Supplement to the 2021 Final Combined Sewer Overflow Post Construction Monitoring Program and Performance Assessment Report

December 27, 2024

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1. Background and Update on the Combined Sewer Overflow Program

In December 2021 the Massachusetts Water Resources Authority (MWRA) submitted the results of its assessment of the performance of its Combined Sewer Overflow (CSO) program to the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP) in the *Final CSO Post Construction Monitoring Program and Performance Assessment Report* (Final Assessment Report) https://www.mwra.com/cso/pcmpa-reports/Final12302021.pdf. The report documented that of the 46 CSO outfalls that remain active (i.e. are not physically closed or effectively closed as being associated with the North Dorchester Bay CSO Storage Tunnel), 30 outfalls were meeting the Long Term Control Plan (LTCP) goals as of the end of 2021 (Q4-2021 conditions). Of the remaining 16 outfalls, six were projected to meet the LTCP goals after December 2021, and four had a concept plan in place to bring them into compliance after December 2021. The remaining six outfalls were found to present significant challenges in terms of identifying reasonable and effective alternatives to achieve the LTCP goals, and investigations for those outfalls were to continue.

The purpose of this update is to document the progress made towards meeting the LTCP goals at each of the 16 locations since the submittal of the December 2021 CSO Report. The work at these locations has included field investigations, modeling assessments, and conceptual plan development, and for 10 locations the work has included final design, with construction of the recommended improvements being completed at eight locations and construction underway to provide the recommended improvements at the two remaining locations. The status of each of the outfalls is summarized in Table 1-1 to Table 1-3 below and is presented in more detail in Chapters 2 and 3. Model changes incorporated between 2021 and 2024 are summarized in Appendix A and additional detail is provided in the Annual Reports (CSO Discharge Estimates and Rainfall Analyses) for 2021[1], 2022[2], and 2023[3].

Table 1-1 presents a progress update for the six locations where specific projects were identified in the Final Assessment Report as being in design or otherwise underway to allow those outfalls to meet the LTCP goals after December 2021. Following the submittal of the December 2021 CSO report, construction of those projects was completed with the exception of the new connection at the Somerville Marginal CSO Facility which was delayed due to additional time required to address project constraints. In addition, as described in more detail below, the completion of work associated with outfall BOS003 (dry weather flow [DWF] connection relief and completion of Boston Water and Sewer Commission (BWSC) Sewer Separation Phase 3) did not result in the anticipated reduction in activation frequency and volume at that outfall. However, completion by BWSC of the East Boston Sewer Separation Phase 4 (expected by 2030) is now anticipated to result in no discharges at outfall BOS003 in the Typical Year[4], thereby outperforming its LTCP goals.

Table 1-2 presents a progress update for the four locations where the Final Assessment Report indicated that conceptual plans had been developed to allow those outfalls to meet the LTCP goals. Following the submittal of the Final Assessment Report, MWRA and BWSC worked together to develop designs for the projects at those locations, and those improvements have since been constructed.

[1] AECOM, 2022. CSO Annual Report April 29, 2022: CSO Discharge Estimates and Rainfall Analyses for Calendar Year 2021. Prepared for MWRA. https://www.mwra.com/sites/default/files/2023-11/042922-annualcso.pdf
[2] AECOM, 2023. CSO Annual Report April 28, 2023: CSO Discharge Estimates and Rainfall Analyses for Calendar Year 2022. Prepared for MWRA. https://www.mwra.com/sites/default/files/2023-11/042823-annualcso.pdf
[3] AECOM, 2024. CSO Annual Report April 30, 2024: CSO Discharge Estimates and Rainfall Analyses for Calendar Year 2023. Prepared for MWRA. https://www.mwra.com/sites/default/files/2024-07/043024-annualcso.pdf
[4] **Typical Year Rainfall or Typical Year:** The performance objectives of MWRA's approved Long-Term CSO Control Plan include annual frequency and volume of CSO discharge at each outfall based on "Typical Year" rainfall from 40 years of rainfall records at Logan Airport, 1949-1987 plus 1992. The Typical Year was a specifically constructed rainfall series that was based primarily on a single year (1992) that was close to the 40-year average in total rainfall and distribution of rainfall events of different sizes. The rainfall series was adjusted by adding and subtracting certain storms to make the series closer to the actual averages in annual precipitation, number of storms within different ranges of depth and storm intensities. The development of the Typical Year is described in MWRA's System Master Plan Baseline Assessment, June 15, 1994. The Typical Year consists of 93 storms with a total precipitation of 46.8 inches.

Table 1-3 presents a progress update for the six locations identified in the Final Assessment Report as presenting significant challenges in meeting the LTCP goals. As shown in Table 1-3, outfall CAM401A has been added to the list of locations that present significant challenges. Following the submittal of the Final Assessment Report, differences between meter data at the CAM401A regulator and model predictions of CSO activations and volumes led to further investigations of the CAM401A system. Those investigations included field inspections and the installation of temporary flow meters adjacent to and downstream of the CAM401A regulator. As a result of the information collected, adjustments were made to the model so that it would more closely correlate to the meter data. The adjusted model was then run for the Typical Year and the model predicted an activation frequency of 10 and a volume of 6.29 MG which do not meet the LTCP goals of 5 activations and 1.61 MG.

Table 1-1. Progress Update on the Outfalls Forecast to Attain LTCP Goals After 2021 in the Final Assessment Report

OUTFALL	Typical Year								PROPOSED SYSTEM IMPROVEMENT AS DOCUMENTED IN THE FINAL ASSESSMENT REPORT	SYSTEM IMPROVEMENT PROGRESS TO DATE	CURRENT OR PROJECTED STATUS VS. LTCP GOALS
	Q4-2021[1][2] SYSTEM CONDITIONS MODEL		Q4-2024[1][2] SYSTEM CONDITIONS MODEL		EXPECTED FUTURE CONDITIONS[3]		LONG TERM CONTROL PLAN				
	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)			
MWR205 (Somerville Marginal CSO Facility)	30	99.71	30	100.39	19	65.34[4]	39	60.58	• Construct new connection from the facility influent conduit to the interceptor.	• The construction contract was awarded in September 2024. Substantial completion is anticipated in December 2025. • Project constraints due to the location of the work have extended the start of construction and the duration of construction.	Predicted to materially meet after project under construction is complete.
SOM007A/ MWR205A	5	4.50	5	4.33	3	3.51[4]	3	3.48			Predicted to materially meet after project under construction is complete.
BOS003	9	5.93	9	4.76	0	0.00	4	2.87	• Complete BWSC East Boston Sewer Separation Phase 3; upgrade interceptor connection at regulator RE003-12; Close regulators RE003-2 and RE003-7.	• Regulators RE003-2 and RE003-7 were closed in May 2022. • Regulator RE003-12 interceptor connection size increase from 12 to 24-inch diameter was completed May 2022. • BWSC East Boston Sewer Separation Phase 3 was completed December 2023.	Completion of BWSC East Boston Sewer Separation Phase 3 and the work at the BOS003 regulators reduced the volume at outfall BOS003 but not enough to meet LTCP goals. Additional separation work associated with BWSC East Boston Sewer Separation Phase 4 upstream of regulator RE003-12 is anticipated to allow this outfall to meet the LTCP goals. Phase 4 is anticipated to be completed in 2030.
BOS009	10	0.73	5	0.13	5	0.13	5	0.59	• Complete BWSC East Boston Sewer Separation Phase 3.	• Project completed December 2023.	Meets LTCP goal.
BOS014	8	1.44	0	0.00	0	0.00	0	0.00	• Construct new interceptor connection.	• Project completed January 26, 2022.	Meets LTCP goal.
CHE008	6	1.94	0	0.00	0	0.00	0	0.00	• Replace/upgrade interceptor connection.	• Project completed June 30, 2023.	Meets LTCP goal.

Notes:

(1) Q4-2021 and Q4-2024 System Conditions represent conditions as of the end of 2021 and conditions projected at the end of 2024, respectively.
(2) Grey shading indicates model prediction is greater than LTCP value.
(3) Expected Future Conditions represents conditions following the completion of the projects specified for each outfall in the table that have not been completed by December 2024. For outfalls MWR205A/SOM007A and MWRA205 the Expected Future Conditions include the new connection at Somerville Marginal and for outfalls BOS003, BOS009, BOS014 it includes BWSC East Boston Phase 4 sewer separation.
(4) Model predicted activation and/or volume will have decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to precisely meet activation and/or volume goals at these locations is considered to be immaterial.

Table 1-2. Progress Update on the Locations for which Conceptual Plans to Meet LTCP Goals were Presented in the Final Assessment Report

OUTFALL	Typical Year								PROPOSED SYSTEM IMPROVEMENT AS DOCUMENTED IN THE FINAL ASSESSMENT REPORT	SYSTEM IMPROVEMENT PROGRESS TO DATE	CURRENT OR PROJECTED STATUS VS. LTCP GOALS
	Q4-2021(1)(2) SYSTEM CONDITIONS MODEL		Q4-2024(1) (2) SYSTEM CONDITIONS MODEL		EXPECTED FUTURE CONDITIONS(3)		LONG TERM CONTROL PLAN				
	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)			
BOS017	6	0.34	0	0.00	0	0.00	1	0.02	• Construct modifications to the Sullivan Square siphon structure including adjustable stop logs upstream of each siphon barrel.	Project Completed October 2024.	Meets LTCP goal.
BOS062	5	1.26	0	0.00	0	0.00	0	0.00	• Relieve the interceptor connection	Project Completed July 31, 2024.	Meets LTCP goal.
BOS065	1	0.62	0	0.00	0	0.00	1	0.03	• Raise the weir at the regulator	Project Completed July 11, 2024.	Meets LTCP goal.
BOS070/ DBC	7	6.18	6(4)(5)	1.87(4)	1	0.78	3	2.19	• Complete BWSC South Boston Sewer Separation Contracts 1 and 2 • Add a parallel relief pipe downstream of regulator RE070/7-2.	• BWSC South Boston Sewer Separation Contract 1 completed August 2023. • BWSC South Boston Sewer Separation Contract 2: 23 acres completed by December 2024; separation of the remaining area of 22.8 acres is anticipated to be completed by April 2026. • Parallel Relief Pipe Project. Project was scheduled to be completed in December 2024, however, construction was delayed due to unforeseen field conditions. Anticipated construction completion is January 2025.	Meets LTCP goal for volume. The activation frequency is higher than the goal by three, however, the activations are relatively small-volume (<0.1 MG). Therefore this outfall is considered to materially meet the LTCP goals. Completion of BWSC South Boston Sewer Separation Contract 2 is predicted to further reduce the activation frequency to one activation.

Notes:
(1) Q4-2021 and Q4-2024 System Conditions represent conditions as of the end of 2021 and conditions projected at the end of 2024, respectively.
(2) Grey shading indicates model prediction is greater than LTCP value.
(3) Expected Future Conditions represents conditions following the completion of the projects specified for each outfall in the table that have not been completed by December 2024. For outfall BOS070 the Expected Future Conditions include the full South Boston Contract 2 Sewer Separation project that was partially completed by Q4-2024. The remainder of the project will be completed by April 2026.
(4) Values reflect anticipated completion of parallel relief pipe which has been delayed to January 2025.
(5) Model predicted activation and/or volume will have decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to precisely meet activation and/or volume goals at these locations is considered to be immaterial.

Table 1-3. Progress Update on the Locations Identified as having Significant Challenges Since the Final Assessment Report

OUTFALL	Typical Year								PROPOSED SYSTEM IMPROVEMENT	TENTATIVE/ACTUAL COMPLETION DATE
	Q4-2021(1)(2) SYSTEM CONDITIONS MODEL		Q4-2024(1) (2) SYSTEM CONDITIONS MODEL		EXPECTED FUTURE CONDITIONS(3)		LONG TERM CONTROL PLAN			
	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)		
SOM001A	8	4.47	8	4.54	8	4.54	3	1.67	None currently proposed; outfall will be addressed under Updated CSO Control Plan(5)	N/A
CAM005	8	0.75	7	0.63	5	0.64	3	0.84	Raise and lengthen weir and clean outfall pipe; outfall will also be addressed under Updated CSO Control Plan(5)	TBD
MWR018	2	1.11	2	0.38	2	0.38	0	0.00	None currently proposed; outfall will be addressed under Updated CSO Control Plan(5)	N/A
MWR019	2	0.47	2	0.14	2	0.14	0	0.00	None currently proposed; outfall will be addressed under Updated CSO Control Plan(5)	N/A
MWR020	2	0.46	1(6)	0.02(6)	1(6)	0.02(6)	0	0.00	Due to the reduction in CSO volume and activation frequency at this location this outfall is now considered to be materially meeting the LTCP goals.	N/A
MWR201 (Cottage Farm)	2	9.09	2	6.72(6)	2	6.76(6)	2	6.30	Due to the reduction in CSO volume at this location this outfall is now considered to be materially meeting the LTCP goals.	N/A
CAM401A(4)	5	0.66	10	6.27	10	6.27	5	1.61	None currently proposed; outfall will be addressed under Updated CSO Control Plan(5)	N/A

Notes:

(1) Q4-2021 and Q4-2024 System Conditions represent conditions as of the end of 2021 and conditions projected at the end of 2024, respectively.
(2) Grey shading indicates model prediction is greater than LTCP value.
(3) Expected Future Conditions represents conditions following the completion of the projects specified for each outfall in the table that have not been completed by December 2024.
(4) Outfall CAM401A was added to the list of outfalls presenting significant challenges after submittal of the Final Assessment Report, as a result of recalibration of the model in the CAM401A area (see text above and in Section 3).
(5) Updated CSO Control Plans as required by the August 2024 *Final Determination to Adopt a Water Quality Standards Variance for Combined Sewer Overflow Discharges to Alewife Brook/Upper Mystic River Basin* and *Final Determination to Adopt a Water Quality Standards Variance for Combined Sewer Overflow Discharges to Lower Charles River/Charles Basin*.
(6) Model predicted activation and/or volume will have decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to precisely meet activation and/or volume goals at these locations is considered to be immaterial.

During the course of the project MWRA documented the progress of the 16 locations in the three reports listed in Table 1-4. These reports provide additional detail on the items discussed above and are referenced in the chapters that follow.

Table 1-4. Annual CSO Discharge Reports

Annual Report	Data Collection Period	Submitted
1	January 1, 2021 through December 31, 2021	April 29, 2022
2	January 1, 2022 through December 31, 2022	April 28, 2023
3	January 1, 2023 through December 31, 2023	April 30, 2024

2. CSO Outfalls Predicted to Attain LTCP Goals by December 2024

2.1 East Boston Outfalls (Upper/Lower Inner Harbor, Mystic/Chelsea Confluence) BOS003/ BOS009/ BOS014

As originally described in Section 4.1.1 of the Final Assessment Report and as updated in Table 1-1 above, outfalls BOS003, BOS009 and BOS014 were not meeting the LTCP goals as of Q4-2021. However, the following projects were identified to bring these outfalls into compliance after 2021:

- BWSC East Boston Sewer Separation Phase 3: this project separated the combined areas tributary to outfalls BOS012 and BOS009, and a portion of the combined area tributary to outfall BOS003. The construction contract was awarded in late spring of 2021 and was completed in December 2023.
- Improvement to the configuration of the restricted interceptor connection at regulator RE003-12: this project involved replacing the existing 12-inch DWF connection and restricted nozzle between regulator RE003-12 and the East Boston Branch Sewer with a 24-inch pipe and removing a manhole. This work was completed in May 2022.
- Closure of regulators RE003-2 and RE003-7 (which previously could overflow to outfall BOS003). This work was completed in May 2022 and August 2022, respectively.
- Construction of a new dry weather flow connection for flow tributary to regulator RE014-2: this project involved constructing a new 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. This work was completed on January 26, 2022.

A more detailed description of these improvements as well as previous work in East Boston is provided in Semiannual Report No. 6. Note that in Section 4.1.1 of the Final Assessment Report and in Semiannual Report No. 6 regulators RE003-2 and RE003-7 were described as remaining open as high outlets to provide relief during large storm events. However, the final design for the work associated with regulators RE003-2 and RE003-7 called for closure of the regulator structures without the high outlet relief points.

Figure 2-1 presents a figure of the areas where BWSC has completed sewer separation as part of East Boston sewer separation Phases 1, 2 and 3 and the area planned to be separated as part of the Phase 4 sewer separation project. The Q4-2024 system conditions model was updated to reflect the projects described above. The completion of BWSC's three sewer separation phases in East Boston and modifications to regulators RE003-2, RE003-7, RE003-12, and RE0014-2 significantly reduced CSO activations and volumes at the CSO outfalls within the sewer separation project areas. As indicated in Table 2-1, under Q4-2024 system conditions, the East Boston outfalls are predicted to meet LTCP levels of control for activation frequency and volume with the exception of outfall BOS003.

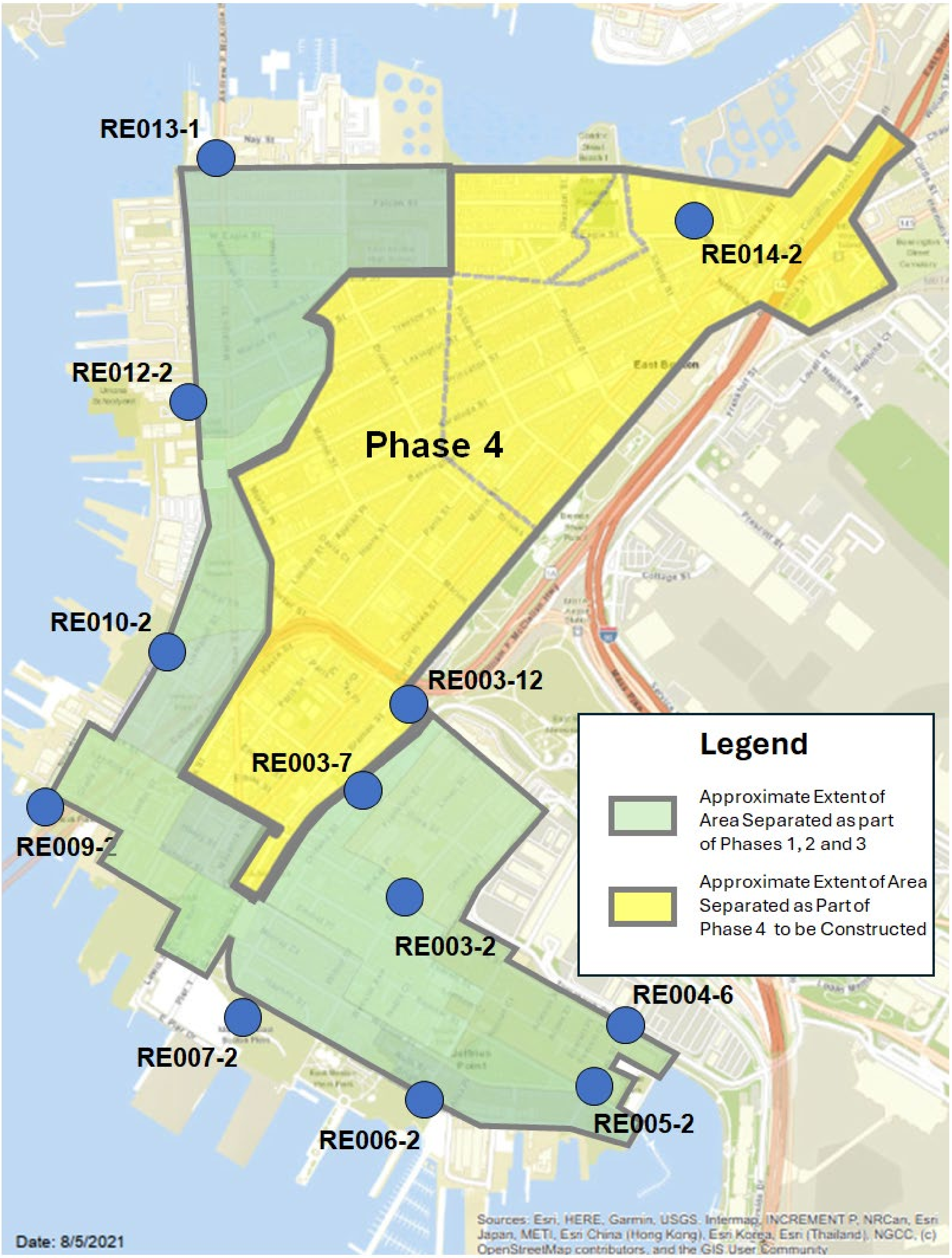

Figure 2-1. East Boston Sewer Separation

Table 2-1. East Boston Q4-2021, Q4-2024, and Expected Future Conditions Compared to the LTCP Goals

<table>
<tr><th rowspan="3">Outfall</th><th rowspan="3">Regulator</th><th colspan="8">Typical Year</th></tr>
<tr><th colspan="2">Q4-2021 System Conditions(1)(2)</th><th colspan="2">Q4-2024 System Conditions(1)(2)</th><th colspan="2">Expected Future Conditions (Q4-2024 with BWSC Sewer Separation Phase 4 Completed)</th><th colspan="2">Long Term Control Plan</th></tr>
<tr><th>Activation Frequency</th><th>Volume (MG)</th><th>Activation Frequency</th><th>Volume (MG)</th><th>Activation Frequency</th><th>Volume (MG)</th><th>Activation Frequency</th><th>Volume (MG)</th></tr>
<tr><td>BOS013</td><td>RE013-1</td><td>8</td><td>0.27</td><td>4</td><td>0.11</td><td>4</td><td>0.11</td><td>4</td><td>0.54</td></tr>
<tr><td>BOS014</td><td>RE014-2</td><td>8</td><td>1.44</td><td>0</td><td>0.00</td><td>0</td><td>0.00</td><td>0</td><td>0</td></tr>
<tr><td>BOS009</td><td>RE009-2</td><td>10</td><td>0.73</td><td>5</td><td>0.13</td><td>5</td><td>0.13</td><td>5</td><td>0.59</td></tr>
<tr><td>BOS010</td><td>RE010-2</td><td>1</td><td>0.07</td><td>1</td><td>0.08</td><td>1</td><td>0.06</td><td>4</td><td>0.72</td></tr>
<tr><td>BOS012</td><td>RE012-2</td><td>0</td><td>0.00</td><td>0</td><td>0.00</td><td>0</td><td>0.00</td><td>5</td><td>0.72</td></tr>
<tr><td rowspan="3">BOS003</td><td>RE003-2</td><td>1</td><td>0.01</td><td rowspan="3">9</td><td>CLOSED</td><td rowspan="3">0</td><td>CLOSED</td><td rowspan="3">4</td><td rowspan="3">2.87</td></tr>
<tr><td>RE003-7</td><td>8</td><td>1.65</td><td>CLOSED</td><td>CLOSED</td></tr>
<tr><td>RE003-12</td><td>9</td><td>4.27</td><td>4.76</td><td>0.00</td></tr>
<tr><td>BOS004</td><td>RE004-6</td><td>0</td><td>0.00</td><td>0</td><td>0.00</td><td>0</td><td>0.00</td><td>5</td><td>1.84</td></tr>
<tr><td>BOS005</td><td>RE005-1</td><td>0</td><td>0.00</td><td>CLOSED</td><td>CLOSED</td><td>CLOSED</td><td>CLOSED</td><td>1</td><td>0.01</td></tr>
<tr><td colspan="2">Total (3)</td><td>10 (max)</td><td>8.44</td><td>8 (max)</td><td>5.08</td><td>5 (max)</td><td>0.30</td><td>5 (max)</td><td>7.29</td></tr>
</table>

Notes:

(1) Q4-2021 and Q4-2024 System Conditions represent conditions as of the end of 2021 and conditions projected at the end of 2024, respectively.
(2) Grey shading indicates model prediction is greater than LTCP value.
(3) Activation frequency shown is the maximum among East Boston regulators. Volume is the total summed volume.

Upon completion of BWSC East Boston Sewer Separation Phase 3 and the regulator modifications, meter data appeared to show that regulator RE003-12, which is the only remaining regulator tributary to outfall BOS003, was not performing as expected. The model had originally been calibrated for the 2018 to 2019 period and the meter and model correlated well as documented in the January 8, 2021 *Task 4.2: Model Calibration Technical Memorandum*. Since then, the model network was updated to include construction projects as they were completed. Following completion of the regulator modifications associated with regulators RE003-2, RE003-7 and RE003-12, differences began to be noted between the activation frequency and volume assessed from the meter data at regulator RE003-12 and the model-predicted activation frequency and volume.

In order to investigate the performance of regulator RE003-12, meter data for the period of January 1, 2024 through August 1, 2024 was collected. Available meter data included flow rate, depth and velocity data for the three influent lines and the overflow at regulator RE003-12, and depth data from a “smart” manhole cover where the DWF connection from regulator RE003-12 ties into the East Boston Branch Sewer. The comparison of the meter data and the model showed that the flow into the regulator structure as well as the headlosses through the DWF connection were under-predicted by the model. The model had been updated to reflect the concept design for the improved DWF connection. The record drawings, however, showed that a slightly different configuration had been constructed by BWSC, which may be contributing to the headloss through the connection being higher than expected. The dry weather HGL in the interceptor was also under-predicted by the model, which could be indicative of sediment in the interceptor downstream of the smart manhole cover. Increasing the flow to the regulator structure, increasing the headlosses through the DWF connection, and adding sediment in the East Boston Branch Sewer allowed the model to more closely correlate to the meter data in regulator RE003-12 and the depth data from the smart manhole cover. The updated model predicted 9 activations and 4.76 MG at regulator

RE003-12 for the Typical Year, not meeting the LTCP goal for outfall BOS003 of 4 activations and 2.87 MG.

BWSC is continuing sewer separation and system improvements within East Boston including East Boston Sewer Separation Phase 4 as shown in Figure 2-1 above. Construction of the first contract of sewer separation associated with Phase 4 is scheduled to begin in Spring of 2025, with completion of the full scope of Phase 4 projected to be in 2030. With the full Phase 4 sewer separation work incorporated into the model, no activations are predicted for outfall BOS003 in the Typical Year.

2.2 Outfall CHE008 (Mystic/Chelsea Confluence)

Table 1-1 above indicates that as of Q4-2021, outfall CHE008 was predicted to activate 6 times and discharge 1.94 MG in the Typical Year, which did not meet the LTCP goal of zero activations. As described in Section 4.1.2 of the Final Assessment Report, recommended modifications to the DWF connection at regulator RE-081 were predicted to reduce the activation frequency and volume to one activation with a discharge volume of 0.07 MG in the Typical Year.

The following modifications were recommended:

- Replace the existing 30-inch connection between regulator RE-081 and Structure C with a 48-inch connection along the same route;
- Provide an orifice plate at the downstream end of the 48-inch connection, with a 36-inch diameter orifice set with the invert of the orifice at the downstream invert of the 48-inch connection;
- Eliminate the existing interior weir within Structure C; and
- Lower the weir in MH22 on the Chelsea Branch Sewer from elevation 106’ to elevation 105’.

After the Final Assessment Report was submitted, final design on the recommended modifications was completed, and the construction contract was awarded in December 2022. Construction began in April 2023 and was completed on June 30, 2023. The construction project was as described in the bullets above with the exception that a plate was constructed across the 48-inch connection to create the equivalent of a 36-inch diameter orifice. The MWRA model was updated with the modifications and now predicts no activations in the Typical Year as shown in Table 1-1 above.

2.3 Somerville-Marginal CSO Facility Discharges (Upper Mystic River, Mystic/Chelsea Confluence) (MWR205 & MWR205A/SOM007A)

As originally described in Section 4.1.3 of the Final Assessment Report and updated in Table 1-1, under Q4-2021 conditions, the Somerville-Marginal CSO Facility activation frequency was consistent with the LTCP level of control, but the treated discharge volume (99.71 MG) was higher than the LTCP target (60.58 MG). Under Q4-2024 conditions the volume increased slightly to 100.39 MG. MWRA conducted evaluations of a range of projects to reduce overflows to the Somerville-Marginal CSO Facility and discharges from outfalls MWR205 and MWR205A/SOM007A. Based on these evaluations a project was identified which included constructing a gated connection between an existing 42-inch storm drain that ties into the 85 x 90-inch influent combined sewer to the Somerville Marginal Facility and the 42-inch Somerville-Medford Branch Sewer. With these modifications the model predicted that the activation frequency at the Somerville-Marginal CSO Facility would be reduced by over 35 percent, significantly better than the LTCP target. The treated discharge volume at outfall MWR205 is predicted to be 65.34 MG in the Typical Year compared to the LTCP goal of 60.58 MG, and the treated discharge combined with stormwater coming in downstream of the facility at outfall SOM007A/ MWR205A is predicted to be 3.51 MG compared to the goal of 3.48 MG. The differences in treated volume between the predicted performance of this project and the LTCP goals for outfalls MWR205 and MWR205A/SOM007A are considered to be immaterial, and the outfalls after construction completion will be considered to materially meet the LTCP goals.

Construction of the gated connection was predicted to result in an increase in treated discharge volume at the Prison Point CSO Facility, but the net treated CSO volume between the Somerville-Marginal and Prison

Point CSO Facilities would still decrease by 24 MG (Table 2-2). The gated connection was not predicted to affect other outfalls in the MWRA system in the Typical Year.

Table 2-2. Somerville-Marginal and Prison Point CSO Facilities Comparison of Q4-2021, Q4-2024, and Expected Future Conditions

Outfall	Typical Year							
	Q4-2021 Conditions(1)(2)		Q4-2024 Conditions(1)(2)		Expected Future Conditions (Q4-2024 with a New Connection at Somerville Marginal)		Long Term Control Plan	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
SOM007A/MWR205A	5	4.50	5	4.33	3	3.51(3)	3	3.48
MWR205 (Somerville Marginal Facility)	30	99.71	30	100.39	19	65.34(3)	39	60.58
MWR203 (Prison Point)	17	248.33(3)	17	248.00(3)	17	260.26(3)	17	243.00
Total of Above Outfalls		**353**		**353**		**329**		**307**
Net Change From Q4-2021 Conditions				**0**		**-24**		

Notes:

(1) Q4-2021 and Q4-2024 System Conditions represent conditions as of the end of 2021 and conditions projected at the end of 2024, respectively.

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

(3) Model predicted activation and volume will have decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to precisely meet activation and/or volume goals at these locations is considered to be immaterial.

MWRA completed the design for the new connection and has a contractor under agreement to construct these modifications. Project constraints due to the location of the work have delayed the construction completion date. The construction contract was awarded in September 2024, and substantial completion is anticipated in December 2025.

2.4 Outfall BOS017 (Mystic/Chelsea Confluence)

Table 1-2 above indicates that outfall BOS017 was not predicted to meet the LTCP goal of one activation and 0.02 MG of CSO discharge in the Typical Year under Q4-2021 conditions. As originally described in Section 4.2.1.1 of the Final Assessment Report the following modifications were recommended to the Sullivan Square siphon chamber upstream of regulator RE017-3 to allow BOS017 to meet the LTCP goals:

- Remove existing weir walls upstream of siphon and reconstruct to remove existing restrictions.
- Construct weirs with stop logs so they are adjustable for larger storm events.
- Set weir no. 1 elevation to 109.27’ and weir no. 2 to 113.45’. These settings allow no flow through the siphons during the Typical Year but would allow one siphon to be used as a relief during storms larger than the Typical Year and the other to be used as a relief during storms larger than the 5-year, 24-hour storm.

Following the submittal of the Final Assessment Report, BWSC completed the final design of these recommendations. The construction contract was awarded in December 2023 and the contractor mobilized on April 1, 2024. Construction was completed in October 2024, consistent with the description in the bullets above. The model was updated to reflect these modifications and predicts that BOS017 will have zero activations in the Typical Year.

2.5 Outfall BOS070 (Fort Point Channel)

As originally described in Section 4.2.1.2 of the Final Performance Assessment and updated in Table 1-2 above, outfall BOS070 was not predicted to meet the LTCP goals as of Q3Q4-2020 system conditions. The outfall had an activation frequency of 7 and discharge volume of 6.10 MG predicted in the Typical Year compared to the LTCP goal of 3 activations and 2.19 MG. A total of nine regulators discharge to the BOS070 outfall. As shown in Table 4-5 of the Final Assessment Report, with the construction of BWSC South Boston Sewer Separation Contracts 1 and 2, outfall BOS070 was predicted to meet the LTCP goal for activation frequency, however, the discharge volume was still predicted to be higher than the LTCP goal. The largest contributor to volume at this outfall was regulator RE070/7-2 which by itself would still have a higher discharge volume than the total discharge volume goal for outfall BOS070. MWRA identified a project that, if implemented in conjunction with BWSC South Boston Sewer Separation Contracts 1 and 2, was predicted to reduce the discharge volume at regulator RE070/7-2 by 2.14 MG in the Typical Year allowing BOS070 to meet the LTCP goals. The project included constructing a new 60-inch diameter relief pipe parallel to the Boston Main Interceptor (BMI) downstream of regulator RE070/7-2. The proposed relief pipe would extend approximately 540 linear feet along Massachusetts Avenue between the regulator RE070/7-2 connection to the BMI and Enterprise Street.

