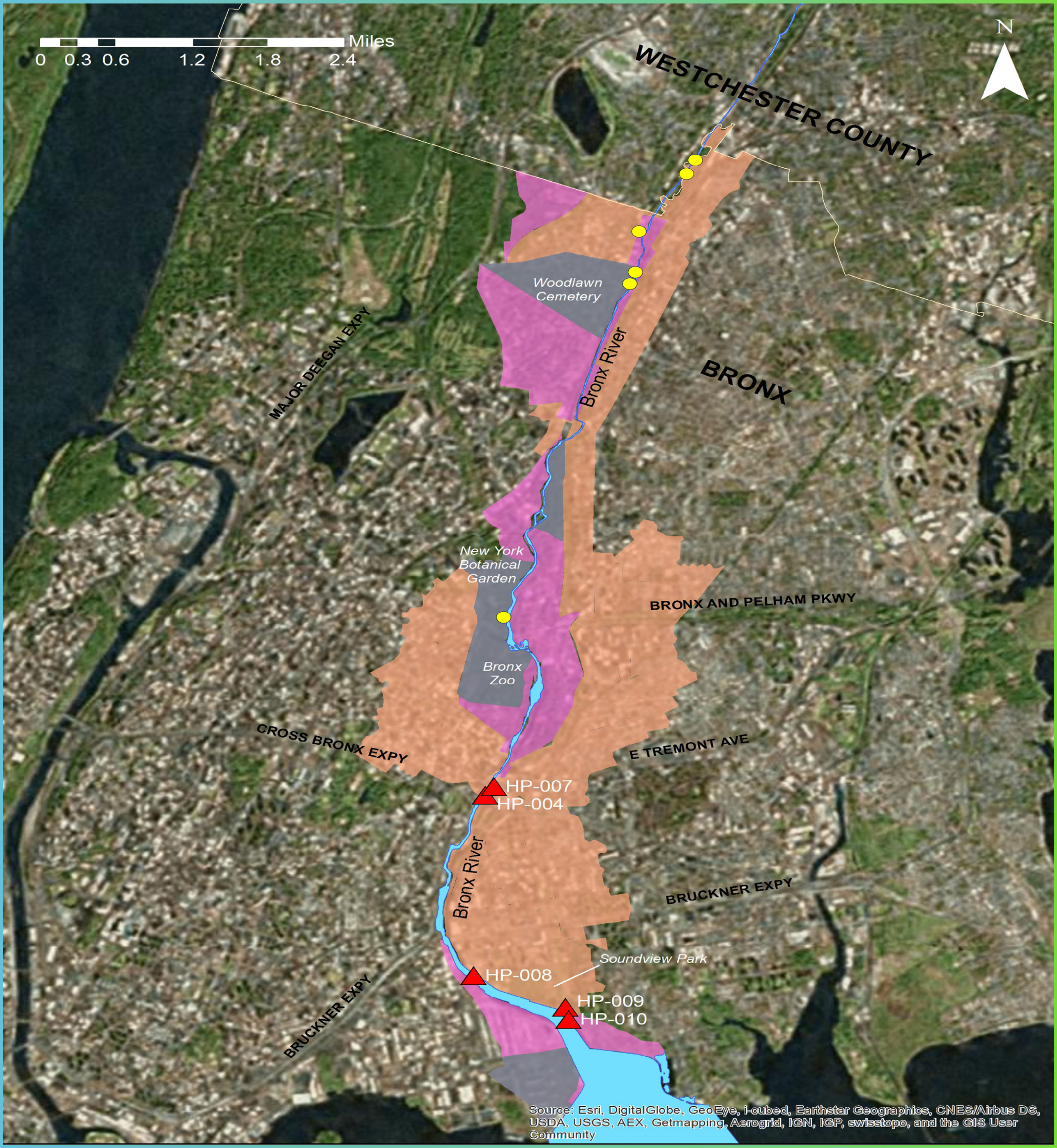
New York City Department of Environmental Protection

Capital Project No. WP-169
Long Term Control Plan II

Combined Sewer Overflow Long Term Control Plan for Bronx River



June 2015

Environmental Protection

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Keith W. Beckmann, P.E.
NY License No. 066623

The City of New York
Department of Environmental Protection
Bureau of Wastewater Treatment

Prepared by: AECOM USA, Inc.

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EXECUTIVE SUMMARY

This Executive Summary is organized as follows:

- Background — An overview of the regulations, approach and existing waterbody information.
- Findings — A summary of the key findings of the water quality (WQ) data analyses, the WQ modeling simulations and the alternatives analysis.
- Recommendations — A list of recommendations that are consistent with the Federal Combined Sewer Overflow (CSO) Control Policy and the Clean Water Act (CWA).

1. BACKGROUND

The New York City (NYC) Department of Environmental Protection (DEP) prepared this Long Term Control Plan (LTCP) for the Bronx River pursuant to a CSO Order on Consent (Department of Environmental Conservation (DEC) Case No. CO2-20110512-25), dated March 8, 2012 (2012 CSO Order on Consent). The 2012 CSO Order on Consent modified a 2005 CSO Order on Consent (DEC Case No. CO2-20000107-8). Under the 2012 CSO Order on Consent, the DEP is required to submit 11 waterbody-specific LTCPs to the DEC by December 2017. The Bronx River LTCP is the fifth of those LTCPs.

As described in the LTCP Goal Statement in the 2012 CSO Order on Consent, the goal of each LTCP is to identify, with public input, appropriate CSO controls necessary to achieve waterbody-specific water quality standards (WQS) consistent with the Federal CSO Control Policy and related guidance. In addition, the Goal Statement provides: *"Where existing water quality standards do not meet the Section 101(a)(2) goals of the Clean Water Act, or where the proposed alternative set forth in the LTCP will not achieve existing water quality standards or the Section 101(a)(2) goals, the LTCP will include a Use Attainability Analysis examining whether applicable waterbody classifications, criteria, or standards should be adjusted by the State."* DEP conducted water quality assessments where the data is represented by percent attainment with pathogen targets and associated recovery times. Consistent with guidance from DEC, 95 percent attainment of applicable water quality criteria constitutes compliance with the existing WQS or the Section 101(a)(2) goals conditioned on verification through post-construction compliance monitoring (PCM).

Regulatory Requirements

The waters of NYC are subject to Federal and New York State (NYS) laws and regulations. Particularly relevant to this LTCP is the U.S. Environmental Protection Agency's (EPA) CSO Control Policy, which provides guidance on the development and implementation of LTCPs, and the setting of WQS. In NYS, CWA regulatory and permitting authority has been delegated to DEC.

DEC has designated the saline portion of the Bronx River as a Class I waterbody. The best usages of Class I waters are "secondary contact recreation and fishing" (6 NYCRR 701.13). Figure ES-1 shows the Bronx River with the freshwater/saline boundary at E. Tremont Avenue in the Bronx.

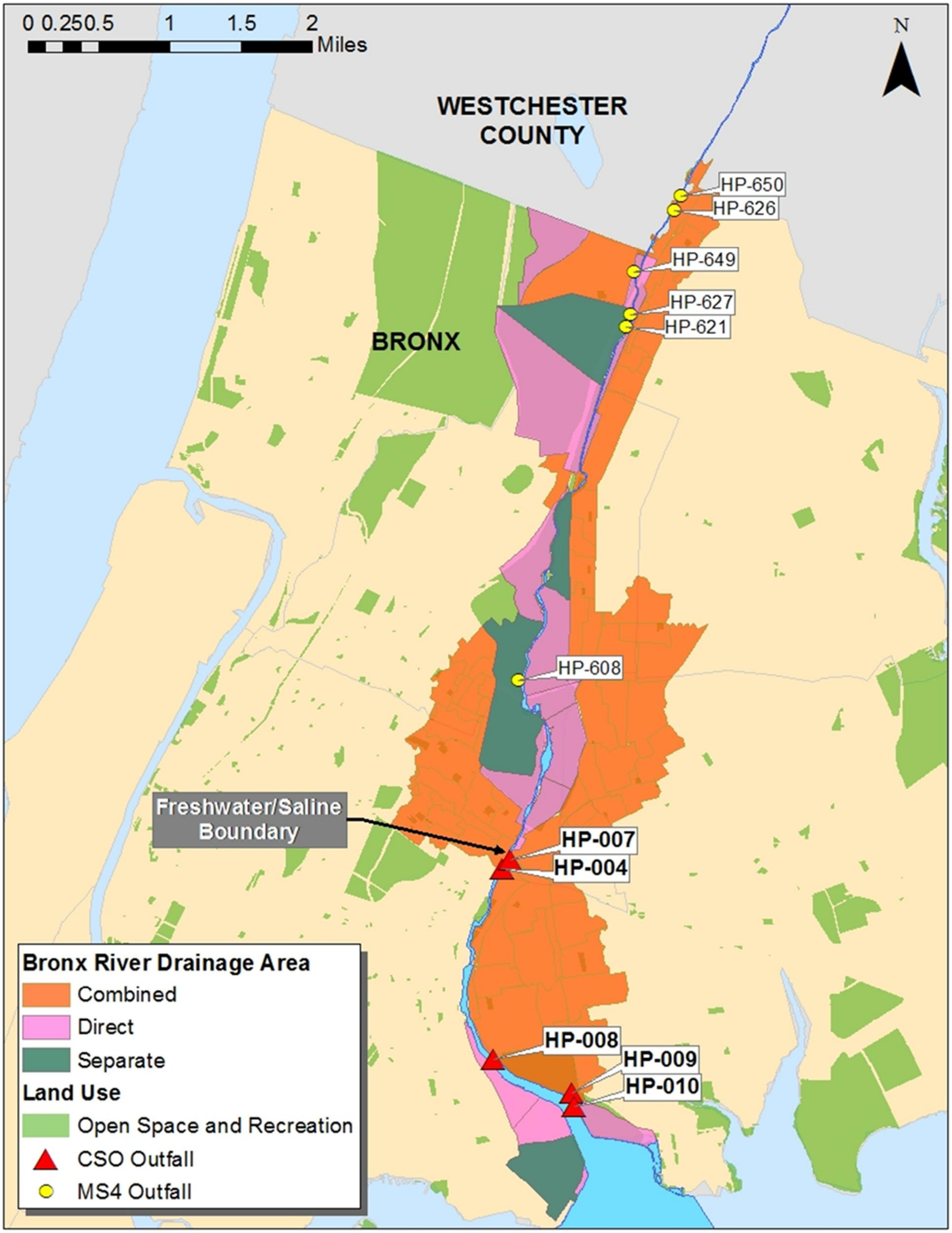

Figure ES-1. Bronx River Watershed Characteristics

DEC has publicly noticed a proposed rulemaking to amend 6 NYCRR Parts 701 and 703. The proposed total and fecal coliform bacteria criteria of 200 cfu/100mL would be the same for Class I and SC waters. In addition, DEC has advised DEP that it will soon adopt the 30-day rolling geometric mean (GM) for enterococci of 30 cfu/100mL, with a not-to-exceed the 90^{th} percentile statistical threshold value (STV) of 110 cfu/100mL, which is the EPA Recommended Recreational Water Quality Criteria (2012 EPA RWQC). It is not expected that the recommendations herein will be altered by the new criteria.

The criteria assessed in this LTCP include the Existing WQ Criteria (Class I – secondary contact recreation) for the Bronx River, and Class SC - limited primary contact recreation. The best usage of Class SC waters is fishing. The SC classification further states that water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use of the waterbody for those purposes. Enterococci criteria do not apply to tributaries such as the Bronx River under the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000; therefore, the Bronx River water quality assessments for Class SC considered only the fecal coliform criteria.. Because the 2012 EPA RWQC recommended certain changes to the bacterial water quality criteria for primary contact, this LTCP includes attainment analyses for both the Existing WQ Criteria and for the proposed 2012 EPA RWQC (referred to hereinafter as the "Potential Future Primary Contact WQ Criteria").

Table ES-1 summarizes the Existing WQ Criteria, Primary Contact WQ Criteria and Potential Future Primary Contact WQ Criteria applied in this LTCP.

Table ES-1. Classifications and Standards Applied

Analysis	Numerical Criteria Applied	
Existing WQ Criteria	Freshwater (Class B)	Fecal Monthly GM ≤ 200; Daily Average DO ≥ 5.0 mg/L; DO never < 4.0 mg/L
	Saline Water (Class I)	Fecal Monthly GM ≤ 2,000 DO never <4.0 mg/L
Primary Contact WQ Criteria(1)	Freshwater (Class B)	Fecal Monthly GM ≤ 200 Daily Average DO ≥ 5.0 mg/L; DO never < 4.0 mg/L
	Saline Water (Class SC)	Fecal Monthly GM ≤ 200 Daily Average DO ≥ 4.8 mg/L; DO never < 3.0 mg/L
Potential Future Primary Contact WQ Criteria(2)	Entero: rolling 30-d GM – 30 cfu/100mL Entero: STV – 110 cfu/100mL	

Notes:
GM = Geometric Mean; STV = 90 Percent Statistical Threshold Value
(1) This water quality standard is not currently assigned to the saline Bronx River.
(2) The Potential Future Primary Contact WQ Criteria have not yet been adopted by DEC.

