



Massachusetts Water Resources Authority's Journey from Long-Term Control Plan to Post Construction Compliance

Monitoring Program

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Background

- MWRA was established in 1984 to provide wholesale water and sewer services to 3.1 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities.
- 1985 Federal Court Order in the Boston Harbor Case required MWRA to develop a Long Term Control Plan (LTCP) to reduce CSO discharges for MWRA and member community outfalls.
- Four MWRA member communities have CSOs:
 - Cambridge
 - \circ Somerville
 - o Boston
 - \circ Chelsea



https://www.mwra.com/02org/html/whatis.htm

Background – MWRA's CSO Recommended Plan

- MWRA issued a recommended CSO plan in **1997**
- **2006** Second Stipulation incorporated revisions to the LTCP and established the final schedule
- From **1987 to 2015**
 - MWRA addressed **182** CSO-related court scheduled milestones
 - Constructed **35** wastewater system projects that comprised the LTCP
- The last 2 court milestones required MWRA to:
 - Commence a four-year performance assessment in compliance with EPA's CSO Policy and
 - Submit by December 2021 the results of the performance assessment



LTCP Recommended Plan

- Recommended plan included a range of costeffective projects targeted to site specific control including:
 - System optimization
 - Sewer separation
 - Interceptor relief
 - Detention treatment facilities
 - Storage facilities
 - Upgrades to existing CSO facilities
 - Outfall closures
- Constructed between 1988 to 2015
- Total cost \$911 million
- Annual CSO volume system wide reduced by over 2.8 billion gallons, a reduction of 87%.







Union Park Detention/Treatment Facility





BOS019 Storage Conduit

LTCP Goals – CSO Outfall Activation Frequency and Volume

- Performance objectives for the MWRA's approved LTCP included annual frequency and discharge volume at each outfall based on the Typical Year rainfall
- 86 outfalls listed in LTCP
- MWRA's collection system model is used to assess compliance with LTCP goals for activation frequency and volume

CSO OUTFALL	LONG TERM CONTROL PLAN ⁽¹⁾ TYPICAL YEAR				
	Activation Frequency	Volume (MG)			
	6	0.10			
CAM001	5	0.19			
MW/B003	7	0.09			
CAMOOA	To be closed	0.90 N/A			
CAM004	To be closed	N/A			
	5	1.61			
CAM401B	7	2 15			
SOM001A	3	1.67			
SOM001A	Closed	N/A			
SOM001	Closed	N/A			
SOM002A	Closed	N/A			
SOM004	Closed	N/A			
	Closed	7 29			
UPPER MYSTIC RIVER		1.20			
SOM007A/MWR205A (Somerville Marginal)	3	3.48			
SOM007	Closed	N/A			
TOTAL		3.48			
MYSTIC / CHELSEA CONFLUENCE					
MWR205 (Somerville Marginal)	39	60.58			
BOS013	4	0.54			
BOS014	0	0.00			
BOS015	Closed	N/A			
BOS017	1	0.02			
CHE002	4	0.22			
CHE003	3	0.04			
CHE004	3	0.32			
CHE008	0	0.00			
TOTAL		61.72			

Exhibit B to the Second Stipulation LTCP Goals (Partial List)

LTCP Goals – Water Quality Standards

MWRA adopted the Demonstration Approach from the CSO policy:

- Demonstrate that the plan was adequate to meet water quality standards and protect designated uses unless water quality standards or uses cannot be met as a result of natural background conditions or pollution sources other than CSOs.
- CSO discharges remaining after implementing the planned control program will not preclude attainment of water quality standards or the receiving waters' designated uses or contribute to their impairment.

Water quality models were used to establish compliance with water quality goals as part of 1997 LTCP



LTCP Goals – Water Quality Standards-

Water Quality Standard Classification		Receiving Water Segment	Required Level of CSO Control		
Class B		Neponset River	CSO prohibited (25-year storm control for the South Boston beaches)		
Class SB		North Dorchester Bay South Dorchester Bay Constitution Beach			
Class B(cso)		Back Bay Fens	>95% compliance with Class B or SB ("fishable/swimmable")		
Class SB(cso)		Mystic/Chelsea Rivers Confluence Boston Inner Harbor Fort Point Channel Reserved Channel	Must meet level of control for CSO activation frequency and volume in the approved Long- Term Control Plan (LTCP)		
Class B (CSO Variance)		Alewife Brook Upper Mystic River Charles River	Class B standards sustained with temporary authorizations for CSO discharges as the LTCP is implemented and verified (1998-2024)		



Water Quality LTCP Goals for Receiving Waters

Post Construction Compliance Program

- To assess the attainment of the levels of CSO control set forth in the Authority's LTCP
- Conducted over a 4-year period beginning November 8, 2017
- Work activities
 - Field Inspections/Data Collection
 - Collection System Model Update
 - WQ Model Development
 - CSO Community Coordination
 - Activation Frequency and Volume Findings
 - $_{\odot}$ WQ Modeling Findings