BWSC South Boston Sewer Separation Contract 1 was completed in September 2023. Construction of the new 60-inch parallel pipe was projected to be completed in December of 2024, but construction was delayed due to unforeseen field conditions and the anticipated construction completion date is now January 2025. Construction of BWSC South Boston Sewer Separation Contract 2 is in progress. This contract was originally scheduled to be completed by the end of 2024, however, given the significant disruption to the community, Contract 2 is currently anticipated to be completed by April 2026.

The Q4-2024 system conditions model was updated to include the new relief pipe, BWSC South Boston Sewer Separation Contract 1, and the portion of Contract 2 (23 acres of sewer separation) that is projected to be constructed by December 2024. Table 2-3 summarizes the performance of the BOS070 regulators for Q4-2021 conditions, Q4-2024 conditions (with the relief pipe, all of BWSC South Boston Sewer Separation Contract 1, and 23 acres of Contract 2), and Expected Future Conditions with completion of BWSC South Boston Sewer Separation Contract 2. As indicated in Table 2-3, under Q4-2024 conditions the volume goal for outfall BOS070 is predicted to be met, but the activation frequency goal is not predicted to be met. However, it should be noted that of the six remaining activations predicted at regulator RE070/8-3 in the Typical Year, three are predicted to have volumes less than 0.10 MG. Contract 2 is anticipated to be completed in April 2026 at which time the activation frequency at regulator RE070/8-3 is predicted to be reduced from 6 activations to 2 activations in the Typical Year allowing BOS070 to meet the LTCP goals for both activation frequency and volume.

Table 2-3. Outfall BOS070 Comparison of Q4-2021, Q4-2024 System Conditions, and Expected Future Conditions for the Typical Year

Outfall	Regulator	Typical Year							
		Q4-2021 Conditions(1)(2)		Q4-2024 Conditions(1)(2)		Expected Future Conditions (Q4-2024 with BWSC South Boston Sewer Separation Contract 2 Completed)		Long Term CSO Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
BOS070/ DBC	RE070/8-3	7	1.31	6	0.73	1	0.02	3	2.19
	RE070/8-6	0	0.00	0	0.00	0	0.00		
	RE070/8-7	2	0.05	0	0.00	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		

Table 2-3. Outfall BOS070 Comparison of Q4-2021, Q4-2024 System Conditions, and Expected Future Conditions for the Typical Year

Outfall	Regulator	Typical Year							
		Q4-2021 Conditions(1)(2)		Q4-2024 Conditions(1)(2)		Expected Future Conditions (Q4-2024 with BWSC South Boston Sewer Separation Contract 2 Completed)		Long Term CSO Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
	RE070/8-15	0	0.00	0	0.00	0	0.00		
	RE070/9-4	6	1.94	2	0.33	1	0.06		
	RE070/10-5	1	0.04	1	0.04	0	0.00		
	RE070/7-2	2	2.84	1	0.77	1	0.70		
SUM BOS070/DBC		**7 (max)**	**6.18**	**6 (max)(3)**	**1.87**	**1 (max)**	**0.78**	**3 (max)**	**2.19**

Notes:

(1) Q4-2021 and Q4-2024 System Conditions represent conditions as of the end of 2021 and conditions projected at the end of 2024, respectively.

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

(3) Model predicted activation and volume will have decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to precisely meet activation and/or volume goals at these locations is considered to be immaterial.

2.6 Outfalls BOS062 and BOS065 (Fort Point Channel)

As originally described in Section 4.2.1.3 of the Final Assessment Report and updated in Table 1-2 above, outfalls BOS062 and BOS065 were not predicted to meet the LTCP goals as of Q4-2021 system conditions. MWRA, in coordination with BWSC, had identified modifications to regulators RE062-4 and RE065-2 which would allow outfalls BOS062 and BOS065 to meet LTCP goals. The evaluations identified an alternative which included the following components:

- Construct a second interceptor connection at regulator RE062-4
- Raise 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 from El. 102.83’ to El.105.60’

Adding a second interceptor connection at regulator RE062-4 was predicted to bring CSO discharges at outfall BOS062 into attainment with the LTCP goals and result in no activations in the Typical Year. The increased flow to the New East Side Interceptor (NESI) resulting from the modification at regulator RE062-4 required that the weir at regulator RE064-5 be raised as described above. The regulators in this area are hydraulically interconnected and with these two changes the model predicted that by allowing more flow to enter the NESI at regulator RE062-4, a very small-volume activation was predicted to reappear at regulator RE064-5 even with raising that weir as described above. While this one activation would theoretically put outfall BOS064 slightly over the LTCP goal, the one predicted small-volume activation is still considered to be immaterial. With the completion of the BWSC South Boston Sewer Separation Contract 2 anticipated in April 2026, outfall BOS064 is predicted to have zero activations in the Typical Year. The project was constructed as described in the bullets above with the exception that during design it was decided to increase the size of the existing DWF connection from 24 inches to 36 inches instead of constructing a second connection. In addition, at RE065-2 the weir elevation was increased by 2.84 feet resulting in a weir elevation of 105.64.

Following submittal of the Final Assessment Report, final design of these modifications was completed and the construction contract was awarded in December 2023. The contractor mobilized on April 1, 2024, and the projects were completed as follows:

- Regulator RE62-4 (SMH A Seaport Boulevard/Atlantic Avenue) work completed on July 31, 2024
- Regulator RE64-5 (SMH B - East Street/South Street) work completed on July 8, 2024
- Regulator RE65-2 (SMH C Kneeland Street/ Atlantic Avenue) work completed on July 11, 2024

Table 2-4 presents a comparison of the Typical Year model results for the Q4-2021 System Conditions, the Q4-2024 System Conditions which include the recommended improvements as constructed, Expected Future Conditions and the LTCP goals.

Table 2-4. Outfalls BOS062, BOS064, and BOS065 Comparison of Q4-2021, Q4-2024 System Conditions, and Expected Future Conditions for the Typical Year

Outfall	Regulator	Typical Year							
		Q4-2021 System Conditions(1)(2)		Q4-2024 System Conditions(1)(2)		Expected Future Conditions (Q4-2024 with Completion of BWSC South Boston Sewer Separation Contract 2)		Long-Term Control Plan	
		Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
BOS062	RE062-4	5	1.26	0	0.00	0	0.00	1	0.01
BOS064	RE064-4	0	0.00	1(3)	0.01(3)	0	0.00	0	0.00
	RE064-5	0	0.00	0	0.00	0	0.00		
BOS065	RE065-2	1	0.62	0	0.00	0	0.00	1	0.06
BOS068	RE068-1A	0	0.00	0	0.00	0	0.00	0	0.00

Notes:

(1) Q4-2021 and Q4-2024 System Conditions represent conditions as of the end of 2021 and conditions projected at the end of 2024, respectively.

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

(3) Model predicted activation and volume will have decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to precisely meet activation and/or volume goals at these locations is considered to be immaterial.

3. Outfalls Presenting Significant Challenges

Table 1-3 above summarized the six locations identified in the Final Assessment Report as presenting significant challenges in meeting the LTCP goals. As noted in Section 1 above, outfall CAM401A has been added to the list of locations that present significant challenges. Differences between meter data at the CAM401A regulator and model predictions of CSO activations and volumes led to a recalibration of the model in the area associated with outfall CAM401A. As a result, outfall CAM401A is no longer predicted to meet the LTCP goals of 5 activations and 1.61 MG. As also indicated in Table 1-3 above system improvements implemented after 2021 resulted in lower volume and/or activation frequency at outfalls MWR201 (Cottage Farm) and MWR020 and those outfalls are now considered to materially meet the LTCP goals. Evaluations of alternatives to meet the LTCP goals at these outfalls had been conducted based on the Q4-2023 conditions prior to the implementation of the system improvements. This chapter presents the further investigations of alternatives that have been conducted for the six outfalls originally identified as presenting significant challenges. With CAM401A no longer meeting LTCP goals, an alternative for this outfall that would allow it to meet its LTCP goals is also presented in this chapter.

3.1 Outfall SOM001A

Six CSO outfalls (CAM001, CAM002, MWR003, SOM001A, CAM401A, and CAM401B) discharge to Alewife Brook. The dry weather flow outlets from the regulators associated with these CSO outfalls connect to either the Alewife Brook Branch Sewer (ABBS) or the Alewife Brook Conduit (ABC). Dry weather flow is carried by the ABBS and ABC to the Alewife Brook Pump Station. When the hydraulic grade line (HGL) is higher than the elevation of the overflow points in the regulators connected to the ABBS and ABC, excess flow discharges to Alewife Brook.

Regulator RE-01A is located under the Alewife Brook Parkway at Murray Hill Road, and discharges to outfall SOM001A. The influent to regulator RE-01A is a twin 4.5-foot diameter circular conduit (the Tannery Brook Drain). Dry weather flow passes through a 32x32-inch orifice in the invert of the regulator structure into the ABC. During wet weather, when the depth of flow in the regulator is higher than the weir crest at elevation 110.12 ft., overflow occurs to Alewife Brook. A schematic of the Alewife Brook System is shown in Figure 3-1.

The LTCP goals for outfall SOM001A are three activations and 1.67 MG in the Typical Year. As indicated in Table 1-3 above, at the time of submittal of the Final Assessment Report (Q4-2021 conditions), outfall SOM001A was predicted to activate eight times in the Typical Year, with a total volume of 4.47 MG. That level of performance was predicted to be essentially the same for Q4-2024 conditions. Evaluations of alternatives for outfall SOM001A were conducted in 2023, on a baseline of Q1-2023 system conditions, which resulted in essentially the same predicted performance as the Q4-2021 and Q4-2024 conditions. Thus, the sizing of alternatives for outfall SOM001A would not be different for Q4-2024 conditions.

As indicated in the Final Assessment Report, a number of alternatives to reduce the activation frequency and volume at outfall SOM001A were evaluated both independently and in combination with one another. After evaluating many different variations of alternatives, 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 by 3 inches;
- Increasing the size of the orifice connection to the ABC from 32x32-inch to 56x32-inch; and
- Relining the ABC and ABBS from approximately the location of SOM001A to the Alewife Brook Pump Station to slightly increase the conveyance capacity.

The capital cost of this alternative was estimated to be $16.4 million.

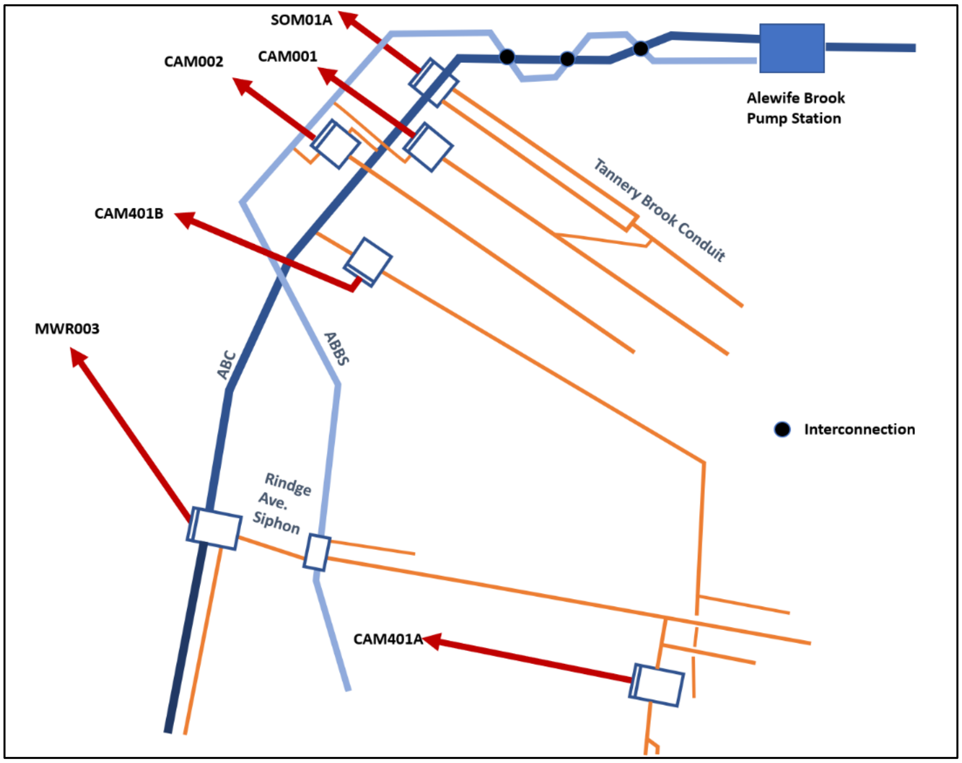

Figure 3-1. Schematic of Alewife Brook System

The model predicted that in the Typical Year this alternative would reduce the CSO activation frequency and CSO discharge volume at outfall SOM001A to 3 activations and 1.23 MG, meeting the LTCP goal of 3 activations and 1.67 MG. However, this alternative was predicted to increase the discharge volume at other Alewife regulators, and in particular the volume at outfall MWR003 was predicted to increase above the LTCP goal. However, this alternative was predicted to cause adverse impacts to the HGL during the Typical Year and during larger storms such as the 5-year, 24-hour storm. In the Typical Year, the peak HGL was predicted to increase by 1 foot compared to baseline conditions, to within 1.2 feet of the ground at a critical location just downstream of the SOM001A regulator along the ABC. For the 5-year, 24-hour design storm the alternative was predicted to increase the peak HGL at that location by 0.75 feet, exceeding the ground surface. Several additional model runs were conducted with modifications to operations at outfall MWR003 as well as making small reductions to the size of the dry weather flow connection to attempt to mitigate the HGL impacts, but the adverse impacts remained.

MWRA continued to investigate methods to reduce and/or attenuate the stormwater tributary to outfall SOM001A and mitigate the adverse impacts noted for the alternative described above in the Typical Year and the 5-year, 24-hour storm. Storage was also evaluated as an alternative means to meet the LTCP goals. The alternatives described below include the following:

- Stormwater removal from the Tannery Brook Drain;
- Green infrastructure;
- Box conduit storage; and
- Microtunneled storage

The evaluation of these alternatives is presented below.

Stormwater Removal from the Tannery Brook Drain

Significant portions of the area tributary to the SOM001A regulator through the Tannery Brook drain are comprised of separate stormwater areas that discharge to the combined sewer system tributary to the Tannery Brook drain. Removal of the separate stormwater areas was evaluated to assess the impact on the activation frequency and discharge volume at outfall SOM001A. Stormwater removal was analyzed both as an independent alternative and in combination with the regulator modifications as described in the previous section. It was assumed that 100% of the stormwater tributary to the existing storm drains would be removed by physically disconnecting the existing storm drains from the combined sewer system.

Figure 3-2 shows the areas currently served by separate storm drains that were evaluated for removal. The total area served by the separate storm drains shown in Figure 3-2 is 115 acres. The model predicted that removal of the 115 acres from the combined sewer system would result in 6 activations and 2.54 MG at outfall SOM001A, which would still not meet the LTCP goals. With 115 acres of stormwater removal, raising the weir in the SOM001A regulator 3-inches, and enlarging the DWF connection to the ABC from 32x32-inch to 56x32-inch, outfall SOM001A was predicted to meet the LTCP goals with 3 activations and 0.77 MG, and outfall MWR003 was still predicted to meet its LTCP goals (Table 3-1). However, the 115 acres of stormwater removal did not fully mitigate the adverse HGL impacts of the regulator modifications. In the Typical Year, the peak HGL was predicted to increase by 0.65 feet compared to baseline conditions, to within 1.5 feet of the ground at a critical location just downstream of the SOM001A regulator along the ABC. For the 5-year, 24-hour design storm the alternative was predicted to increase the peak HGL at that location by 0.5 feet, to within 0.2 feet of the ground.

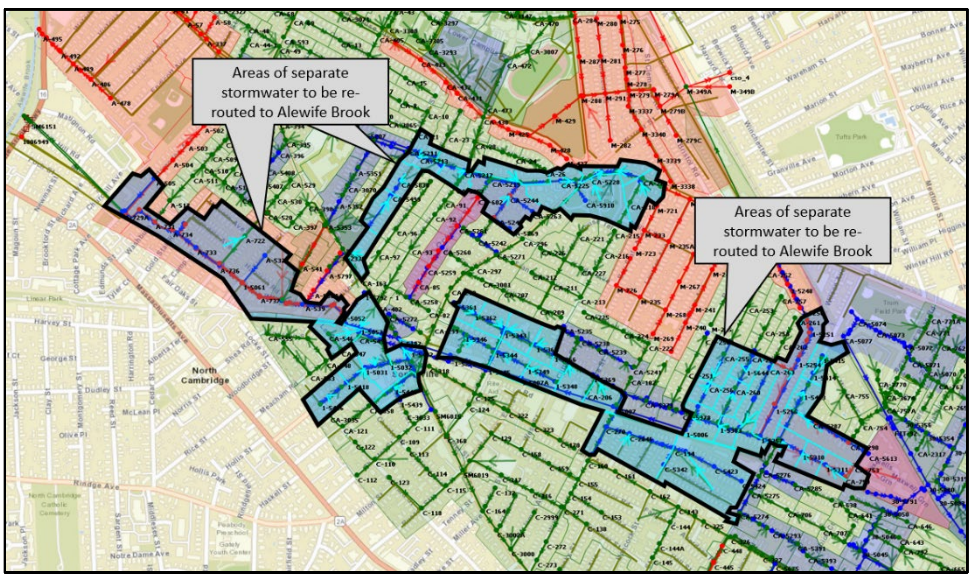

Figure 3-2. Separate Stormwater Area Tributary to the SOM001A Regulator

Table 3-1. SOM001A Typical Year Results - Q1-2023 System Conditions & Alternatives

Outfall	Typical Year									
	Q1-2023 System Conditions		Regulator Modifications and Relining ABC/ABBS(1) (2)(3)		115 acres SW Removal(1)		Regulator Modifications and 115 acres SW Removal(1)		LTCP	
	Act Freq	Vol (MG)	Act Freq	Vol (MG)	Act Freq	Vol (MG)	Act Freq	Vol (MG)	Act Freq	Vol (MG)
CAM001	1	0.02	2	0.05	1	0.01	2	0.03	5	0.19
CAM002	0	0.00	0	0.00	0	0.00	0	0.00	4	0.69
MWR003	3	0.61	3	1.09	3	0.47	3	0.92	5	0.98
CAM401A(4)	5	0.66	5	0.70	5	0.64	5	0.70	5	1.61
CAM401B	4	0.50	4	0.68	3	0.42	4	0.61	7	2.15
SOM001A	8	4.47	3	1.23	6	2.54	3	0.77	3	1.67
Total	8	6.26	5	3.75	6	4.08	5	3.03	7	7.29

Notes:

(1) Grey shading indicates model prediction is greater than LTCP value.
(2) Model results indicate adverse hydraulic grade line impacts during the 5-year design storm, and MWR003 volume increased to be out of compliance with LTCP goals.
(3) Results reflect a previous version of the MWRA's model (Q3Q4-2020).
(4) Performance of outfall CAM401A does not reflect 2024 recalibration. See Section 17.5 for further discussion of outfall CAM401A.

In addition, the feasibility of removing 115 acres of stormwater from the combined sewer system and routing it to Alewife Brook is uncertain. Utility conflicts are likely, and limited corridors exist to route the new stormwater piping. Additionally, rerouting the stormwater directly to Alewife Brook could potentially increase the peak flow to the brook, resulting in the need for flow attenuation.

Although stormwater removal would reduce the volume of CSO being discharged to the Alewife Brook, it would contribute additional stormwater volume to the brook. The alternative was projected to result in a net increase in both the bacteria and phosphorus loadings to Alewife Brook if no treatment were to be provided for the new stormwater discharge. The water quality impacts of the changes in loadings were not evaluated.

Table 3-2 presents the loading calculations for this alternative compared to the Baseline Conditions assuming no treatment of the additional stormwater discharged. As indicated in Table 3-2, the stormwater removal is predicted to reduce total CSO discharge to Alewife Brook by 3.23 MG/yr, and increase the volume of stormwater to Alewife Brook by 31.78 MG/yr. Values for *E. coli* and *Enterococcus* bacteria concentrations in the untreated SOM001A discharge were taken from Table 4-2 from the August 27, 2021 *Task 5.3 Water Quality Assessment Report.* Values for *E. coli* and *Enterococcus* bacteria concentrations in untreated stormwater were taken from the *December 15, 2020 Task 5.2 Receiving Water Quality Model Development and Calibration Report.* As described in both reports, these values were based on sampling data and calibration of the water quality model to in-receiving water concentrations.

Table 3-2 also presents the predicted net change in phosphorus loading to the brook assuming no treatment of the additional stormwater. The phosphorus concentration used for CSO was 1.77 mg/L, based on Cottage Farm sampling data. The phosphorus concentration used for stormwater was 0.20 mg/L, taken from the *Cambridge Department of Public Works Report: Partial Sewer Separation Report Model Calibration Report*, prepared by Stantec, dated March 11, 2022.

Table 3-2. Outfall SOM001A Regulator Modifications and Stormwater Removal Alternative: Net Bacteria and Phosphorus Loading Assuming no Treatment of Additional Stormwater Discharged

	Typical Year Volume Change (MG)	*E. coli* Concentration (MPN/100 mL)	Typical Year Change in *E. coli* Loading (Counts x 10^{10})	*Enterococcus* Concentration (MPN/100 mL)	Typical Year Change in *Enterococcus* Loading (Counts x 10^{10})	Phosphorus Concentration (mg/L)	Typical Year Change in Phosphorus Loading (lbs)
CSO	**-3.23**	**69,206(1)**	**-846**	**28,758(1)**	**-352**	**1.77(3)**	**-47.7**
SW	**+31.78**	**25,000(2)**	**+3,007**	**6,700(2)**	**+806**	**0.20(4)**	**+53**
Net Change			**+2,161**		**+454**		**+5.3**

Notes:
(1) *E. coli* and *Enterococcus* CSO concentrations from Table 4-2 from the August 27, 2021 *Task 5.3 Water Quality Assessment Report.*
(2) *E. coli* and *Enterococcus* stormwater concentrations from Table 5-7 from the *Task 5.2 Receiving Water Quality Model Development and Calibration Report*.
(3) CSO Phosphorus concentration from Cottage Farm sampling data.
(4) SW Phosphorus concentration from Cambridge Department of Public Works Report: *Partial Sewer Separation Report Model Calibration Report.*

As indicated in Table 3-2, without providing additional treatment of the stormwater, the regulator modification and stormwater removal alternative would result in an increase in the bacteria loading to the brook of 2,161 x 10^{10} counts for *E. coli*, and 454 x 10^{10} counts for *Enterococcus*. In addition, the net loading of phosphorus to the brook would increase by 5.3 lbs in the Typical Year.

Based on input received from the MassDEP, stormwater discharged as a result of sewer separation would not be considered a “new discharge” under the stormwater regulations but would be considered an “increased discharge”. Since Alewife Brook has an approved Total Maximum Daily Load (TMDL) for pathogen indicator bacteria, any increase in *E. coli* or *Enterococcus* load that was not included in the TMDL would need to be removed. The regulations include some flexibility in that the location of load removal does not have to be at the location of increased discharge, as long as the load removal occurs somewhere in the watershed. The 2020 *Mystic River Watershed Alternative TMDL Development for Phosphorus Management - Final Report* also established phosphorus reduction targets for the Lower Mystic River Watershed which includes Alewife Brook.

Based on these requirements, it was assumed that the stormwater separation alternative would require treatment of the additional stormwater discharged as a result of the stormwater separation work. The technology, efficacy, configuration, space requirements, cost, and feasibility of providing treatment of the additional stormwater have not been assessed.

Preliminary estimated construction costs were developed for the regulator modifications based on anticipated costs for materials and installation. However, with concerns regarding the feasibility of removing 115 acres of stormwater, a construction cost was not prepared for this component of the alternative. The preliminary estimated capital cost for the regulator modifications component of the alternative, the annual CSO volume reduction for outfall SOM001A and for all of the Alewife Brook CSO outfalls, and the cost per gallon of CSO reduction are summarized in Table 3-3. Cost per gallon is presented for the purpose of comparing the cost of alternatives relative to the reduction of CSO. Other factors, including constructability, siting issues, community impacts, stakeholder input, etc. would also be considered in evaluating alternatives.

Table 3-3. Alewife Brook Stormwater Removal with Regulator Modifications Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost ($2024)(1)	Annual CSO Volume Reduction (MG)(2)	Cost/Gallon CSO Reduction ($/gal)(2)
115 Acres Stormwater Removal with Regulator Modifications	$0.8 million + Stormwater Relocation Costs(3)	SOM001A: 3.7 Total Reduction to Alewife Brook: 3.23	Not Developed(3)

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operations and maintenance costs are not included.

(2) Based on the Typical Year.

(3) Estimated construction costs were not developed for stormwater relocation due to uncertainty over the scope and feasibility of this component of the alternative.

Green Infrastructure

The analysis of green infrastructure alternatives for outfall SOM001A was based on infiltrating existing separate stormwater that discharges to the combined sewer system tributary to the SOM001A outfall using sub-surface infiltration basins. Areas served by separate storm drains that tie into the combined sewer system tributary to outfall SOM001A were identified using the Unified Model.[5] The delineation of the stormwater areas that could be directly captured by green infrastructure included an assessment of roof runoff. For residences with existing exterior downspouts and pitched roofs observed from aerial imagery, it was assumed that half of the runoff from the roof would reach the separate storm drain, whereas the other half would infiltrate into other pervious surfaces such as backyards. The subcatchments in the outfall SOM001A tributary areas had various soil infiltration rates, and only areas with soil infiltration rates higher than 0.1 in/hr were considered for green infrastructure, as infiltration rates less than 0.1 in/hr were not considered suitable for infiltration. The delineated stormwater areas tributary to the green infrastructure included 35 individual locations with a total of 30.25 acres to be directly routed to the green infrastructure as shown in Table 3-3. It was also assumed that hydrodynamic separators would be provided with each infiltration basin to reduce the build-up of solids within the basins.

[5] The Unified Model is a version of the model created for the development of the Updated CSO Control Plans required by the 2024 water quality variances for the Alewife Brook/Upper Mystic River and Charles River. This model was developed by integrating the MWRA's collection system model with the collection system models developed by the cities of Cambridge and Somerville.

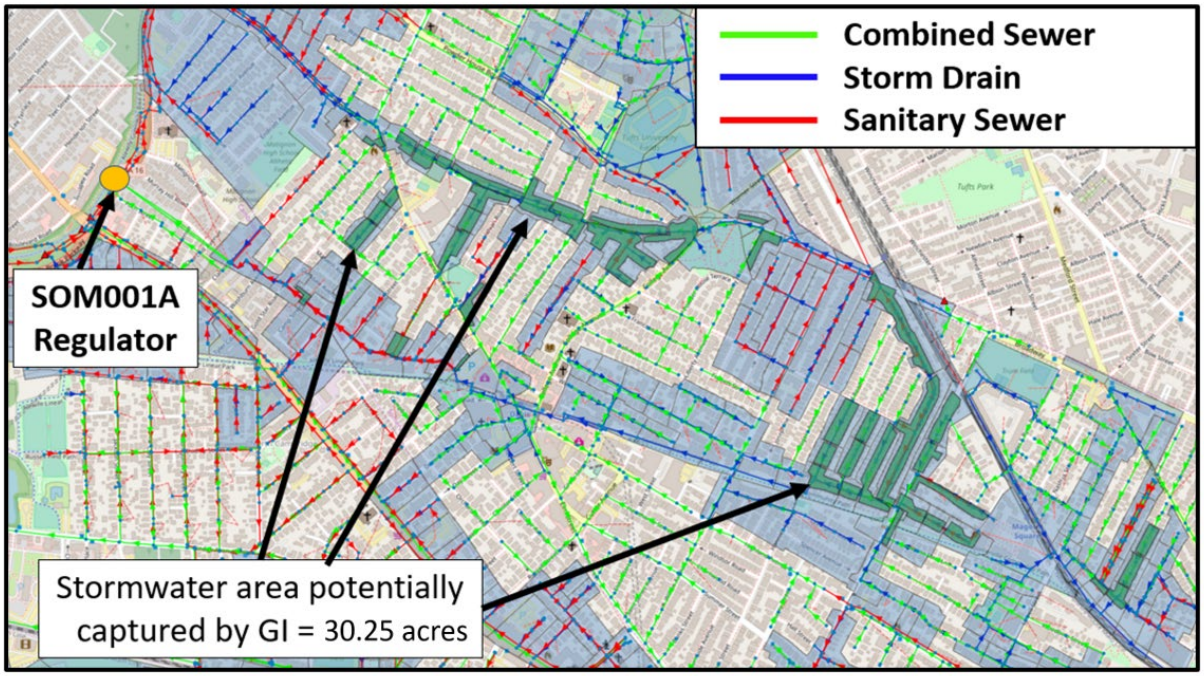

Figure 3-3. SOM001A Separate Stormwater Areas Identified for Green Infrastructure

In terms of how the green infrastructure was represented in the model, Figure 3-4 presents a schematic of how the model routes runoff from a subcatchment into the pipe network under normal conditions without green infrastructure. Figure 3-5 presents a typical configuration with green infrastructure. For this condition, the portion of the subcatchment that is not routed to green infrastructure gets routed directly to the collection system similar to the configuration shown in Figure 3-4. For the portion of the delineated area that is directed to green infrastructure, the flow is routed to an infiltration basin sized to hold the volume from the first 0.5 inches of rainfall from that portion of the delineated separate stormwater catchment. The infiltration basins were assumed to have a chamber floor 8 feet below grade, a sidewall depth of 4 feet, and an overflow weir discharging back into the collection system at the top of the chamber with 4 feet of cover. With these dimensions set, the length/width dimensions were computed to provide the required volume of capture. Exfiltration rates from the basin into the groundwater were set to vary from 0.5 to 0.1 in/hr based on available information from the city of Somerville.

The Unified Model was used for the green infrastructure assessment due to its enhanced level of detail in this area. With the 35 locations for green infrastructure sized as described above, in some cases the substantial size of the infiltration basins created constructability concerns with regard to utility conflicts and roadway disruptions. If the infiltration basins were limited to dimensions of 10 ft wide by 25 ft long by 4 ft deep, a total of 41 infiltration basins with would be needed to achieve the same volume reduction as 35 infiltration basins with no size limit. As shown in Table 3-4, with or without the maximum size restricted, green infrastructure was predicted to have minimal impact on the activation frequencies and volumes as predicted by the Unified Model for outfall SOM001A.