Bronx River Watershed

The Bronx River watershed characteristics, along with the CSO and stormwater outfalls, are as shown in Figure ES-1. The Bronx River begins in Westchester County, and is a tributary of the Upper East River. Within NYC, it is located in the eastern section of the Bronx. The Bronx River LTCP Study Area spans large portions of Westchester County and the NYC Borough of the Bronx. It is both an urbanized and a suburbanized area. The natural watershed of the Bronx River consists of approximately 23,020 acres, based on interpretation of the local topography, 4,320 acres of which lie in NYC. The majority of the Bronx River watershed is served by the Hunts Point (HP) Wastewater Treatment Plant (WWTP). Sanitary flows and a portion of combined sanitary and stormwater flows are conveyed to the Hunts Point WWTP for treatment. Flows that exceed the capacity of the conveyance and treatment system are discharged into the waterbodies via CSO outfalls permitted by DEC. Limited portions of the drainage area along the shorelines discharge their runoff directly to the Bronx River. This LTCP report focuses on the saline portion of the Bronx River.

Green Infrastructure

DEP plans significant investments in Green Infrastructure (GI) in the Bronx River watershed within the Hunts Point WWTP service area. DEP projects that GI penetration rates would manage 14 percent of the impervious surfaces within the Bronx River combined sewer service area by 2030. This accounts for Right-of-Way (ROW) practices, public property retrofits, GI implementation on private properties, and for conservatively estimated new development trends based on NYC Department of Buildings (DOB) permit data. DOB data from 2000 to 2011 has been projected for the 2012-2030 period to account for compliance with the stormwater performance standard. The model has predicted a reduction in annual overflow volume of 41 million gallons (MG) from this GI implementation, based on the 2008 baseline rainfall condition. The 2008 year rainfall was determined to be representative of average rainfall conditions in NYC, and was used in the LTCP evaluations to represent a "typical" year.

2. FINDINGS

Current Water Quality Conditions

Water quality analyses in the Bronx River were based, in part, on data collected from May to July of 2014, during the development of the Bronx River LTCP. The sampling stations are shown in Figure ES-2.

Figure ES-3 presents fecal coliform bacteria data collected at Stations BR-1 to BR-9; Figure ES-4 presents the enterococci data. The results represent data that were collected by multiple parties including the LTCP, Harbor Survey Monitoring Program (HSM), Sentinel Monitoring (SM), Citizen Testing Group and Bronx River Alliance.

The data indicate significantly higher concentrations of enterococci and fecal coliform bacteria in the dry and wet-weather samples at in-stream Station BR-1 near the border with Westchester County, with GMs during the wet-weather for enterococci at approximately 931 cfu/100mL and for fecal coliform bacteria near 2,631 cfu/100mL. Lower bacteria concentrations were detected towards the mouth of the Bronx River (BR-9) with GMs during the wet-weather for enterococci at approximately 16 cfu/100mL, and fecal coliform bacteria near 220 cfu/100mL.

As noted in Figures ES-3 and ES-4, dry-weather fecal coliform concentrations are lower than those for wet-weather conditions. The general trend for both fecal coliform and enterococci bacteria is for the highest values to be at the boundary with Westchester County (BR-1), and decreasing downstream towards the East River (BR-9).

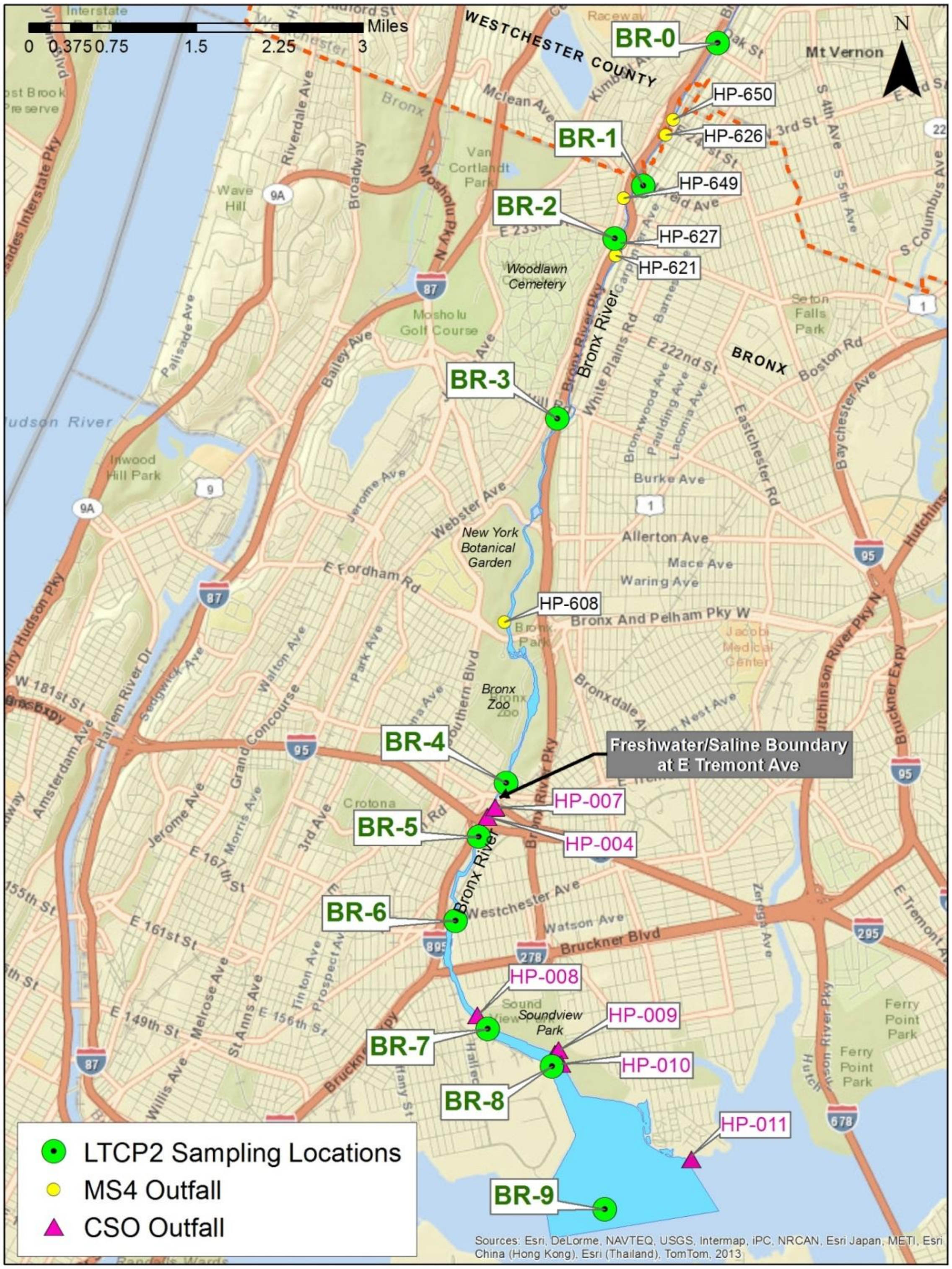

Figure ES-2. Bronx River Sampling Locations

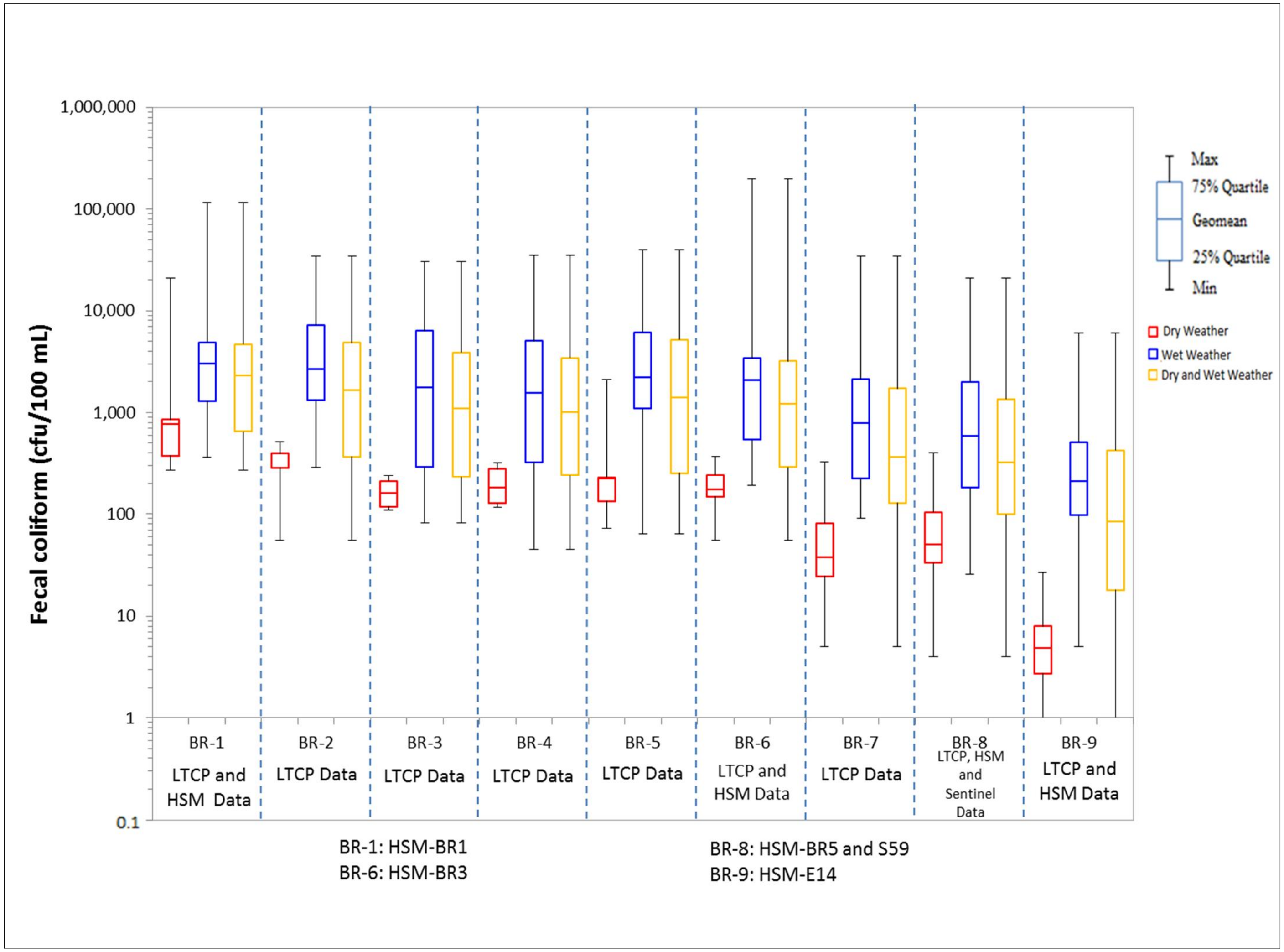

Figure ES-3. Fecal Coliform Data from LTCP, HSM, and SM – Bronx River, May – July 2014

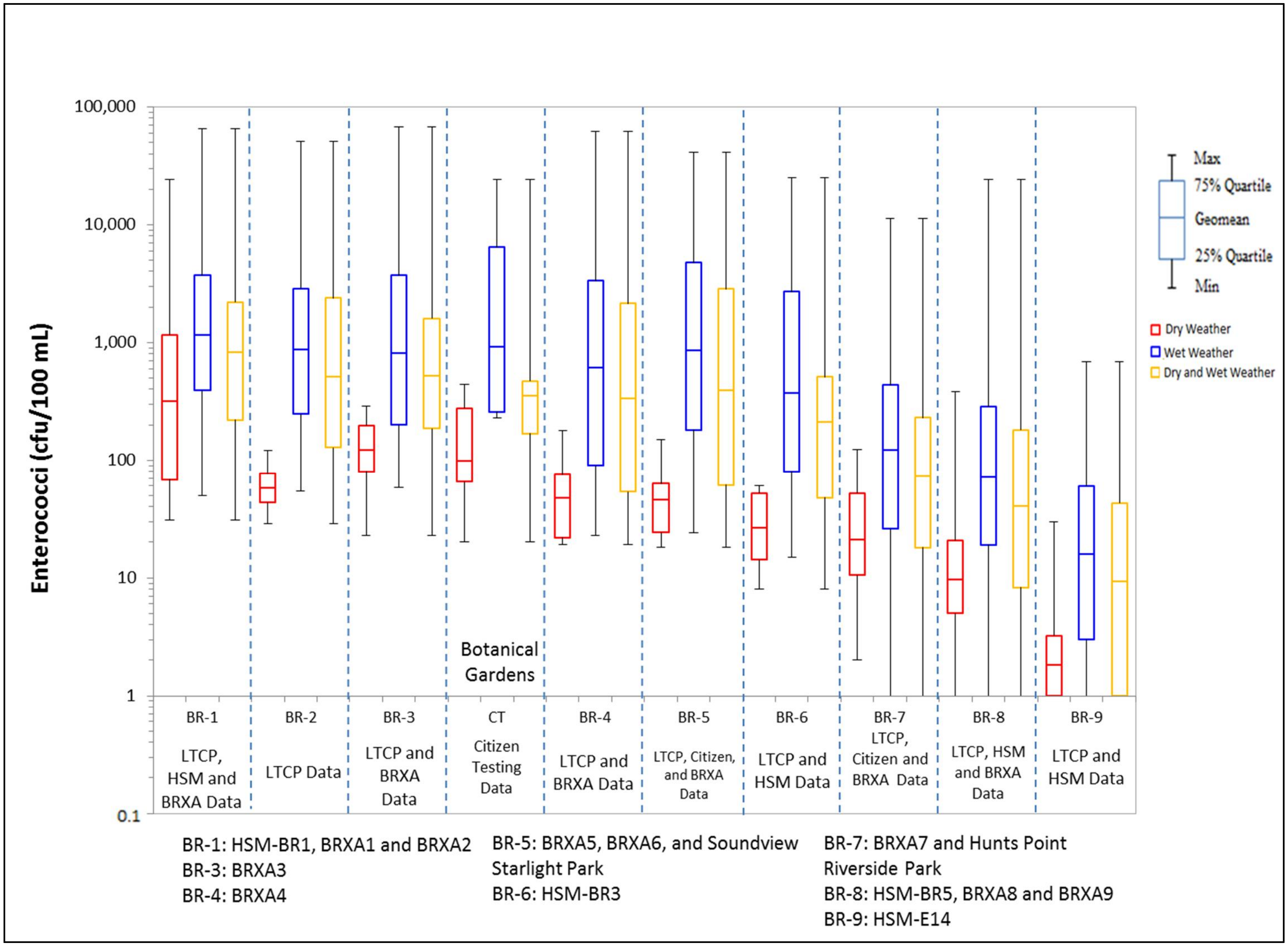

Figure ES-4. Enterococci Data from LTCP, HSM, Citizen Testing Group and Bronx River Alliance – Bronx River, May – July 2014