 Inspect CSO regulators addressed in the LTCP



Closed outfall (top), former CSO discharge that now discharges stormwater, only (bottom)

- Inspect CSO regulators addressed in the LTCP
- Collect meter data at active CSO regulators



Meter data at an Active CSO regulator

- Inspect CSO regulators addressed in the LTCP
- Collect meter data at active CSO regulators
- Upgrade and improve calibration of collection system model using data collected



InfoWorks ICM Model

- Inspect CSO regulators addressed in the LTCP
- Collect meter data at active CSO regulators
- Upgrade and improve calibration of hydraulic model using data collected
- Receiving water quality modeling and assessment



Charles River



Mystic River

Coordination with CSO Communities

- CSO community meetings
- System knowledge
- Record drawings
- Existing collection system models
- Additional metering data



MWRA's Hydraulic Collection System Model

- Model was first developed in 1992 using EPA SWMM software.
- Model is continuously updated to incorporate system changes.
- Model was converted to Infoworks CS in the early 2000s.
- For this assessment the model was converted to InfoWorks ICM, updated and recalibrated.



MWRA InfoWorks ICM North System Model

MWRA's Collection System Model

- Meter data collected from April 2018 through June 2020 was used to recalibrate the collection system model
 - Interceptor Meters
 - Regulator Structure Meters
 - Facility Data
- Updated system information was collected from the CSO Communities
- The updated model was used to assess the CSO activation frequency and volume for the Typical Year



MWRA InfoWorks ICM North System Model

LTCP Goals- Activation Frequency and Volume by Outfall

- 86 outfalls identified in LTCP
- 35 outfalls closed including 10 outfalls not required to be closed by LTCP
- 70 of the 86 outfalls meet LTCP goals for activation frequency and volume as of the end of 2021
- At 10 locations designs are underway and construction is anticipated to be completed by the end of 2024
- At 6 locations, MWRA and the CSO communities continue to identify and evaluate measures to reduce CSO toward LTCP goals.



LTCP Goals – Water Quality Standards – Variance Waters

- For the variance waters (Charles River and Alewife/Upper Mystic Rivers), new water quality models were developed to assess water quality performance
- What Changed?
- Modeling software
 - In 1997 LTCP annual WQ compliance was estimated from compliance in 3-month and 1year storms
 - New modeling software allowed for continuous annual simulations
- Compliance Criteria:
 - In 1997 water quality goals were based Fecal Coliform
 - New water quality goals are based on *E. coli* and *Enterococcus*.



Extent of the Charles River and Alewife Brook/Upper Mystic River Models

	Class B Criteria for Non-Bathing Beach Waters (#/100 ml)					
Parameter	6-month Geometric Mean	Single Sample Maximum				
E. coli	126	235				
Enterococcus	33	61				

Class B Criteria during the Study Period

LTCP Goals – Water Quality Standards – Variance Water Models

- Modeled stormwater concentrations were based on the average values from sampling data
- Modeled CSO concentrations were based on mass balance (relative sanitary and stormwater fractions) calculated from collection system model
- Models were calibrated to CSO and inreceiving water sampling points



Measured and Calculated E. coli counts at Cottage Farm and Prison Point



Calibration Plot for STA001 and STA144 in the Charles River

Charles River E.coli Counts, 1-Year Storm – All Sources



Charles River Attainment All Sources and Non-CSO Sources Only

- The models were able to distinguish between the impacts of:
 - \circ All Sources
 - Non-CSO Sources Only
 - Stormwater Only
 - DWF Sources Only
 - Boundary Conditions Only
 - $\,\circ\,$ CSOs only
- The percent compliance is the same for All Sources and Non-CSO Sources Only
- Eliminating CSOs provides no real change in water quality percent compliance



Hours of Exceedance and Percent Compliance with 235#/100mL *E. coli* Single-Sample Max. Criterion for the Typical Year, 2019 Conditions

Charles River Attainment - CSO Only

- For CSO only very little time out of compliance for the Typical Year
- Percent compliance is over 99% in the Typical Year



Hours of Exceedance and Percent Compliance with 235#/100mL *E. coli* Single-Sample Max. Criterion for the Typical Year for CSO Sources Only, 2019 Conditions

Charles River – Percent Annual Compliance

Condition	Percent Annual Compliance with <i>E. coli</i> Single-Sample Maximum Criterion (235#/100m Non-CSO Stormwater Dry Weather Boundaries All Sources Sources Only Only Sources Only							
Charles River						-		
Q1-2021	48%	48%	64%	100%	59%	99.9%		

- The predominant source of bacteria loading was demonstrated to be non-CSO sources.
- Very little difference between non-CSO sources and all sources.
- Among the non-CSO sources, stormwater and boundary conditions both contribute substantially to the non-attainment.
- Further reduction of CSO would not increase the level of compliance.