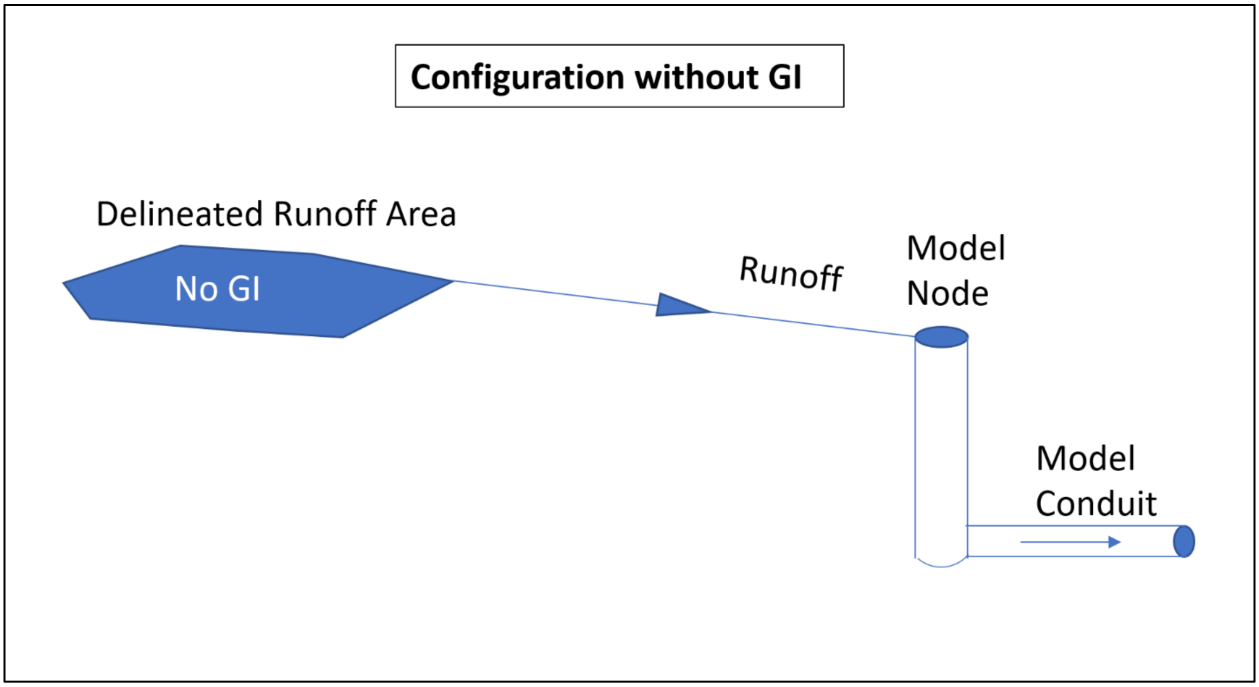

Figure 3-4: Schematic of Model Configuration without Green Infrastructure

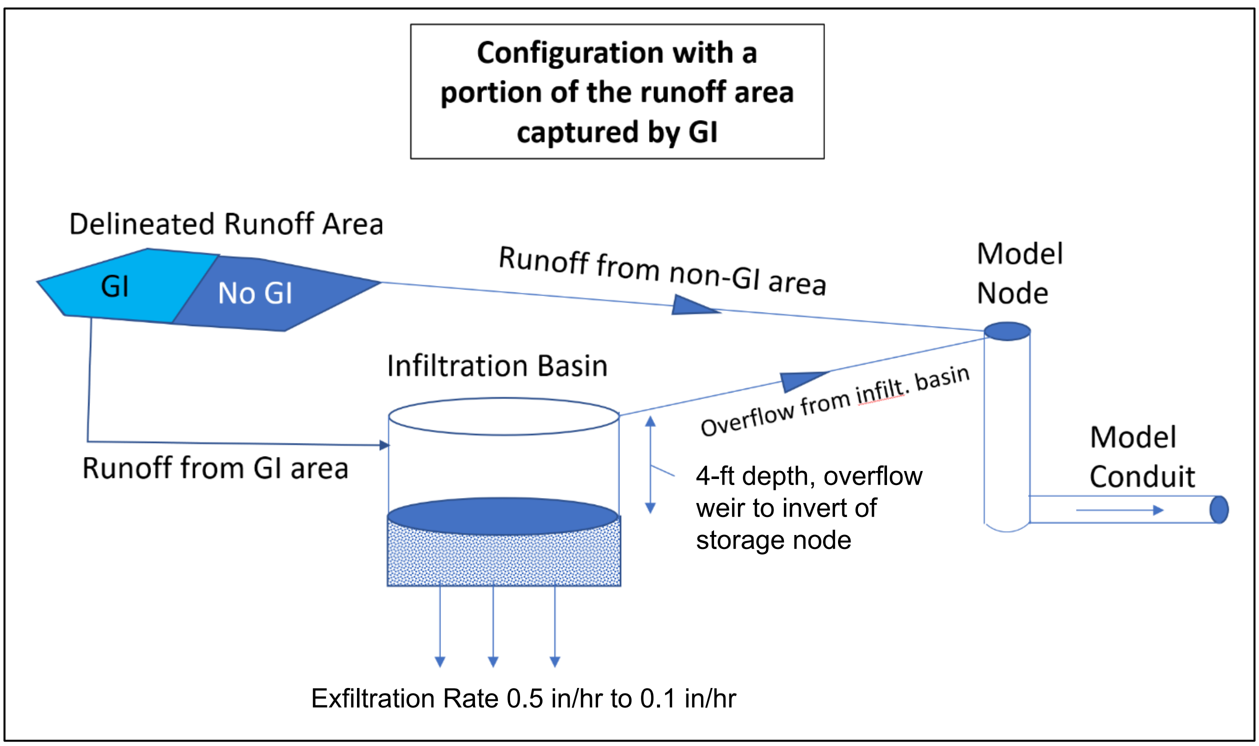

Figure 3-5: Schematic of Model Configuration with a Portion of Runoff Captured by Green Infrastructure

Table 3-4. SOM001A Green Infrastructure Typical Year Results

Outfall	Typical Year					
	Unified Model 2023 Conditions Baseline		Unified Model SOM001A GI No size limit		Unified Model SOM001A GI 10 ft x 25 ft x 4 ft	
	Act Freq	Vol (MG)	Act Freq	Vol (MG)	Act Freq	Vol (MG)
SOM001A	8	4.46	7	4.11	7	4.15

Preliminary estimated construction costs were developed for the green infrastructure alternative with the infiltration basin size set to 10 ft x 25 ft x 4 ft. The preliminary estimated construction cost, annual CSO volume reduction, and cost per gallon of CSO reduction for this alternative are summarized in Table 3-5 for SOM001A.

Table 3-5. Outfall SOM001A Green Infrastructure Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost(1) ($2024)	Annual CSO Volume Reduction (MG)(2)	Cost/Gallon CSO Reduction ($/gal)(2)
Green Infrastructure: Stormwater Infiltration Units with the size limited to 10 ft x 25 ft x 4 ft and hydrodynamic separators(3)	$12 million	SOM001A: 0.31	$39

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operation and maintenance costs are not included.

(2) Based on the Typical Year using the Unified Model.

CSO Storage

CSO storage was investigated to meet LTCP goals at outfall SOM001A. Table 3-6 presents the volume of discharge for the eight storms that cause activations at outfall SOM001A in the Typical Year. As indicated in Table 3-6, providing a storage volume of 0.61 MG would meet the LTCP goals of three activations and 1.67 MG.

Potential constraints to constructing a storage facility adjacent to outfall SOM001A would include below-grade infrastructure (ABBS and ABC), the Alewife Brook, a public walking/bike path, Alewife Brook Parkway, and the presence of mature trees. Based on the site configuration and the storage volume requirements, the storage facility was configured as either a box conduit or as a microtunneled storage conduit.

Table 3-6. SOM001A Q1-2023 Conditions Activations and Storage Requirements to Meet LTCP Goal for Typical Year

Typical Year			
Date	**Q1-2023 CSO Volume Outfall SOM001A (MG)**	**SOM001A Storage Volume Required to Meet LTCP Goal (MG)**	**Remaining CSO Volume at SOM001A with Storage (MG)**
5/2	0.38	0.61	0
6/6	0.08		0
8/11	0.61		0
8/18	0.66		0.05
9/3	0.07		0
9/9	0.24		0
9/23	0.91		0.30
10/23	1.52		0.91
Total Vol. (MG)	**4.47**		**1.26**

Figure 3-6 presents a concept layout of the 0.61 MG box conduit storage between the ABC and ABBS along Alewife Brook. The overall dimensions of the storage facility would be approximately 265 feet long by 25 feet wide. The facility would include an influent channel and flushing system, two 10-foot wide by 17-foot high by 210-foot long parallel box storage conduits, and a dewatering facility sized to dewater the full storage volume in approximately 24 hours. A piped connection would be made between the SOM001A outfall and the storage conduit influent channel. After the storm the facility would be dewatered with the dewatering pumps. As indicated in Figure 3-6, the storage facility would be located between the ABC and the ABBS. Further investigation into the feasibility of locating the facility in that space would be needed to confirm the viability of this alternative.

Figure 3-6. Box Conduit Storage Alternative for Outfall SOM001A

Figure 3-7 presents the layout of a 0.61 MG microtunneled storage conduit running approximately from outfall SOM001A to Broadway, parallel to Alewife Brook Parkway. The microtunneled storage conduit shown in Figure 3-7 would be approximately 1,800 feet long and 8 feet in diameter. Shorter or longer configurations could be considered with appropriate adjustments to the diameter to maintain the storage capacity. A 0.61 MGD dewatering pumping facility would be located at one end of the conduit to dewater the stored flow back to the interceptor system. Approximately four jacking/retrieval shafts would need to be located along the route. Further investigation of siting, potential utility conflicts, and soil conditions would be needed to confirm the layout of this alternative.

Table 3-7 presents the preliminary estimates of the construction costs developed for the storage alternatives described above. The cost for the box conduit storage alternative was developed based on the bid costs received for the MWRA's similar outfall BOS019 box conduit storage facility in 2005 adjusted to account for the smaller storage volume required, the unique features of this site, and escalation to 2024 dollars. Costs would need to be further refined based on a more detailed assessment of the layout, dewatering requirements, geotechnical conditions, utility conflicts and other variables that would be further defined during the next phase of project development if it is decided to move forward with this alternative. In addition, due to the proposed location in parkland, Article 97 legislation would likely be required in order to construct the facility on that site.

The estimated construction cost for the microtunneled storage facility was based on the conceptual layout provided in Figure 3-7 below. Costs would need to be further refined based on the number and location of launching and receiving shafts, dewatering requirements, geotechnical conditions, utility conflicts and other variables that would be further defined during the next phase of project development if it is decided to move forward with this alternative.

Table 3-7 also presents the annual CSO reduction associated with these alternatives, and the cost per gallon of CSO reduced.

Figure 3-7. Microtunneled Storage Alternative for Outfall SOM001A

Table 3-7. SOM001A Storage Alternatives – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost ($2024)(1)	Annual CSO Volume Reduction (MG)(2)	Cost/Gallon CSO Reduction ($/gal)(2)
0.61 MG Box Conduit	$60M	SOM001A :3.21	$19
		Total Reduction to Alewife Brook: 3.21	$19
0.61 MG Microtunneled Storage	$45M	SOM001A: 3.21	$14
		Total Reduction to Alewife Brook: 3.21	$14

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operations and maintenance costs are not included.

(2) Based on the Typical Year.

Summary and Conclusions

Table 3-8 presents a summary of the alternatives for outfall SOM001A described above. As indicated in Table 3-8, the box storage conduit and microtunneled storage alternatives would each meet the LTCP goals for CSO activation and volume at outfall SOM001A. While the regulator modifications with 115 acres of stormwater removed would meet the LTCP goals for activation frequency and volume, the predicted adverse HGL impacts of this alternative would make it infeasible. The 115 acres of stormwater

Table 3-8. Summary of Alternatives Evaluated to Meet LTCP Goals for Outfall SOM001A

Alternative	Meets LTCP Goals?	Comments	Preliminary Estimated Capital Cost[1] (2024 dollars)	Benefit (Typical Year)				$/gallon for Typical Year
				Parameter	From	To	Reduction	
Regulator modifications[2] and lining the ABC and ABBC	No[3]	This alternative would put outfall MWR003 out of compliance with the LTCP goals	$16.4 million	SOM001A Activation Frequency	8	3	5	
				SOM001A Vol. (MG)	4.47	1.23	3.24	$5
				Total Volume to Alewife Brook (MG)	6.26	3.75	2.51	$6
Regulator modifications[2] and approximately 115 acres of stormwater relocation	No[4]	Feasibility of relocating 115 acres of stormwater directly to Alewife Brook and water quality impacts/Alewife Brook flood impacts have not been assessed.	$0.8 million + Stormwater Relocation Costs	SOM001A Activation Frequency	8	3	5	
				SOM001A Vol. (MG)	4.47	0.77	3.70	Not developed
				Total Volume to Alewife Brook (MG)	6.26	3.03	3.23	TBD
Green Infrastructure: Stormwater Infiltration with the size limit and hydrodynamic separators(5)	No	Additional investigations into soil and ground water conditions and potential sanitary connections to storm drain to assess feasibility.	$12 million	SOM001A Activation Frequency[6]	8	7	1	
				SOM001A Vol. (MG)[6]	4.46	4.15	0.31	$39
Box Storage Conduit (0.61 MG)	Yes	Feasibility of locating the box storage conduit between the ABC and ABBS needs further evaluation.	$60 million	SOM001A Activation Frequency	8	3	5	
				SOM001A Vol. (MG)	4.47	1.26	3.21	$19
				Total Volume to Alewife Brook (MG)	6.26	3.05	3.21	$19

Table 3-8. Summary of Alternatives Evaluated to Meet LTCP Goals for Outfall SOM001A

Alternative	Meets LTCP Goals?	Comments	Preliminary Estimated Capital Cost(1) (2024 dollars)	Benefit (Typical Year)				$/gallon for Typical Year
				Parameter	From	To	Reduction	
Microtunneled Storage (0.61 MG, 8 ft diameter, 1,800 feet long)	Yes	Feasibility of locating areas for jacking and retrieving shafts as well as further investigation of utility conflicts needs further evaluation.	$45 million	SOM001A Activation Frequency	8	3	5	
				SOM001A Vol. (MG)	4.47	1.26	3.21	$14
				Total Volume to Alewife Brook (MG)	6.26	3.05	3.21	$14

Notes:
(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operations and maintenance costs are not included.
(2) Regulator modifications include raising the weir and enlarging the DWF connection.
(3) Meets LTCP goal for SOM001A, however, the MWR003 volume goal is higher than the LTCP goal by 0.11 MG.
(4) Meets LTCP goal for SOM001A, but adverse HGL impacts in the Typical Year and larger storms make this alternative infeasible.
(5) Assumes maximum infiltration unit dimensions of 10 ft wide by 25 ft long by 4 ft deep.
(6) Model results are from the Unified Model.

removal associated with the regulator modification and stormwater removal alternative would likely have a much higher construction cost than the storage conduit alternatives. In addition, this alternative would require stormwater treatment to avoid net increases in phosphorus and bacteria loading to Alewife Brook, is likely to have utility conflict and pipe routing challenges and would create widespread construction-period disruption to residents and businesses.

The storage alternatives would allow outfall SOM001A to meet the current LTCP goals without the HGL impacts, the need to mitigate the net increase in phosphorus and bacterial loads and the widespread construction impacts associated with the stormwater removal and regulator modification alternative. The microtunneled storage and box conduit storage alternatives would each provide the same reduction in CSO activation frequency and volume, but microtunneled storage may be more cost effective based on preliminary estimated costs. However, either storage alternative would carry significant capital costs ($45M to $60M) and would not likely result in a measurable improvement in water quality in Alewife Brook. In addition, the duration for implementation of the storage alternatives (planning/design/ construction) would likely extend beyond five years.

Under the Final Determination to Adopt a Water Quality Standards Variance for Combined Sewer Overflow Discharges to Alewife Brook/Upper Mystic River Basin (2024 Alewife Variance) issued by the MassDEP in August 2024 and pending approval from EPA, the City of Somerville in coordination with MWRA will be evaluating alternatives for higher levels of CSO control for outfall SOM001A based on a new Typical Year and design storms developed using 2050 projections of rainfall that incorporate climate change impacts. Given the high costs and feasibility challenges associated with the alternatives to meet the LTCP goals at outfall SOM001A summarized in Table 3-8 above, and the potential for those alternatives to interfere with alternatives for achieving higher levels of control that may be identified as part of the Updated CSO Control Plan under the 2024 Alewife Variance, no further action is proposed towards improving performance at outfall SOM001A for the 1992 Typical Year at this time.

3.2 Outfall CAM005

Regulator RE-051 discharges to outfall CAM005 and is located on Mount Auburn Street at Longfellow Road at the entrance to Mount Auburn Hospital. The influent to regulator RE-051 is a 2.33 x 3-foot combined sewer that transitions to a 4.5-foot diameter conduit at the regulator. During dry weather, flow from the upstream combined sewer is conveyed to the North Charles Metropolitan Sewer (NCMS) through a 42-inch DWF connection. During wet weather, when the water level in the regulator is higher than an elevation of 108.34 ft, overflow is discharged to a 4.25 x 4.5-foot outfall pipe to the Charles River. Figure 3-8 presents a schematic of the interceptor system associated with the Cottage Farm CSO Facility, with outfall CAM005 located at the upstream end along the NCMS.

For this evaluation the MWRA's Q1-2023 system conditions model was modified to create an Expected Future Baseline Condition model that included the following planned projects:

- Raising the weir at regulator RE051 by 1 foot and lengthening it to 10 feet as recommended in the *Task 8.2-8.3: Alewife Brook and Charles River System Optimization Evaluations* report dated December 22, 2022. MWRA has procured the services of a design consultant to design a project to raise and length the weir in the CAM005 regulator. Site investigations found that the structure is narrower than indicated on record drawings, affecting the ability to fit a 10-foot weir in the structure. However, installation of a slightly shorter 8-foot long weir, instead of the 10-foot weir mentioned above, appears to be feasible. MWRA is reviewing this finding with the city of Cambridge prior to proceeding with final design. The shorter weir is predicted to have a less-than 0.05 MG impact on the overflow volume at outfall CAM005.
- Sediment removal from the CAM005 outfall pipe to be conducted by the City of Cambridge
- Sewer separation at Willard Street conducted by the City of Cambridge. This work was completed after the CAM005 alternative analysis in the Summer of 2024.

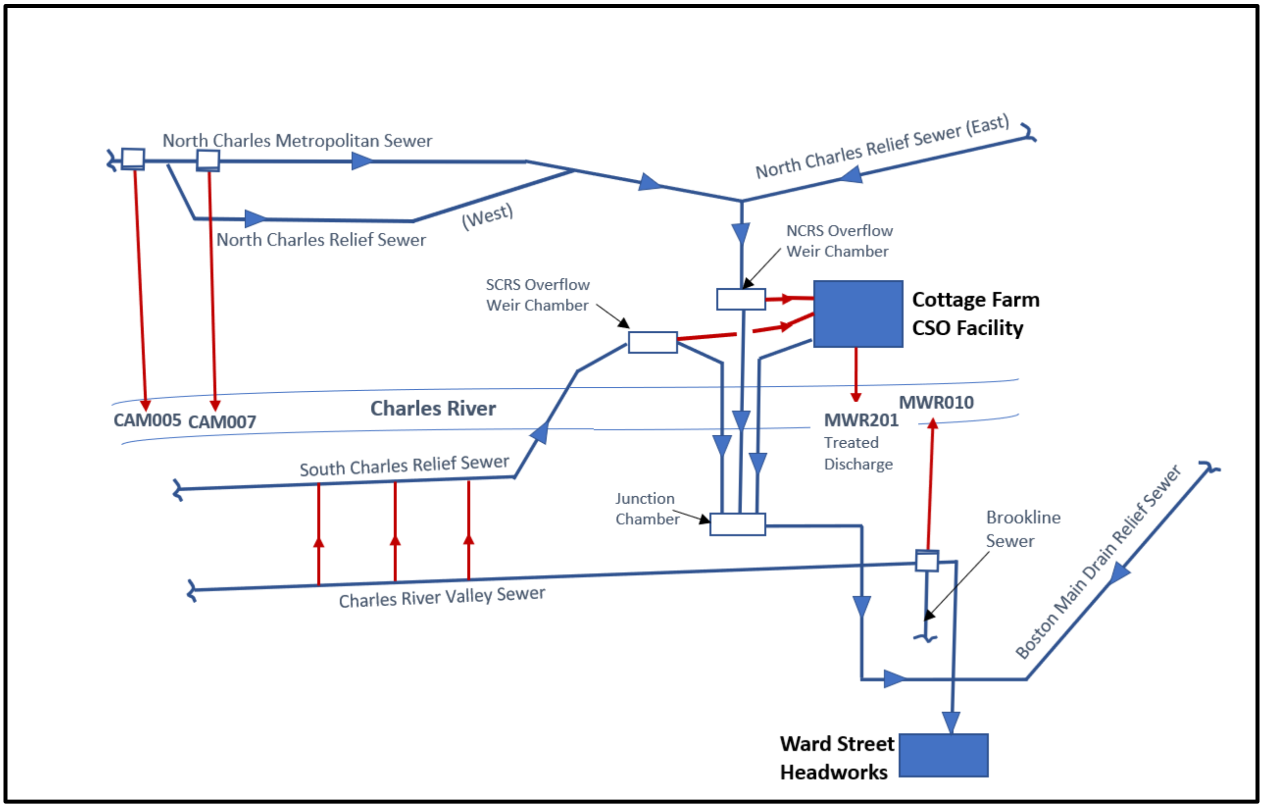

Figure 3-8. Schematic of the Interceptor System Associated with Outfall CAM005

Table 3-9 presents the Typical Year model results for the Q1-2023 system conditions and the Expected Future Baseline Condition. As indicated in Table 3-9, under the Expected Future Baseline Condition, outfall CAM005 was predicted to meet the LTCP goal for annual CSO volume but would not meet the LTCP goal for annual CSO activation frequency.

Table 3-9. CAM005 Typical Year Results - Q1-2023 and Expected Future Baseline Conditions

Outfall	Typical Year					
	Q1 2023(1)		Expected Future Baseline Condition(1)(2)		LTCP	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
CAM005	8	0.73	5	0.64	3	0.84

Notes:

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

(2) Expected Future Baseline includes raising the weir at regulator RE051, removal of sediment from the CAM005 outfall pipe and sewer separation at Willard Street.

Investigations into alternatives that could allow outfall CAM005 to meet the LTCP goal for activation frequency under the Expected Future Baseline Condition included the following:

- Upstream sewer separation
- Upstream green infrastructure

The evaluation of each of these alternatives is presented below.

Sewer Separation

Separation of the combined sewer area tributary to the CAM005 regulator along the NCMS was evaluated to assess the impact on the activation frequency and discharge volume at outfall CAM005. In the model, sewer separation within a subcatchment was assumed to remove 75% of the total runoff-based inflow to the combined sewer from that subcatchment. Figure 3-9 shows the modeled subcatchments tributary to regulator RE-051 and outfall CAM005. The model predicted that separation of runoff areas HAR10 to HAR13, totaling 23 acres, would reduce the CAM005 activation frequency from 5 to 2 and reduce the discharge volume from 0.64 MG to 0.38 MG, thus meeting the LTCP goal of 3 activations and 0.84 MG in the Typical Year (Table 3-10).

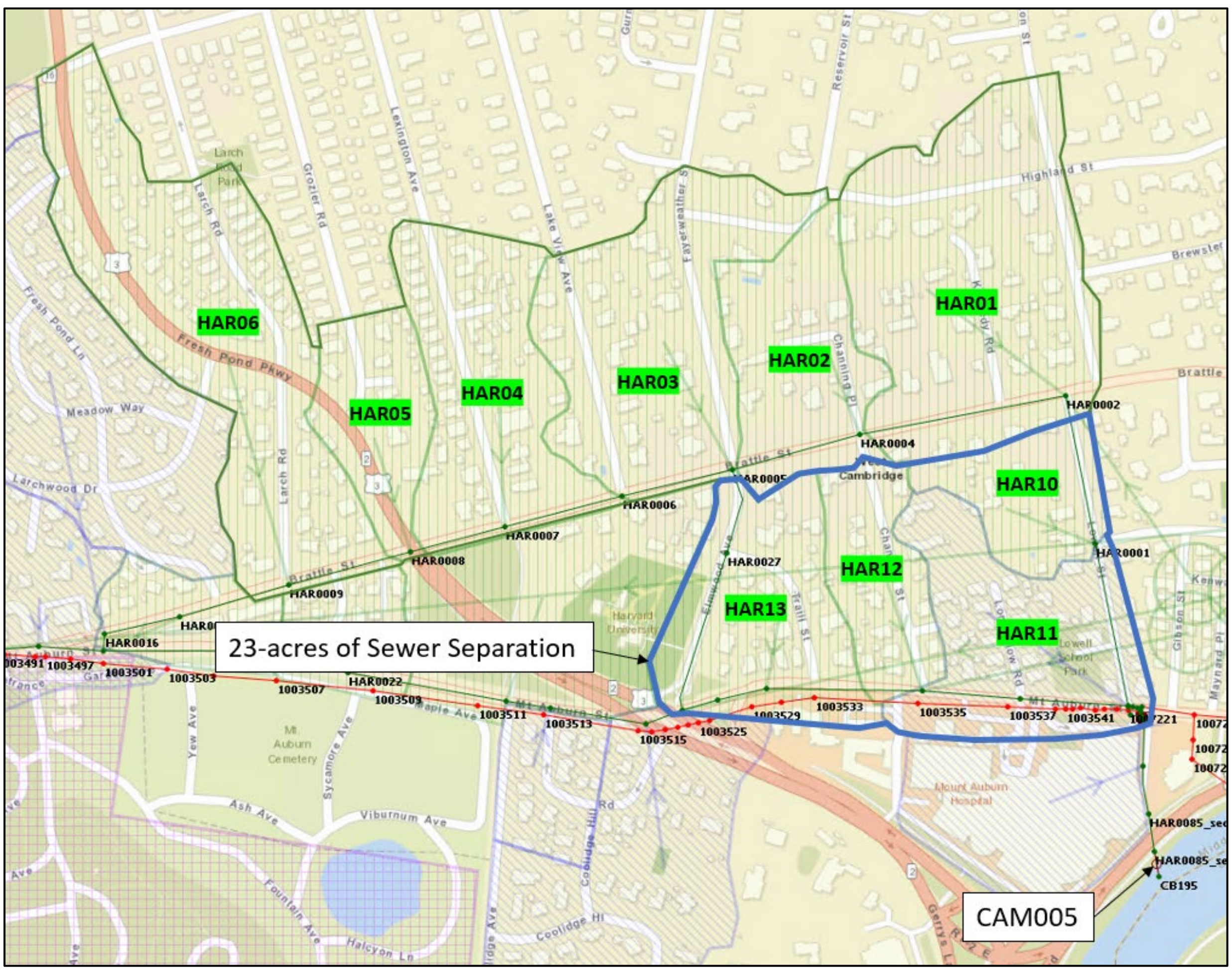

Figure 3-9. Potential Sewer Separation Areas Upstream of Outfall CAM005

Table 3-10. CAM005 Typical Year Results – Expected Future Baseline and 23 Acres of Sewer Separation

Outfall	Typical Year					
	Future Baseline Condition(1)(2)		Expected Future Baseline Condition with 23 Acres Separated(1)		LTCP	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
CAM005	5	0.64	2	0.38	3	0.84

Notes:

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

(2) Expected Future Baseline includes raising the weir at regulator RE051, removal of sediment from the CAM005 outfall pipe and sewer separation at Willard Street.

The separated stormwater from the 23-acre area would need to be conveyed to the Charles River, likely through a new storm drain outfall or discharging into the existing CAM005 outfall downstream of the weir. The feasibility of routing a sufficiently-sized drain pipe to the Charles River has not been evaluated. Although sewer separation would reduce the volume of CSO being discharged to the Charles River, it would contribute additional stormwater to the river. The alternative was projected to result in a net increase in both the bacteria and phosphorus loadings to the Charles River without treatment of the additional stormwater. The water quality impacts of the changes in loadings were not evaluated.

Table 3-11 presents the loading calculations for this alternative compared to the Future Baseline Conditions assuming no treatment of the additional stormwater discharged. As indicated in Table 3-11, the sewer separation alternative is predicted to reduce untreated CSO from CAM005 by 0.26 MG/yr, and increase the volume of stormwater to the Charles River by 4.88 MG/yr. CSO values for *E. coli* and *Enterococcus* bacteria in the untreated CAM005 discharge were taken from Table 3-2 from the August 27, 2021 *Task 5.3 Water Quality Assessment Report.* Stormwater values for *E. coli* and *Enterococcus* bacteria in untreated stormwater were taken from the *December 15, 2020 Task 5.2 Receiving Water Quality Model Development and Calibration Report.* As described in both reports, these values were based on sampling data and calibration of the water quality model to in-receiving water concentrations.

Table 3-11 also presents the predicted net change in phosphorus loading to the river assuming no treatment of the additional stormwater discharged. The phosphorus concentration used for CSO was 1.77 mg/L, based on Cottage Farm sampling data collected from 1992 through 2000. The phosphorus concentration used for stormwater was 0.20 mg/L, taken from the *Cambridge Department of Public Works Report: Partial Sewer Separation Report Model Calibration Report*, prepared by Stantec, dated March 11, 2022.

As indicated in Table 3-11, the sewer separation alternative would result in an increase in the bacteria loading to the river of 233 x 10^{10} counts for *E. coli*, and 175 x 10^{10} counts for *Enterococcus* in the Typical Year without treatment of the additional stormwater discharged. Similarly, the net loading of phosphorus to the river would increase by 4.3 lbs in the Typical Year. For perspective on the phosphorus loading, the total phosphorus TMDL for the Lower Charles River is 19,544 kg[6], or approximately 43,000 lbs. The additional 4.3 lbs of phosphorus would represent an increase of approximately 0.01%.

[6] Final Nutrient TMDL Development for the Lower Charles River Basin, Massachusetts June 2003

Table 3-11. CAM005 Sewer Separation Alternative: Net Bacteria and Phosphorus Loading Assuming no Treatment of Additional Stormwater Discharged

	Typical Year Volume Change (MG)	*E. coli* Concentration (MPN/100 mL)	Typical Year Change in *E. coli* Loading (Counts x 10^{10})	*Enterococcus* Concentration (MPN/100 mL)	Typical Year Change in *Enterococcus* Loading (Counts x 10^{10})	Phosphorus Concentration (mg/L)	Typical Year Change in Phosphorus Loading (lbs)
CSO	-0.26	26,409(1)	-26	11,759(1)	-12	1.77(3)	-3.8
SW	+4.88	14,000(2)	259	10,000(2)	185	0.20(4)	8.1
Net Change			**+233**		**+175**		**+4.3**

Notes:

(1) *E. coli* and *Enterococcus* concentrations from Table 3-2 from the August 27, 2021 *Task 5.3 Water Quality Assessment Report*

(2) *E. coli* and *Enterococcus* stormwater concentrations from Table 4-7 from the December 15, 2020 *Task 5.2 Receiving Water Quality Model Development and Calibration Report*.

(3) CSO phosphorus concentration from Cottage Farm Effluent Sampling Data 1992-2000

(4) SW phosphorus concentration from Cambridge Department of Public Works Report: *Partial Sewer Separation Report Model Calibration Report.*

As noted above under Section 3.1, based on input received from the MassDEP, stormwater discharged as a result of sewer separation would not be considered a "new discharge" under the stormwater regulations but would be considered an "increased discharge". Since the Charles River has an approved TMDL for phosphorus, any increase in phosphorus load that was not included in the TMDL would need to be removed. The regulations include some flexibility in that the location of load removal does not have to be at the location of increased discharge, as long as the load removal occurs somewhere in the watershed.

Based on these requirements, it was assumed that the sewer separation alternative would require treatment of the additional stormwater discharged as a result of the sewer separation work. The technology, efficacy, configuration, space requirements, and feasibility of providing treatment of the additional stormwater have not been assessed.

In addition to the adverse pollutant loading impacts, sewer separation construction work would be disruptive to the residents and businesses located within the 23-acre project area.

Preliminary estimated construction costs were developed for the sewer separation alternative based on sewer separation costs per acre provided by the BWSC for ongoing work in South and East Boston, as well as separation costs developed by the City of Somerville. A concept-level unit cost for stormwater treatment was developed by the City of Cambridge. The bases of these costs are documented in the August 23, 2024 *Alternatives Costing Methodology and Unit Prices Technical Memorandum* prepared by Dewberry. The preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for this alternative are summarized in Table 3-12.

Table 3-12. CAM005 Sewer Separation Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost ($2024)(1)	Annual CSO Volume Reduction (MG) (2)	Cost/Gallon CSO Reduction ($/gal)
Sewer Separation (23 ac)	$22M	0.26	$85/gal

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operations and maintenance costs are not included.

(2) Based on the Typical Year.

Green Infrastructure

The approach to assessing green infrastructure alternatives for outfall CAM005 was based on infiltrating existing separate stormwater that discharges to the combined sewer system tributary to the CAM005 outfall using sub-surface infiltration basins. Using GIS mapping tools from the City of Cambridge's website, multiple locations were identified where separate stormwater discharged to the combined sewers tributary to outfall CAM005. Existing green infrastructure in the CAM005 tributary area was identified and accounted for in the quantification of runoff. This analysis assumed that the separate stormwater pipes identified using the GIS mapping tools were receiving only stormwater. Before moving forward with this alternative each of these stormwater pipes would need to be investigated to confirm that sanitary flow is not entering these pipes.

Following the identification of separate stormwater pipes discharging to the combined sewers, the areas tributary to the separate stormwater pipes were delineated. Aerial mapping and Google Streetview were used to help identify residences with existing downspouts and pitched roofs. For those locations, it was assumed that half of the runoff from the roof would reach the separate storm drain, and the other half would infiltrate into the backyard. The delineations identified 15 areas with a total of 32 acres of runoff area that could potentially be routed to green infrastructure as shown in Figure 3-10. Refer to Section 3.1 above for a description of how the green infrastructure was represented in the model. For the area upstream of outfall CAM005, exfiltration rates from the infiltration basins into the groundwater were set to vary from 0.5 to 0.25 in/hr based on available information from Cambridge. It was assumed that hydrodynamic separators would be provided with each infiltration basin to reduce the build-up of solids within the basins.