Baseline Conditions, 100% CSO Control and Performance Gap

Computer models were used to assess attainment with Existing WQ Criteria (Class I), Primary Contact WQ Criteria (Class SC) and Potential Future Primary Contact WQ Criteria. The analyses focused on two primary objectives:

1. Determine the levels of compliance with water quality criteria under future baseline conditions, defined as conditions with sanitary flows based on 2040 population projections, with all other NYC sources being discharged at existing levels to the waterbody, and assuming the Bronx River flow from Westchester County is in attainment with Class B at the border. The NYC sources would primarily be direct drainage runoff, stormwater and CSO. This analysis is presented for Existing WQ Criteria, Primary Contact WQ Criteria (Class SC) and Potential Future Primary Contact WQ Criteria.
2. Determine potential attainment levels with 100% of CSO controlled or no discharge of CSO to the waterbody, keeping the remaining non-CSO sources. This analysis is presented for the criteria shown in Table ES-1.

DEP assessed water quality using the East River Tributary Model (ERTM). This model was updated and recalibrated using data from the 2014 LTCP sampling program for the Bronx River. Model outputs for fecal and enterococci bacteria, as well as for dissolved oxygen (DO), were compared with various monitored data sets during calibration and validation. This improved the accuracy and robustness of the models for LTCP evaluations. The InfoWorks CS™ (IW) sewer system model was used to provide flows and loads from intermittent wet-weather sources as input to the ERTM water quality model. The EPA Stormwater Management Model (SWMM) was used to determine the incoming flows and loadings crossing the NYC/Westchester County border, as well as the wet-weather loadings originating within NYC contributing to the freshwater reach of the Bronx River. The water quality model was then used to calculate ambient pathogen concentrations within the waterbody for a set of baseline conditions.

Baseline conditions were established in accordance with the guidance provided by DEC to represent future conditions. These included the following assumptions: the design year for projected future flows was established as 2040; Hunts Point WWTP would receive peak flows at two times design dry-weather flow (2xDDWF) or wet-weather capacity of 400 million gallons per day (MGD); grey infrastructure would include those elements recommended in the 2011 Waterbody/Watershed Facility Plan (WWFP); and waterbody-specific GI application rates would be based on the best available information. In the case of the Bronx River project area, GI was assumed to have 14 percent coverage. The Bronx River receives flows and loadings from Westchester County. For the baseline conditions, the Bronx River flow at the NYC border was assigned to be in attainment of the Class B water quality criteria. Illicit dry-weather loadings from Westchester County were not included in the baseline conditions.

The water quality assessments were conducted using continuous water quality simulations. A one-year (2008 rainfall) simulation for bacteria and DO assessment was used to support alternatives evaluation. A 10-year (2002 to 2011 rainfall) simulation for bacteria for attainment analysis was used for the preferred alternative. The gaps between calculated baseline bacteria, as well as DO, were then compared to the applicable pathogen and DO criteria to quantify the level of attainment.

The analyses were performed for the freshwater and saline sections for the 2008 rainfall simulation. A summary of the baseline attainment of Existing WQ Criteria for the freshwater and saline sections is presented in Table ES-2. As shown, all stations in the Bronx River meet Existing WQ Criteria in the recreational season (May 1st through October 31st), and all stations meet the criteria on an annual basis, except at Stations BR-3 and BR-4 in the freshwater section.

Table ES-2. Calculated 2008 Baseline Fecal Coliform Maximum Monthly GM and Attainment of Existing WQ Criteria

Station			Maximum Monthly Geometric Means		% Attainment	
			Annual	Recreational Season	Annual	Recreational Season
BR-1	Fresh Water (Class B)	Non-Tidal	199	64	100	100
BR-2	Fresh Water (Class B)	Non-Tidal	199	64	100	100
BR-3	Fresh Water (Class B)	Non-Tidal	213	64	92	100
BR-4[(1)]	Fresh Water (Class B)	Tidal	325	183	92	100
BR-5	Saline(Class I)	Tidal	357	159	100	100
BR-6	Saline(Class I)	Tidal	439	38	100	100
BR-7	Saline(Class I)	Tidal	406	29	100	100
BR-8	Saline(Class I)	Tidal	382	30	100	100
BR-9	Saline(Class I)	Tidal	242	21	100	100

Notes:
(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

Levels of attainment for the annual and recreational season (May 1st through October 31st) are shown for the Primary Contact WQ Criteria (Class SC) in Table ES-3. All stations in the Bronx River are in attainment during the recreational season (May 1st through October 31st). On an annual basis, Stations BR-5 to BR-9 in the saline section achieves 83 percent attainment, and Stations BR-3 and BR-4 in the freshwater section achieves 92 percent attainment. The recreational season (May 1st through October 31st) attainment levels are met throughout the Bronx River and the annual attainment levels are met at Stations BR-1 and BR-2.

The Primary Contact WQ Criteria baseline and 100% CSO Control attainment levels are shown in Table ES-4. The projected level of attainment following 100% control of the CSO overflows is the same as for baseline conditions. Attainment in the freshwater sections is not affected by CSOs. In the saline section, attainment appears to be more affected by bacteria loads from the East River, which enter on the incoming tide, as well as upstream bacteria loads that tend to linger through multiple tidal cycles. Impacts of the Bronx River CSO overflows, which are of relatively short duration, tend to be more transient. The data indicate that little improvement in bacteria water quality criteria would be achieved even with 100% CSO control.

Table ES-3. Calculated 2008 Baseline Fecal Coliform Maximum Monthly GM and Attainment of Primary Contact WQ Criteria

Station			Maximum Monthly Geometric Means (cfu/100mL)		% Attainment	
			Annual	Recreational[1] Season	Annual	Recreational[1] Season
BR-1	Fresh Water (Class B)	Non-Tidal	199	64	100	100
BR-2			199	64	100	100
BR-3			213	64	92	100
BR-4[2]		Tidal	325	183	92	100
BR-5	Saline (Class SC)		357	159	83	100
BR-6			439	38	83	100
BR-7			406	29	83	100
BR-8			382	30	83	100
BR-9			242	21	83	100

Notes:

(1) The Recreational Season is from May 1st through October 31st.
(2) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

Table ES-4. Comparison of the Calculated 2008 Baseline and 100% Bronx River CSO Control Fecal Coliform Maximum Monthly GM and Attainment of Primary Contact WQ Criteria

Station			Maximum Monthly Geometric Means (Annual)		% Attainment (Annual)	
			Baseline	100% CSO Control	Baseline	100% CSO Control
BR-1	Fresh Water (Class B)	Non-Tidal	199	199	100	100
BR-2			199	199	100	100
BR-3			213	213	92	92
BR-4[1]		Tidal	325	325	92	92
BR-5	Saline (Class SC)		357	351	83	83
BR-6			439	382	83	83
BR-7			406	344	83	83
BR-8			382	307	83	83
BR-9			242	231	83	83

Notes:

(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

The comparison of baseline and 100% CSO control for DO similarly shows no difference in attainment (Table ES-5). The DO attainment levels are met for the Existing WQ Criteria.

Table ES-5. Model Calculated Baseline and 100% CSO Control DO Attainment – Existing WQ Criteria (2008)

Station		Annual Attainment Percent Attainment (Water Column)	
		Baseline	100% Bronx River CSO Control
BR-05	Saline (Class I)	99	99
BR-06		95	95
BR-07		97	97
BR-08		99	99
BR-09		98	98

The Potential Future Primary Contact WQ Criteria attainment is shown below in Table ES-6. The 30-day moving GM target of 30 cfu/100mL is met throughout the Bronx River, other than at Stations BR-4 and BR-5, and that the STV target of 110 cannot be met. The drop in attainment between Stations BR-3 and BR-4 is due primarily to the constant loading input from Cope Lake, which is located between Stations BR-3 and BR-4.

Table ES-6. Calculated 2008 Baseline Enterococci Maximum 30-day GM and Attainment of Potential Future Primary Contact WQ Criteria

Station			Maximum Recreational Season 30-day Enterococci (cfu/100mL)		% Attainment	
			GM	90th Percentile STV	GM	90th Percentile STV
BR-1	Fresh Water	Non-Tidal	30	1,253	100	5
BR-2			30	1,253	100	5
BR-3			33	1,310	99	4
BR-4(1)		Tidal	69	1,464	61	2
BR-5	Saline		61	1,480	73	2
BR-6			31	479	98	10
BR-7			28	380	100	10
BR-8			31	337	99	11
BR-9			20	135	100	67

Notes:
(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

The baseline modeling showed that the Bronx River exhibits a high level of attainment with the Existing WQ Criteria. The attainment levels with the Primary Contact WQ Criteria (Class SC) and the Potential Future Primary Contact WQ Criteria are lower. The enterococci STV value 90th percentile limit cannot be met.

Public Outreach

DEP's comprehensive public participation plan ensured that interested stakeholders were involved in the LTCP process. Stakeholders included local residents and citywide and regional groups, a number of whom offered comments at two public meetings held for this LTCP. DEP received a letter from the Bronx River Alliance and an e-mail from Columbia University. DEP will continue to gather public feedback on waterbody uses and will provide further information to the public at a third Bronx River Public Meeting. The third meeting will present the identified preferred alternative to the public after DEC's review of the LTCP.

At the second of two public meetings conducted to date, some members of the public expressed a preference for an alternative that did not involve chlorination. Additional information on the public outreach activities is presented in Section 7 and Appendix B, Public Meeting Materials.

In addition to the two public meetings conducted to date, the following additional stakeholder meetings were held:

- Meeting with Combined Borough Board and Borough Services (January 22, 2015)

  DEP staff met with the Deputy Borough President (and staff), the District Managers of all of the Bronx Community Boards, and representatives from various Council Members. Staff from DEP presented information on the LTCP Program, the Bronx River water quality and waterbody characteristics, and explained the LTCP planning and alternatives processes.

- Meeting with Riverkeeper and Bronx Alliance (February 9, 2015)

  DEP staff with Riverkeeper and the Bronx Alliance to present sampling data obtained during the LTCP Bronx River sampling programs as well as data from Harbor Survey and Sentinel monitoring.

- Meeting with Environmental Committee of Community Board 2 (April 1, 2015)

  DEP staff met with the Environmental Committee of Community Board 2 to present the Kick-off Meeting presentation given during the February 12, 2015 public meeting.

- Meeting with Riverkeeper, Bronx Alliance and NRDC (May 5, 2015)

  DEP staff met with the Riverkeeper, Bronx Alliance and a representative from the NRDC to present sampling data and alternatives considered during development of the LTCP.

Evaluation of Alternatives

DEP used a multi-step process to evaluate control measures and CSO control alternatives. The evaluation process considered: environmental benefits; community and societal impacts; issues relating to implementation and operation and maintenance (O&M). Following the comments generated by detailed technical workshops, the retained alternatives were subjected to a functional review and cost-performance and cost-attainment evaluations, where economic factors were introduced. Table ES-7 presents the retained alternatives.

