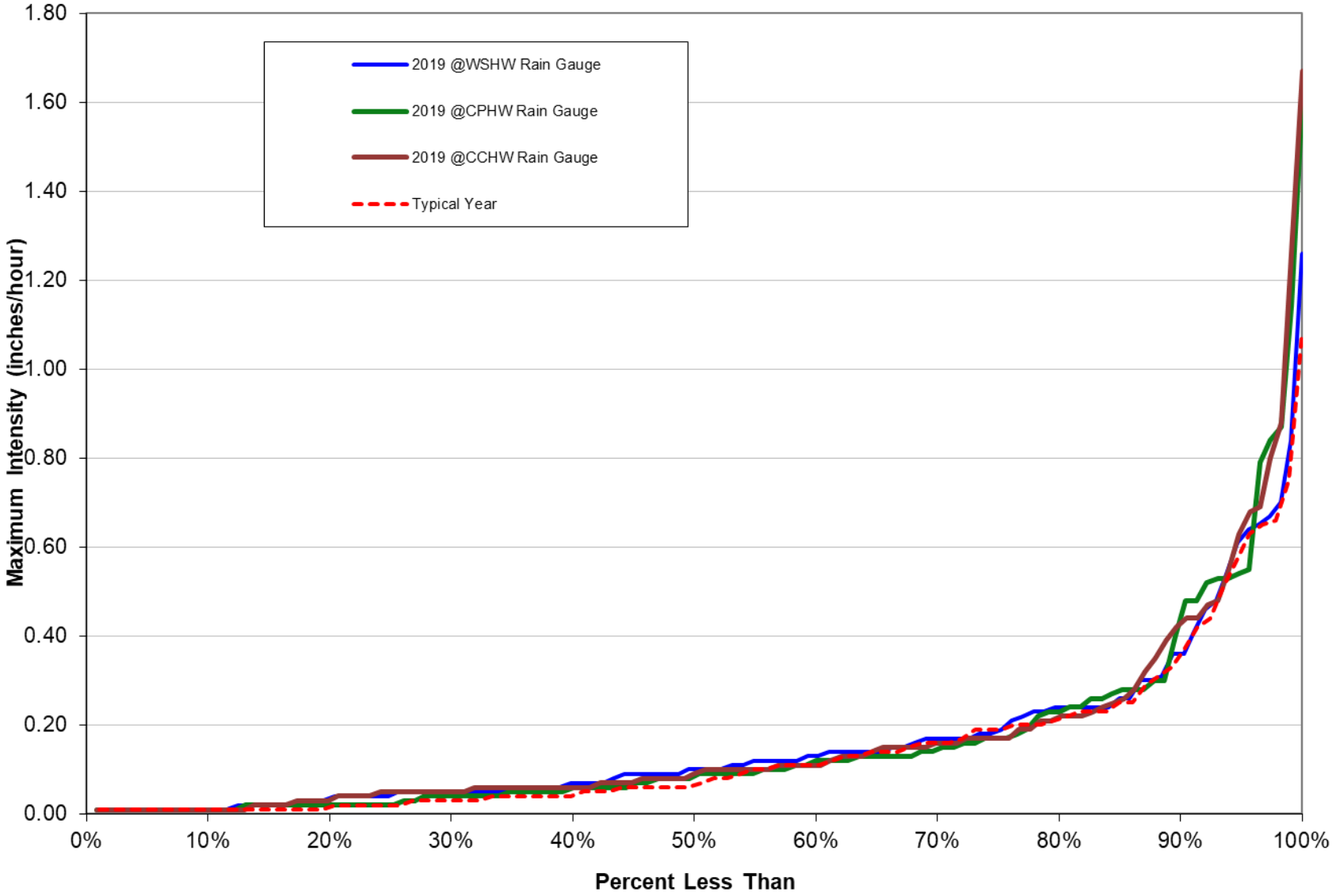

FIGURE R-1. RAINFALL INTENSITY COMPARISON: 2019 VS. TYPICAL YEAR

TABLE 4: TYPICAL YEAR MODEL SIMULATION RESULTS FOR BASELINE 1992 CONDITIONS, CURRENT (2019) CONDITIONS AND LONG-TERM CSO CONTROL PLAN