Model results indicated that when the size of the infiltration basins was not restricted, the LTCP goals could be achieved at outfall CAM005 with infiltration basins installed in 15 locations. However, in some cases the substantial size of the infiltration basins created concerns with constructability related to utility conflicts, roadway disruptions and proximity to trees. With the maximum size of the infiltration basins limited to 10 ft wide by 25 ft long by 4 ft deep, a total of 18 units would be required to meet the LTCP goals. Table 3-13 summarizes the results of these evaluations.

Other challenges for the infiltration basins would include potential sanitary connections to the stormwater lines, soil conditions not suitable for infiltration, and potentially high groundwater conditions which may affect the performance of the basins.

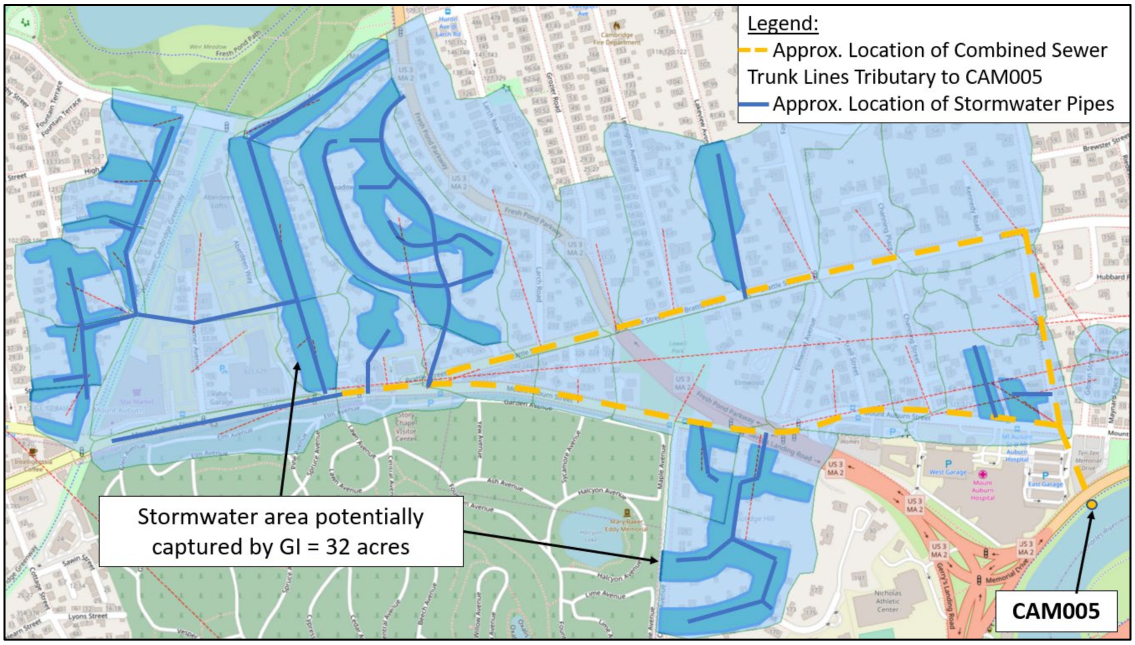

Figure 3-10. Separate Stormwater Areas Upstream of Outfall CAM005 Identified for Green Infrastructure

Table 3-13. CAM005 Green Infrastructure Typical Year Results

Outfall	Typical Year					
	Expected Future Baseline(1)(2)		Expected Future Baseline with CAM005 GI (18 units at 10ft x 25ft x 4ft max. size)(1)		LTCP	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
CAM005	5	0.64	3	0.44	3	0.84

Notes:

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

(2) Expected Future Baseline includes raising the weir at regulator RE051, removal of sediment from the CAM005 outfall pipe and sewer separation at Willard Street.

In an effort to reduce the concerns regarding utility conflicts and street disruption associated with the infiltration basins described above, an alternative concept was identified which would involve providing smaller infiltration basins attached to individual catch basins. A concept sketch for the catch basin-based infiltration basins is shown in Figure 3-11. Each individual catch basin infiltration configuration was assumed to have an estimated storage volume of 200 cubic feet, resulting in approximately 60 installations necessary to achieve equivalent CSO performance to the infiltration basin alternative which met the LTCP goals. While- the smaller size of the individual catch basin units could potentially reduce the impact of the constructability challenges identified above for the larger infiltration basins, the much higher number of installations that would be required could create challenges in terms of finding a sufficient number of suitable locations.

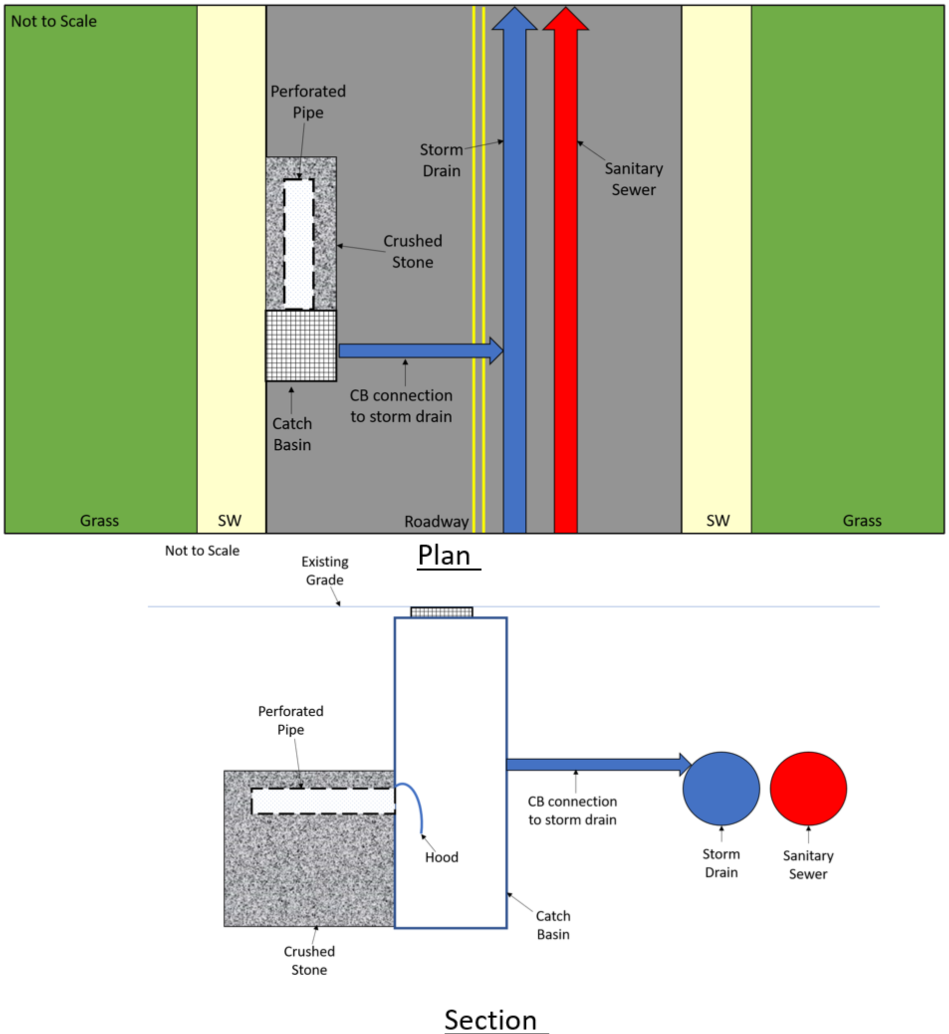

Figure 3-11. Individual Catch Basin Infiltration Concept Sketch

An operational consideration for the multiple catchbasin units would be the potential for the infiltration units to plug up over time, limiting their capacity to exfiltrate to the groundwater. As noted above, it was assumed that the larger infiltration units would be provided with hydrodynamic separators just upstream to control the solids, oils and grease loads to the units. The individual catch basin configurations would not have upstream hydrodynamic separators, and therefore would have a higher risk of losing their ability to exfiltrate the flow due to clogging of the media with solids, oils and grease.

The preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for the two green infrastructure alternative concepts are summarized in Table 3-14.

Table 3-14. CAM005 Green Infrastructure Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost(1) ($2024)	Annual CSO Volume Reduction(2) (MG)	Cost/Gallon CSO Reduction ($/gal)(2)
Green Infrastructure: Stormwater Infiltration (18 units) with Hydrodynamic Separators	$5M	0.20	$25/gal
Green Infrastructure: Individual Catch Basin Infiltration (60 units)	$2.5M	0.20	$13/gal

Notes:
(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operation and maintenance costs are not included.
(2) Based on the Typical Year.

Summary and Conclusions

Table 3-15 presents a summary of the sewer separation and green infrastructure alternatives evaluated to meet the LTCP goals for outfall CAM005. As indicated in Table 3-15, all three alternatives would provide relatively nominal (0.20 to 0.26 MG) reductions in annual CSO volume at outfall CAM005 in the Typical Year.

The 23 acres of sewer separation would have a substantially higher construction cost than the green infrastructure alternatives, would require treatment of the additional stormwater flows created by the separation work to mitigate the potential net increase in phosphorus loading to the Charles River, and would require extensive construction-period disruption to residents and businesses within the areas proposed for separation. In addition, the duration for implementation of the sewer separation alternative (planning/design/ construction) would likely extend beyond five years.

The green infrastructure alternatives would provide similar relatively nominal reductions in CSO volume at outfall CAM005, but at a lower cost compared to sewer separation. The green infrastructure alternatives would not increase the stormwater loading to the Charles River and would involve more localized construction impacts. The infiltration basins, however, could still face constructability obstacles related to utility conflicts, proximity to trees, temporary street closures, and other impacts to residents, and the performance of the basins could be affected by soil conditions not suitable for infiltration, and potentially high groundwater conditions. Further investigation of soil and groundwater conditions, and the locations of utilities, trees, and other potential obstacles to infiltration basin installations would be needed before moving forward with this alternative. Operational concerns with the green infrastructure would include the potential to lose exfiltration capacity due to clogging of the stone media. This concern would be partially mitigated for the larger units by the hydrodynamic separators that are included as part of the alternative.

The green infrastructure alternatives would allow outfall CAM005 to meet the current LTCP goals without the need to mitigate the net increase in phosphorus and bacterial loads, the more extensive construction impacts, and the higher cost associated with the sewer separation alternative. However, given the relatively nominal reduction in CSO volume that would be provided, the green infrastructure alternatives would not likely result in a measurable improvement in water quality in the Charles River. In addition, the duration for implementation of the green infrastructure alternatives (planning/design/ construction) could potentially extend beyond five years.

Under the *Final Determination to Adopt a Water Quality Standards Variance for Combined Sewer Overflow Discharges to the Lower Charles River/Charles Basin* (2024 Charles River Variance) issued by

Table 3-15. Summary of Alternatives to Meet LTCP Goals for Outfall CAM005

Alternative	Meets LTCP Goals	Comments	Preliminary Estimated Capital Cost[1] (2024 dollars)	Benefit (Typical Year)				$/gallon in Typical Year
				Parameter	From	To	Reduction	
Sewer Separation (23 ac)	Yes	Assumes stormwater treatment would be provided to address potential net increase in phosphorus loading	$22 million	Activation Frequency	5	2	3	$85
				Vol. (MG)	0.64	0.38	0.26	
Green Infrastructure: Stormwater Infiltration (18 units)[2] with Hydrodynamic Separators	Yes	Additional investigations into soil and ground water conditions and potential sanitary connections to storm drains would be needed to assess feasibility.	$5 million	Activation Frequency	5	3	2	$25
				Vol. (MG)	0.64	0.44	0.20	
Green Infrastructure: Individual Catch Basin Infiltration (60 units)	Yes	Additional investigations into soil and ground water conditions and potential sanitary connections to storm drains would be needed to assess feasibility.	$2.5 million	Activation Frequency	5	3	2	$13
				Vol. (MG)	0.64	0.44	0.20	

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operations and maintenance costs are not included.

(2) Assumes maximum infiltration unit dimensions of 10 ft wide by 25 ft long by 4 ft deep.

the MassDEP in August 2024 and pending approval from EPA, the City of Cambridge in coordination with MWRA will be evaluating alternatives for higher levels of CSO control for outfall CAM005 based on a new Typical Year and design storms developed using 2050 projections of rainfall that incorporate climate change impacts. Given the costs and limited CSO reduction benefit associated with the alternatives to meet the LTCP goals at outfall CAM005 summarized in Table 3-15 above, and the potential for those alternatives to interfere with or be redundant with alternatives for achieving higher levels of control that may be identified as part of the Updated CSO Control Plan under the 2024 Charles River Variance, no further action beyond the currently planned weir raising at the CAM005 regulator is proposed towards improving performance at outfall CAM005 for the 1992 Typical Year at this time.

3.3 Outfalls MWR018/MWR019/MWR020

The regulator structures associated with outfalls MWR018, MWR019 and MWR020 provide relief to the Boston Marginal Conduit (BMC) along the Charles River Esplanade in Boston during wet weather. During dry weather, flow is conveyed down the 6.33 x 7.67-foot BMC towards the Prison Point CSO Facility where the flow is pumped to the interceptor system tributary to the Chelsea Creek Headworks. As the HGL rises in the BMC during wet weather, flow passes into large, complex weir structures associated with outfalls MWR018, MWR019 and MWR020 and discharges to the Charles River. The controlling elevations at each structure are established by stop logs in chambers located just downstream of each of the large weir chambers. The stop log elevation controlling overflow at outfall MWR018, located across Storrow drive from Hereford Street, is elevation 108.68 feet. For outfall MWR019, located across Storrow Drive from Gloucester Street, the elevation is 109.03 feet. For outfall MWR020, located across Storrow Drive from Berkeley Street, the elevation is 109.05 feet. The MWR018 and MWR019 outfall pipes are both 6.5 x 6.5-foot rectangular pipes, while the MWR020 outfall pipe is a 7 x 10-foot rectangular pipe. Figure 3-12 presents the general schematic of the outfall MWR018, MWR019 and MWR020 sub-system.

The LTCP goals for outfalls MWR018, MWR019 and MWR020 are zero activations and volume in the Typical Year. As indicated in Table 1-3 above, at the time of submittal of the Final Assessment Report (Q4-2021 conditions), outfalls MWR018, MWR019 and MWR020 were each predicted to activate two times in the Typical Year, with a total volume of 2.04 MG. As a result of system changes implemented between the Q4-2021 and Q4-2024 periods, outfalls MWR018, MWR019 were still predicted to activate two times in the Typical Year, with a total volume of 0.52 MG, and outfall MWR020 was predicted to activate once with a volume of 0.02 MG. As of Q4-2024 conditions, outfall MWR020 is now considered to materially meet its LTCP goals.

Evaluations of alternatives for outfalls MWR018, MWR019 and MWR020 were conducted in 2023, on a baseline of Q1-2023 system conditions. Some of the system changes that have occurred as of the Q4-2024 conditions had not yet been completed as of Q1-2023 conditions. As a result, the Q1-2023 conditions which served as a baseline for the MWR018, MWR019 and MWR020 evaluations had two activations at each outfall, and a total annual volume in the Typical Year of 0.65 MG (Table 3-16). While the difference between the discharge volumes under Q1-2023 and Q4-2024 conditions could theoretically affect the final sizing of alternatives to meet the LTCP goals for outfall MWR201, the magnitude of the differences would not be sufficient to change the conclusions from the evaluations presented below.

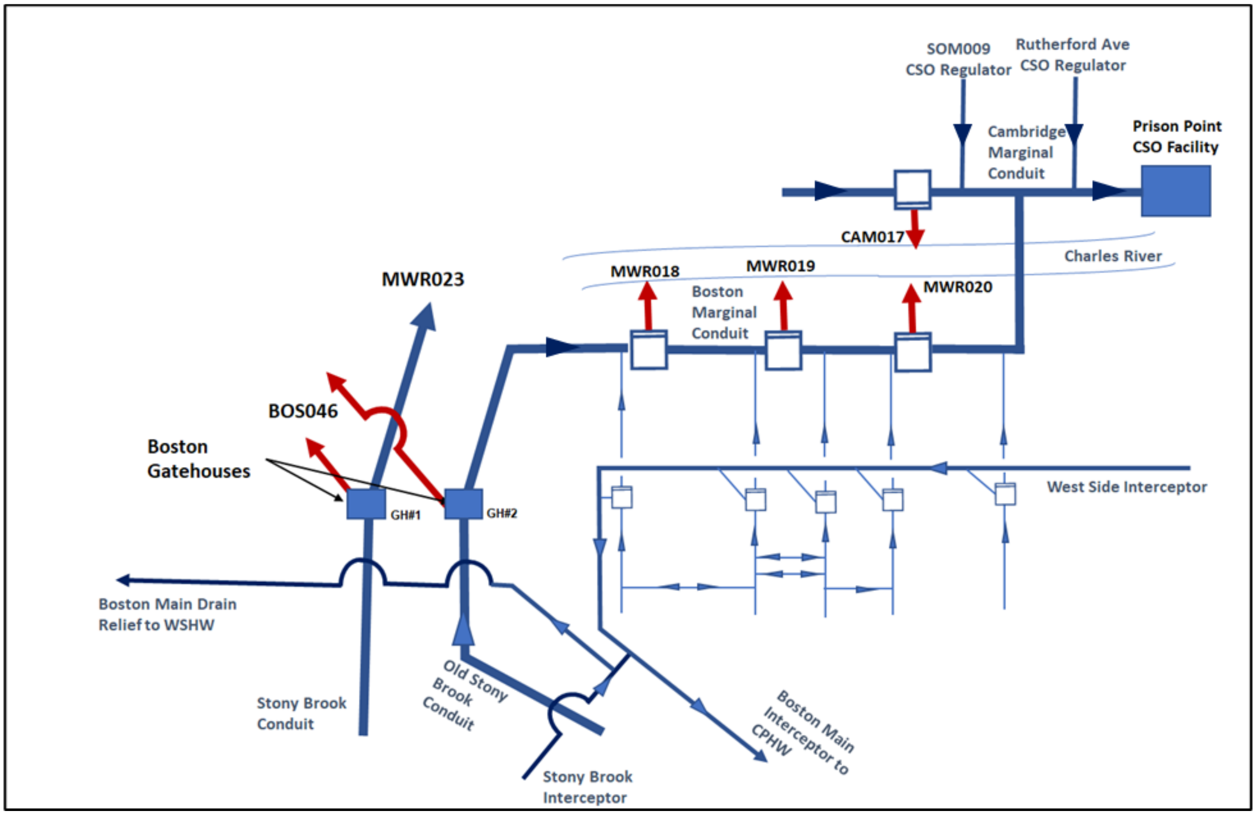

Figure 3-12. Schematic of the Outfall MWR018, MWR019, MWR020 Sub-System

Table 3-16. Q1-2023 Typical Year Performance for Outfalls MWR018, MWR019 and MWR020

Outfall	Typical Year			
	Q1-2023 System Conditions(1)		Long-Term Control Plan	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
MWR018	2	0.43	0	0
MWR019	2	0.18	0	0
MWR020	2	0.04	0	0

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

Investigations into alternatives that could allow outfalls MWR018, MWR019 and MWR020 to meet LTCP goals included the following:

- Remove restrictions from Roxbury Canal Sewer
- Sewer separation
- Relocate separate stormwater from Old Stony Brook Conduit to Stony Brook Conduit (Limited Stormwater Acceptance)
- Green infrastructure
- Green infrastructure + Limited stormwater acceptance
- Box Conduit Storage
- Microtunneled Storage

Each of these alternatives is described below. Of the alternatives evaluated, three were predicted to meet the LTCP goals in the Typical Year:

- Sewer Separation
- Box Conduit Storage
- Microtunneled Storage

Removing Restrictions from the Roxbury Canal Sewer

Part of the Roxbury Canal Sewer (RCS) includes an existing 72-inch stormwater line that enters an overflow structure, located in Nubian Square (Figure 3-13), where the preferred path conveys brook flow and stormwater to Fort Point Channel. The outlet from the diversion structure towards Fort Point Channel consists of a 24-inch pipe with a flap gate to prevent backflow into the overflow structure from the downstream system. Downstream of the 24-inch pipe, the conveyance system increases to 30-inch diameter and a section of 24 x 36-inch egg-shaped sewer, before ultimately increasing to a 72-inch diameter pipe and then to a 204-inch wide x 120-inch tall rectangular pipe for the remaining distance to Fort Point Channel. During wet weather, a side outlet weir in the overflow structure diverts stormwater to the Old Stony Brook Conduit (OSBC). Modeling indicated that the 24-inch, 30-inch, and 24x36-inch sections downstream of the diversion structure created hydraulic restrictions in larger storms, contributing to the diversion of flow towards the OSBC.

An analysis was performed to examine impacts of allowing more flow through the RCS by reducing the number of restrictions downstream of the diversion structure. Increasing the flow through the RCS would increase the flow to the Fort Point Channel and reduce the amount of stormwater that enters the OSBC. Four configurations were developed to evaluate removing the restrictions as described in Table 3-17 and shown in Figure 3-14. Impacts on CSO volumes and activations at outfalls MWR018, MWR019 and MWR020 was assessed using the Typical Year, while potential impacts to the peak HGL along the RCS were assessed using the 5-year, 24-hour storm.

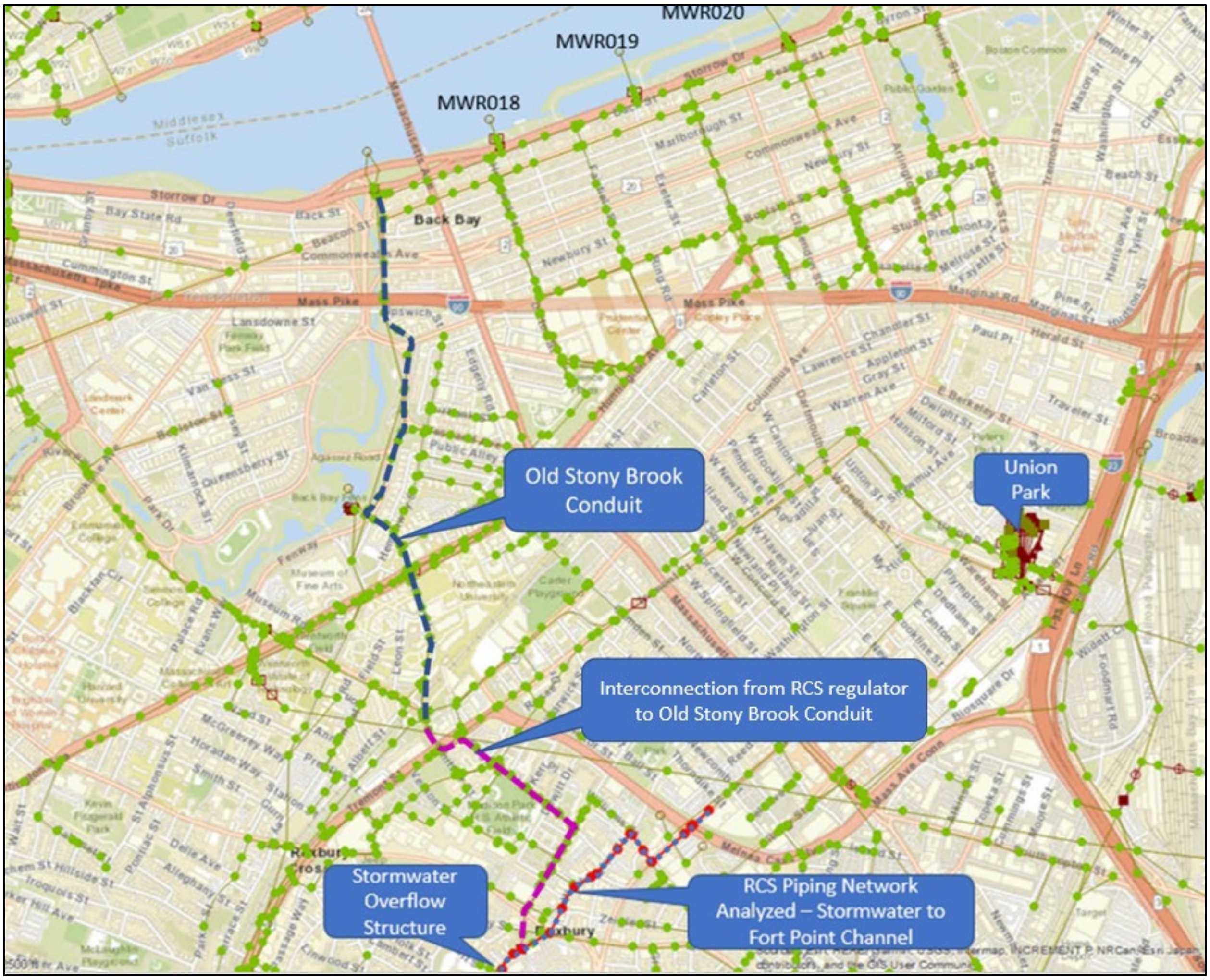

Figure 3-13. Schematic of the Pipe Network in the Area of the Interconnection between the RCS and the OSBC

Table 3-17. Alternatives to Reduce Hydraulic Restrictions Downstream of RCS Diversion Structure

Alternative	Description
1	Replace the 364 ft long, 24-inch diameter pipe downstream of the diversion structure with a 36-inch diameter pipe and replace the 24-inch diameter flap valve with a 36-inch diameter flap valve.
2	Alternative 1 + replace a 32-ft section of 24-inch pipe further downstream towards Fort Point Channel with a 36-inch diameter pipe.
3	Alternative 2 + replace the 542 ft long 30-inch circular pipe and 285 ft long 24-inch/36-inch egg-shaped pipe downstream of the diversion structure with 36-inch circular pipes.
4	Alternative 3, but convert the 36-inch pipe downstream the diversion structure to a 36-inch orifice with flow restricted to 30.6 MGD, corresponding to the peak flow in the Typical Year under Alternative 3.

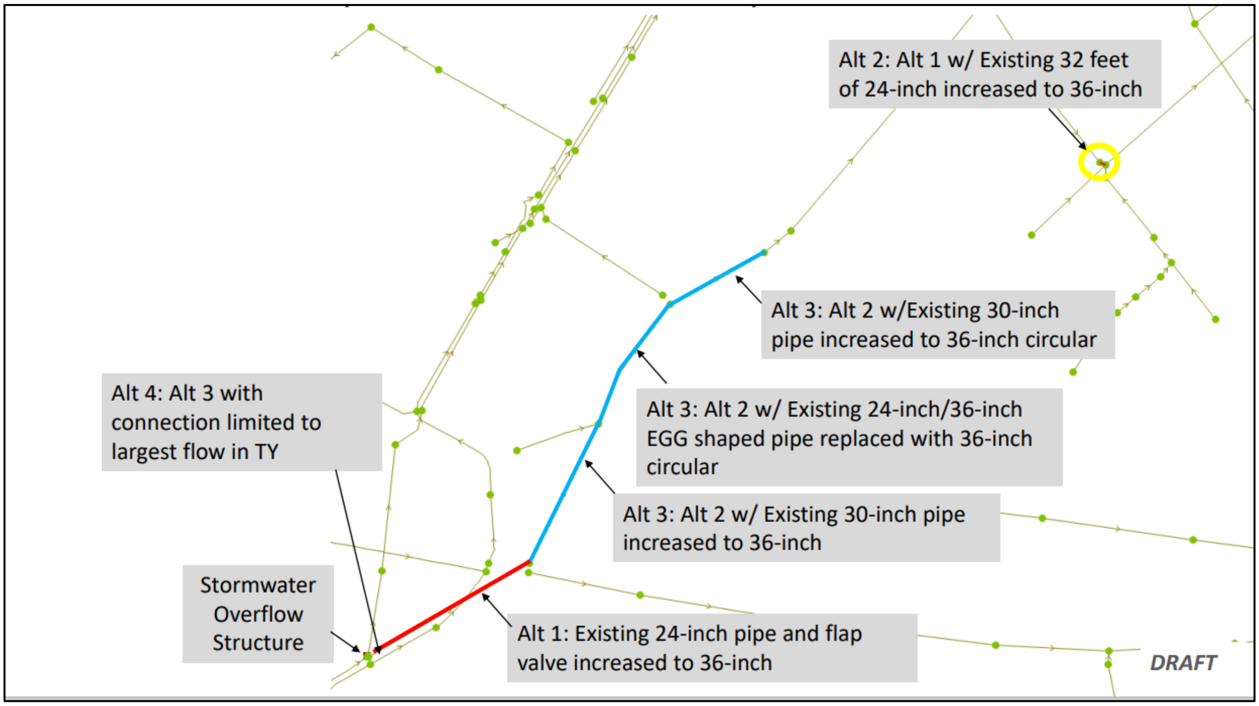

Figure 3-14. Model Schematic of the RCS Alternatives

The intent of Alternative 1 was to remove the most upstream hydraulic restriction by upsizing the 24-inch pipe to 36-inch diameter. Model results for Alternative 1 showed that removing this restriction allowed more flow to be conveyed downstream to another restriction, resulting in an increase in the HGL during the 5-year, 24-hour storm. Alternative 2 upsized a short section of 24-inch pipe that was creating a hydraulic restriction farther downstream. Alternative 3 relieved restrictions on the length of pipe between Alternatives 1 and 2. Table 3-18 presents a comparison of the Q1-2023 conditions to Alternatives 2 and 3 and the LTCP Goals. As indicated in Table 3-18, Alternative 2 was predicted to decrease the volume at outfalls MWR018 and MWR019 without changing the activation frequency and was predicted to eliminate the discharge at outfall MWR020 in the Typical Year. Alternative 3 was predicted to further reduce the volume at outfalls MWR018 and MWR019, but the activation frequency remained at 2 in the Typical Year.

However, when Alternative 3 was evaluated with the 5-year, 24-hour storm, adverse impacts to the peak HGL were predicted downstream due to the increased flow that could be conveyed downstream by removing the restrictions. Figure 3-15 presents a comparison of the peak HGL during the 5-year, 24-hour storm for the Q1-2023 conditions and Alternative 3. As indicated in Figure 3-15, relieving the restrictions with Alternative 3 increased the predicted flow downstream of the diversion structure in the 5-year, 24-hour storm from 20 to 36.4 MGD, resulting in an increase in the peak HGL through the entire reach shown in the profile.

A fourth alternative was then evaluated which limited the amount of flow that could be conveyed in the RCS to 30.6 MGD, corresponding to the peak flow in the Typical Year under Alternative 3. However, with this flow restriction, adverse impacts to the HGL downstream were still predicted for the 5-year, 24-hour storm. Since the increased HGL would increase the risk of flooding at the downstream low point, these alternatives were not recommended for further evaluation.