Table ES-7. Summary of Retained Alternatives

Alternative	Description
1. Combination of Outfall HP-007 Direct Disinfection and Outfall HP-009 Relief	Outfall HP-007 • Direct Disinfection Outfall HP-009 • Raise weir at Regulator 13 • Relief pipe between Regulator 13 and the Bronx River siphon Outfall HP-011 • Floatables Control
2. Combination of Outfall HP-007 Relief and Outfall HP-009 Relief	Outfall HP-007 • 2,700-LF interceptor relief at Relief Structure 27 Outfall HP-009 • Raise weir at Regulator 13 • Relief pipe between Regulator 13 and the Bronx River siphon Outfall HP-011 • Floatables Control
3. Outfall HP-009 Relief	Outfall HP-009 • Raise weir at Regulator 13 • Relief pipe between Regulator 13 and the Bronx River siphon Outfall HP-011 • Floatables Control
4. Combination of Outfall HP-007 Direct Disinfection and Outfall HP-009 Outfall Disinfection	Outfall HP-007 • Direct Disinfection Outfall HP-009 • Outfall disinfection Outfall HP-011 • Floatables Control
5. Combination of Outfall HP-007 Direct Disinfection and Outfall HP-009 RTB with Disinfection	Outfall HP-007 • Direct Disinfection Outfall HP-009 • RTB with Disinfection Outfall HP-011 • Floatables Control
6. 75% CSO Control Tunnel	• 11,000-LF, 19-ft diameter tunnel • 23.5 MG storage • Floatables Control at Outfall HP-011
7. 100% CSO Control Tunnel	• 11,100-LF, 31-ft diameter tunnel • 61 MG storage • Floatables Control at Outfall HP-011

Table ES-8 shows untreated CSO volume to the Bronx River, the corresponding percent reduction in untreated CSO volume, and fecal coliform and enterococci loads for each of the retained alternatives. Table ES-9 presents the total CSO volumes (treated and untreated) for the Bronx River, the CSO volumes and frequency of CSO overflows at outfalls in the Hunts Point system outside of the Bronx River, and the treated volumes at the Hunts Point WWTP for baseline conditions and the retained alternatives. This table quantifies the impacts of the combinations of the Bronx River alternatives (and floatables control at Outfall HP-011) on outfalls outside of the Bronx River. Table ES-10 presents the percent change in volume from baseline conditions for the categories of outfalls shown in Table ES-9.

Table ES-8. Summary of Bronx River Retained Alternative CSO Reductions

Alternative[1]	Bronx River CSOs			
	Untreated CSO Volume (MGY)	Untreated CSO Volume Reduction (%)	Fecal Coliform Reduction[2] (%)	Enterococci Reduction[2] (%)
Baseline Conditions[3]	455	-	-	-
1. Combination of Outfall HP-007 Direct Disinfection and Outfall HP-009 Relief	263	42	40	40
2. Combination of Outfall HP-007 Relief and 9-1 Outfall HP-009 Relief	285	37	39	39
3. Outfall HP-009 Relief	295	35	35	35
4. Combination of Outfall HP-007 Direct Disinfection and Outfall HP-009 Outfall Disinfection	237	47	45	45
5. Combination of Outfall HP-007 Direct Disinfection and 9-4 Outfall HP-009 RTB with Disinfection	237	47	45	45
6. 75% CSO Control Tunnel	114	75	75	75
7. 100% CSO Control Tunnel	0	100	100	100

Notes:

(1) The seven alternatives listed all include floatables control at Outfall HP-011 (underflow baffle + bending weir)
(2) Bacteria reduction computed on an annual basis.
(3) Differs from results reported in Section 6.0, which were based on 10 year simulations.

As indicated in Table ES-9, the change in annual volume treated at the Hunts Point WWTP increases for all alternatives. The only predicted change in annual frequency of CSO overflows outside of the Bronx River was at Outfall HP-011, where the frequency is predicted to change from 44 under baseline conditions to 34 for Alternatives 1, 2 and 3, and to 32 for Alternatives 4 to 7. This change is due to the bending weir proposed for Outfall HP-011 as part of the floatables control alternative.

Table ES-9. Summary of Outfall Predicted Impacts for Retained Alternatives – CSO Volumes and Frequency of CSO Overflows

Alternative	Bronx River CSOs(1)		Outfall HP-025(3)		Outfall HP-002(3)		Outfall HP-003(3)		Outfall HP-011(3)		All Other HP CSO Outfalls	HP WWTP(4)
	Vol. MGY	Max. Annual Act.(2)	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Vol. MGY
Baseline	455	42	91.9	51	44.8	33	211	39	604	44	1,007	45,459
1. Outfall HP-007 Direct Disinfection + Outfall HP-009 Relief	295	32	92.2	51	47.5	33	216	39	635	34	1,009	45,577
2. Outfall HP-007 Relief + Outfall HP-009 Relief	285	31	92.2	51	47.9	33	216	39	640	34	1,009	45,578
3. Outfall HP-009 Relief	295	32	92.2	51	47.5	33	216	39	635	34	1,009	45,577
4. Outfall HP-007 Direct Disinfection + Outfall HP-009 Outfall Disinfection	437	29	92.0	51	44.8	33	211	39	540	32	1,007	45,529
5. Outfall HP-007 Direct Disinfection + Outfall HP-009 RTB Disinfection	437	29	92.0	51	44.8	33	211	39	540	32	1,007	45,529
6. 75% Control Tunnel	114	6	91.9	51	44.8	33	211	39	540	32	1,007	45,996
7. 100% Control Tunnel	0.0	0	91.9	51	44.8	33	211	39	540	32	1,007	45,996

Notes:
(1) Total reflects sum of treated and untreated CSO volumes discharged to the Bronx River.
(2) The frequency of CSO overflows at Outfall HP-009.
(3) Outfalls HP-025, HP-002, and HP-003 are located along the East River west of the Bronx River; Outfall HP-011 is located on the East River east of the Bronx River.
(4) This column presents the annual treated volume at the Hunts Point WWTP.

Alternative Cost the Preferred Alternative

The alternatives were reviewed for cost effectiveness, ability to meet WQ criteria, public comments and operations. The retained alternative estimated Probable Bid Costs (PBC) are shown below in Table ES-11. The total present worth ranges from $41M to $701M.

Table ES-10. Summary of Outfall Predicted Impacts for Retained Alternatives – Percent Change in Volume vs. Baseline

Alternative	% Change in Annual Volume vs. Baseline						
	Bronx River CSOs(1) (%)	Outfall HP-025(2)	Outfall HP-002(2) (%)	Outfall HP-003(2) (%)	Outfall HP-011(2) (%)	All Other HP CSO Outfalls (%)	HP WWTP(3) (%)
Outfall HP-007 Direct Disinfection + Outfall HP-009 Relief	-35	-	+6%	+2	+5	+0.2	+0.3
Outfall HP-007 Relief + Outfall HP-009 Relief	-37	-	+7	+2	+6	+0.2	+0.3
Outfall HP-009 Relief	-35	-	+6	+2	+5	+0.2	+0.3
Outfall HP-007 Direct Disinfection + Outfall HP-009 Outfall Disinfection	-4	-	-	-	-11	-	+0.1
Outfall HP-007 Direct Disinfection + Outfall HP-009 RTB Disinfection	-4	-	-	-	-11	-	+0.1
75% Control Tunnel	-75	-	-	-	-11	-	+1
100% Control Tunnel	-100	-	-	-	-11	-	+1

Notes:

(1) Includes treated and untreated CSO volumes discharged to the Bronx River.
(2) Outfalls HP-025, HP-002, and HP-003 are located along the East River west of the Bronx River; Outfall HP-011 is located on the East River east of the Bronx River.
(3) This column presents the change in annual treated volume at the Hunts Point WWTP.

Table ES-11. Cost of Retained Alternatives(1)

Alternative	PBC ($Million)	Annual O&M Cost ($Million)	Total Present Worth ($Million)
1. Combination of Outfall HP-007 Direct Disinfection + Outfall HP-009 Relief	59.1	0.38	65
2. Combination of Outfall HP-007 Relief + Outfall HP-009 Relief	110.1	0.05	111
3. Outfall HP-009 Relief	39.9	0.05	41
4. Combination of Outfall HP-007 Direct Disinfection + Outfall HP-009 Outfall Disinfection	143.0	0.70	153
5. Combination of Outfall HP-007 Direct Disinfection + Outfall HP-009 RTB Disinfection	75.2	0.65	85
6. 75% Control Tunnel	418.1	1.5	440
7. 100% Control Tunnel	660.0	2.7	701

Notes:

(1) Includes $9M associated with the implementation of floatables control at CSO Outfall HP-011, on the East River.

A traditional knee-of-the-curve (KOTC) analysis is presented in Section 8.5. After reviewing the costs and public input, DEP has chosen Alternative 2 (Figure ES-5). While it is not the lowest-cost alternative, it provides significant reduction of bacteria to the Bronx River and does not include disinfection. Alternative 2 is the preferred alternative and consists of the following grey infrastructure improvements:

- Alternative 2 provides 37 percent CSO volume reduction and 39 percent reduction in the seasonal and annual loads.
- Outfall HP-007: Construct a new 2,700-LF relief interceptor at Relief Structure 27.
- Outfall HP-009: Raise weir at Regulator 13 and provide a new 6-ft. diameter relief pipe between Regulator 13 and the Bronx River siphon.
- Outfall HP-011: Provide Floatables Control with a bending weir and underflow baffle.
- Cost: Present worth of $111M; PBC of $110.1M, and annual O&M of $53K.

3. EVALUATIONS AND CONCLUSIONS

DEP will implement the plan elements identified in this section after approval of the LTCP by DEC. This LTCP also recommends the continued implementation of WWFP recommendations.

The LTCP analyses for Bronx River LTCP are summarized below for the following:

1. Water Quality Modeling Results;
2. Use Attainability Analysis (UAA), Water Quality Compliance and Time to Recovery; and
3. Summary of Recommendations.

Water Quality Modeling Results

The water quality modeling results for the Bronx River are shown in Tables ES-11 through ES-15 for the preferred alternative. These results provide the calculated annual attainment of the fecal coliform bacteria concentrations. The results show, for the different calculated levels of attainment, when concentrations would be at or lower than the Existing WQ Criteria, Primary Contact WQ Criteria (Class SC) and Potential Future Primary Contact WQ Criteria with 2012 EPA RWQC for the 10-year simulation.

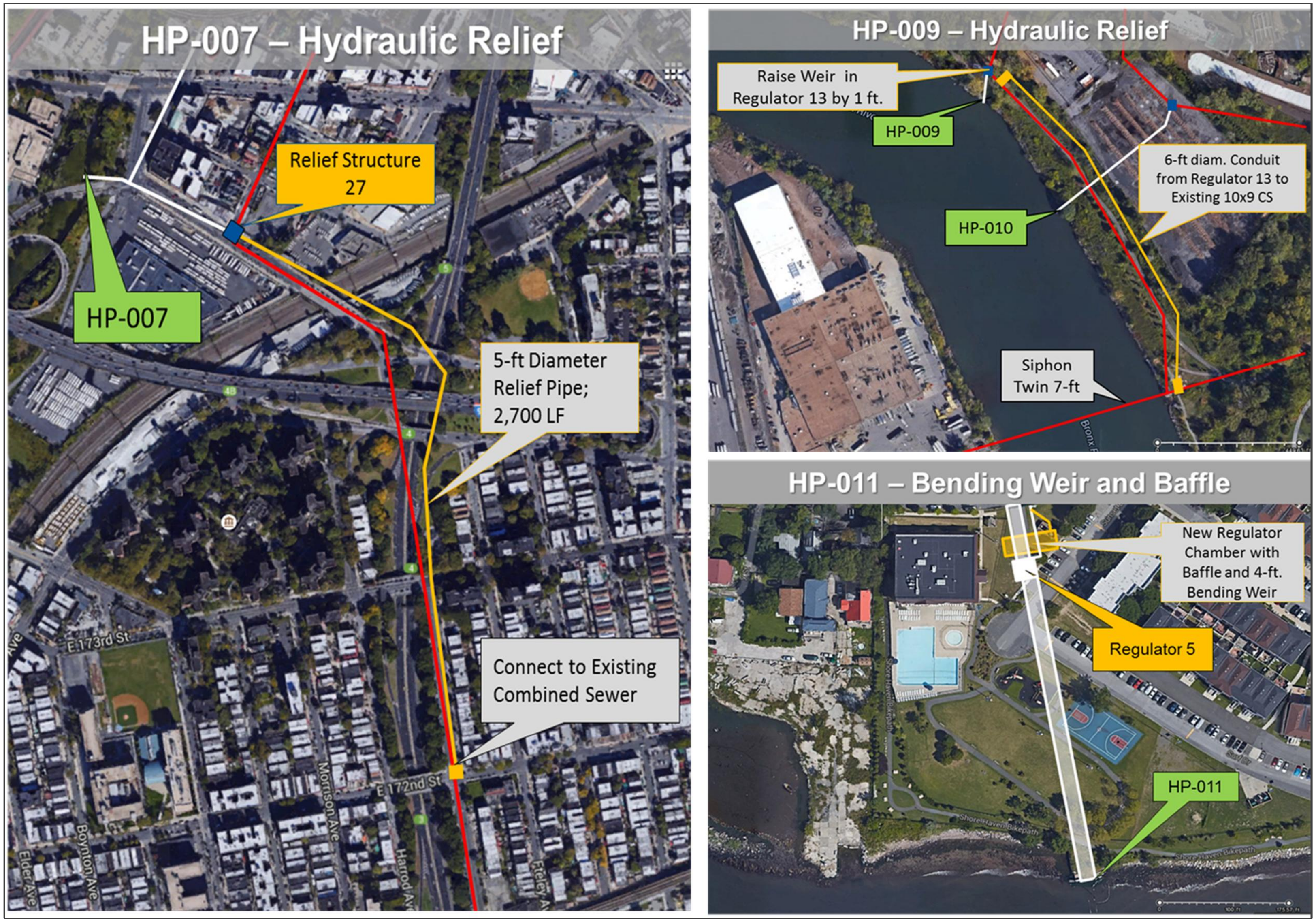

Figure ES-5. Bronx River Preferred Alternative

The recommended plan achieves annual attainment of the existing fecal coliform criteria. For the Primary Contact WQ Criteria (Class SC), the Bronx River is projected to achieve attainment with the fecal coliform criterion at all stations in the saline reach during the recreational season (May 1st through October 31st) except at Station BR-5, where recreational season (May 1st through October 31st) attainment is predicted to be 87 percent. However, Potential Future Primary Contact WQ Criteria for enterococci (geometric mean <30 cfu/100mL) is met between 77 and 96 percent of the time in the saline section, and the 2012 EPA RWQC 90th percentile STV of >110 cfu/100mL will not be met. The Existing WQ Criteria (200 cfu/100mL) attainment levels for the 10-year simulation are shown below in Table ES-12. That table shows that the annual and recreational season period (May 1st through October 31st) attainment levels are met 100 percent of the time in the saline section of the Bronx River. The freshwater section meets compliance at Stations BR-1 and BR-2, but is slightly below compliance (defined by DEC as a minimum 95 percent attainment), at Stations BR-3 and BR-4.