Outfall	1992 SYSTEM CONDITIONS[1]		2019 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[3]	1.60[3]	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	10	3.59	5	1.61
CAM401B			5	0.73	7	2.15
SOM001A	10	11.93	6	3.60	3	1.67
SOM001	0	0.00	Closed	N/A	Closed	N/A
SOM002	0	0.00	Closed	N/A	N/I[4]	N/I[4]
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**		**9.54**		**7.29**
UPPER MYSTIC RIVER						
SOM007A/MWR205A	9	7.61	6	4.95	3	3.48
SOM006[4]	0	0.00	Closed	N/A	N/I[4]	N/I[4]
SOM007	3	0.06	Closed	N/A	Closed	N/A
TOTAL		**7.67**		**4.95**		**3.48**
MYSTIC/CHELSEA CONFLUENCE						
MWR205 (Somerville Marginal Facility)	33	120.37	39	109.63	39	60.58
BOS013	36	4.40	10	0.74	4	0.54
BOS014	20	4.91	8	1.45	0	0.00
BOS015	76	2.76	Closed	N/A	Closed	N/A
BOS017	49	7.16	6	0.32	1	0.02
CHE002	49	2.51	Closed	N/A	4	0.22
CHE003	39	3.39	0	0	3	0.04
CHE004	44	18.11	7	1.01	3	0.32
CHE008	35	22.35	11	3.81	0	0.00
TOTAL		**185.96**		**116.96**		**61.72**
UPPER INNER HARBOR						
BOS009	34	3.60	10	0.70	5	0.59
BOS010	48	11.83	7	0.77	4	0.72
BOS012	41	7.90	13	1.34	5	0.72
BOS019	107	4.48	1	0.09	2	0.58
BOS050	No Data		Closed	N/A	Closed	N/A
BOS052	0	0.00	Closed	N/A	Closed	N/A
BOS057	33	14.71	2	1.37	1	0.43
BOS058	17	0.29	Closed	N/A	Closed	N/A
BOS060	64	2.90	2	0.17	0	0.00
MWR203 (Prison Point)	28	261.85	17	241.71	17	243.00
TOTAL		**307.56**		**246.15**		**246.04**

TABLE 4: TYPICAL YEAR MODEL SIMULATION RESULTS FOR BASELINE 1992 CONDITIONS, CURRENT (2019) CONDITIONS AND LONG-TERM CSO CONTROL PLAN

Outfall	1992 SYSTEM CONDITIONS[1]		2019 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN[2]	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
LOWER INNER HARBOR						
BOS003	28	18.09	9	6.13	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**		**6.19**		**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	4.15	4	0.97	1	0.01
BOS064	14	0.99	0	0.00	0	0.00
BOS065	11	3.08	3	0.71	1	0.06
BOS068	4	0.62	0	0.00	0	0.00
BOS070	4	281.62				
BOS070/DBC			7	6.21	3	2.19
MWR215 (Union Park)			10	26.66	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**		**34.55**		**73.89**
RESERVED CHANNEL						
BOS076	65	65.94	2	0.22	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**		**0.22**		**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**

TABLE 4: TYPICAL YEAR MODEL SIMULATION RESULTS FOR BASELINE 1992 CONDITIONS, CURRENT (2019) CONDITIONS AND LONG-TERM CSO CONTROL PLAN

Outfall	1992 SYSTEM CONDITIONS[1]		2019 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN[2]	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
UPPER CHARLES						
BOS032	4	3.17	Closed	N/A	Closed	N/A
BOS033	7	0.26	Closed	N/A	Closed	N/A
CAM005	6	41.56	8	0.73	3	0.84
CAM007	1	0.81	1	0.82	1	0.03
CAM009	19	0.19	Closed[5]	N/A	2	0.01
CAM011	1	0.07	Closed[5]	N/A	0	0.00
TOTAL		**46.06**		**1.55**		**0.88**
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	2	3.18	2	1.92	0	0.00
MWR019	2	1.32	2	0.56	0	0.00
MWR020	2	0.64	2	0.32	0	0.00
MWR021	2	0.50	Closed	N/A	Closed	N/A
MWR022	2	0.43	Closed	N/A	Closed	N/A
MWR201 (Cottage Farm)	18	214.10	4	12.36	2	6.30
MWR023	39	114.60	1	0.14	2	0.13
SOM010	18	3.38	Closed	N/A	Closed	N/A
TOTAL		**342.98**		**15.30**		**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	2	5.25	0	0.00	2	5.38
TOTAL		**5.25**		**0.00**		**5.38**
Total Treated		**698**		**390**		**381**
Total Untreated		**759**		**40**		**23**
GRAND TOTAL		**1457**		**430**		**404**

(1) 1992 System Conditions include completion of Deer Island Fast-Track Improvements, upgrades to headworks and new Caruso and DeLauri pumping stations.

(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) Value may change pending ongoing review of model calibration for Outfall MWR003.

(4) N/I: Outfall was closed by MWRA Long-Term Control Plan but is not included in Exhibit B to the Second CSO Stipulation.

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