Table 3-18. Q1-2023 Baseline Conditions and RCS Alternatives 2 and 3, Typical Year

Outfall	Typical Year							
	Q1-2023 System Conditions(1)		Q1-2023 RCS Alt 2(1)		Q1-2023 RCS Alt 3(1)		LTCP Goals	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
MWR018	2	0.44	2	0.36	2	0.26	0	0.00
MWR019	2	0.18	2	0.10	2	0.04	0	0.00
MWR020	2	0.03	0	0	0	0	0	0.00

Notes:

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

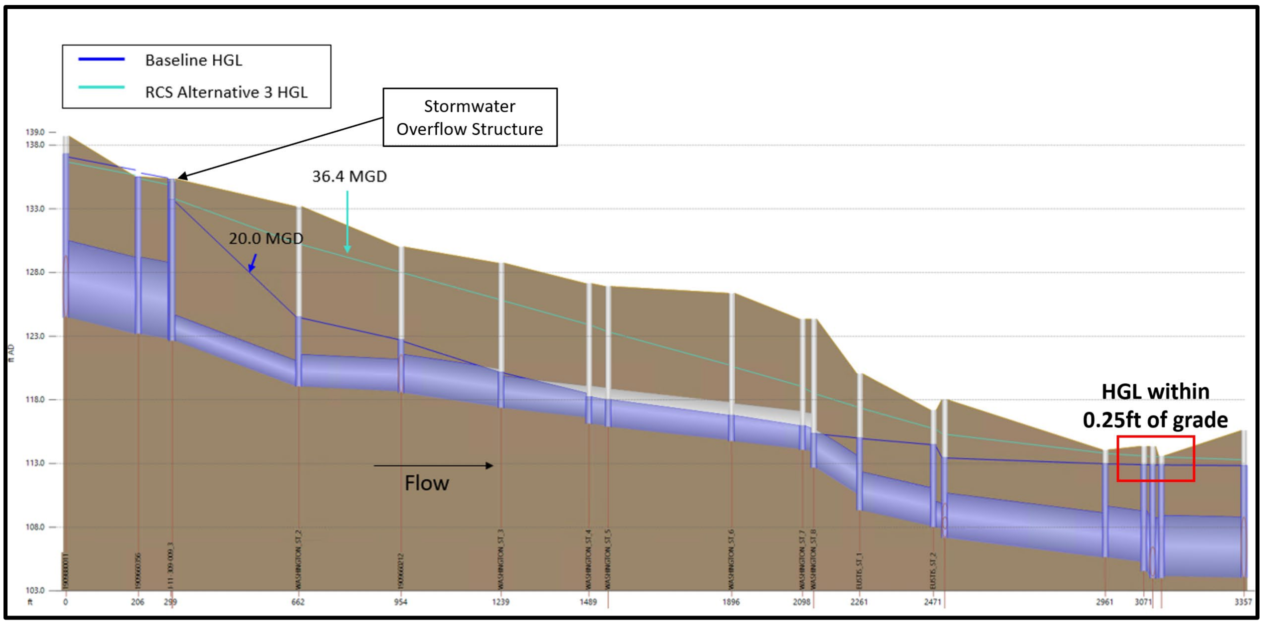

Figure 3-15. Comparison of the Q1-2023 System Conditions and RCS Alternative 3 Peak HGL for the 5-Year, 24-hour Storm

Sewer Separation

An evaluation was conducted of the extent of sewer separation upstream of outfalls MWR018, MWR019 and MWR020 needed to eliminate the discharges from those outfalls in the Typical Year, and thereby meet the LTCP goals. The upstream combined sewer area includes some areas served by separate storm drains that tie into the combined sewer system. Thus, the evaluation considered relocating this separate stormwater along with more traditional separation of the combined sewer areas. Based on iterative model runs, separation of 97 acres of combined sewer area, and relocating 35 acres of already-separated stormwater was predicted to eliminate the discharges at outfalls MWR018, MWR019 and MWR020 in the Typical Year. The total 132-acre area to be separated is shown in Figure 3-16. For the modeling evaluation, the sewer separation was assumed to remove 75% of the directly connected

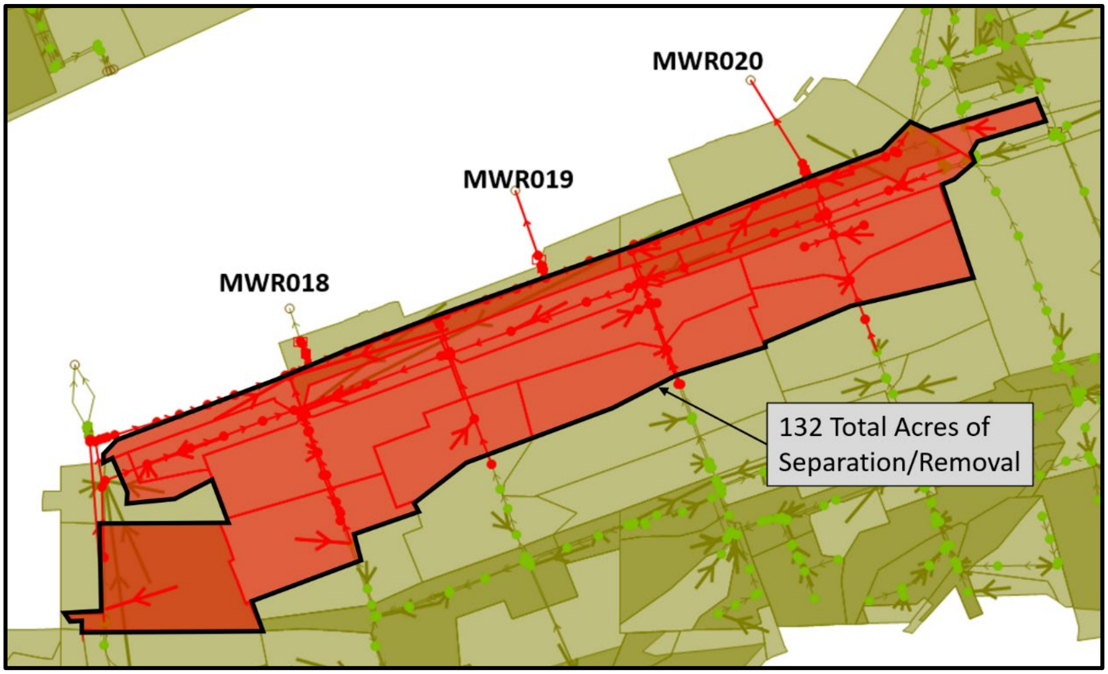

Figure 3-16. Extent of Sewer Separation Area Needed to Meet LTCP Goals for Outfalls MWR018, MWR019 and MWR020

impervious area. It was assumed that 100% of the stormwater tributary to the existing separate storm drains would be removed by physically disconnecting the existing storm drains from the combined sewer system.

While the sewer separation and stormwater removal alternative would achieve LTCP compliance at outfalls MWR018, MWR019 and MWR020, there are concerns regarding the feasibility of implementing this alternative in the Back Bay. The BWSC's level of service requirement for new drainage systems in the Back Bay neighborhood of Boston is a 25-year event. Constructing a stormwater network to convey the flow from the 25-year storm event to the Charles River would be a significant challenge given the relatively narrow streets and potential for utility conflicts. A particular challenge would be the need to convey the flow under the BMC and Storrow Drive to get to the Charles River.

Although the sewer separation and stormwater removal alternative would reduce the CSO discharge to the Charles River, it would contribute additional stormwater to the river. The alternative was projected to result in a net increase in both the bacteria and phosphorus loadings to the Charles River if no treatment were to be provided for the additional stormwater discharged. The water quality impacts of this change in loading were not evaluated.

Table 3-19 presents the loading calculations for this alternative compared to the Baseline Conditions. As indicated in Table 3-19, the sewer separation and stormwater removal is predicted to reduce total CSO discharge to the Charles River by 0.65 MG/yr, and increase the volume of stormwater to the Charles River by 35.4 MG/yr. Concentrations of *E. coli* and *Enterococcus* bacteria in the untreated MWR018/019/020 CSO were taken from Table 3-2 from the August 27, 2021 *Task 5.3 Water Quality Assessment Report.* Concentrations of *E. coli* and *Enterococcus* bacteria in untreated stormwater were taken from the *December 15, 2020 Task 5.2 Receiving Water Quality Model Development and Calibration*

Table 3-19. Outfalls MWR018, MWR019 and MWR020 Sewer Separation Alternative: Net Bacteria and Phosphorus Loading if No Treatment of Additional Stormwater

Source	Typical Year Volume Change (MG)	*E. coli* Concentration (MPN/100 mL)	Typical Year Change in *E. coli* Loading (Counts x 10^{10})	*Enterococcus* Concentration (MPN/100 mL)	Typical Year Change in *Enterococcus* Loading (Counts x 10^{10})	Phosphorus Concentration (mg/L)	Typical Year Change in Phosphorus Loading (lbs)
MWR018 CSO	-0.43	42,197(1)	-69	13,996(1)	-23	1.77(3)	-6.3
MWR019 CSO	-0.18	84,959(1)	-58	20,056(1)	-14	1.77(3)	-2.7
MWR020 CSO	-0.04	32,032(1)	-5	12,555(1)	-2	1.77(3)	-0.6
SW	35.4	14,000(2)	1,877	10,000(2)	1,341	0.20(4)	59.1
Net Change			**+1,745**		**+1,302**		**+49.5**

Notes:
(1) *E. coli* and *Enterococcus* concentrations from Table 3-2 from the August 27, 2021 *Task 5.3 Water Quality Assessment Report*
(2) *E. coli* and *Enterococcus* stormwater concentrations from Table 4-7 from the December 15, 2020 *Task 5.2 Receiving Water Quality Model Development and Calibration Report*
(3) CSO phosphorus concentration from Cottage Farm Effluent Sampling Data 1992-2000
(4) SW phosphorus concentration from Cambridge Department of Public Works Report: *Partial Sewer Separation Report Model Calibration Report*

Report. As described in both reports, these values were based on sampling data and calibration of the water quality model to in-receiving water concentrations.

Table 3-19 also presents the predicted net change in phosphorus loading to the river. The phosphorus concentration used for CSO was 1.77 mg/L, based on Cottage Farm sampling data collected from 1992 through 2000. The phosphorus concentration used for stormwater was 0.20 mg/L, taken from the *Cambridge Department of Public Works Report: Partial Sewer Separation Report Model Calibration Report*, prepared by Stantec, dated March 11, 2022.

As indicated in Table 3-19, without treatment of the additional stormwater, the sewer separation and stormwater removal alternative would result in an increase in the bacteria loading to the river of 1,745 x 10^{10} counts for *E. coli*, and 1,302 x 10^{10} counts for *Enterococcus* for the Typical Year. In addition, the net loading of phosphorus to the river would increase by 49.5 lbs in the Typical Year. For perspective on the phosphorus loading, the phosphorus total maximum daily load (TMDL) for the Charles River is 19,544 kg[7], or approximately 43,000 lbs. The additional 49.5 lbs would represent an increase of approximately 0.1%.

As noted above under Section 3.1, based on input received from the MassDEP, stormwater discharged as a result of sewer separation would not be considered a "new discharge" under the stormwater regulations but would be considered an "increased discharge". Since the Charles River has an approved TMDL for phosphorus, any increase in phosphorus load that was not included in the TMDL would need to be removed. The regulations include some flexibility in that the location of load removal does not have to be at the location of increased discharge, as long as the load removal occurs somewhere in the watershed.

[7] Final Nutrient TMDL Development for the Lower Charles River Basin, Massachusetts June 2003

Based on these requirements, it was assumed that the sewer separation alternative would require treatment of the additional stormwater discharged as a result of the sewer separation work. The technology, efficacy, configuration, space requirements, and feasibility of providing treatment of the additional stormwater have not been assessed.

In addition to the adverse pollutant loading impacts, sewer separation construction work would be disruptive to the residents and businesses located within the 132-acre project area.

Preliminary estimated construction costs were developed for the sewer separation alternative based on sewer separation costs per acre provided by the BWSC for ongoing work in South and East Boston, as well as separation costs developed by the City of Somerville. A concept-level unit cost for stormwater treatment was developed by the City of Cambridge. The bases of these costs are documented in the August 23, 2024 *Alternatives Costing Methodology and Unit Prices Technical Memorandum* prepared by Dewberry. Additional costs were included to account for the construction of three new stormwater conduits that would siphon under Storrow Drive and tie into the existing MWR018, MWR019 and MWR020 outfalls. The preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for this alternative are summarized in Table 3-20.

Table 3-20. MWR018/019/020 Sewer Separation Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost ($2024)(1)	Annual CSO Volume Reduction (MG)(2)	Cost/Gallon CSO Reduction ($/gal)(2)
Sewer Separation (97 ac.) and Stormwater Relocation (35 ac.)	$115M	0.65	$177/gal

Notes:
(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operation and maintenance costs are not included.
(2) Based on the Typical Year.

Limited Stormwater Acceptance

For the Limited Stormwater Acceptance (LSA) alternative, separate storm drains connected to the OSBC were identified, and the impact of relocating those connections to the Stony Brook Conduit (SBC) on activation frequency and volume at outfalls MWR018, MWR019 and MWR020 was assessed. The separate storm drains were identified using GIS and pipe location drawings provided by the BWSC.

A total of 20 separate storm drain areas were initially identified as possible locations for implementation of the LSA concept. After evaluation of each location, four were selected as having the largest contributing area and were analyzed further. These four locations are identified in Figure 3-17 as "8", "7", "3f", and "5". These connections were analyzed sequentially starting with the largest contributing area to the smallest contributing area to assess the performance at outfalls MWR018, MWR019 and MWR020. The tributary areas for these four locations are summarized in Table 3-21.

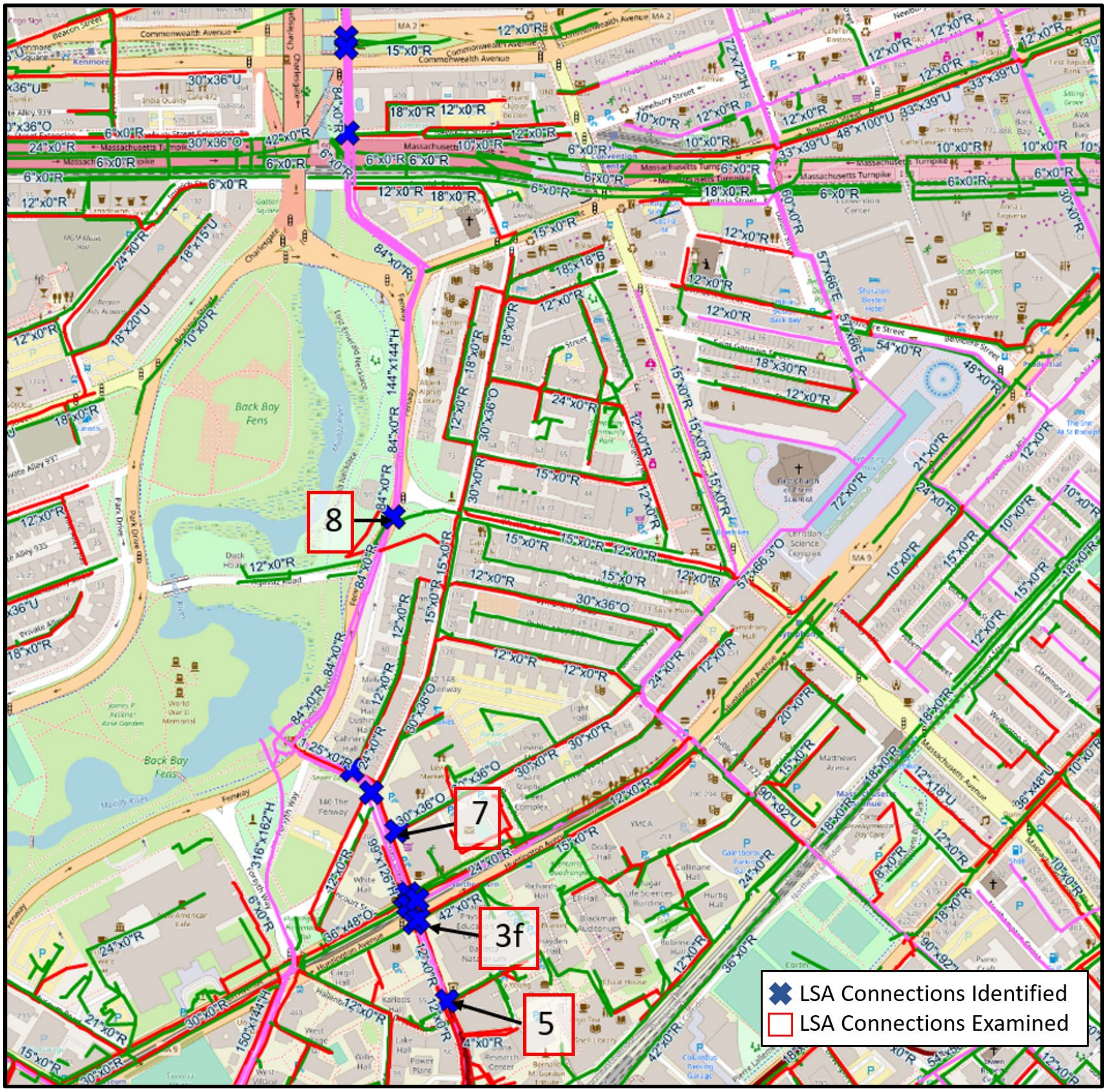

Figure 3-17. Potential Locations for LSA Concept Implementation

Table 3-21. Subcatchment Areas Upstream of Potential LSA Connection Locations

Connection ID	Separate Stormwater Subcatchment Area (acres)
8	32.5
3f	26.3
7	7.7
5	5.5

Figure 3-18 presents a schematic of the configuration of the LSA 8 location and how it was modeled. Currently the existing stormwater pipe (shown in green) connects directly to the OSBC via a 48-inch pipe. The alternative would reduce the size of the existing connection to either a 12 or 18-inch pipe with a flap gate to prevent backflow from the OSBC. The smaller connection would allow small rain events to continue to be conveyed to the OSBC. A new 48-inch connection would be constructed over the OSBC into the SBC allowing larger rain events to be conveyed to the SBC. The pipe configuration would need to be further refined if this alternative is further pursued. The connections for LSA connections 5, 7, and 3f were modeled using a configuration similar to LSA 8.

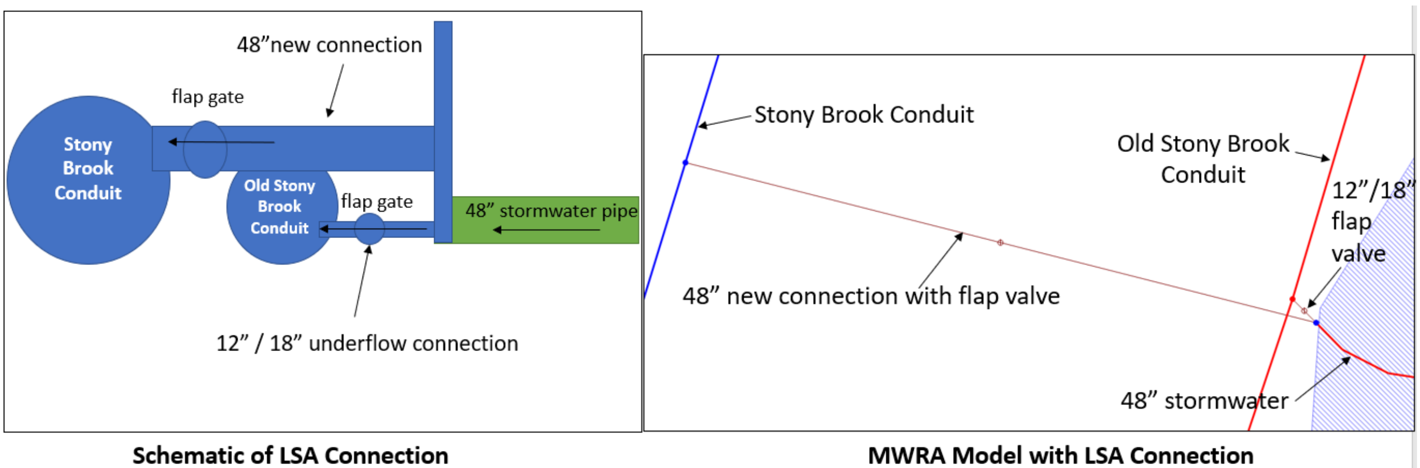

Figure 3-18. Schematic of the LSA 8 Alternative Connection and Modeling Configuration

In developing this alternative, the first step was to evaluate the size of the connection from the existing storm drain to the OSBC for LSA 8. The model was run with both the 18-inch connection at LSA 8 and the 12-inch connection. Both connections reduced the activation frequency and volume at outfalls MWR018, MWR019 and MWR020, but the 12-inch connection was more effective in reducing the volume and activation frequency. LSA 8 with the 12-inch connection was then combined with relocating the stormwater at connection 5, then 5 and 7, and 5, 7 and 3f. Table 3-22 presents a comparison of CSO activation frequencies and volumes for the Typical Year for the LSA alternative configurations.

As indicated in Table 3-22, relocating the LSA 8 connection alone would offer the largest benefit in reducing the CSO volumes at outfalls MWR018 and MWR019 and would eliminate the two activations at outfall MWR020 in the Typical Year. Relocating the stormwater from connections 5, 7, and 3f would only provide marginal additional benefit due to the small amount of stormwater that would be relocated.

Relocating LSA 8 was then simulated for the 5-year, 24-hour storm to analyze impacts on the HGL with and without the gates open at the Boston Gate House # 1 (BGH #1). BGH #1 is located on the Stony Brook Conduit approximately 1,200 feet upstream of the evaluated LSA 8 connection. BGH#1 can be overtopped resulting in CSO discharge to BOS046, should upstream regulators in the BOS046 system also be active. In addition, during substantial storm events BWSC may manually open this gate for flood mitigation. Figure 3-19 shows the peak HGL in the 5-year, 24-hour storm with BGH #1 open for the baseline condition (blue line) and with LSA 8 (green line). In this profile view, the 48-inch stormwater pipe ties directly into the OSBC for the baseline condition, while for the LSA 8 alternative the connection is made with a 12-inch diameter pipe. The overflow pipe to the SBC for the LSA 8 alternative is not shown on the profile. As indicated in Figure 3-19, LSA 8 was predicted to result in a substantial drop in the peak HGL in the 48-inch tributary stormwater system, and a slight drop in the peak HGL in the OSBC in the 5-year, 24-hour storm with BGH #1 open.

Table 3-22. Impact of LSA Alternatives on Outfalls MWR018, MWR019 and MWR020

Outfall	Typical Year													
	Q1-2023 System Conditions(1)		Q1-2023 LSA 8 18-inch Connection(1)		Q1-2023 LSA 8 12-inch Connection(1)		Q1-2023 LSA 8 (12 inch) + 3f(1)		Q1-2023 LSA 8 (12-inch) + 3f + 7(1)		Q1-2023 LSA 8 (12-inch) + 3f + 7 + 5(1)		Long-Term Control Plan	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
MWR018	2	0.44	2	0.37	2	0.34	2	0.32	2	0.32	2	0.32	0	0.00
MWR019	2	0.18	2	0.12	2	0.10	2	0.09	2	0.08	2	0.08	0	0.00
MWR020	2	0.03	1	0.01	0	0	0	0	0	0	0	0	0	0.00

Notes:

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

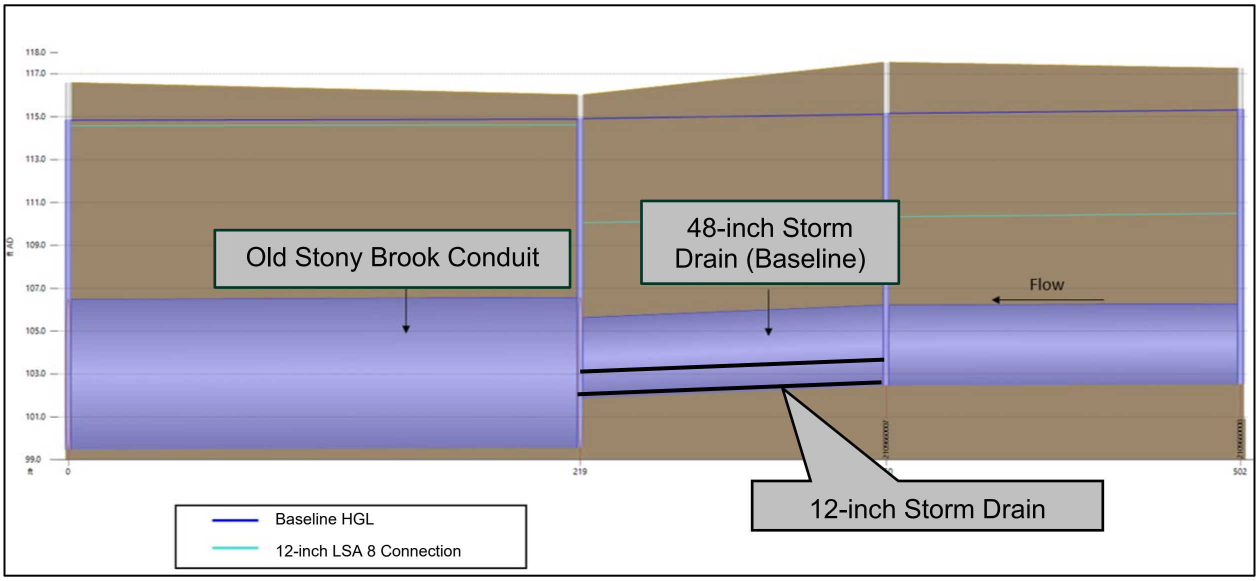

Figure 3-19. Baseline vs. LSA 8 for 5-Year, 24-Hour Storm (BGH #1 Gates Open)

Figure 3-20 shows the peak HGL in the 5-year, 24-hour storm with BGH #1 closed for the baseline condition (purple line) and with LSA 8 (green line). As with the previous profile view, the 48-inch stormwater pipe ties directly into the OSBC for the baseline condition, while for the LSA 8 alternative the connection is made with a 12-inch diameter pipe. The overflow pipe to the SBC for the LSA 8 alternative is not shown on the profile. As indicated in Figure 3-20, LSA 8 was predicted to result in a drop in the peak HGL in both the 48-inch tributary stormwater system and in the OSBC in the 5-year, 24-hour storm with BGH #1 closed, but the reduction in the HGL in the 48-inch upstream tributary stormwater system was not as pronounced as with BGH #1 open. The LSA 8 alternative was not predicted to have adverse HGL impacts in the Stony Brook Conduit in the 5-year, 24-hour storm.

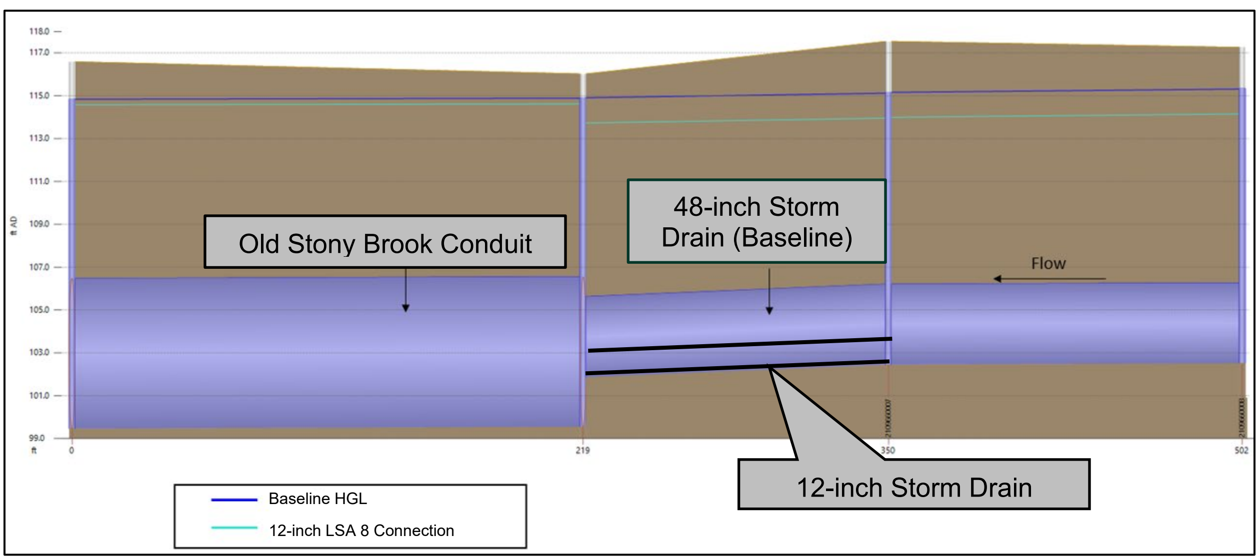

Figure 3-20. Baseline vs. LSA 8 for 5-Year, 24-Hour Storm (BGH #1 Gates Closed)

Although the LSA 8 alternative would reduce the CSO discharge to the Charles River, it would contribute additional stormwater to the river by increasing the stormwater discharged from the SBC at outfall MWR023. The alternative was projected to result in a net increase in both the bacteria and phosphorus loadings to the Charles River if treatment of the additional stormwater was not provided. The water quality impacts of the changes in loadings were not evaluated.

Table 3-23 presents the loading calculations for this alternative compared to the Baseline Conditions. As indicated in Table 3-23, the LSA 8 alternative is predicted to reduce total CSO discharge to the Charles River by 0.21 MG/yr, and increase the volume of stormwater to the Charles River by 2.53 MG/yr. Concentrations of *E. coli* and *Enterococcus* bacteria in the untreated MWR018/019/020 CSO were taken from Table 3-2 from the August 27, 2021 *Task 5.3 Water Quality Assessment Report.* Concentrations of *E. coli* and *Enterococcus* bacteria in untreated stormwater were taken from the *December 15, 2020 Task 5.2 Receiving Water Quality Model Development and Calibration Report.* As described in both reports, these values were based on sampling data and calibration of the water quality model to in-receiving water concentrations. The values from that report were used in Table 3-23 below to compute the net change in bacterial loading for the sewer separation alternative.

Table 3-23 also presents the predicted net change in phosphorus loading to the river. The phosphorus concentration used for CSO was 1.77 mg/L, based on Cottage Farm sampling data collected from 1992 through 2000. The phosphorus concentration used for stormwater was 0.20 mg/L, taken from the *Cambridge Department of Public Works Report: Partial Sewer Separation Report Model Calibration Report*, prepared by Stantec, dated March 11, 2022.

Table 3-23. LSA 8 Alternative: Net Bacteria and Phosphorus Loading

Source	Typical Year Volume Change (MG)	*E. coli* Concentration (MPN/100 mL)	Typical Year Change in *E. coli* Loading (Counts x 10^{10})	*Enterococcus* Concentration (MPN/100 mL)	Typical Year Change in *Enterococcus* Loading (Counts x 10^{10})	Phosphorus Concentration (mg/L)	Typical Year Change in Phosphorus Loading (lbs)
MWR018 CSO	-0.10	42,197(1)	-16	13,996(1)	-5	1.77(3)	-1.5
MWR019 CSO	-0.08	84,959(1)	-13	20,056(1)	-4	1.77(3)	-1.2
MWR020 CSO	-0.03	32,032(1)	-5	12,555(1)	-2	1.77(3)	-0.4
SW	2.53	14,000(2)	134	10,000(2)	96	0.20(4)	4.2
Net Change			**+101**		**+85**		**+1.1**

Notes:
(1) *E. coli* and *Enterococcus* concentrations from Table 3-2 from the August 27, 2021 *Task 5.3 Water Quality Assessment Report*
(2) *E. coli* and *Enterococcus* stormwater concentrations from Table 4-7 from the December 15, 2020 *Task 5.2 Receiving Water Quality Model Development and Calibration Report*
(3) CSO phosphorus concentration from Cottage Farm Effluent Sampling Data 1992-2000
(4) SW phosphorus concentration from Cambridge Department of Public Works Report: *Partial Sewer Separation Report Model Calibration Report*

As indicated in Table 3-23, without treatment of the additional stormwater, the LSA 8 alternative would result in an increase in the bacteria loading to the river of 101 x 10^{10} counts for *E. coli*, and 85 x 10^{10} counts for *Enterococcus* in the Typical Year. In addition, the net loading of phosphorus to the river would increase by 1.1 lbs.

As noted above, based on input received from the MassDEP, stormwater discharged as a result of sewer separation would not be considered a “new discharge” under the stormwater regulations but would be considered an “increased discharge”. Since the Charles River has an approved TMDL for phosphorus, any increase in phosphorus load that was not included in the TMDL would need to be removed. The regulations include some flexibility in that the location of load removal does not have to be at the location of increased discharge, as long as the load removal occurs somewhere in the watershed.

Based on these requirements, it was assumed that the LSA 8 alternative would require treatment of the additional stormwater discharged as a result of the sewer separation work, or treatment of a similar volume of stormwater discharging to the Charles River in a different location. The technology, efficacy, configuration, space requirements, and feasibility of providing treatment of the additional stormwater have not been assessed.

The preliminary estimated capital cost for the LSA 8 stormwater relocation alternative, annual CSO volume reduction, and cost per gallon of CSO reduction are summarized in Table 3-24. The estimated cost includes an allowance for stormwater treatment. As noted above, this alternative was not sufficient to meet the LTCP goals at outfalls MWR018, MWR019 and MWR020.

Table 3-24. LSA 8 Stormwater Relocation Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost ($2023)(1)	Annual CSO Volume Reduction (MG) (2)	Cost/Gallon CSO Reduction ($/gal) (2)
LSA8 Stormwater Relocation	$6.8M	0.21	$32/gal

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operations and maintenance costs are not included.

(2) Based on the Typical Year.

Green Infrastructure

The analysis of green infrastructure alternatives for outfalls MWR018, MWR019 and MWR020 was based on infiltrating flow from existing separate storm drains that currently discharge to the combined sewer system tributary to the MWR018, MWR019 and MWR020 outfalls using sub-surface infiltration basins. As noted in the 2022 Annual Report, this area of the model was updated to incorporate elements of the BWSC model to further define the location of the separate stormwater areas that were available to be routed to green infrastructure.

Delineation of the stormwater areas that could be directly captured by green infrastructure included an assessment of roof runoff. For residences with existing exterior downspouts observed from aerial imagery, it was assumed that half of the runoff from the roof would reach the separate storm drain, whereas the other half would infiltrate into other pervious surfaces such as backyards. The delineated stormwater areas tributary to the green infrastructure totaled 61.5 acres as shown in Figure 3-21.

Refer to Section 3.1 above for a description of how the green infrastructure was represented in the model. Infiltration rates were based on information available from the Stony Brook model with a 0.5 in/hr maximum exfiltration rate and a 0.25 in/hr minimum exfiltration rate. It was assumed that hydrodynamic separators would be provided with each infiltration basin to reduce the build-up of solids within the basins.