Table ES-12. Calculated 10-year Preferred Alternative Attainment of Existing WQ Criteria

<table>
<tr><th colspan="3" rowspan="2">Station(1)</th><th colspan="2">Fecal Coliform (200 cfu/100mL)
% Attainment</th></tr>
<tr><th>Annual</th><th>Recreational Season(2)</th></tr>
<tr><td>BR-1</td><td rowspan="4">Fresh Water (Class B - GM<200)</td><td rowspan="3">Non-Tidal</td><td>100</td><td>100</td></tr>
<tr><td>BR-2</td><td>100</td><td>100</td></tr>
<tr><td>BR-3</td><td>93</td><td>93</td></tr>
<tr><td>BR-4(3)</td><td rowspan="6">Tidal</td><td>83</td><td>80</td></tr>
<tr><td>BR-5</td><td rowspan="5">Saline(Class I – GM<2000)</td><td>100</td><td>100</td></tr>
<tr><td>BR-6</td><td>100</td><td>100</td></tr>
<tr><td>BR-7</td><td>100</td><td>100</td></tr>
<tr><td>BR-8</td><td>100</td><td>100</td></tr>
<tr><td>BR-9</td><td>100</td><td>100</td></tr>
</table>

Notes:

(1) Freshwater stations are not affected by the Bronx River CSOs, which are all located in the saline section of the Bronx River.
(2) The Recreational Season is from May 1st through October 31st.
(3) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

The DO levels for the Existing WQ Criteria using the one-year 2008 simulation shows attainment in the saline section to be greater than the DEC target attainment levels of 95 percent or higher (Table ES-13).

Table ES-13. Model Calculated Preferred Alternative DO Attainment – Existing WQ Criteria (2008)

Station		DO Annual Attainment (%)
		Entire Water Column
		≥4.0 mg/L
BR-5	Saline (Class I)	99
BR-6		95
BR-7		97
BR-8		99
BR-9		98

The proposed Primary Contact WQ Criteria for bacteria for a 10-year simulation for fecal coliform is presented in Table ES-14. The saline section meets the recreational season (May 1st through October 31st) attainment target of 95 percent at all stations, with the exception of Station BR-5, where attainment is 87 percent. The annual attainment targets are close to the target and range, from 83 to 96 percent.

Table ES-14. Calculated 10-year Preferred Alternative Attainment of Primary Contact WQ Criteria

Station(1)			Fecal Coliform % Attainment (GM <200 cfu/100mL)	
			Annual	Recreational(2) Season
BR-1	Fresh Water	Non-Tidal	100	100
BR-2			100	100
BR-3			93	93
BR-4(3)		Tidal	83	80
BR-5	Saline		83	87
BR-6			90	98
BR-7			90	98
BR-8			90	98
BR-9			96	100

Notes:
(1) Freshwater stations are not affected by the Bronx River CSOs, which are all located in the saline section of the Bronx River.
(2) The Recreational Season is from May 1st through October 31st.
(3) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

A one-year simulation for DO was done for the 2008 year (Table ES-15). The saline section shows DO attainment meeting the 3.0 mg/L or greater acute standard criterion and just missing the 95 percent target for the 4.8 mg/L threshold of the daily average chronic standard.

Table ES-15. Model Calculated 2008 Preferred Alternative DO Attainment of Primary Contact WQ Criteria

Station		DO Annual Attainment % Attainment (Water Column)	
		Preferred Alternative	
		≥4.8 mg/L	≥3.0 mg/L
BR-5	Saline	100	100
BR-6		92	97
BR-7		94	99
BR-8		94	100
BR-9		93	100

The Potential Future Primary Contact WQ Criteria for the 10-year simulation for enterococci is shown below (Table ES-16). As in other waterbodies in and around NYC, the STV criteria cannot be met. The 30 cfu/100mL is very close to being met.

Table ES-16. Calculated 10-year Preferred Alternative Attainment of Potential Future Primary Contact WQ Criteria

Station[1]			Enterococci % Attainment	
			GM <30	90th Percentile STV <110
BR-1	Fresh Water	Non-Tidal	100	18
BR-2			100	18
BR-3			97	10
BR-4[2]		Tidal	73	9
BR-5	Saline		77	8
BR-6			93	25
BR-7			93	30
BR-8			92	32
BR-9			96	52

Notes:

(1) Freshwater stations are not affected by the Bronx River CSOs, which are all located in the saline section of the Bronx River.

(2) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

The LTCP shows that the Bronx River meets Existing WQ Criteria and is very close to meeting, but does not fully meet, the proposed Primary Contact WQ Criteria. Table ES-17 presents an overview.

Table ES-17. Recommended Plan Compliance with Bacteria WQ Criteria Annual Attainment

Location	Meets Existing WQ Criteria(1) (Class I)	Meets Primary Contact WQ Criteria (Class SC)	Meets Potential Future Primary Contact WQ Criteria(2)
Saline Bronx River	YES	NO	NO

Notes:

YES indicates attainment is calculated to occur ≥ 95 percent of time.
NO indicates attainment is calculated to be less ≤ 95 percent of time.

(1) Annual attainment.
(2) Criteria not met annually or during the recreational season (May 1st through October 31st).

The preferred alternative allows the primary contact fecal coliform (200 cfu/100mL) and future enterococci (30 cfu/100mL) criteria to be met over 90 percent of the time with few exceptions.

UAA, WQ Compliance and Time to Recovery

Since the recommended LTCP projects will not result in full compliance in the Bronx River with the Primary Contact WQ Criteria (Class SC), DEP has prepared a UAA for the Bronx River (See Appendix C).

DEP has performed an analysis to determine the amount of time following the end of rainfall required for the outer portion of the Bronx River to recover and return to concentrations of less than 1,000 cfu/100mL fecal coliform. The analyses consisted of examining water quality model pathogen concentrations for recreational periods (May 1st through October 31st) under the August 14-15, 2008 storm event. The selection of the August 14-15, 2008 event for this analysis is described in Section 6. The time to return to fecal coliform concentrations below 1,000 cfu/100mL was then tabulated for each water quality station along the waterbody.

The results of these analyses are summarized in Table ES-18 for the freshwater and saline sections of the Bronx River from BR-1 to BR-9. As noted, the duration of time for the bacteria concentrations to return to levels that the NYS Department of Health (DOH) considers safe for primary contact will vary with location. Generally, a value of approximately 24 hours would be typical for the Bronx River. The freshwater section of the Bronx River is not influenced by CSOs.

Table ES-18. Time to Recovery within the Bronx River (August 14-15 2008 Storm)

<table>
<tr><th colspan="3">Station</th><th>Time to Recovery (hrs)
Fecal Coliform Target
(1,000 cfu/100mL)
Preferred Alternative</th></tr>
<tr><td>BR-1</td><td rowspan="4">Fresh Water</td><td rowspan="3">Non-Tidal</td><td>25</td></tr>
<tr><td>BR-2</td><td>25</td></tr>
<tr><td>BR-3</td><td>26</td></tr>
<tr><td>BR-4(1)</td><td rowspan="6">Tidal</td><td>27</td></tr>
<tr><td>BR-5</td><td rowspan="5">Saline</td><td>27</td></tr>
<tr><td>BR-6</td><td>23</td></tr>
<tr><td>BR-7</td><td>19</td></tr>
<tr><td>BR-8</td><td>15</td></tr>
<tr><td>BR-9</td><td>4</td></tr>
</table>

Notes:
(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

Summary of Recommendations

The actions items identified in this Bronx River LTCP are:

1. The LTCP includes a UAA based on the projected performance of the selected CSO controls. A PCM program will be initiated after the LTCP improvements are operational.

2. Based on the UAA, DO conditions are not met for the existing standard under the existing classification, or under the alternatives that are being considered. DO levels appear to be related to non-CSO related conditions in the Bronx River. However, based on the predicted water quality improvements with the proposed project, it is anticipated that the Bronx River should be upgraded to SC classification during recreational season (May 1st through October 31st), although a variance for DO levels would still be required. DEP will issue a wet-weather advisory during the recreational season (May 1st through October 31st), during which swimming and bathing in the Bronx River are not recommended. The LTCP includes a recovery time analysis that can be used to establish an approximate duration for the wet-weather advisory for public notification.

3. DEP will continue to implement the Green Infrastructure Program.

4. In the Westchester Creek LTCP, DEP committed to analyze floatables control at Outfall HP-011 for the Bronx River. The Bronx River LTCP preferred alternative includes a floatables control recommendation for Outfall HP-011.

5. In the Westchester Creek LTCP, DEP committed to investigate a new siphon at Outfall HP-011 at the East River. This analysis was completed and a new siphon is not recommended because adequate capacity exists currently.

6. Alternative 2 is the preferred alternative for the Bronx River LTCP. A complete description is presented in Section 8, and a summary is presented above in this Executive Summary.

7. DEP is committed to improving water quality in the Bronx River, which will be advanced by the improvements and recommendations presented in this plan. These identified actions have been balanced with input from the public and awareness of the cost to the citizens of NYC.

Other Bronx River Initiatives

Throughout the LTCP process, DEP has focused on the best alternatives to reduce CSOs and to improve water quality. While the LTCP has identified cost-effective investments in CSO control projects that will reduce CSO volume and floatables from the saline portion of the Bronx River, DEP acknowledges that this waterbody traverses many neighborhoods in the upstream freshwater portion and that interest and support exist for access to the water. Hence, DEP will be taking a more holistic approach to this watershed, recognizing that opportunities exist for greening and stormwater management throughout the freshwater portion of the Bronx River. Such measures would improve water quality still further, while building on the knowledge acquired during preparation of this LTCP. The Bronx River Corridor is recognized as an area of focus in OneNYC, which seeks to ensure that NYC agencies will work together to amplify the positive impacts of individual programs. This comprehensive approach will enable DEP to consider all opportunities to implement its vision for greening NYC as an adjunct to managing stormwater. To that end, DEP is committed to working with adjacent neighborhoods and communities to expand both GI and smart designs for stormwater management on public land.

1.0 INTRODUCTION

This LTCP for Bronx River was prepared pursuant to the CSO Order on Consent (DEC Case No. CO2-20110512-25), dated March 8, 2012 (2012 CSO Order on Consent). The 2012 CSO Order on Consent is a modification of the 2005 CSO Order on Consent (DEC Case No. CO2-20000107-8) (2005 CSO Order on Consent). Under the 2012 CSO Order on Consent, the DEP is required to submit ten waterbody-specific and one Citywide LTCP to the DEC by December 2017. The Bronx River LTCP is the fifth of those 11 LTCPs to be completed.

1.1 Goal Statement

The following is the LTCP Introductory Goal Statement, which appears as Appendix C in the 2012 CSO Order on Consent. It is generic in nature, so that waterbody-specific LTCPs will take into account, as appropriate, the fact that certain waterbodies or waterbody segments may be affected by NYC's concentrated urban environment, human intervention, and current waterbody uses, among other factors. DEP will identify appropriate water quality outcomes based on site-specific evaluations in the drainage basin specific LTCP, consistent with the requirements of the CSO Control Policy and CWA.