Alewife Brook and Mystic River – Percent Annual Compliance

	Percent Annual Compliance with <i>E. coli</i> Single-Sample Maximum Criterion (235#/100mL)								
Q1-2021 Condition	All Sources	Non-CSO Sources Only	Stormwater Only	Dry Weather Sources Only	Boundaries Only	CSOs Only			
Alewife Brook	45%	45%	47%	100%	100%	99.6%			
Upper Mystic River	55%	55%	57%	100%	100%	97.9%			

- The predominant source of bacteria loading was demonstrated to be non-CSO sources.
- Similar results to the Charles River, except in this case of the non-CSO sources stormwater had by far the greatest impact.
- Further reduction of CSO would not increase the level of compliance.

LTCP Goals – Water Quality Standards- Non-Variance Waters

- For the non-variance waters achievement of water quality goals was assessed through attainment with activation frequency and volume goals and an assessment of water quality monitoring data
- CSOs eliminated to Class B/SB waters of Neponset River, North and South Dorchester Bay and Constitution Beach
- Areas of Boston Harbor with remaining CSOs are Class SB (CSO)
- MWRA long-term CSO Receiving Water Monitoring Program has collected and analyzed samples since 1989.
- Monitoring data generally show good quality throughout the harbor with the exception of head end of Fort Point Channel.
 - Limited circulation and stormwater inputs contribute to poorer water quality at this location



MWRA Monitoring Stations in Non-Variance Regions, with Colored Symbols Showing Associated "Report Card" Grades for 2020

Summary and Conclusions

- Since 1988 the average annual CSO volume systemwide has been reduced by over 2.8 billion gallons, a reduction of 87%
- As of the end of 2021, the LTCP goals for CSO activation and volume were achieved at 70 of the 86 outfalls
- 16 outfalls did not meet LTCP goals for activation frequency and/or volume by the end of 2021
- System wide volume short of LTCP goal by 10 MG (2%)



CSO Discharge Reduction from 1988 to Present Conditions Compared to LTCP Goals

Summary and Conclusions – 16 Outfalls Remaining- 10 with a Plan in Place

- BOS003, BOS009 and BOS014: Sewer Separation
- CHE008: DWF Connection Relief
- Somerville Marginal CSO Facility- Gated Interceptor Connection
 - MWR205
 - SOM007A/MWR205A





East Boston Sewer Separation

Somerville Marginal CSO Facility- Proposed Gated Interceptor Connection

Summary and Conclusions – 16 Outfalls Remaining – 10 with a Plan in Place

- BOS017-Siphon structure modification
- BOS062 and BOS065 Regulator optimization
- BOS070 Relief pipe



BOS017- Concept Sketch of Sullivan Square Siphon Structure Modifications



Schematic of New East Side Interceptor System

Summary and Conclusions – 16 Outfalls Remaining – 6 Outfalls Continue to be Investigated

• SOM001A

- 63% reduction in annual volume to date
- Currently within 2.8 MG of the LTCP goal

• CAM005

- Currently achieving annual volume LTCP goal
- Exceeding activation frequency LTCP goal by five relatively low-volume (< 0.1 MG) activations

	1992 System Conditions		Q4-2021 System Conditions		LTCP		Comment
	Act Freq	Vol (MG)	Act Freq	Vol (MG)	Act Freq	Vol (MG)	
SOM001A (Alewife Brook)	10	11.93	8	4.47	3	1.67	63% reduction in CSO discharge
CAM005 (Charles River)	6	41.56	8	0.75	3	0.84	Volume < LTCP goal but activation frequency > LTCP Goal

Summary and Conclusions – 16 Outfalls Remaining – 6 Outfalls Continue to be Investigated

Cottage Farm CSO Facility-MWR201

- Treated discharge has been reduced by 96% since 1992
- Currently meeting activation frequency LTCP goal
- Missing treated discharge volume by 2.7 MG

• MWR018, MWR019, MWR020

- o 60% reduction in annual volume
- $\circ~$ Missing activation frequency goal by 2 $\,$

	1992 System Conditions		Q4-2021 System Conditions		LTCP		Comment	
	Act Freq	Vol (MG)	Act Freq	Vol (MG)	Act Freq	Vol (MG		
Charles River								
Cottage Farm CSO Facility – MWR201	18	214.10	2	9.09	2	6.30	Facility discharge is treated. Discharge volume reduced 96%	
MWR018	2	3.18	2	1.11	0	0.00		
MWR019	2	1.32	2	0.47	0	0.00	60% reduction discharge in CSO discharge.	
MWR020	2	0.64	2	0.46	0	0.00		

Summary and Conclusions

- Since 1988 the average annual CSO volume systemwide has been reduced by over 2.8 billion gallons, a reduction of 87%.
- Water quality modeling and ongoing sampling has indicated substantial improvement in water quality throughout the project receiving waters as a result of MWRA's substantial investments in CSO control.
- Water quality modeling indicated that further reducing CSOs at the few outfalls not meeting the LTCP goal would not change the annual attainment of water quality standards.
- Nevertheless, MWRA and the CSO communities continue to evaluate options to further reduce CSOs at these few locations.







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