Model results indicated that with 327 infiltration basins installed, and no restriction on the maximum size of the infiltration basins, the LTCP goals would be achieved at outfalls MWR019 and MWR020, but not at outfall MWR018 (Table 3-25). However, constructability concerns with regard to utility conflicts and roadway disruptions would likely limit the maximum size of the infiltration basins that could feasibly be installed. With the maximum dimensions of each infiltration unit limited to 10 ft wide by 25 ft long by 4 ft deep (1,000 cf of volume), outfalls MWR018 and MWR020 would not meet the LTCP activation frequency goal (Table 3-25). It is noted that with the size of the GI units restricted the total volume increased by 0.03 MG compared to when the size of the GI units was not restricted.

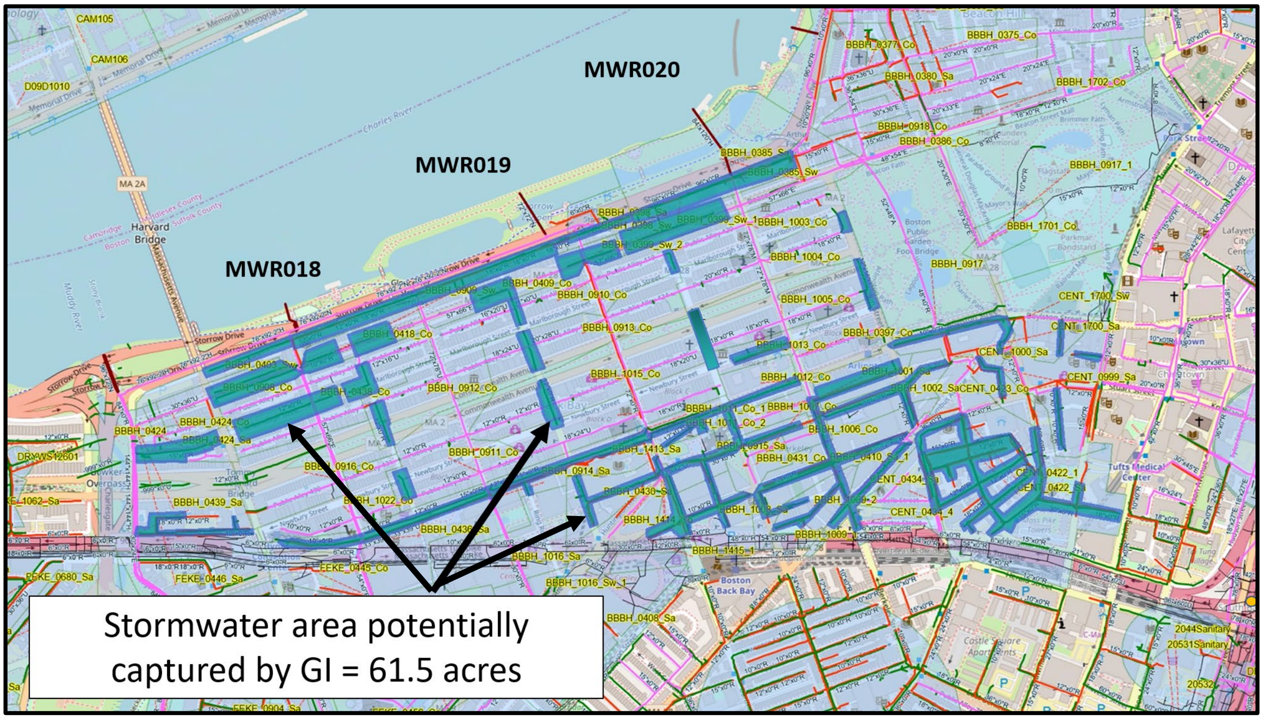

Figure 3-21. MWR018, MWR019 and MWR020 Separate Stormwater Areas Identified for Green Infrastructure

Table 3-25. MWR018, MWR019 and MWR020 Green Infrastructure Typical Year Results

Outfall	Typical Year							
	Q1-2023 System Conditions(1)		Q1-2023 MWR018/019/020 GI 327 Units No Size Limit(1)		Q1-2023 MWR018/019/020 GI 327 Units 10 ft x 25 ft x 4 ft(1)		LTCP	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
MWR018	2	0.43	2	0.20	2	0.19	0	0
MWR019	2	0.18	0	0	0	0	0	0
MWR020	2	0.04	0	0	1	0.04	0	0

Notes:

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

Table 3-26 presents the preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for the GI alternative with the size of the infiltration basins restricted. As noted above, this alternative was not sufficient to meet the LTCP goals at outfalls MWR018 and MWR020.

Table 3-26. MWR018, MWR019 and MWR020 GI Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost ($2024)(1)	Annual CSO Volume Reduction (MG) (2)	Cost/Gallon CSO Reduction ($/gal) (2)
GI including 327 units 10 ft x 25 ft x 4 ft	$96M	0.42	$229/gal

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operation and maintenance costs are not included.

(2) Based on the Typical Year.

Limited Stormwater Acceptance and Green Infrastructure

After evaluating LSA and GI individually these alternatives were combined to evaluate their impact on activation frequency and volume at outfalls MWR018, MWR019 and MWR020. Limited Stormwater Alternative LSA 8 was combined with each of the two GI alternatives (with unrestricted infiltration basin size and with infiltration basin size restricted to 10 ft x 25 ft x 4 ft to store 1,000 cf). Table 3-27 presents the Typical Year results for the Q1-2023 Baseline, LSA 8 with 18-inch connection (from Table 3-22), 327 units of 10 x 25 x 4-ft GI infiltration basins (from Table 3-25), and the combination of LSA 8 and the 327 units of GI alternatives. As shown in Table 3-27, adding the GI to LSA 8 improved the performance compared with LSA 8 alone, but did not appreciably change the performance compared to the GI alone.

Table 3-27. MWR018/019/020 LSA and GI Combined Typical Year Results

Outfall	Q1-2023 System Conditions(1)		Q1-2023 LSA 8 18-inch Connection(1)		Q1-2023 GI 327 Units at 10 ft x 25 ft x 4 ft(1)		Q1-2023 LSA 8 18-inch + GI 327 Units 10 ft x 25 ft x 4 ft(1)		LTCP	
	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)	Act. Freq.	Vol. (MG)
MWR018	2	0.43	2	0.37	2	0.19	2	0.13	0	0.00
MWR019	2	0.18	2	0.12	0	0	0	0	0	0.00
MWR020	2	0.04	1	0.01	1	0.04	0	0	0	0.00

Notes:

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

The preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for the LSA 8 stormwater relocation alternative plus GI are summarized in Table 3-28. As noted above, this alternative was not sufficient to meet the LTCP goals at outfall MWR018.

Table 3-28. MWR018/019/020 LSA 8 Stormwater Relocation and GI Combined Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost ($2024)(1)	Annual CSO Volume Reduction (MG) (2)	Cost/Gallon CSO Reduction ($/gal)(2)
LSA 8 18-inch Stormwater Relocation + GI (327 units at 10 ft x 25 ft x 4 ft)	$103M	0.52	$198/gal

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operation and maintenance costs are not included.

(2) Based on the Typical Year.

CSO Storage

CSO storage in the form of a rectangular box storage conduit or microtunneled storage conduit was investigated to meet LTCP goals at outfalls MWR018, MWR019 and MWR020. For the storage conduit alternatives, it was assumed that a single facility would be provided to capture the volume from all three outfalls, rather than having individual storage facilities for each outfall. Therefore, to size the storage facility, an initial assessment was made as to whether a diversion structure could be configured for outfall MWR018 such that all of the overflow in the Typical Year could be conveyed out of outfall MWR018. This approach would eliminate the need to construct diversion chambers on outfalls MWR019 and MWR020. As noted above, under the current configuration, the controlling discharge elevation at outfall MWR018 is the elevation of the stop logs located downstream of the large weir structure. The elevation of the stop logs relative to the walls and roof slab of the stop log structure create a hydraulic restriction in the MWR018 outfall. By configuring a diversion structure into a storage facility that would have less of a restriction, a higher flow rate could pass into the storage facility than could currently discharge through the existing outfall. As a result, outfall MWR018 could serve as the single point of relief from the BMC, allowing the weirs at outfalls MWR019 and MWR020 to be raised to the level that no discharge occurred at those outfalls in the Typical Year. This configuration was found to have no adverse HGL impacts in the 5-year, 24-hour storm.

With this configuration, the largest discharge at outfall MWR018 during the Typical Year was used to estimate the size of the storage needed. Table 3-29 presents the Typical Year activation frequency and volume at outfalls MWR018, MWR019 and MWR020 for Q1-2023 Baseline Conditions compared to the configuration with the outfalls modified for diverting to storage at outfall MWR018 as described above. As indicated in Table 3-29, consolidating the flows to outfall MWR018 was predicted to increase the total volume from 0.65 to 1.4 MG for the Typical Year. It should be noted that even if individual storage facilities were to be provided for each outfall, the volumes going into each individual tank would likely be larger than the volumes currently discharged, as the diversion structures into the tanks would be similarly configured to relieve the existing hydraulic restrictions in the outfalls.

Table 3-29. Outfalls MWR018, MWR019 and MWR020 Q1-2023 Conditions and Consolidated MWR018 Configuration, Typical Year

Outfall	Typical Year					
	Q1 2023 System Conditions		Q1 2023 Consolidated MWR018		Long-Term Control Plan	
	Act Freq	Vol (MG)	Act Freq	Vol (MG)	Act Freq	Vol (MG)
MWR018	2	0.43	3	1.40	0	0
MWR019	2	0.18	0	0	0	0
MWR020	2	0.04	0	0	0	0
Total		0.65		1.40		0

Table 3-30 presents the volume of discharge for the three storms that would cause activations at the consolidated outfall MWR018 in the Typical Year. As indicated in Table 3-30, providing a storage volume of 0.84 MG which would store the largest storm in the Typical Year would be sufficient to meet the LTCP target of no discharge in the Typical Year.

Table 3-30. Consolidated MWR018 Q1-2023 Conditions Typical Year Activations and Storage Requirements to Meet LTCP Goal

Consolidated MWR018 Q1-2023 Typical Year Activations				
Date	**Duration (hr)**	**Consolidated MWR018 Q1-2023 CSO Volume (MG)**	**Approximate Storage Volume Required to Meet LTCP Goal (MG)**	**Remaining CSO Volume**
8/18	0.5	0.04	0.84	0
9/23	1.3	0.84		0
10/23	1	0.52		0
Total Vol. (MG)		1.40		0

The existing MWR018 weir structure is located in the Charles River Esplanade by the Stoneman Playground, just north of Hereford Street. Constraints to siting storage adjacent to outfall MWR018 would include below-grade infrastructure, disruptions to the park and playground, the need for Article 97 legislation to use the parkland for non-park purposes, and the presence of mature trees. Vehicle access to the park/playground area would be required for long term maintenance and a permanent above ground odor control/electrical building would be required in the parkland. Two conceptual storage layouts were developed at this location, one featuring a rectangular box conduit, generally similar to the configuration of MWRA's BOS019 facility, and one as a microtunneled conduit storage.

Figure 3-22 presents a conceptual layout of the 0.84 MG rectangular box conduit storage between the BMC and the Charles River. The overall dimensions of the storage facility would be approximately 40 feet wide by 240 feet long. The facility would include an influent channel and flushing system, three 10 feet wide by 17 feet high by 190 feet long parallel box storage conduits, and a 0.84 MGD dewatering facility. A diversion structure on the MWR018 outfall pipe would direct overflow into the storage facility. The intent would be to capture overflow until the storage facility is full, then additional flows would discharge to the Charles River through the existing MWR018 outfall. After the storm, the facility would be dewatered to the BMC by the dewatering pumps located at one end of the facility. Further investigation into the feasibility of this location would need to be conducted.

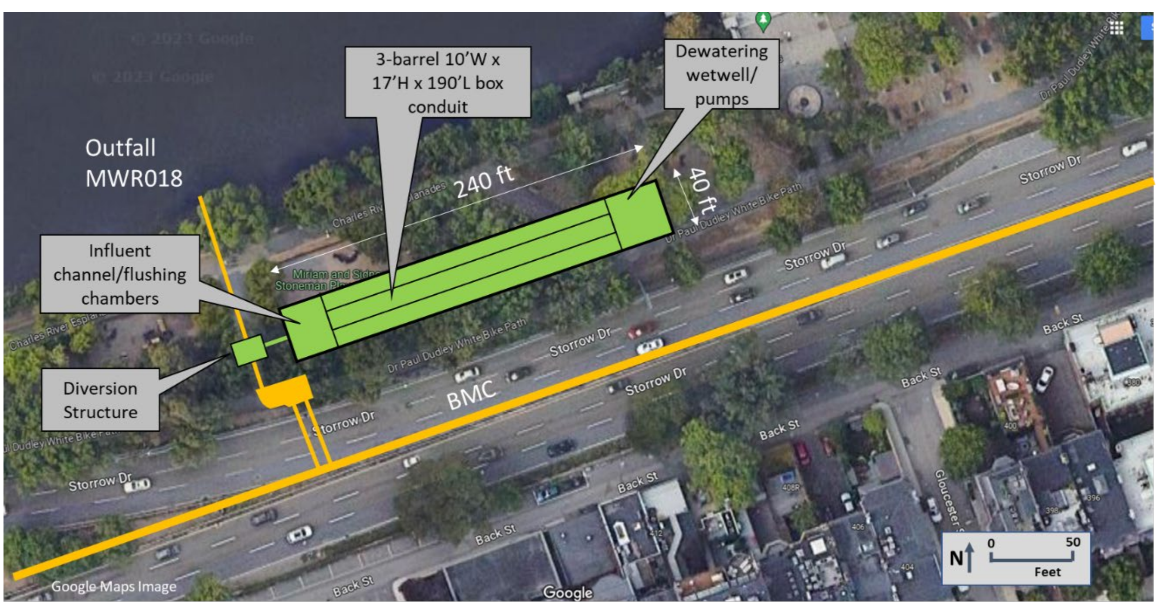

Figure 3-22. Box Conduit Storage Layout at Outfall MWR018

Figure 3-23 presents the layout of a 0.84 MG microtunneled storage conduit running between outfall MWR018 and a location part way between outfalls MWR019 and MWR020 along the Charles River Esplanade. The conduit would be 2,900 feet long and 7 feet in diameter. A 0.84 MGD dewatering pump station would be required at one end of the conduit to dewater the contents back to the BMC after a storm event. This alternative would require jacking/receiving shafts at the upstream and downstream end, and potentially two intermediate shafts. The feasibility of locating the shafts along the spit of land in between the Storrow Lagoon and the Charles River would need further investigation.

The preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for these alternatives are summarized in Table 3-31. Costs would need to be further refined based on the number and location of launching and receiving shafts, dewatering requirements, geotechnical conditions, utility relocation and other variables that would be further defined during the next phase of project development if this alternative were to be considered for implementation.

Figure 3-23. Microtunneled Conduit Storage Layout at Outfall MWR018

Table 3-31. Outfalls MWR018, MWR019 and MWR020 Storage Alternatives – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost ($2024)(1)	Annual CSO Volume Reduction (MG) (2)	Cost/Gallon CSO Reduction ($/gal)(2)
0.84 MG Box Storage Conduit	$63M	0.65	$97/gal
0.84 MG Microtunneled Storage Conduit	$51M	0.65	$78/gal

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operation and maintenance costs are not included.

(2) Based on the Typical Year.

Summary and Conclusions

Table 3-32 presents a summary of the alternatives evaluated to meet the LTCP goals at outfalls MWR018, MWR019 and MWR020. As indicated in Table 3-32, the sewer separation, box storage conduit, and microtunneled storage conduit alternatives are predicted to meet the LTCP goals for CSO activation and volume at outfalls MWR018, MWR019 and MWR020. Sewer separation (132 acres) is estimated to have a much higher construction cost than the storage alternatives, would result in net increases in phosphorus and bacteria loading to the Charles River if treatment of the additional stormwater is not provided, and would create widespread construction-period disruption to residents and businesses in the Back Bay tributary area, while providing a relatively nominal reduction in CSO discharge at outfalls MWR018, MWR019 and MWR020. The storage alternatives would provide a similar nominal reduction in CSO volume, but at a lower cost compared to sewer separation, and without the net increase in phosphorus and bacterial loads and the widespread construction impacts associated with the sewer separation alternative. The microtunneled storage conduit and the box storage conduit alternatives would provide the same level of performance in terms of reductions in CSO activation frequency and volume, but would still carry significant capital costs ($51 to $63M), would have significant permitting challenges and construction impacts to the Esplanade area, and are not likely to result in a measurable improvement in water quality in the Charles River. In addition, the duration for implementation of these alternatives (planning/design/ construction) would likely extend beyond five years.

Under the 2024 Charles River Variance issued by the MassDEP in August 2024 and pending approval from EPA, MWRA will be evaluating alternatives for higher levels of CSO control for outfalls MWR018, MWR019 and MWR020 based on a new Typical Year and design storms developed using 2050 projections of rainfall that incorporate climate change impacts. Given the costs and limited CSO reduction benefit associated with the alternatives to meet the LTCP goals at outfalls MWR018, MWR019 and MWR020 summarized in Table 3-32 below, and the potential for those alternatives to interfere with or be redundant with alternatives for achieving higher levels of control that may be identified as part of the Updated CSO Control Plan under the 2024 Charles River Variance, no further action is proposed towards improving performance at outfalls MWR018, MWR019 and MWR020 for the 1992 Typical Year at this time.

Table 3-32. Summary of Alternatives to Meet LTCP Goals for Outfalls MWR018, MWR019 and MWR020

Alternative	Meets LTCP Goals ?	Comments	Preliminary Estimated Capital Cost (2024 dollars)[1]	Benefit				$/gallon in Typical Year
				Parameter	From	To	Reduction	
Remove Restrictions from Roxbury Canal Sewer	No	Alternative eliminated due to projected increase in HGL in the 5-year, 24-hour storm	N/A	Activation Frequency	N/A	N/A	N/A	N/A
				Total Vol. for MWR018/019/ 020 (MG)	N/A	N/A	N/A	N/A
Sewer Separation (97 ac.) and Stormwater Relocation (35 ac.)	Yes	Treatment of additional stormwater would be required to avoid net increase in phosphorus and bacteria loading. Assumes new storm drains would cross under BMC and tie into existing outfalls. Additional evaluations on the feasibility of routing new storm drains to existing outfalls would be needed.	$115 million	Activation Frequency	MWR018: 2 MWR019: 2 MWR020: 2	MWR018: 0 MWR019: 0 MWR020: 0	MWR018: 2 MWR019: 2 MWR020: 2	$177
				Total Vol. for MWR018/019/ 020 (MG)	0.65	0.00	0.65	
Relocate Stormwater from OSBC to SBC with Limited Stormwater Connection to OSBC	No	Results in net increase in bacteria and phosphorus loads to Charles River unless stormwater treatment is provided	$6.8 million	Activation Frequency	MWR018: 2 MWR019: 2 MWR020: 2	MWR018: 2 MWR019: 2 MWR020: 0	MWR018: 0 MWR019: 0 MWR020: 2	
				Total Vol. for MWR018/019/ 020 (MG)	0.65	0.44	0.21	$32

Table 3-32. Summary of Alternatives to Meet LTCP Goals for Outfalls MWR018, MWR019 and MWR020

Alternative	Meets LTCP Goals ?	Comments	Preliminary Estimated Capital Cost (2024 dollars)[(1)]	Benefit				$/gallon in Typical Year
				Parameter	From	To	Reduction	
Green Infrastructure: Stormwater Infiltration (327 units) with size capped and hydrodynamic separators[(2)]	No	Additional investigations into soil and ground water conditions and potential sanitary connections to storm drains needed to assess feasibility.	$96 million	Activation Frequency	MWR018: 2 MWR019: 2 MWR020: 2	MWR018: 2 MWR019: 2 MWR020: 0	MWR018: 0 MWR019: 0 MWR020: 2	$229
				Total Vol. for MWR018/019/020 (MG)	0.65	0.23	0.42	
GI + Stormwater Relocation	No	High additional cost with nominal improvement compared to stormwater relocation without GI	$103 million	Activation Frequency	MWR018: 2 MWR019: 2 MWR020: 2	MWR018: 2 MWR019: 0 MWR020: 0	MWR018: 0 MWR019: 2 MWR020: 2	$198
				Total Vol. for MWR018/019/020 (MG)	0.65	0.13	0.52	
Box Conduit Storage (0.84 MG)	Yes	Located in park land potential need for Article 97 legislation	$63 million	Activation Frequency	MWR018: 2 MWR019: 2 MWR020: 2	MWR018: 0 MWR019: 0 MWR020: 0	MWR018: 2 MWR019: 2 MWR020: 2	$97
				Total Vol. for MWR018/019/020 (MG)	0.65	0.00	0.65	
Microtunneled Storage Conduit (0.84 MG, 7 ft diameter, 2,900 feet long)	Yes	Located in park land potential need for Article 97 legislation	$51 million	Activation Frequency	MWR018: 2 MWR019: 2 MWR020: 2	MWR018: 0 MWR019: 0 MWR020: 0	MWR018: 2 MWR019: 2 MWR020: 2	$78
				Total Vol. for MWR018/019/020 (MG)	0.65	0.00	0.65	

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operations and maintenance costs are not included.

(2) Assumes maximum infiltration unit dimensions of 10 ft wide by 25 ft long by 4 ft deep.

3.4 Outfall MWR201 (Cottage Farm CSO Facility)

The Cottage Farm CSO Facility provides relief to the North Charles Metropolitan Sewer/Relief Sewer (NCRS) and to the South Charles Relief Sewer (SCRS), and functions as the primary upstream relief point when Ward Street Headworks capacity is exceeded and the Headworks must choke incoming flow, given the downstream tunnel and Deer Island Treatment capacity. Overflow enters the Cottage Farm Facility when flow from the interceptors overtops the interconnected NCRS and/or SCRS weir chambers and a high-level set point is reached at the facility influent structure, notifying operations staff to open the influent gates, activating the facility. A gate on the Brookline Connection (which runs directly from the Cottage Farm Facility to the junction chamber on the other side of the river) is manually operated to maximize flow to Ward Street Headworks in the open position and prevent flow from Ward Street Headworks from backing up into the facility in the closed position. Flows into the Cottage Farm facility receive screening, sedimentation, disinfection and dechlorination before discharge to the Charles River. The facility has approximately 1.3 MG of storage capacity before the facility discharges to the Charles River. A schematic of the interceptor system in the vicinity of the Cottage Farm Facility is presented in Figure 3-24.

The LTCP goals for outfall MWR201 (Cottage Farm) are two activations and 6.30 MG in the Typical Year. As indicated in Table 1-3 above, at the time of submittal of the Final Assessment Report (Q4-2021 conditions), outfall MWR201 was predicted to activate two times in the Typical Year, with a total treated volume of 9.09 MG.

Since December 2021, the following model adjustments and system changes have been incorporated into the model:

- 90% Sewer Separation of a 28-acre area tributary to the MWRA interceptor downstream of outfall CAM005 in the Willard Street area by the City of Cambridge. Construction was completed in summer 2024. This sewer separation project reduces the flow to the North Charles Metropolitan Sewer which is tributary to Cottage Farm CSO Facility.
- Roxbury Phase I, II, and III sewer separation projects which included 90% separation of 116 acres. This work was completed in December 2024 by BWSC. This sewer separation project reduces the flow to Ward Street Headworks from the Boston Main Drain Relief Sewer, allowing more flow from the interceptors tributary to the Cottage Farm CSO Facility.

As a result of these system changes implemented between the Q4-2021 and Q4-2024 periods, outfall MWR201 is still predicted to activate two times in the Typical Year, but the total treated volume has been reduced by 2.37 MG to 6.72 MG. The LTCP goal is 2 activations and 6.30 MG for the Typical Year. Cottage Farm was already meeting the goal in terms of activation frequency but with Q4-2024 system conditions the treated discharge volume is now within 0.42 MG of the LTCP goal. Based on this reduction the Cottage Farm CSO Facility is now considered to be materially meeting the LTCP goals.

Evaluations of alternatives for the Cottage Farm facility were conducted in 2023, on a baseline of Q1-2023 system conditions. Some of the system changes described above for the Q4-2024 conditions had not yet been completed as of Q1-2023 conditions. As a result, the Q1-2023 conditions which served as a baseline for the MWR201 evaluations had a total annual volume in the Typical Year of 7.74 MG. While the difference between the treated discharge volumes under Q1-2023 and Q4-2024 conditions would affect the final sizing of alternatives to meet the LTCP goals for outfall MWR201, the magnitude of the differences would not be sufficient to change the conclusions from the evaluations presented below. In addition, as noted above, with the system changes associated with the Q4-2024 system conditions MWR201 (Cottage Farm) is now considered to materially meet the LTCP goals.

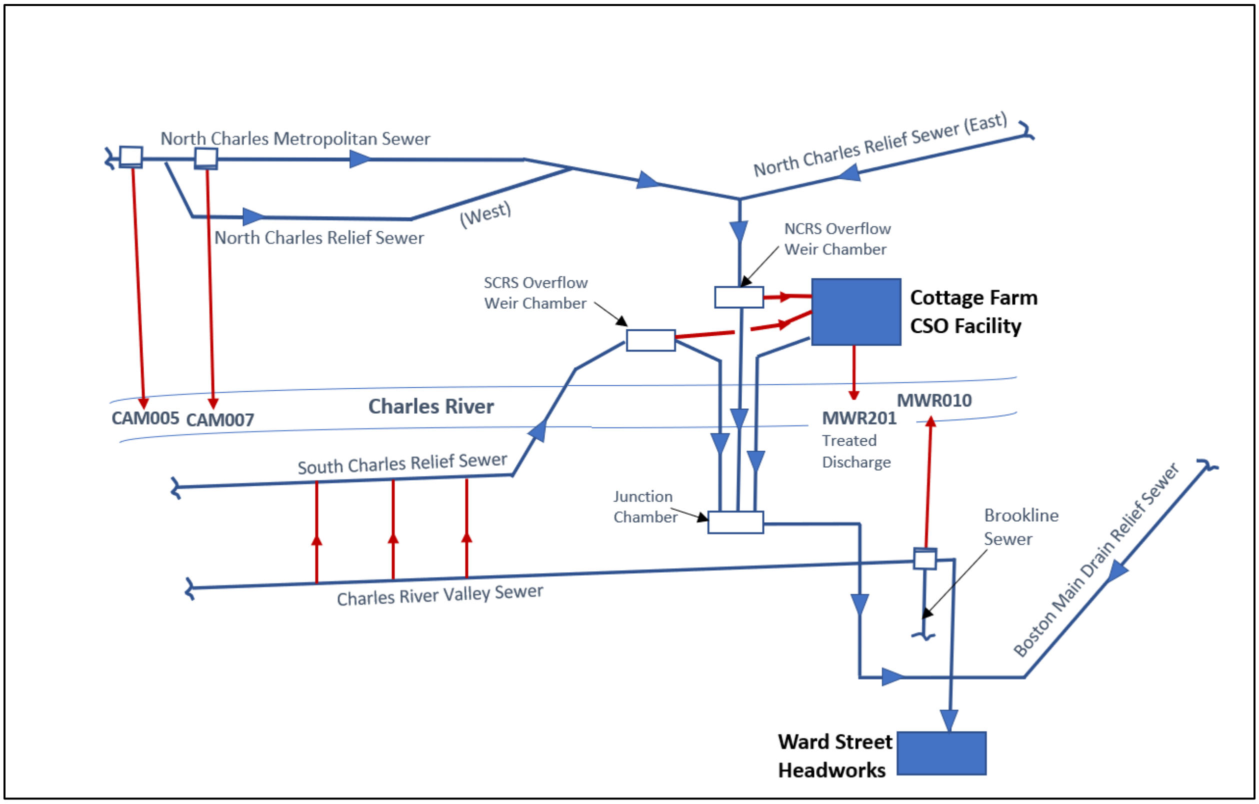

Figure 3-24. Schematic of the Charles River/Cottage Farm Sub-System

Investigations into alternatives that could allow the Cottage Farm CSO Facility to meet LTCP goals included the following:

- facility operation optimization;
- upstream sewer separation; and
- CSO storage

The evaluations of these alternatives are presented below.

Facility Operation Optimization

As part of the December 22, 2023 *Task 8.2 – 8.3: Alewife Brook and Charles River System Optimization Evaluations Report* (December 22, 2023 Report), evaluations were conducted to assess opportunities to optimize the operation of the Cottage Farm facility. The water surface elevation upstream of the facility influent gates currently dictates when the facility activates. Therefore, optimization at Cottage Farm consisted of adjusting the elevations that would trigger opening and closing the influent gates to the facility. The influent gates open when the HGL in the influent wet well reaches elevation 98 ft and close when the HGL reaches elevation 95 ft. Altering the setpoint elevations to open the influent gates when the HGL reached 98.5 feet and close the gates when the HGL reached 96 feet resulted in a reduction in treated CSO volume of 1.75 MG in the Typical Year but did not reduce the activation frequency. In practice, the gate opening and closing elevations of 98.0 and 95.0 are considered general targets. During actual storm events, MWRA facility operators consider weather forecasting and in-system conditions in operating the influent gates, and the actual gate-opening and gate-closing elevations may vary. In the December 22, 2023 report it was recommended that the MWRA continue to operate the Cottage Farm facility consistent with current practice, as defining absolute elevations for the gate opening and closing operations would not allow for consideration of the specific hydraulic and hydrologic conditions that may exist for individual storm events of the size that may cause activation of the facility.

Sewer Separation

Sewer separation of an approximately 300-acre area tributary to the closed[8] CAM011 regulator along the North Charles Relief Sewer upstream of Cottage Farm was evaluated for impact on the activation frequency and discharge volume at Cottage Farm (Figure 3-25). For the modeling evaluation, the sewer separation was assumed to remove 75% of the directly-connected impervious area. The model predicted that with 75% separation the Cottage Farm Facility discharge would decrease from 7.74 MG to 6.01 MG in the Typical Year and would therefore achieve the LTCP goal (Table 3-33).

Table 3-33. Cottage Farm Q1-2023 System Conditions, Sewer Separation, and LTCP Goals

	Typical Year					
	Q1-2023 System Conditions(1)		Q1-2023 System Conditions with 300 acres of Sewer Separation(1)		LTCP Goals	
	Act Freq	Vol (MG)	Act Freq	Vol (MG)	Act Freq	Vol (MG)
Outfall MWR201 (Cottage Farm CSO Facility)	2	7.74	2	6.01	2	6.30

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

[8] CAM011 is tentatively closed pending additional hydraulic evaluation by City of Cambridge.

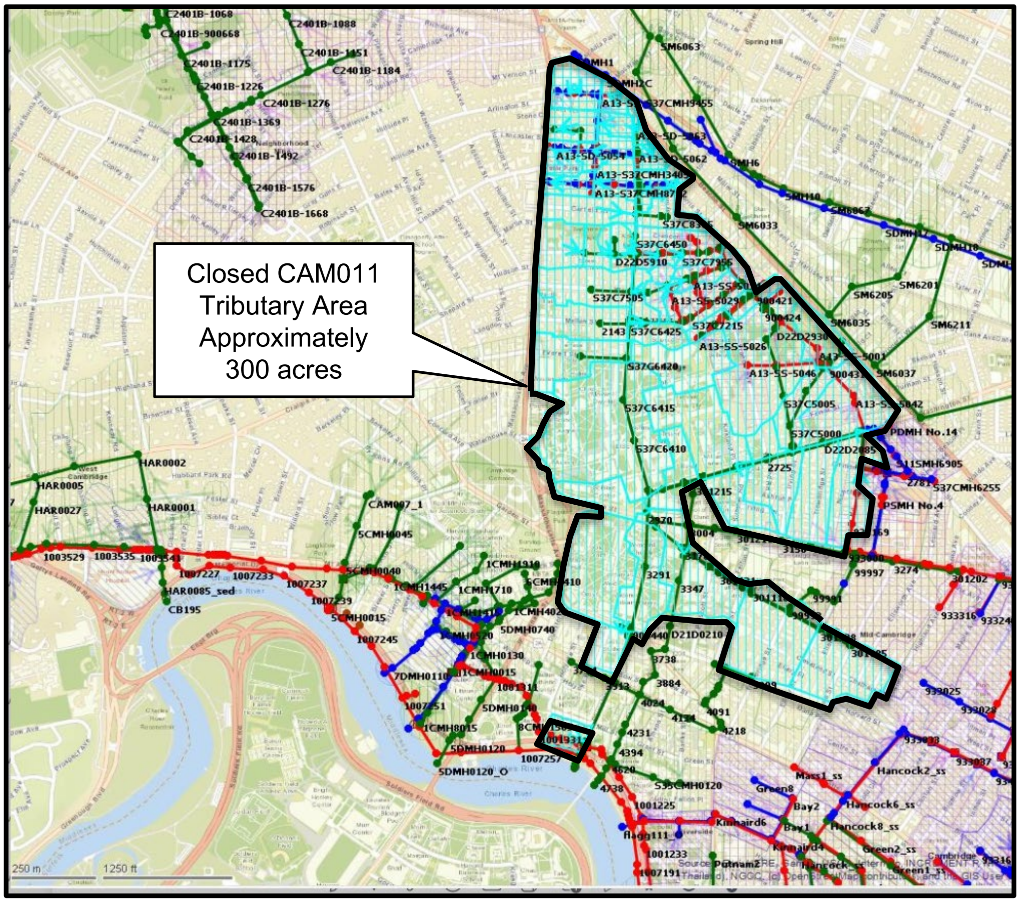

Figure 3-25. Cottage Farm Sewer Separation - Area Tributary to the Closed CAM011 Regulator

The separated stormwater from the 300-acre area would need to be conveyed to the Charles River likely through a new storm drain outfall. Although sewer separation would reduce the volume of treated CSO being discharged to the Charles River, the new storm drain outfall would contribute additional stormwater to the river. The alternative was projected to result in a net increase in both the bacteria and phosphorus loadings to the river if treatment of the additional stormwater discharge is not provided. The water quality impacts of the changes in loadings were not evaluated.