> *"The New York City Department of Environmental Protection submits this Long Term Control Plan (LTCP) in furtherance of the water quality goals of the Federal Clean Water Act and the State Environmental Conservation Law. We recognize the importance of working with our local, State, and Federal partners to improve water quality within all citywide drainage basins and remain committed to this goal.*
>
> *After undertaking a robust public process, the enclosed LTCP contains water quality improvement projects, consisting of both grey and green infrastructure, which will build upon the implementation of the U.S. Environmental Protection Agency's (EPA) Nine Minimum Controls and the existing Waterbody/Watershed Facility Plan projects. As per EPA's CSO Control Policy, communities with combined sewer systems are expected to develop and implement LTCPs that provide for attainment of water quality standards and compliance with other Clean Water Act requirements. The goal of this LTCP is to identify appropriate CSO controls necessary to achieve waterbody-specific water quality standards, consistent with EPA's 1994 CSO Policy and subsequent guidance. Where existing water quality standards do not meet the Section 101(a)(2) goals of the Clean Water Act, or where the proposed alternative set forth in the LTCP will not achieve existing water quality standards or the Section 101(a)(2) goals, the LTCP will include a Use Attainability Analysis, examining whether applicable waterbody classifications, criteria, or standards should be adjusted by the State. The Use Attainability Analysis will assess the waterbody's highest attainable use, which the State will consider in adjusting water quality standards, classifications, or criteria and developing waterbody-specific criteria. Any alternative selected by a LTCP will be developed with public input to meet the goals listed above.*
>
> *On January 14, 2005, the NYC Department of Environmental Protection and the NYS Department of Environmental Conservation entered into a Memorandum of Understanding (MOU), which is a companion document to the 2005 CSO Order also executed by the parties and the City of New York. The MOU outlines a framework for coordinating CSO long-term planning with water quality*

standards reviews. We remain committed to this process outlined in the MOU, and understand that approval of this LTCP is contingent upon our State and Federal partners' satisfaction with the progress made in achieving water quality standards, reducing CSO impacts, and meeting our obligations under the CSO Orders on Consent."

This Goal Statement has guided the development of the Bronx River LTCP and accompanying UAA.

1.2 Regulatory Requirements (Federal, State, Local)

The waters of NYC are subject to Federal and New York State regulations. The following sections provide an overview of the regulatory issues relevant to long term CSO planning.

1.2.a Federal Regulatory Requirements

The CWA established the regulatory framework to control surface water pollution, and gave the EPA the authority to implement pollution control programs. The CWA established the National Pollutant Discharge Elimination System (NPDES) permit program. NPDES regulates point sources discharging pollutants into waters of the United States. CSOs and municipal separate storm sewer systems (MS4) are also subject to regulatory control under the NPDES program. In New York, the NPDES permit program is administered by the DEC, and is thus a State Pollution Discharge Elimination System (SPDES) program. New York State has had an approved SPDES program since 1975. Section 303(d) of the CWA and 40 CFR §130.7 (2001) require states to identify waterbodies that do not meet WQS and are not supporting their designated uses. These waters are placed on the Section 303(d) List of Water Quality Limited Segments (also known as the list of impaired waterbodies or "303(d) List"). The 303(d) List identifies the stressor causing impairment, and establishes a schedule for developing a control plan to address the impairment. Placement on the list can lead to the development of a Total Maximum Daily Load (TMDL) for each waterbody and associated pollutant/stressor on the list. Pollution controls based on the TMDL serve as the means to attain and maintain WQS for the impaired waterbody.

The upper part of the Bronx River was considered as high priority for TMDL development and was included on the 2004 303(d) List for Depressed DO Levels. In 2006, the NYC section of the reach was removed from the 303(d) List because of the 2005 CSO Order on Consent between DEC and DEP. As shown in Table 1-1, the Middle and Lower Bronx River remains delisted (updated February 2013) as a Category 4b waterbody for which required control measures (i.e. approved LTCP) other than a TMDL are expected to restore uses in a reasonable period of time.

Table 1-1. 2012 DEC 303(d) Impaired Waters Listed and Delisted (with Source of Impairment)

Waterbody	Pathogens	DO/Oxygen Demand	Floatables
Bronx River (Middle and Lower Part)	Delisted Category 4b Urban/Storm/CSOs	Delisted Category 4b CSOs, Urban/Storm	Not Listed

1.2.b Federal CSO Policy

The 1994 EPA CSO Control Policy provides guidance to permittees and NPDES permitting authorities on the development and implementation of a LTCP in accordance with the provisions of the CWA. The CSO policy was first established in 1994 and codified as part of the CWA in 2000.

1.2.c New York State Policies and Regulations

NYS has established WQS for all navigable waters within its jurisdiction. Bronx River has three classifications. Class C is assigned to the Westchester County part of the Bronx River. Class B is assigned to the freshwater part of the Bronx River north of E. Tremont Avenue up to Westchester County. Class I is assigned to the tidal/saline part of the Bronx River south of E. Tremont Avenue. A Class C waterbody best usage is fishing and defined as “suitable for fishing and suitable for fish, shellfish, and wildlife propagation and survival”. A Class B waterbody best usage is primary and secondary contact recreation and fishing and defined as “suitable for fish shellfish, and wildlife propagation and survival”. A Class I waterbody is defined as “suitable for fish propagation and survival”. The best usages of Class I waters are “secondary contact recreation and fishing” (6 NYCRR 701.11). On December 3, 2014, DEC publicly noticed a proposed rulemaking which, if promulgated, would, in part, amend 6 NYCRR Part 701 to require that the quality of Class I waters be suitable for “primary contact recreation” and to adopt corresponding total and fecal coliform standards in 6 NYCRR Part 703. In developing the Bronx River LTCP, these proposed new regulations are referred to as Potential Future Primary Contact WQ Criteria. At the conclusion of DEC rulemaking, the LTCP will be reviewed for impacts to the findings.

The States of New York, New Jersey and Connecticut are signatories to the Tri-State Compact which designated the Interstate Environmental District and created the Interstate Environmental Commission (IEC). The Interstate Environmental District includes all saline waters of greater NYC, including Bronx River. The IEC has recently been incorporated into and is now part of the New England Interstate Water Pollution Control Commission (NEIWPCC), a similar multi-state compact of which NYS is a member. Bronx River is classified as Type B-1 under the IEC system. Details of the IEC Classifications are presented in Section 2.2.

1.2.d Administrative Consent Order

NYC and DEC entered into a 2005 CSO Order on Consent to address NYC CSOs. The 2005 CSO Order on Consent, which has been modified on multiple occasions requires DEP to evaluate and implement CSO abatement strategies on an enforceable timetable for 18 waterbodies and, ultimately, for citywide long-term CSO control, in accordance with the 1994 EPA CSO Control Policy. The 2005 CSO Order on Consent was modified as of April 14, 2008, to change certain construction milestone dates. In addition, DEP and DEC entered into a separate Memorandum of Understanding (MOU) to facilitate WQS reviews in accordance with the EPA CSO Control Policy. A 2009 modification addressed the completion of the Flushing Bay CSO Retention Facility.

In March 2012, DEP and DEC amended the 2005 CSO Order on Consent to provide for incorporation of GI into the LTCP process, as proposed under NYC’s Green Infrastructure Plan, and to update certain project plans and milestone dates.

1.3 LTCP Planning Approach

The LTCP planning approach includes several phases. The first is the characterization phase – an assessment of current waterbody and watershed characteristics, system operation and management practices, the status of current green and grey infrastructure projects, and an assessment of current system performance. DEP is gathering the majority of this information from field observations, historical records, analyses of studies and reports, and collection of new data. The next phase involves the identification and analysis of alternatives to reduce the amount and frequency of wet-weather discharges and improve water quality. DEP expects that alternatives will include a combination of green and grey infrastructure elements that are carefully evaluated using both the collection system and receiving water models. Following the analysis of alternatives, DEP will develop a recommended plan, along with an implementation schedule and strategy. If the proposed alternative does not achieve existing WQS or the Section 101(a)(2) goals of CWA, the LTCP will include a UAA examining whether applicable waterbody classifications, criteria, or standards should be adjusted by DEC.

1.3.a Integrate Current CSO Controls from Waterbody/Watershed Facility Plans (Facility Plans)

This LTCP builds upon DEP's prior efforts by capturing the findings and recommendations from the previous facility planning documents for this watershed, including the Waterbody/Watershed Facility Plan (WWFP). The LTCP integrates and builds on this existing body of work.

In July 2010, DEP issued the Bronx River WWFP. The WWFP, which was prepared pursuant to the 2005 CSO Order on Consent, includes an analysis and presentation of operational and structural modifications targeting the reduction of CSOs and improvement of the overall performance of the collection and treatment system within the watershed. The DEC approved the Bronx River WWFP on July 27, 2010.

1.3.b Coordination with DEC

As part of the LTCP process, DEP has sought to work closely with DEC to share ideas, track progress, and work toward developing strategies and solutions to address wet-weather challenges for the Bronx River LTCP.

DEP shared the Bronx River alternatives and held discussions with DEC on the formulation of various control measures, and coordinated public meetings and other stakeholder presentations with DEC. On a quarterly basis, DEC, DEP, and outside technical consultants also convene for larger progress meetings that typically include technical staff and representatives from DEP and DEC's Legal Departments and Department Chiefs who oversee the execution of the CSO program.

1.3.c Watershed Planning

DEP prepared its CSO WWFPs before the emergence of GI as an established method for reducing stormwater runoff. Consequently, the WWFPs did not include a full analysis of GI alternatives for controlling CSOs. In comments on DEP's CSO WWFPs, community and environmental groups voiced widespread support for GI, urging DEP to place greater reliance upon that sustainable strategy. In September 2010, NYC published the *NYC Green Infrastructure Plan*, hereinafter referred to as the GI Plan. Consistent with the GI Plan, the 2012 CSO Order on Consent requires DEP to analyze the use of GI in LTCP development. As discussed in Section 5.0, this sustainable approach includes the management of stormwater at its source through the creation of vegetated areas, bluebelts and greenstreets, green parking lots, green roofs, and other technologies.

1.3.d Public Participation Efforts

DEP made a concerted effort during the Bronx River LTCP planning process to involve relevant and interested stakeholders, and keep interested parties informed about the project. A public outreach participation plan was developed and implemented throughout the process; the plan is posted and regularly updated on DEP's LTCP program website, www.nyc.gov/dep/ltcp. Specific objectives of this initiative included the following:

- Develop and implement an approach that would reach interested stakeholders;
- Integrate the public outreach efforts with other aspects of the planning process; and
- Take advantage of other ongoing public efforts being conducted by DEP and other NYC agencies as part of related programs.

The public participation efforts for this Bronx River LTCP are summarized in Section 7.0 in more detail.

2.0 WATERSHED/WATERBODY CHARACTERISTICS

This section summarizes the major characteristics of the Bronx River watershed and waterbody, building upon earlier documents that present a characterization of the area including, most recently, the WWFP for Bronx River (DEP, 2010a). Section 2.1 addresses watershed characteristics and Section 2.2 addresses waterbody characteristics.

2.1 Watershed Characteristics

The Bronx River begins in Westchester County, NY, flows through the Borough of the Bronx, and empties into the Upper East River. The waters of the Bronx River are saline throughout three miles upstream of the confluence with the Upper East River within Bronx County and receive freshwater input in Westchester County, NY and from CSO and stormwater discharges within NYC. The Bronx River waterbody and watershed is largely urbanized and suburbanized. The watershed is bounded on the north by Westchester County, NY, the east by the Westchester Creek watershed, the west by the Hudson River and Harlem River watersheds and the south by the Upper East River. The Bronx River watershed is served by the Hunts Point WWWTP which first came on-line in 1952 and which has been providing full secondary treatment since that time.

This subsection contains a summary of the watershed characteristics as they relate to land use, zoning, permitted discharges and their characteristics, and the sewer system configuration, performance, and impacts to the adjacent waterbodies, as well as the modeled representation of the collection system used for analyzing system performance and CSO control alternatives.

2.1.a Description of Watershed

The Bronx River, a tributary to the Upper East River, runs south from the Davis Brook and Kensico Dam, through Westchester County and the Bronx, until it empties into the Upper East River. The Bronx River watershed spans large portions of Westchester County, and then the Borough of the Bronx in NYC. The total watershed area, excluding the area tributary to the Kensico Dam, is approximately 27,400 acres, out of which approximately 23,020 acres are located within Westchester County, NY and the remaining 4,320 acres are located within NYC. This LTCP report focuses on the portion of the Bronx River within NYC that accounts for 2,764 acres which is impacted by CSO discharges. The sewershed assessment area is shown in Figures 2-1 and 2-2.

There are three main sections of the watershed. The most upstream portion is Westchester County, upstream of NYC, which consists largely of a residential area. Next is the portion of the watershed that drains to the freshwater section of the Bronx River. This portion of the watershed has extensive park land and open space, including Woodlawn Cemetery, New York Botanical Gardens and the Bronx Zoo. Finally, is the portion of the watershed that drains to the saline section of the Bronx River, which is generally residential with industrial clusters around the west bank and Soundview Park on the east bank. As noted in Figures 2-1 and 2-2, there are numerous discharges to each section of the Bronx River. In total 108 pipes have been documented to exist along the freshwater shoreline of the Bronx River by the Shoreline Survey Unit of DEPs Compliance Monitoring Section (CMS) of the DEP and 112 pipes documented along the saline shoreline of the Bronx River as shown in Table 2-1.

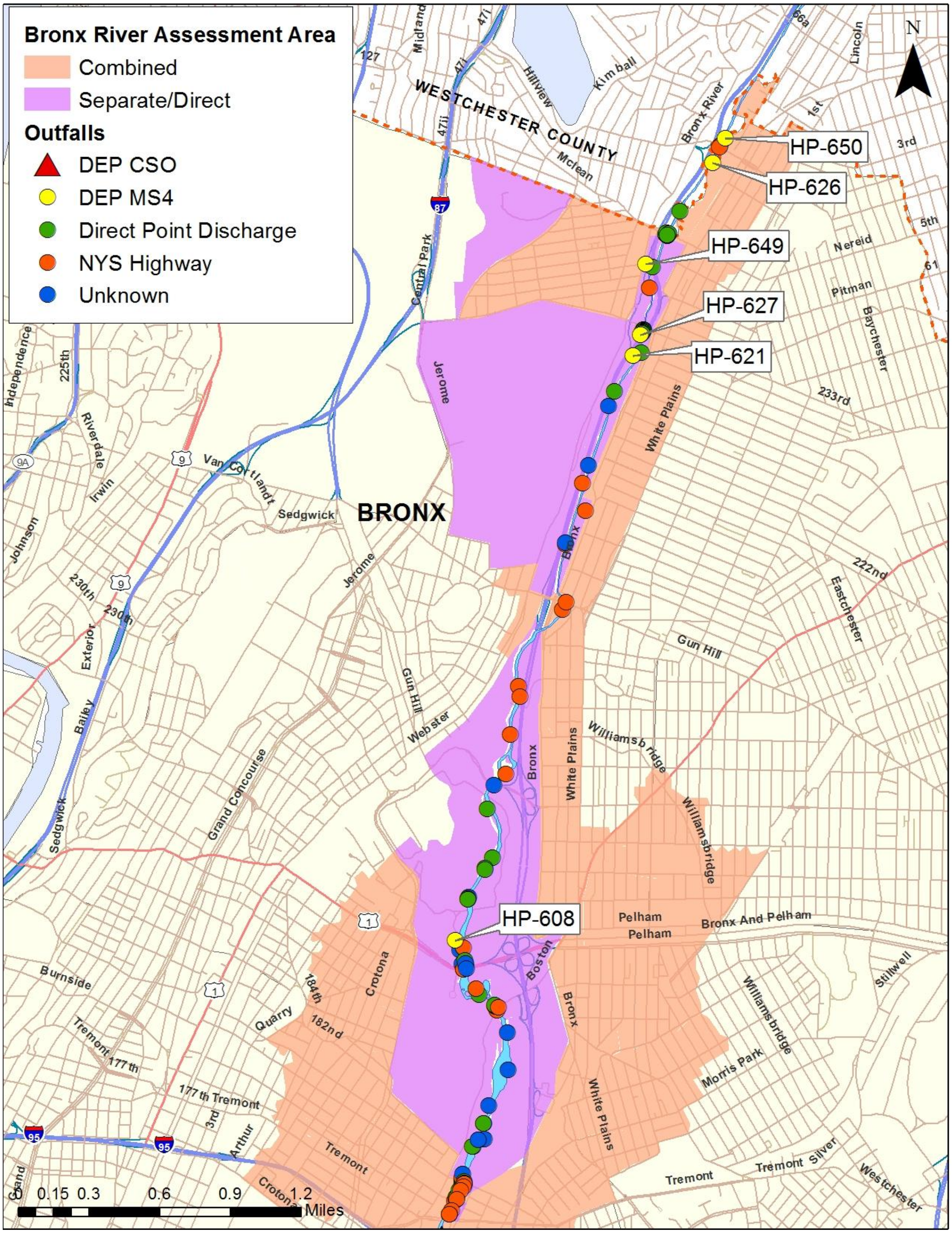

Figure 2-1. Bronx River Assessment Area (Freshwater Portion of River)

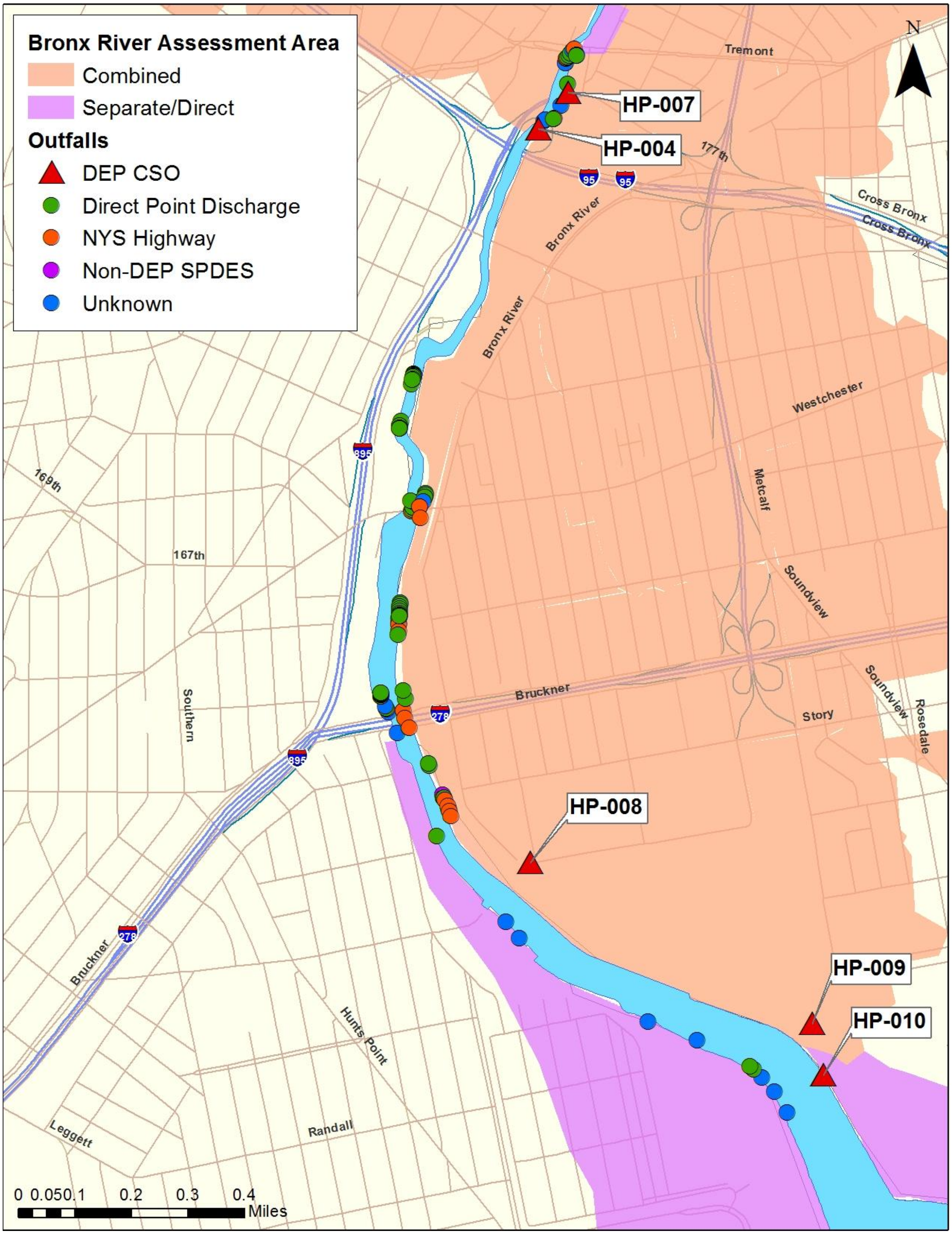

Figure 2-2. Bronx River Assessment Area (Saline Portion of River)

Table 2-1. Outfall Pipes to Bronx River

	Identified Ownership of Pipes	Number of Pipes
Freshwater Section	NYCDEP	DEP MS4 Permitted = 6
		DEP CSO Permitted = 0
	NYCDOT	31
	Private	33
	Unknown	38
	Total - Freshwater	108
Saline Section	NYCDEP	DEP MS4 Permitted = 0
		DEP CSO Permitted = 5
	NYCDOT	27
	Non-DEP SPDES	1
	Private	61
	Unknown	18
	Total – Saline	112

The urbanization of the Bronx River has led to the creation of combined sewer systems (CSS) and separate stormwater conveyance systems that discharge to the Bronx River. Urbanization brought increased population and increased loadings from sewage and industry. This led to the construction of sewer systems and physical changes affecting the surface topography and imperviousness of the watershed. The urbanized condition resulted in additional sources of pollution from CSOs and industrial/commercial activities. Urbanization also reduced infiltration and natural subsurface transport and eliminated natural streams previously tributary to the Bronx River.

Several large and notable transportation corridors cross the watershed providing access between commercial and manufacturing areas and residential areas. These are shown in Figure 2-3. The most notable transportation features within the watershed are the Bronx River Parkway, the Bruckner Expressway, the Cross Bronx Expressway, the Pelham Parkway and the Metro-North Rail.

2.1.a.1 Existing and Future Land Use and Zoning

The following section describes current land uses, zoning, neighborhood and community characteristics, as well as NYC's planned future zoning and uses.

Land uses for the portion of the Bronx River located within the limits of NYC are varied, but can generally be divided into three segments: upper, middle and lower. The upper portion, from East Gun Hill Road to the Westchester County border, contains primarily residential and parkland. The middle segment runs from East 180th Street north to East Gun Hill Road, located in the freshwater portion of the Bronx River, and consists of extensive parkland and small areas of residential, institutional and commercial uses. The lower segment, which drains to the saline section and encompasses lands from the mouth of the Bronx River to East 180th Street, includes mostly industrial, parkland and residential areas. This area also contains pockets of commercial, institutional and vacant land scattered along the waterfront.

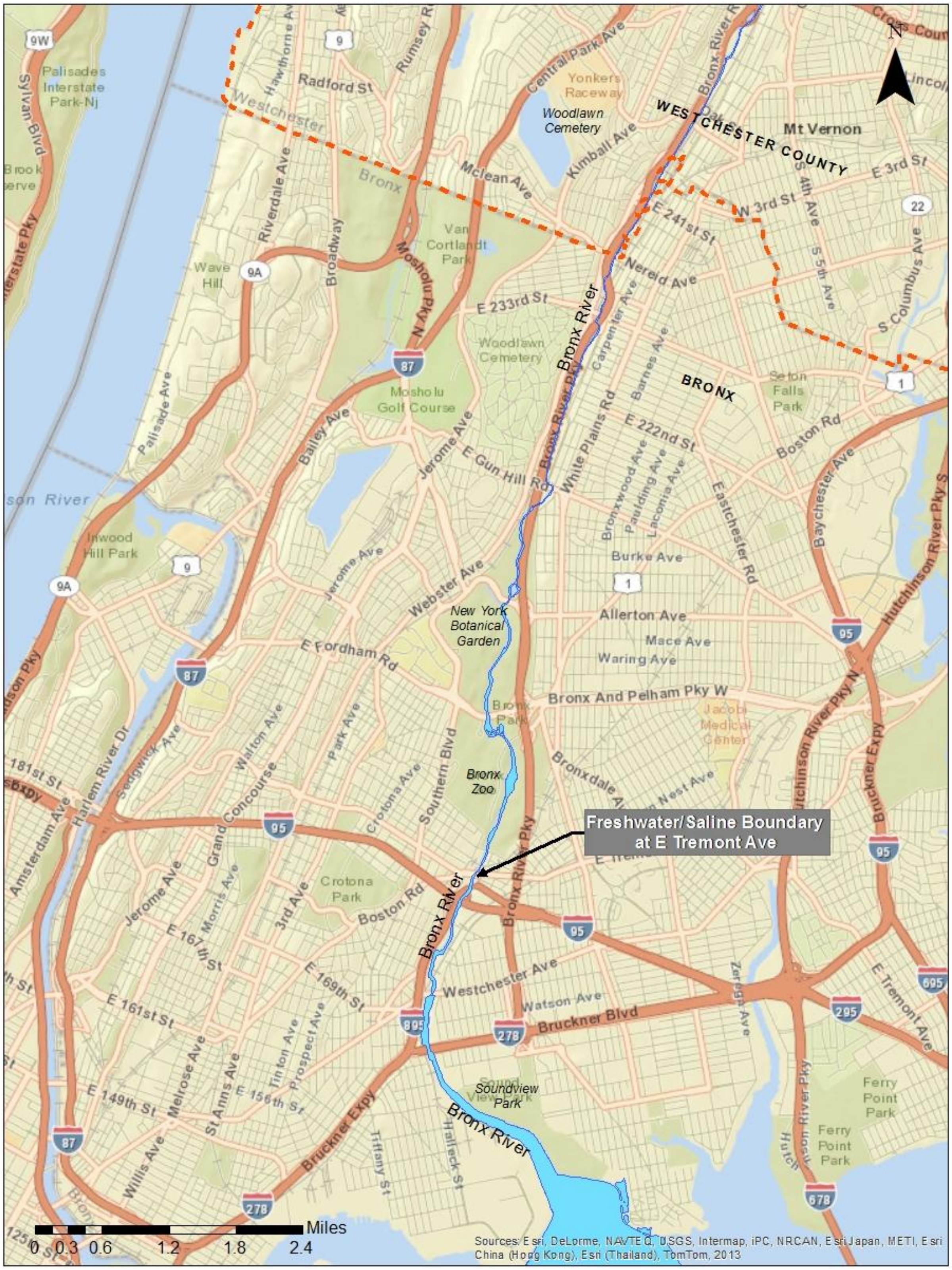

Figure 2-3. Bronx River Watershed Above-ground Key Transportation Features

Adjacent to the western shore of the upper portion of the Bronx River, the land use is dominated by Woodlawn Cemetery and the Metro-North Railroad, which runs parallel to and adjacent to the Bronx River. The area south of Woodlawn Cemetery is primarily residential, but also contains several industrial and commercial tracts and a large park, Williamsbridge Playground. The area immediately north of the cemetery between East 233rd Street and East 234th Street is mostly industrial, with a commercial strip along Webster Avenue. Further north and extending to the Westchester County border are largely residential uses with several institutional uses interspersed.