Table 3-34 presents the loading calculations for this alternative compared to the Baseline Conditions. As indicated in Table 3-34, the sewer separation is predicted to reduce treated CSO from Cottage Farm by 1.73 MG/yr, and increase the volume of untreated stormwater to the Charles River by 48.2 MG/yr. The December 15, 2020 *Task 5.2 Receiving Water Quality Model Development and Calibration Report* presented the values for *E. coli* and *Enterococcus* bacteria in the treated Cottage Farm discharge and in untreated stormwater that were used for water quality modeling. As described in that report, these values were based on sampling data and calibration of the water quality model to in-receiving water concentrations. The values from that report were used in Table 3-34 below to compute the net change in bacterial loading for the sewer separation alternative. Table 3-34 also presents the predicted net change in phosphorus loading to the river. The phosphorus concentration used for CSO was 1.77 mg/L, based on Cottage Farm sampling data. The phosphorus concentration used for stormwater was 0.20 mg/L, taken from the *Cambridge Department of Public Works Partial Sewer Separation Report Model Calibration Report*, prepared by Stantec, dated March 11, 2022.

Table 3-34. Cottage Farm Sewer Separation Alternative: Net Bacteria and Phosphorus Loading Assuming no Treatment of Additional Stormwater Discharged

	Typical Year Volume Change (MG)	*E. coli* Concentration (MPN/100 mL)	Typical Year Change in *E. coli* Loading (Counts x 1010)	*Enterococcus* Concentration (MPN/100 mL)	Typical Year Change in *Enterococcus* Loading (Counts x 1010)	Phosphorus Concentration (mg/L)	Typical Year Change in Phosphorus Loading (lbs)
CSO	-1.73	394(1)	-3	212(1)	-1	1.77(3)	-25.5
SW	+48.2	14,000(1)	+2,554	10,000(1)	+1,824	0.20(4)	+80.4
Net Change			+2,551		+1,823		+54.9

Notes:

(1) *E. coli* and *Enterococcus* concentrations from the August 27, 2021 *Task 5.3 Water Quality Assessment Report Table 3-2 Flow Weighted counts for Cottage Farm.*

(2) *E. coli* and *Enterococcus* concentrations from Table 4-7 from the December 15, 2020 *Task 5.2 Receiving Water Quality Model Development and Calibration Report.*

(3) CSO phosphorus concentration from Cottage Farm Sampling Data 1992-2000.

(4) SW phosphorus concentration from Cambridge Department of Public Works Report: *Partial Sewer Separation Report Model Calibration Report.*

As indicated in Table 3-34, without providing additional treatment of the stormwater, the sewer separation alternative would result in an increase in the bacteria loading to the river of 2,551 x 10^{10} counts for *E. coli*, and 1,823 x 10^{10} counts for *Enterococcus*. In addition, the net loading of phosphorus to the river would increase by 54.9 lbs in the Typical Year. For perspective on the phosphorus loading, the total phosphorus TMDL for the Lower Charles River is 19,544 kg[9], or approximately 43,000 lbs. An increase of 54.9 lbs would represent a percent increase of less than 0.1%.

Based on input received from the MassDEP, the stormwater discharged as a result of the sewer separation would not be considered a “new discharge” under the stormwater regulations but would be considered an “increased discharge”. Since the Charles River has an approved TMDL for phosphorus, any increase in phosphorus load that was not included in the TMDL would need to be 100-percent removed. The regulations include some flexibility in that the location of load removal does not have to be at the location of increased discharge, as long as the load removal occurs somewhere in the watershed.

Based on these requirements, it was assumed that the sewer separation alternative would require treatment of the additional stormwater discharged as a result of the sewer separation work. The technology, efficacy, configuration, space requirements, and feasibility of providing treatment of the additional stormwater have not been assessed.

In addition to the challenges associated with treating the additional stormwater, sewer separation construction work would be very disruptive to the residents and businesses located within the 300-acre project area.

Preliminary estimated capital costs were developed for the sewer separation alternative based on sewer separation costs per acre provided by the BWSC for ongoing work in South and East Boston, as well as separation costs developed by the City of Somerville. A concept-level unit cost for stormwater treatment was developed by the City of Cambridge. The bases of these costs are documented in the August 23, 2024 *Alternatives Costing Methodology and Unit Prices Technical Memorandum* prepared by Dewberry. The preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for this alternative are summarized in Table 3-35.

[9] Final Nutrient TMDL Development for the Lower Charles River Basin, Massachusetts June 2003

Table 3-35. Cottage Farm Sewer Separation Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost(1) ($2024)	Annual CSO Volume Reduction (MG)	Cost/Gallon CSO Reduction(2) ($/gal)
Sewer Separation (300 ac)	$257M	1.73	$149/gal

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition costs are not included.

(2) Based on the Typical Year.

CSO Storage

CSO storage was also investigated to meet LTCP goals at Cottage Farm CSO Facility. As described above, under Q1-2023 conditions, the Cottage Farm CSO Facility met the LTCP goal for activation frequency of two per year, but had a higher volume than the LTCP goal for annual volume by 1.44 MG. Table 3-36 presents the duration and volume of discharge for the two storms that cause activations at Cottage Farm in the Typical Year. As indicated in Table 3-36, providing a storage volume of 0.72 MG would be sufficient to reduce the annual discharge volume to the LTCP target of 6.3 MG.

Table 3-36. Cottage Farm Q1-2023 Conditions Typical Year Activations and Storage Requirements to Meet LTCP Goal

Cottage Farm Q1-2023 Conditions Activations in the Typical Year				
Date	Duration (hr)	Q1-2023 CSO Volume (MG)	Approximate Storage Volume Required to Meet LTCP Goal (MG)	Remaining CSO Volume
9/23	4.2	6.12	0.72	5.4
10/23	2.4	1.62	0.72	0.9
Total Vol. (MG)		7.74		6.3

The existing Cottage Farm CSO facility is located in Cambridge along Memorial Drive between Magazine Beach and the Boston University Bridge. Constraints to siting storage adjacent to the Cottage Farm facility would include below-grade infrastructure (the NCRS, the SCRS, diversion chambers and related piping), playing fields in the park adjacent to the facility, a parking area for the playing fields, Memorial Drive and the adjacent bike path, and the presence of mature trees. Based on the site configuration and the storage volume requirements, the storage facility was configured as a rectangular box conduit, generally similar to the configuration of MWRA's BOS019 facility.

Figure 3-26 and Figure 3-27 present a concept layout of the 0.72 MG rectangular box conduit storage facility in the grassy area west of the NCRS. The overall dimensions of the storage facility would be approximately 40 feet wide by 220 feet long. The facility would include an influent channel and flushing system, three 10 feet wide by 17.5 feet high by 165 feet long parallel box storage conduits, and a 0.72 MGD dewatering facility. A piped connection would be made between the existing Cottage Farm pump

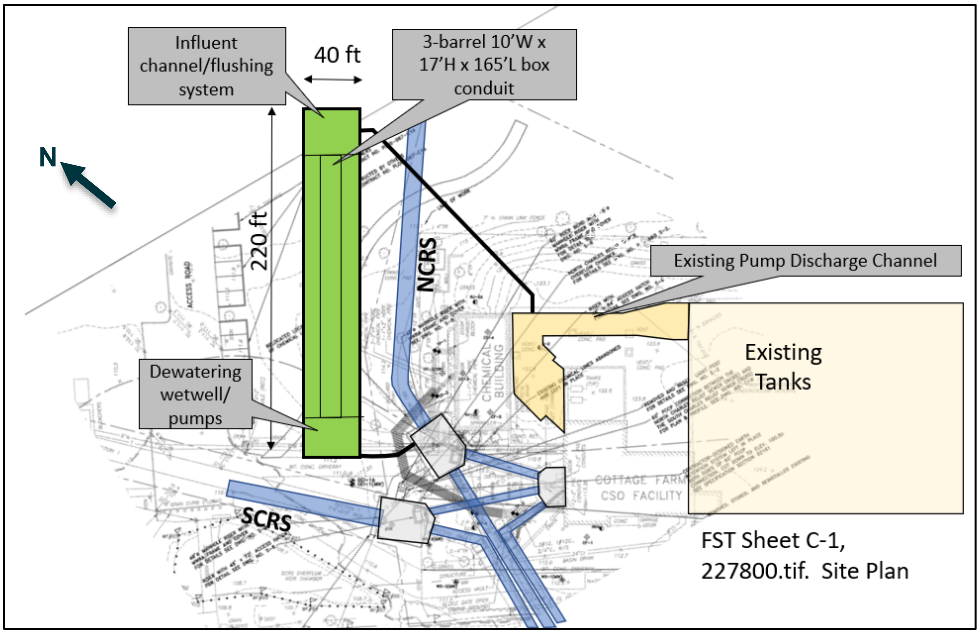

Figure 3-26. Cottage Farm – Box Conduit Storage Layout

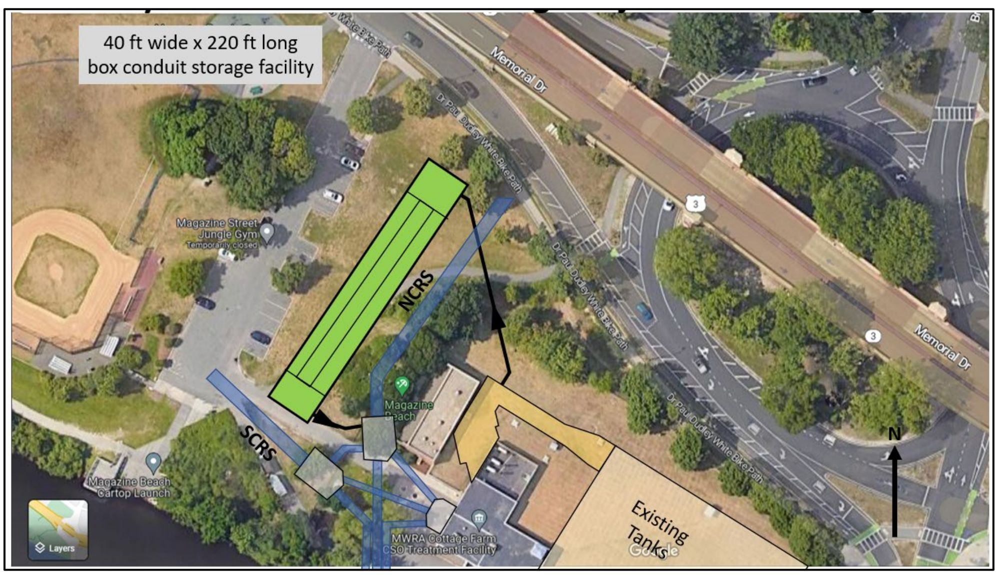

Figure 3-27. Cottage Farm – Box Conduit Storage Aerial View

discharge channel and the storage conduit influent channel, with a gate at the upstream end in the existing pump discharge channel. The intent would be to fill the new storage facility first, then close the gate to the new facility to allow remaining flow to pass into the existing Cottage Farm tanks. After the storm the facility would be dewatered with the dewatering pumps located at the south end of the facility.

At this location the main construction/implementation challenges would be providing support of excavation to protect the NCRS and SCRS, the disturbance of the open grassy area, bike path, trees and parking, and the need for the connection from the existing pump discharge channel to pass over the NCRS.

Figure 3-28 presents the layout of the box storage conduit in a potential alternative location between the roadway/bike path and the existing tanks. This location would not require the influent conduit to cross over the NCRS, would avoid construction in the grassy area west of the existing facility, and potentially would have less impact to the parking lot. However, due to the close proximity to the existing tanks, bike path and road this location would be a much more constrained site and may require additional measures to protect the existing tanks and the roadway/bike path during construction. The box conduit would also have to be configured with one longer box and two shorter boxes to fit the geometry of the site. This site would likely affect more existing trees. While this alternative would avoid the need for excavation in the grassy area west of the existing facility, that area and the parking lot could still be affected by construction staging and lay down requirements.

Figure 3-28. Cottage Farm – Box Conduit Storage Alternative Location

Preliminary estimates of the construction costs were developed for the two box conduit storage alternatives described above. The costs were developed based on the bid costs received for the BOS019 facility in 2005 adjusted to account for the larger storage volume required and the unique features of this site and were escalated to 2024 dollars. The preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for this alternative are summarized in Table 3-37.

Table 3-37. Cottage Farm Sewer Storage Conduit Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost(1) ($2024)	Annual CSO Volume Reduction (MG)(2)	Cost/Gallon CSO Reduction(2) ($/gal)
0.72 MG Box Conduit	$50M	1.44	$35/gal
0.72 MG Box Conduit Alternative Location	$65M	1.44	$46/gal

Notes:
(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition costs are not included.
(2) Based on the Typical Year.

Summary and Conclusions

Table 3-38 presents a summary of the sewer separation and storage conduit alternatives evaluated to meet the LTCP goals for outfall MWR201 (Cottage Farm CSO Facility) based on Q1-2023 system conditions. Although system optimization was also investigated, it did not result in additional progress towards meeting the LTCP goals so it was not pursued further.

As indicated in Table 3-38, outfall MWR201 was meeting the LTCP goal for activation frequency as of Q1-2023, and both sewer separation and storage would result in outfall MWR201 meeting the LTCP goal for CSO volume. The 300 acres of sewer separation would have a much higher capital cost than the storage conduit alternative and would require treatment of the additional stormwater discharged to avoid increasing the phosphorus and bacteria loading to the Charles River. The technology, efficacy, configuration, space requirements, and feasibility of providing treatment of the additional stormwater have not been assessed. The sewer separation work would also create widespread construction-period disruption to residents and businesses, while providing a relatively nominal reduction in treated CSO discharge at the Cottage Farm facility.

The storage alternative would provide a similar relatively nominal reduction in treated CSO volume, but at a much lower cost compared to sewer separation, and without the widespread construction impacts associated with the sewer separation alternative and the need to provide additional stormwater treatment. However, the storage alternative would still carry significant capital costs ($50 to $65M) and is not likely to result in a measurable improvement in water quality in the Charles River, since the relatively nominal CSO volume being reduced was already treated. In addition, the duration for implementation of these alternatives (planning/design/ construction) would likely extend beyond five years.

Table 3-38. Summary of Alternatives to Meet LTCP Goals for Outfall MWR201 (Cottage Farm CSO Facility)

Alternative	Meets LTCP Goals?	Preliminary Estimated Capital Cost[1] (2024 dollars)	Benefit[2]				Cost/Gallon CSO Reduction[2] ($/gal)	Comments
			Parameter	From	To	Reduction		
Sewer Separation (300 ac.)	Yes	$257M	Activation Frequency	2	2	0	$149/gal	• Treatment of additional stormwater required to avoid net increase in phosphorus and bacteria loading • Extensive construction impacts to residents and businesses
			Vol. (MG)	7.74	6.01	1.73		
Box Conduit Storage (0.72 MG)	Yes	Option 1: $50M Option 2: $65M	Activation Frequency	2	2	0	Option 1: $24 Option 2: $31	• Two location options identified • Construction impacts to passive recreation area, bike path and parking
			Vol. (MG)	7.74	6.3	1.44		

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operation and maintenance costs are not included.

(2) Based on the Typical Year.

Considerations for Q4-2024 Conditions

As noted above, the evaluations of CSO control alternatives for outfall MWR201 (Cottage Farm CSO Facility) were conducted based on Q1-2023 system conditions. In the period of time since those evaluations were conducted, the City of Cambridge completed a sewer separation project in the area of Willard Street, upstream of the Cottage Farm facility. In addition, as stated above, the reduction is also partially attributed to the BWSC sewer separation work in Roxbury. By reducing the wet weather flow tributary to the North Charles Metropolitan Sewer via the Willard Street separation project in combination with the Roxbury sewer separation the annual treated discharge at the Cottage Farm facility is predicted to be reduced from 7.74 to 6.72 MG for the Typical Year for Q4-2024 conditions. Based on these improvements, Cottage Farm is now considered to materially meet its LTCP goals.

The lower baseline volume at the Cottage Farm facility would likely mean that something less than 300 acres of sewer separation would be needed to fully meet the LTCP goal, and that a smaller volume of storage would similarly be required. However, as noted above, the difference between the Q1-2023 treated discharge volume of 7.74 MG and the LTCP goal at Cottage Farm of 6.30 MG would have essentially no measurable improvement in water quality in the Charles River. The difference in treated discharge volume between the new Q4-2024 baseline (6.72 MG) and the LTCP goal (6.30 MG) would have even less of an impact.

Under the 2024 Charles River Variance issued by the MassDEP in August 2024 and pending approval from EPA, MWRA will be evaluating alternatives for higher levels of CSO control for outfall MWR201 (Cottage Farm CSO Facility) based on a new Typical Year and design storms developed using 2050 projections of rainfall that incorporate climate change impacts. Given the relatively close match between the Q4-2024 Conditions performance and the LTCP goals based on the 1992 Typical Year, no further action is proposed towards improving performance for the 1992 Typical Year. Additional evaluation of alternatives for higher levels of control for outfall MWR201 will, however, be conducted as part of the Updated CSO Control Plan development as required under the conditions of the 2024 Charles River Variance.

3.5 Outfall CAM401A

Regulator RE-401 is located near the intersection of Pemberton Street and Sherman Street in Cambridge, and discharges to Alewife Brook via outfall CAM401A. Regulator RE-401 functions as a side-outlet relief off of a 5.5 x 5-foot combined sewer on Sherman Street. During dry weather, flow continues down the combined sewer to a junction structure on the downstream Alewife Brook Branch Sewer. At that junction structure, flow can either continue down the Alewife Brook Branch Sewer or overflow into a siphon that ties into the Alewife Brook Conduit at regulator RE-031, associated with outfall MWR003. During wet weather, flow enters the regulator RE-401 structure through a 5 x 5.5-foot rectangular connection. When the HGL is higher than the weir elevation of 111.69 ft, flow begins to pass through a brush structure mounted on the overflow weir. The brush structure is intended to capture floatables and larger solids in the overflow. If the water level in the regulator continues to rise, flow can pass over the top of the brush structure. This flow path is represented in the model as a weir at elevation 114.49 ft (MDC Datum). Flow then enters the 6-foot diameter circular outfall pipe through a flap gate. The outfall pipe also collects storm drainage from areas south and west of CAM401A.

As noted in Section 1 above, in the Final Assessment Report outfall CAM401A was predicted to activate 5 times in the Typical Year and discharge 0.66 MG based on Q4-2021 system conditions. The outfall was therefore believed to be meeting the LTCP goals of 5 activations and 1.61 MG. However, as noted in the MWRA CSO Annual Reports in 2022 through 2024, model predictions of activation frequency and volume at outfall CAM401A deviated from values reported by the City of Cambridge meter data and Cambridge Annual Reports, which showed that CAM401A did not meet the LTCP goals.

The MWRA model used to generate the predicted values for the recent CSO Annual Reports and for the Final Assessment Report was calibrated in 2019 as part of the Post Construction Monitoring Program. The metering program for the model calibration included one flow meter in the CAM401A regulator structure to measure influent to the structure and data from level sensors in the regulator structure to help determine when levels were above the weir elevation, provided by the City of Cambridge. During the calibration, significant sediment was found in the CAM401A system. In 2020, updates were made to the model in the Alewife Brook system as part of the work to investigate the Alewife Brook Pump Station. The model was also updated to include physical changes to the system constructed at SOM001A and CAM002. These updates are documented in Semiannual Report No. 4 dated April 30, 2020, and No. 5 dated October 30, 2020. With these updates the model predicted that CAM401A would discharge 16 times with a volume of 2.17 MG in the Typical Year. After the sediment was removed by the City of Cambridge in November of 2020, the MWRA model was updated to reflect the removal of the sediment. As a result, the new performance at CAM401A was predicted to be 5 activations and 0.66 MG for the Typical Year, which would meet the LTCP goals for both frequency and volume. By comparison, the Cambridge 2020 Annual CSO Report listed 5 activations and 3.06 MG for the Typical Year.

In the years following the 2020 updates, the MWRA's model consistently under-predicted the activations and volumes at outfall CAM401A compared to the values reported by the City of Cambridge. The collection system model developed by the City of Cambridge had a more detailed representation of the CAM401A system than the MWRA's model, and generally appeared to provide a better match to the reported activation frequencies and volumes at outfall CAM401A. As part of the review of the Cambridge version of the model it was noted that stormwater from the area along Rindge Avene from Clinton Street to Massachusetts Avenue was directed to the Rindge Avenue combined sewer. These areas are noted to have both sanitary and stormwater pipes in the streets. However, interconnections between these pipes exists and all flows ultimately enter the combined sewer system. In the MWRA model the stormwater had been directed away from the combined sewer. This additional stormwater significantly impacted the wet weather response in the CAM401A sub-system.

To reconcile the differences between the two models, the MWRA implemented a metering program in the CAM401A system from April 18th through July 24th, 2024, and conducted a model recalibration. As shown in Figure 3-29, the metering program consisted of seven flow meters, two level sensors, and one rain gauge at hydraulically important locations throughout the CAM401A system. Activations and discharge volumes for outfall CAM401A reported by the City of Cambridge on their web site were also used for comparison. Sediment and depth of flow measurements reported during meter installation suggested that some sediment was again accumulating upstream of the Pemberton and Sherman Street intersection. Based on these observations, a subsequent field investigation was performed by an MWRA field crew which revealed uneven sediment accumulation of up to nine inches in the Sherman Street combined sewer at the intersection of Pemberton Street.

As part of the development of the updated CSO Control Plans required by the Alewife and Charles River Variances, the MWRA, Cambridge and Somerville developed a "Unified" collection system model. This model was developed by incorporating the more detailed City of Cambridge and City of Somerville models into the MWRA's North System model used in the performance assessment. The Unified Model therefore included Cambridge's more detailed representation of the CAM401A tributary area. The CAM401A portion of the Unified Model was brought into MWRA's model as the starting point for the CAM401A recalibration.

During the metering period, 34 rainfall events were captured including five which caused CSO activations at outfall CAM401A. Before any calibration adjustments, the Unified Model was reasonably close to the metered activations and volumes at outfall CAM401A for the metering period, but the Unified Model did not include the observed sediment, and did not match the MWRA calibration meters in other parts of the CAM401A system. In addition, the baseline version of the Unified Model did not fully capture backwater and headloss conditions along Sherman Street that were observed in the meter data. Hydrologic adjustments to the model were made to more closely match the backwater, metered depth, flow, and velocity, specifically during large storm events which the baseline model tended to overpredict. Hydraulic adjustments to the model were made based on observed sediment and headlosses in the meter data. Following these adjustments, the predicted flow, depth, and velocity more closely correlated to the meter data.

These changes did not result in a big change in the comparison of metered versus modeled total activations and volume at outfall CAM401A for the metering period compared to the baseline version of the Unified Model. However, the recalibrated model improved the representation of the distribution of flow

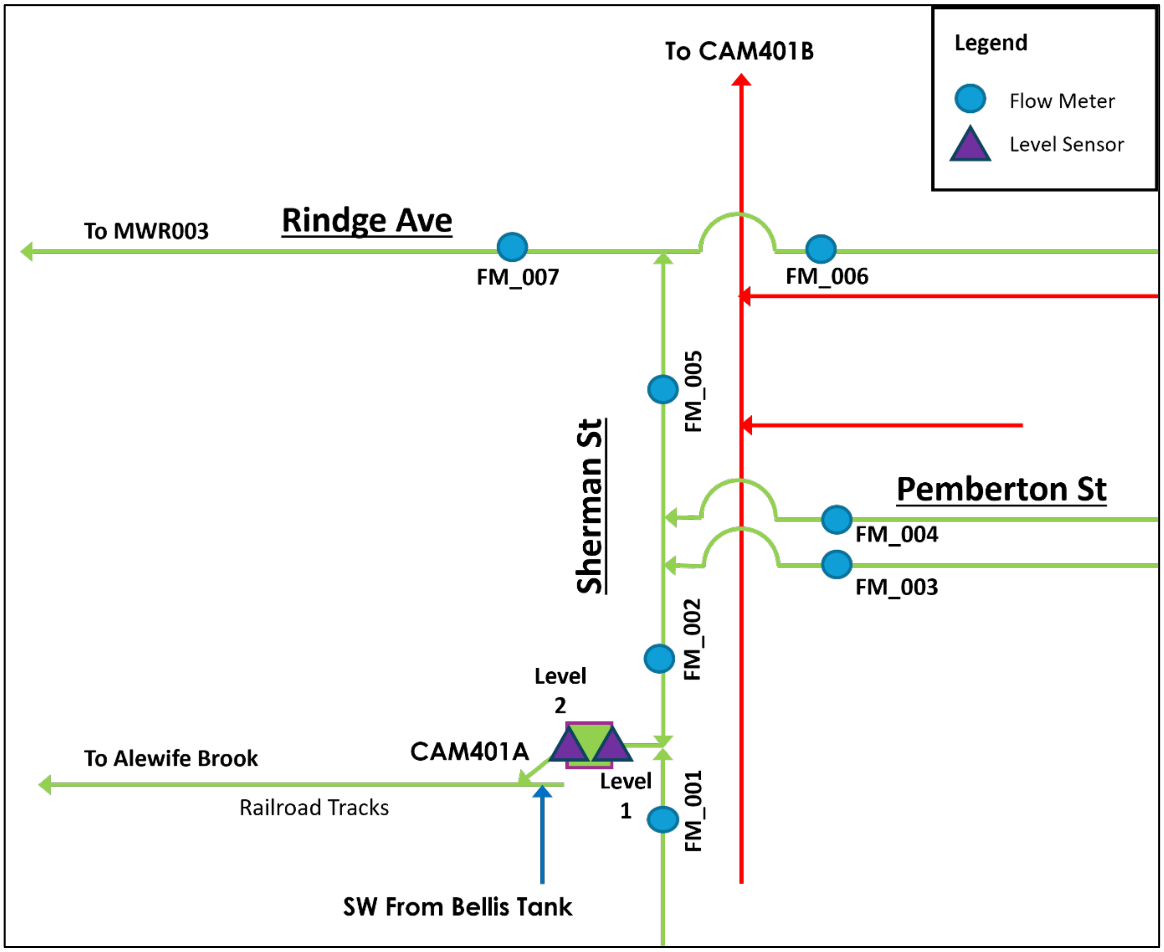

Figure 3-29. Schematic of the CAM401A Metering Area and Individual Meter Locations

and headlosses within the CAM401A system, allowing for assessment of other alternatives including sediment removal and reduction of headlosses. The recalibrated model predicted that for the Typical Year, outfall CAM401A would activate 10 times with a total volume of 6.27 MG, which is higher than the LTCP goal of 5 activations and 1.61 MG.

The next step was to assess whether removal of the observed sediment and reduction in the headloss observed on Sherman Street at Pemberton Street would reduce the activation frequency and/or volume at outfall CAM401A in the Typical Year. However, the model predicted that these changes would result in only a nominal reduction in volume and no reduction in activation frequency. This was attributed to observed backwater conditions along Sherman Street, which limited the effectiveness of sediment removal and headloss reduction on performance at outfall CAM401A.

CSO Storage

Given the updated model predictions of not meeting LTCP goals, a potential CSO storage alternative was also investigated to meet LTCP goals at CAM401A based on the recalibrated model. Table 3-39 presents the volume of discharge for the ten storms that cause activations at CAM401A in the Typical Year. As indicated in Table 3-39, providing a storage volume of 0.40 MG and raising the CAM401A weir crest elevation to 113.28 feet would be sufficient to reduce the annual discharge volume to below the LTCP target of 1.61 MG without causing adverse impacts to the HGL during a 5-year storm.

Table 3-39. Summary of Activations in the Typical Year at CAM401A with the Recalibrated Model

CSO Start Date	Recalibrated Model Volume (MG)	Approximate Storage Volume Required to Meet LTCP Goal (MG)	Remaining CSO Volume (MG)(1)
5/2/1992	0.59	0.40	0
6/1/1992	0.20		0
6/6/1992	0.20		0
8/11/1992	0.57		0
8/18/1992	0.77		0.1
9/3/1992	0.24		0
9/9/1992	0.60		0
9/23/1992	1.23		0.43
10/10/1992	0.17		0
10/23/1992	1.70		1.0
Total Volume (MG)	**6.27**		**1.53**
Total Activations	**10**		**3**

Notes:

(1) Remaining volume also accounts for in-system storage created by raising the existing CAM401A regulator weir to elevation 113.28 feet.

The existing CAM401A regulator structure is located on Sherman Street in Cambridge between Pemberton Street and the MBTA Commuter Rail tracks. A parking lot at Bellis Circle owned by the City of Cambridge was identified as a potential location for a storage facility. Diverting flow from the existing CAM401A regulator structure to a storage facility at this location would require a connecting pipe to be constructed under the existing CAM401A outfall and the railroad tracks. However, by constructing a new diversion structure on the influent pipes to the CAM401A regulator on the south side of the railroad tracks, construction impacts to the tracks could be minimized.

Figure 3-30 presents a conceptual layout of a 0.40 MG rectangular storage tank in a parking lot at the intersection of Bellis Circle and Sherman Street. The overall dimensions of the storage facility would be approximately 40 feet wide by 90 feet long with a 20-foot side water depth. The facility would include an influent channel, a flushing system, and a 0.40 MGD dewatering pump system.

A preliminary estimate of the construction cost was developed for the storage alternative described above. The basis of this cost is documented in the August 23, 2024 *Alternatives Costing Methodology and Unit Prices Technical Memorandum* prepared by Dewberry. The preliminary estimated capital cost, annual CSO volume reduction, and cost per gallon of CSO reduction for this alternative are summarized in Table 3-40.

Figure 3-30. Outfall CAM401A Storage Tank Layout

Table 3-40. Outfall CAM401A Storage Tank Alternative – Cost, CSO Reduction and Cost/Gallon Reduced

Alternative	Estimated Capital Cost(1) ($2024)	Annual CSO Volume Reduction (MG)(2)	Cost/Gallon CSO Reduction(2) ($/gal)
0.40 MG Storage Tank	$19.0M	4.75	$4

Notes:

(1) Capital cost includes estimated construction cost plus 25% contingency and 37% soft costs. Soft costs include items such as engineering design and permitting. Land acquisition and annual operation and maintenance costs are not included.

(2) Based on the Typical Year.

Summary and Conclusions

The additional flow metering and model calibration activities described above resulted in a conclusion that outfall CAM401A is not currently meeting the LTCP goals for CSO activation frequency and volume in the Typical Year. Relatively low-cost alternatives including sediment removal and reduction in headloss were not predicted to move the outfall substantially closer to attainment of the performance goals. However, under the 2024 Alewife Variance issued by the MassDEP in August 2024 and pending approval from EPA, the City of Cambridge in coordination with MWRA will be evaluating alternatives for higher levels of CSO control for outfall CAM401A based on a new Typical Year and design storms developed using 2050 projections of rainfall that incorporate climate change impacts. Given that the storage alternative described above, which would likely take more than five years to implement, would not be sufficient for achieving higher levels of control that may be identified as part of the Updated CSO Control Plan under the 2024 Alewife Variance, no further action is proposed towards improving performance at outfall CAM401A for the Typical Year at this time.

4. Update to the Final Assessment Report - Summary and Conclusions

Chapters 1 through 3 present an update to the Final Assessment Report. The chapters document the progress made towards meeting the LTCP goals at each of the 16 locations that were not predicted to meet LTCP goals by the end of 2021, as well as at two locations (outfalls CAM401A and BOS003) that were previously thought to be meeting the goals but are now understood not to be meeting the goals. These chapters also document the work that has been and will continue to be undertaken to further improve attainment with the LTCP goals as well as documenting the results of field investigations and modeling assessments undertaken to assess the level of performance achieved at these locations. Overall the implementation of the LTCP has been very successful, as demonstrated by the key findings from the Final Assessment Report and in the Update to the Final Assessment Report summarized below.

CSO Performance Assessment Relative to Attainment of LTCP Goals

As indicated above, the most current version of the collection system model available for this performance assessment update was the Q4-2024 system conditions model (i.e. system conditions as of December 2024). The Q4-2024 model is based on the Q4-2023 model, previously presented in the 2023 Annual Report, with recent system updates incorporated as provided in Appendix A. Table 4-1 presents a full accounting of the status and Typical Year overflow activity as of Q4-2024 System Conditions 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. Table 4-1 also presents the previously modeled Typical Year CSO discharge volumes and frequencies for 1992 system conditions and the Q4-2021 system conditions previously reported in the Final Assessment Report. In Table 4-1, Q4-2021 and Q4-2024 System Conditions activations or volumes that are greater than the LTCP goals are shaded in grey. In addition, each CSO outfall is color-coded based on status of attainment with the LTCP goals as of Q4-2024, as follows:

- Dark blue indicates outfalls that achieve the LTCP goals under the Q4-2024 conditions.
- Light blue indicates outfalls that are forecast to achieve the LTCP goals after December 2024.
- No color indicates outfall currently does not achieve LTCP activation and/or volume goal(s).

From 1987 through 2015, MWRA addressed 182 CSO-related court schedule milestones, including completing the construction of the 35 wastewater system projects that comprised the LTCP by December 2015. As a result of the projects implemented under the LTCP and the continued work by MWRA and its CSO partners, both treated and untreated CSO discharges have been reduced significantly as shown both in Figure 4-1 and Table 4-2. Figure 4-1 presents a comparison of the treated discharge, untreated discharge and total discharge volume for 1988, 1992, 2021, and present (Q4-2024) conditions, as well as the LTCP goal, and Table 4-2 provides the values in a tabular format. As indicated in Figure 4-1 and Table 4-2, since 2021 the average annual CSO volume system wide has been reduced by an additional 13 MG from 414 MG in 2021 to 401 MG in 2024, meeting the overall LTCP goal of 404 MG. Since 1988, the overall CSO discharge volume has decreased by just under 2.9 billion gallons (an 88% reduction).

As indicated in Table 4-1, footnote 3, the 1992 model results for CAM401A and CAM401B combined predicted a maximum of 18 activations and the sum of 2.21 MG. For these two CSOs, extensive field investigations after the 1997 CSO Conceptual Plan/EIR identified areas that were combined that were thought to be separate. A later 2001 Alewife Notice of Project Change reported much higher Typical Year values for these CSOs of 25 activations and 13.2 MG (combined for both outfalls).

Table 4-1. Typical Year Performance: Baseline 1992, Q4-2021 Conditions, Q4-2024 Conditions and LTCP Goals

Outfall currently achieves LTCP activation and volume goals.	Outfall is forecast to achieve LTCP goals after 2024
Outfall currently does not achieve LTCP activation and/or volume goal(s).	Model prediction is greater than LTCP value.

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q4-2021 SYSTEM CONDITIONS		Q4-2024 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
ALEWIFE BROOK								
CAM001	5	0.15	1	0.02	1	0.02	5	0.19
CAM002	11	2.73	0	0.00	0	0.00	4	0.69
MWR003	6	0.67	3	0.61	3	0.66	5	0.98
CAM004	20	8.19	Closed	N/A	Closed	N/A	Closed	N/A
CAM400	13	0.93	Closed	N/A	Closed	N/A	Closed	N/A
CAM401A(3)	18	2.12	5	0.66	10	6.27	5	1.61
CAM401B			4	0.50	4	0.54	7	2.15
SOM001A	10	11.93	8	4.47	8	4.54	3	1.67
SOM001	0	0.00	Closed	N/A	Closed	N/A	Closed	N/A
SOM002	0	0.00	Closed	N/A	Closed	N/A	N/I(4)	N/I(4)
SOM002A	0	0.00	Closed	N/A	Closed	N/A	Closed	N/A
SOM003	0	0.00	Closed	N/A	Closed	N/A	Closed	N/A
SOM004	5	0.09	Closed	N/A	Closed	N/A	Closed	N/A
TOTAL		**26.81**		**6.26**		**12.03**		**7.29**
UPPER MYSTIC RIVER								
SOM007A/MWR205A	9	7.61	5	4.50	5	4.33	3	3.48
SOM006	0	0.00	Closed	N/A	Closed	N/A	N/I(4)	N/I(4)
SOM007	3	0.06	Closed	N/A	Closed	N/A	Closed	N/A
TOTAL		**7.67**		**4.50**		**4.33**		**3.48**
MYSTIC/CHELSEA CONFLUENCE								
MWR205 (Somerville-Marginal CSO Facility)	33	120.37	30	99.71	30	100.39	39	60.58
BOS013	36	4.40	8	0.27	3	0.08	4	0.54
BOS014	20	4.91	8	1.44	0	0.00	0	0.00
BOS015	76	2.76	Closed	N/A	Closed	N/A	Closed	N/A
BOS017	49	7.16	6	0.34	0	0.00	1	0.02
CHE002	49	2.51	Closed	N/A	Closed	N/A	4	0.22
CHE003	39	3.39	0	0.00	0	0.00	3	0.04
CHE004	44	18.11	2	0.08	2	0.08	3	0.32
CHE008	35	22.35	6	1.94	0	0.00	0	0.00
TOTAL		**185.96**		**103.78**		**100.55**		**61.72**
UPPER INNER HARBOR								
BOS009	34	3.60	10	0.73	5	0.13	5	0.59
BOS010	48	11.83	1	0.07	1	0.08	4	0.72
BOS012	41	7.90	0	0.00	0	0.00	5	0.72
BOS019	107	4.48	1	0.07	1	0.07	2	0.58
BOS050	No Data		Closed	N/A	Closed	N/A	Closed	N/A
BOS052	0	0.00	Closed	N/A	Closed	N/A	Closed	N/A
BOS057*	33	14.71	2	1.33	2	0.65	1	0.43
BOS058	17	0.29	Closed	N/A	Closed	N/A	Closed	N/A
BOS060*	64	2.90	2	0.47	2	0.50	0	0.00
MWR203 (Prison Point Facility)*	28	261.85	17	248.33	17	250.62	17	243.00
TOTAL		**307.56**		**251.00**		**252.05**		**246.04**

Table 4-1. Typical Year Performance: Baseline 1992, Q4-2021 Conditions, Q4-2024 Conditions and LTCP Goal

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q4-2021 SYSTEM CONDITIONS		Q4-2024 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
LOWER INNER HARBOR								
BOS003	28	18.09	9	5.93	9	4.76	4	2.87
BOS004	34	3.43	0	0.00	0	0.00	5	1.84
BOS005	4	10.23	0	0.00	Closed	N/A	1	0.01
BOS006	17	1.21	Closed	N/A	Closed	N/A	4	0.24
BOS007	34	3.93	Closed	N/A	Closed	N/A	6	1.05
TOTAL		**36.89**		**5.94**		**4.76**		**6.01**
CONSTITUTION BEACH								
MWR207	24	4.00	Closed	N/A	Closed	N/A	Closed	N/A
TOTAL		4.00		N/A		N/A		N/A
FORT POINT CHANNEL								
BOS062	8	4.15	5	1.26	0	0.00	1	0.01
BOS064*	14	0.99	1	0.01	1	0.02	0	0.00
BOS065	11	3.08	1	0.62	0	0.00	1	0.06
BOS068	4	0.62	0	0.00	0	0.00	0	0.00
BOS070/DBC*(5)	4	281.62	7	6.18	6	1.87	3	2.19
MWR215 (Union Park Facility)			10	26.64	9	21.49	17	71.37
BOS070/RCC			0	0.00	0	0.00	2	0.26
BOS072	21	3.62	Closed	N/A	Closed	N/A	0	0.00
BOS073	23	4.73	0	0.00	0	0.00	0	0.00
TOTAL		**298.81**		**34.71**		**23.38**		**73.89**
RESERVED CHANNEL								
BOS076	65	65.94	1	0.10	1	0.08	3	0.91
BOS078	41	14.84	0	0.00	0	0.00	3	0.28
BOS079	18	2.10	0	0.00	0	0.00	1	0.04
BOS080	33	6.21	0	0.00	0	0.00	3	0.25
TOTAL		**89.09**		**0.10**		**0.08**		**1.48**
NORTHERN DORCHESTER BAY								
BOS081	13	0.32	0 / 25 year	N/A	0 / 25 year	N/A	0 / 25 year	N/A
BOS082	28	3.75	0 / 25 year	N/A	0 / 25 year	N/A	0 / 25 year	N/A
BOS083	14	1.05	Closed	N/A	Closed	N/A	0 / 25 year	N/A
BOS084	15	3.22	0 / 25 year	N/A	0 / 25 year	N/A	0 / 25 year	N/A
BOS085	12	1.31	0 / 25 year	N/A	0 / 25 year	N/A	0 / 25 year	N/A
BOS086	80	3.31	0 / 25 year	N/A	0 / 25 year	N/A	0 / 25 year	N/A
BOS087	9	1.27	Closed	N/A	Closed	N/A	0 / 25 year	N/A
TOTAL		**14.23**		**0.00**		**0.00**		**0.00**
SOUTHERN DORCHESTER BAY								
BOS088	0	0.00	Closed	N/A	Closed	N/A	Closed	N/A
BOS089 (Fox Pt.)	31	87.11	Closed	N/A	Closed	N/A	Closed	N/A
BOS090 (Commercial Pt.)	19	10.16	Closed	N/A	Closed	N/A	Closed	N/A
TOTAL		**97.27**		**0.00**		**0.00**		**0.00**
UPPER CHARLES								
BOS032	4	3.17	Closed	N/A	Closed	N/A	Closed	N/A
BOS033	7	0.26	Closed	N/A	Closed	N/A	Closed	N/A
CAM005	6	41.56	8	0.75	7	0.63	3	0.84
CAM007*	1	0.81	1	0.47	1	0.44	1	0.03
CAM009(6)	19	0.19	Closed	N/A	Closed	N/A	2	0.01
CAM011(6)	1	0.07	Closed	N/A	Closed	N/A	0	0.00
TOTAL		**46.06**		**1.22**		**1.07**		**0.88**

Table 4-1. Typical Year Performance: Baseline 1992, Q4-2021 Conditions, Q4-2024 Conditions and LTCP Goals

OUTFALL	1992 SYSTEM CONDITIONS (1)		Q4-2021 SYSTEM CONDITIONS		Q4-2024 SYSTEM CONDITIONS		LONG TERM CONTROL PLAN (2)	
	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)	Activation Frequency	Volume (MG)
LOWER CHARLES								
BOS028	4	0.02	Closed	N/A	Closed	N/A	Closed	N/A
BOS042	0	0.00	Closed	N/A	Closed	N/A	Closed	N/A
BOS049	1	0.01	Closed	N/A	Closed	N/A	Closed	N/A
CAM017	6	4.72	0	0.00	0	0.00	1	0.45
MWR010	16	0.08	0	0.00	0	0.00	0	0.00
MWR018	2	3.18	2	1.11	2	0.40	0	0.00
MWR019	2	1.32	2	0.47	2	0.14	0	0.00
MWR020*	2	0.64	2	0.46	1	0.02	0	0.00
MWR021	2	0.50	Closed	N/A	Closed	N/A	Closed	N/A
MWR022	2	0.43	Closed	N/A	Closed	N/A	Closed	N/A
MWR201 (Cottage Farm Facility)*	18	214.10	2	9.09	2	6.72	2	6.30
MWR023 (7)	39	114.60	1	0.03	2	0.07	2	0.13
SOM010	18	3.38	Closed	N/A	Closed	N/A	Closed	N/A
TOTAL		**342.98**		**11.28**		**7.35**		**6.88**
NEPONSET RIVER								
BOS093	72	1.61	Closed	N/A	Closed	N/A	Closed	N/A
BOS095	11	5.37	Closed	N/A	Closed	N/A	Closed	N/A
TOTAL		**6.98**		**0.00**		**0.00**		**0.00**
BACK BAY FENS								
BOS046 – Boston GH1 (7)	2	5.25	1	0.10	2	0.11	2	5.38
BOS046 – Boston GH2 (8)			0	0.00	0	0.00		
TOTAL		**5.25**		**0.10**		**0.11**		**5.38**
Total Treated		**698**		**384**		**379**		**381**
Total Untreated		**759**		**30**		**22**		**23**
GRAND TOTAL		**1457**		**414**		**401**		**404**

*Model predicted activation and volume for Q4-2024 System Conditions has decreased since 1992 levels to a level believed to achieve anticipated water quality improvements. The inability to precisely meet activation and/or volume goals at these locations is considered immaterial.

(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) was 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) Although the 1992 model results predicted a maximum of 18 activations and the sum of 2.21 MG, for these two CSOs extensive field investigations after the 1997 CSO Conceptual Plan/EIR identified areas that were combined that were thought to be separate. A later 2001 Alewife Notice of Project Change reported much higher Typical Year values for these CSOs of 25 activations and 13.2MG (combined for both outfalls).
(4) N/I: Outfall is not included in Exhibit B to the Second CSO Stipulation.
(5) Construction of a parallel relief pipe to provide further CSO improvement at BOS070/DBC has been delayed due to unforeseen field conditions. Final Q4 system conditions results presented in Table 4-1 include the relief pipe, and therefore is reported as materially meeting its LTCP goal, although construction completion is not expected until January 2025.
(6) Tentatively closed pending additional hydraulic evaluation by City of Cambridge.
(7) 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 it is estimated that 25% of the CSO from the upstream regulators discharges at outfall MWR023 (Charles River) and 75% discharges at outfall BOS046 (Back Bay Fens).
(8) 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.

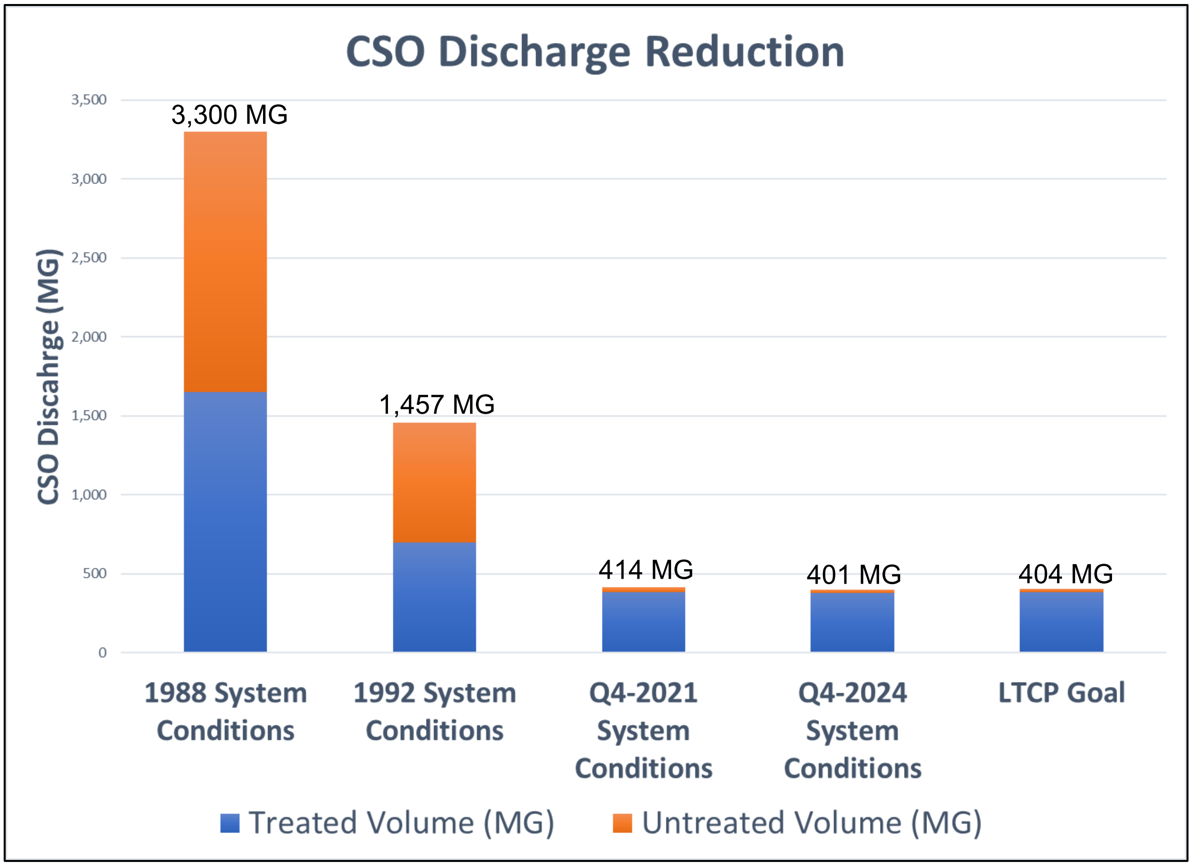

Figure 4-1. CSO Discharge Reduction from 1988 to Present Conditions Compared to LTCP Goals

Table 4-2. CSO Discharge Reduction from 1988 to Present Conditions Compared to LTCP Goals

	1988 System Conditions	1992 System Conditions	Q4-2021 System Conditions	Q4-2024 System Conditions	LTCP Goal
Treated Volume (MG)	1,650	698	384	379	381
Untreated Volume (MG)	1,650	759	30	22	23
Grand Total (MG)	3,300	1,457	414	401	404

As of the end of 2024, the LTCP goals for average annual CSO activation and volume were met , or materially meeting at 78 of the 86 outfalls for which performance targets were defined in the Second Stipulation. This performance reflects eight more outfalls meeting or materially achieving LTCP performance targets than reported in 2021. Of the eight remaining outfalls not projected to meet LTCP goals by the end of 2024, projects are moving forward for three outfalls to meet LTCP goals after 2024.

These three outfalls include the Somerville Marginal CSO Facility (MWR205), SOM007A/MWR205A (Upper Mystic River), and BOS003. For Somerville Marginal CSO Facility (MWR205) and SOM007A/MWR205A the project involves constructing a new connection from the facility influent conduit to the interceptor. The construction contract was awarded in September 2024 and substantial completion is anticipated in December 2025. Upon completion of this work outfalls MWR205 and SOM007A/MWR205A are projected to materially meet the LTCP goals.

For outfall BOS003, BWSC has a plan in place to construct the East Boston Phase 4 Sewer Separation project which includes five contracts to be constructed between 2025 and 2030. With completion of this sewer separation work, the model predicts that outfall BOS003 will have 0 activations in the Typical Year, thus meeting the LTCP goals.

For the remaining five outfalls (SOM001A, CAM005, MWR018, MWR019, CAM401A), additional projects to meet LTCP goals were evaluated, but feasible and cost-effective projects were not identified. Although further reductions at CAM005 are expected with the design and construction of a higher and longer weir wall, these further adjustments are not predicted to fully meet LTCP goals, but may be considered to materially meet when complete. New alternatives to achieve a higher level of control at these outfalls will be evaluated as part of the Updated CSO Control Plans required under the 2024 Alewife and Charles River Variances.

Section 3 of the Final Assessment Report presented the results of water quality modeling for the Alewife Brook/Upper Mystic River and the Charles River. The modeling as reported in Section 3 of that report indicated that the remaining CSOs were predicted to have minimal impact on the attainment of bacterial water quality criteria due to the relatively small contribution of CSOs to the total bacterial loads to these waterbodies. As described above, the predicted CSO volumes to the Upper Mystic River and the Charles River under Q4-2024 conditions are slightly less than the volumes predicted for the Q4-2021 conditions. For those waterbodies, the impact of CSOs on attainment of the bacteria water quality criteria would therefore likely be at least similar to, if not slightly lower than presented for the Q4-2021 conditions.

In Alewife Brook, however, the Q4-2024 conditions activation frequency and volume at outfall CAM401A is higher than what was presented for Q4-2021 conditions as a result of the re-calibration of the model that was conducted in the CAM401A area (see Section 3.5 above). However, the Final Assessment Report also presented water quality modeling results for 2019 conditions, where outfall CAM401A was predicted to activate 10 times in the Typical Year, with a total volume of 3.59 MG. The 2019 conditions performance was therefore much closer to the current Q4-2024 conditions performance of 10 activations and 6.27 MG. Modeling for 2019 conditions showed no difference in annual attainment of bacteria criteria in Alewife Brook when comparing model runs with all sources (CSO, stormwater, dry weather and boundary) to model runs with the CSO sources eliminated (Table 3-10 of the Final Assessment Report). It is unlikely that the slightly higher CSO volume from the Q4-2024 conditions would substantially change the outcome predicted for the 2019 conditions.

Table 4-3 summarizes the status of the 16 outfalls not predicted to meet LTCP goals as of 2021 and the two outfalls (CAM401A and BOS003) that changed status between 2021 and 2024.

Table 4-3. Status Update On 16 Outfalls Not Predicted to Meet LTCP Goals as of 2021 and Two Outfalls that Changed Status Between 2021 and 2024

Outfall	Q4-2021 System Conditions	Q4-2024 System Conditions	Summary of Status
SOM001A	Not Meeting	Not Meeting	Additional projects to meet LTCP goals were evaluated, but a feasible and cost-effective project was not identified. New alternatives to achieve a higher level of control at this outfall will be evaluated as part of the Updated CSO Control Plan required under the 2024 Alewife Variance.
CAM401A	Meeting	Not Meeting	Following extensive sediment removal in the CAM401A system in 2020, differences were observed between the MWRA's model predictions for activation frequency and volume at outfall CAM401A and the values reported by the City of Cambridge meter data and Cambridge Annual Reports. In 2024, a flow metering and model recalibration effort resulted in changes to the MWRA's model to better match the meter data. With these changes, the Typical Year activation frequency and volume at outfall CAM401A increased, and no longer meet the LTCP goals. A storage alternative was identified to meet the LTCP goals, but this alternative was not recommended for implementation because additional alternatives to achieve a higher level of control at this outfall will be evaluated as part of the Updated CSO Control Plan required under the 2024 Alewife Variance.
Somerville Marginal CSO Facility (MWR205)	Not Meeting	Not Meeting	A project is under construction to allow this outfall to materially meet LTCP goals by end of 2025.
SOM007A/MWR205A	Not Meeting	Not Meeting	A project is under construction to allow this outfall to materially meet LTCP goals by end of 2025.
BOS003	Not Meeting	Not Meeting	BWSC completed the East Boston Sewer Separation Phase 3 project and the work at the BOS003 regulators which was predicted to allow outfall BOS003 to meet LTCP goals. Following completion of this work, differences were observed between the MWRA's model predictions for activation frequency and volume at regulator RE003-12 and the values reported by the BWSC based on meter data. In 2024, a flow metering and model recalibration effort resulted in changes to the MWRA's model to better match the meter data. With these changes, the Typical Year activation frequency and volume at outfall BOS003 increased, and no longer were predicted to meet the LTCP goals. Additional separation work associated with BWSC East Boston Sewer Separation Phase 4 upstream of regulator RE003-12 is anticipated to allow this outfall to meet the LTCP goals. This project is scheduled to be completed in 2030.
BOS062	Not Meeting	Meeting	BWSC through a Financial Assistance Agreement (FAA) with MWRA increased the capacity of the DWF connection. The project was completed July 31, 2024.
BOS065	Not Meeting	Meeting	BWSC through an FAA with MWRA raised the weir at the regulator structure. The project was completed July 11, 2024.
BOS009	Not Meeting	Meeting	BWSC completed Phase 3 of the East Boston Sewer Separation in December 2023.
BOS013	Materially Meeting	Meeting	BWSC through an FAA with MWRA increased the capacity of the DWF connection. This project was completed in 2024.

Table 4-3. Status Update On 16 Outfalls Not Predicted to Meet LTCP Goals as of 2021 and Two Outfalls that Changed Status Between 2021 and 2024

Outfall	Q4-2021 System Conditions	Q4-2024 System Conditions	Summary of Status
BOS014	Not Meeting	Meeting	BWSC through an FAA with MWRA constructed a new connection to the interceptor at the regulator structure. The project was completed January 26, 2022 as part of the East Boston Phase 3 Sewer Separation Contract.
BOS017	Not Meeting	Meeting	BWSC through an FAA with MWRA constructed modifications to the Sullivan Square siphon structure including adjustable stop logs upstream of each siphon barrel. The project was completed in October 2024.
CHE008	Not Meeting	Meeting	MWRA constructed a project to replace the interceptor connection at the regulator structure. This project was completed June 30, 2023.
BOS070	Not Meeting	Materially Meeting(1)	Following completion of a parallel relief pipe, BWSC South Boston Sewer Separation Contract 1, and 23 acres of sewer separation under BWSC Contract 2, performance at outfall BOS070 is predicted to improve to 6 activations and 1.87 MG. This performance would meet the LTCP volume goal for outfall BOS070 but the activations would still be higher than the LTCP goal by three activations. However, those three activations would be relatively small-volume (<0.1 MG), and therefore this outfall would be considered to materially meet the LTCP goals. Separation of the remaining 22 acres in BWSC Contract 2 is anticipated to be completed by April 2026 and is predicted to eliminate 5 of the remaining 6 activations at outfall BOS070.
CAM005	Not Meeting	Not Meeting	Under Q4-2024 conditions, outfall CAM005 meets the LTCP goal for volume, but the activations would still be higher than the LTCP goal by four activations. MWRA has procured the services of a design consultant to design a project to raise and lengthen the weir in the CAM005 regulator as proposed in the December 2022 *Task 8.2-8.3: Alewife Brook and Charles River System Optimization Evaluations Report*. This project, in conjunction with outfall cleaning planned by the city of Cambridge, is predicted to eliminate two of the remaining seven activations. Additional projects to meet LTCP goals were evaluated, but a feasible and cost-effective project was not identified. New alternatives to achieve a higher level of control at this outfall will be evaluated as part of the Updated CSO Control Plan required under the 2024 Charles River Variance.
MWR201 (Cottage Farm CSO Facility)	Not Meeting	Materially Meeting	Upstream and downstream system improvements (city of Cambridge separation of the Willard Street area, and BWSC separation work in Roxbury) have reduced the treated discharge volume at Cottage Farm to within 0.42 MG of the 6.3 MG goal, and the facility meets the LTCP goal for activation frequency. This outfall is therefore considered to materially meet the LTCP goal.

Table 4-3. Status Update On 16 Outfalls Not Predicted to Meet LTCP Goals as of 2021 and Two Outfalls that Changed Status Between 2021 and 2024

Outfall	Q4-2021 System Conditions	Q4-2024 System Conditions	Summary of Status
MWR018	Not Meeting	Not Meeting	Upstream system improvements (BWSC separation work in Roxbury) have reduced the discharge volume at outfall MWR018 from 1.11 MG in Q4-2021 to 0.38 MG in Q4-2024, while the annual activation frequency remains at two activations. Additional projects to meet LTCP goals were evaluated, but a feasible and cost-effective project was not identified. New alternatives to achieve a higher level of control at this outfall will be evaluated as part of the Updated CSO Control Plan required under the 2024 Charles River Variance.
MWR019	Not Meeting	Not Meeting	Upstream system improvements (BWSC separation work in Roxbury) have reduced the discharge volume at outfall MWR019 from 0.47 MG in Q4-2021 to 0.14 MG in Q4-2024, while the annual activation frequency remains at two activations. Additional projects to meet LTCP goals were evaluated, but a feasible and cost-effective project was not identified. New alternatives to achieve a higher level of control at this outfall will be evaluated as part of the Updated CSO Control Plan required under the 2024 Charles River Variance.
MWR020	Not Meeting	Materially Meeting	Upstream system improvements (BWSC separation work in Roxbury) have reduced the discharge volume at outfall MWR020 from 0.46 MG in Q4-2021 to 0.02 MG in Q4-2024 and reduced the annual activation frequency to one activation. As a result, this outfall is considered to materially meet the LTCP goals.

(1) Project to allow BOS070 to materially meet LTCP goals has been delayed and is estimated to be completed by the end of January 2025.

Appendix A – Q4-2024 -List of System Changes made from December 30, 2021 through December 30, 2024

Impacted CSO	Summary of Changes	Report Documenting Update
East Boston BOS005	Incorporated BWSC East Boston Sewer Separation Contract 2. Construction was completed in November 2021.	CSO Annual Report April 29, 2022
East Boston BOS005	Closed regulator RE005-1 (outfall BOS005). Construction was completed on September 6, 2022.	CSO Annual Report April 29, 2024
East Boston BOS014	Updated the model to include a new dry weather flow connection upstream of regulator RE014-2 (outfall BOS014); construction was completed on January 26, 2022.	CSO Annual Report April 29, 2022
East Boston RE003-2	Closed regulator RE003-2 (discharged to outfall BOS003). Construction was completed in May 2022.	CSO Annual Report April 29, 2022
East Boston RE003-7	Closed regulator RE003-7 (discharged to outfall BOS003). Construction was completed in August 2022.	CSO Annual Report April 29, 2022
East Boston RE003-12	Updated the configuration of the restricted interceptor connection at regulator RE003-12 by replacing the existing DWF connection with a 24-inch pipe and removing a manhole. Construction was completed in May 2022.	CSO Annual Report April 29, 2022
MWR018/019/020 Roxbury Canal Sewer (RCS)	BWSC piping configuration for the RCS connection was imported to better represent existing conditions. Updates were documented in the 2022 Annual Report.	CSO Annual Report April 29, 2022
MWR018-019-020 Tributary Area	Updated MWRA's Old Stony Brook Conduit (OSBC) system from BWSC's model to include georeferenced subcatchments in the Back Bay and trunk sewers in the OSBC system to enable further alternative analysis. Updates were documented in the 2022 Annual Report.	CSO Annual Report April 29, 2022
RE046-100	Updated the regulator RE046-100 influent pipe diameter from 12-inches to 18-inches based on previous field observations.	CSO Annual Report April 29, 2023
CHE008	Updated the configuration of the DWF connection and other modifications related to regulator RE-081 (outfall CHE008). Construction of modifications was completed on June 30, 2023	CSO Annual Report April 29, 2023
Prison Point Tributary Area	Updated stormwater subcatchment delineations in the Back Bay based on GIS mapping. The updated delineations relocated stormwater from the Stony Brook Conduit to the OSBC. Updates were documented in the 2023 Annual Report.	CSO Annual Report April 29, 2023
BOS070	Incorporated BWSC South Boston Sewer Separation Contract 1. Construction was completed in August 2023.	CSO Annual Report April 29, 2023
East Boston BOS003	Incorporated BWSC East Boston Sewer Separation Phase 3. Construction was completed in December 2023.	2024 Updated Report

Impacted CSO	Summary of Changes	Report Documenting Update
East Boston BOS003	Updated the model calibration at regulator RE003-12 based on recent meter data.	2024 Update Report
MWR205	Incorporated MWRA replacement of the existing leaky tide gate. Construction was completed in May 2023.	2024 Update Report
BOS013	Adjusted the DWF connection and removed nozzle from the model. Construction was completed in 2024	2024 Update Report
BOS017	Incorporated modifications to the siphon structure upstream of regulator RE017-3. Construction was completed in October 2024	2024 Update Report
CAM005, CAM007, & Cottage Farm	Incorporated 90% Sewer Separation of a 28-acres area tributary to the MWRA interceptor downstream of CAM005 in the Willard Street area by the City of Cambridge. Construction was completed in summer 2024.	2024 Update Report
RE062-4	Increased DWF pipe to 36" from 24" and decreased the headloss through the DWF connection. Construction was completed on July 31, 2024.	2024 Update Report
RE064-5	Raised weir crest elevation by 3" to 104.57 ft (was 104.32 ft). Construction was completed on July 8, 2024.	2024 Update Report
RE065-2	Added a 2.47 foot weir with crest elevation of 105.64 to the outfall line. Construction was completed on July 31, 2024.	2024 Update Report
RE070/7-2	Added 60-inch relief pipe parallel to the existing 60-inch BMI. Construction was completed in December 2024.	2024 Update Report
BOS070	Incorporated approximately 23 acres of South Boston Sewer Separation Contract 2 that were separated by December 2024. The remaining work on Contract 2 is anticipated to be completed by April 2026.	2024 Update Report
BOS070/Cottage Farm	Incorporated Roxbury Phase I, II, and III 90% sewer separation (115.9 acres). This work was completed by December 2024.	2024 Update Report