The east side of the Bronx River in this area is predominantly single family and detached houses with an area of light manufacturing just south of the Westchester County border. In addition, a strip of parkland, known as Shoelace Park, straddles the Bronx River extending from the northern edge of the New York Botanical Gardens to the Westchester County border. The Bronx River Parkway runs north along the eastern shore of the Bronx River in this area.

Industrial uses dominate the Bronx River's eastern shore from Lafayette Avenue to Westchester Avenue. The area between Westchester Avenue and East 174th Street is largely industrial with commercial uses lining the ends of the blocks. Land use between the Cross Bronx Expressway and East 180th Street, which is part of the West Farms and Tremont neighborhood, is generally evenly distributed among residential, industrial and transportation uses.

The middle segment of the Bronx River area is dominated by the Bronx Park, which includes the New York Botanical Garden and the Bronx Zoo. Surrounding the west side of the Park, along Southern Boulevard, are mostly medium-density apartment buildings and retail corridors such as Fordham Road, Tremont Avenue, 187th Street and Arthur Avenue. Fordham University is also located in this area. To the east side of the Bronx Park are Van Nest and Morris Park neighborhoods. The park is bordered by medium-density housing, one to two family residential homes and light manufacturing uses along the southern edge of the New York Botanical Gardens.

The west bank of the lower segment, extending from the mouth of the Bronx River to Lafayette Avenue, is dominated by industrial and manufacturing uses, including the Hunts Point Food Distribution Center. The Food Distribution Center includes the Hunts Point Terminal Produce Market, the Hunts Point Cooperative Meat Market and the New Fulton Fish Market. Other industrial uses in the peninsula include a variety of food, auto and construction related businesses. At the center of the peninsula is a 20 block residential core which has a mix of townhomes and three- to eight- story apartment buildings. The Hunts Point Vision Plan which was released in 2005 through a partnership between NYC and various stakeholder groups has resulted in the creation of three waterfront parks (Barreto Point Park, Hunts Point Riverside Park and Hunts Point Landing). Streetscape improvements throughout the peninsula are ongoing as part of its implementation.

Between Lafayette Avenue and Bruckner Boulevard, the Bronx River is bordered by industrial and vacant land uses on both sides. Along the western shore of the Bronx River between Bruckner Expressway and Westchester Avenue is Concrete Plant Park operated by the New York City Department of Parks and Recreation (DPR) which opened in 2011.

The eastern shore of the lower segment is comprised of Clason Point, and the Soundview and Harding Park neighborhoods. Clason Point contains mostly one-, two- and three-family homes, vacant parcels and small commercial uses. Soundview contains three- to four- story townhomes which are new construction and Harding Park which contains single family homes. Both are entirely residential. The uses along the eastern shore of the Bronx River in the Soundview Neighborhood include auto and construction related businesses, a school and a large privately owned vacant lot known as the 'Loral site'. The area further east in Soundview includes the high-rise public housing complex called the Soundview Park Homes and one and two family residences.

Figures 2-4 and 2-5 show generalized land use of the drainage areas contributing to the freshwater and saline sections, respectively. As shown, there are no CSO outfalls discharging to the freshwater reach of the Bronx River. Conversely, there are no MS4 outfalls discharging to the saline reach. However, there are various other stormwater contributors to both reaches of the Bronx River. The breakdown of land use in the Bronx River drainage area is summarized in Table 2-2. The distribution of land use within the riparian boundary of the watershed is shown in Table 2-3. The drainage areas tributary to the freshwater section of the Bronx River and are composed predominantly of parkland and outdoor spaces. The land uses of the drainage areas tributary to the saline CSO impacted section of the Bronx River are a mix of residential, industrial, commercial, transportation and utilities, public facilities and institutions, as well as open space and outdoor recreation areas.

Table 2-2. Generalized Land Use of Drainage Areas Tributary to the Saline and Freshwater Sections of the Bronx River

Generalized Land Use	Saline (%)	Freshwater (%)
Residential	52	0
Park	9	95
Industrial	2	1
Other (1)	37	4

Notes:

(1) "Other" category includes transportation and utility, commercial and office, public facilities, parking facilities, vacant land and unknown.

Table 2-3. Generalized Zoning in the Riparian Watershed of the Bronx River (1/4 mile radius)

Generalized Zoning	(%)
Residential	44
Park	34
Industrial	19
Commercial	3

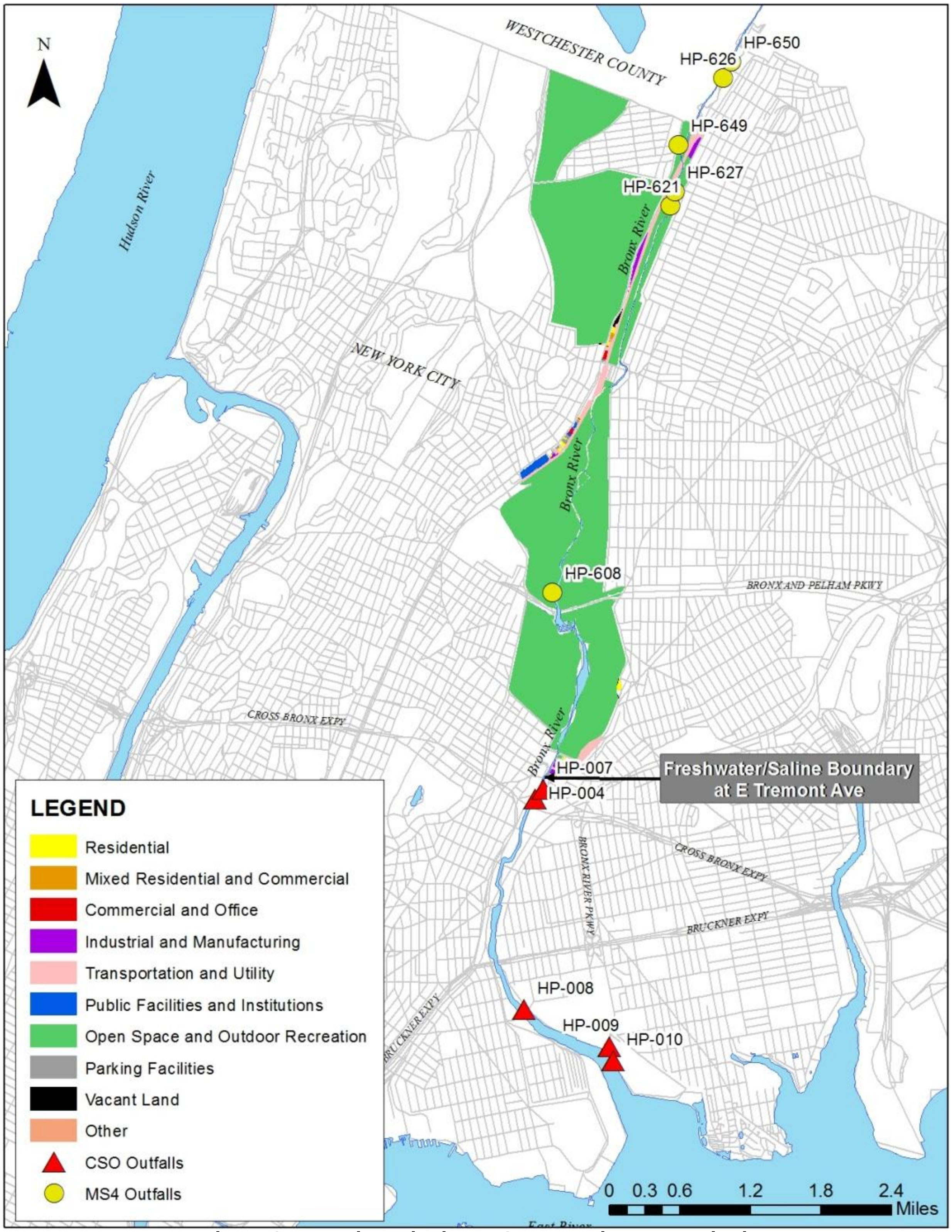

Figure 2-4. Land Use in the NYC Bronx River Watershed (Tributary to the Freshwater Section)

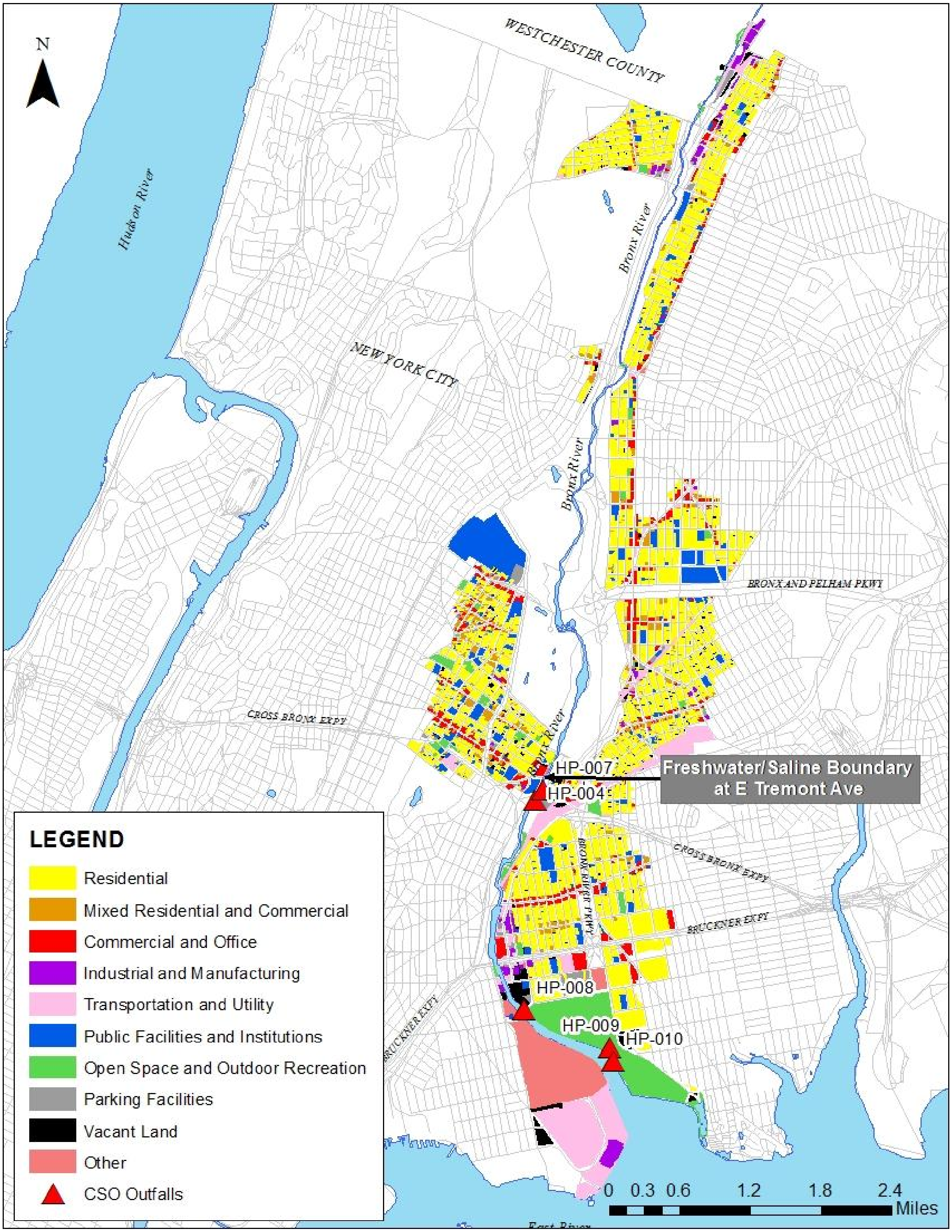

Figure 2-5. Land Use in the NYC Bronx River Watershed (Tributary to the Saline Section)

The NYC zoning categories include R for General Residential, C for Commercial and M for Manufacturing. Subcategories are those designated by the New York City Department of City Planning (DCP). Zoning within a quarter-mile of the Bronx River is primarily dominated by industrial and residential classifications along the lower reach of the Bronx River and parkland and residential zoning to the north.

North of the New York Botanical Gardens, zoning designations within a quarter-mile of the Bronx River are dominated primarily by residential and open space zoning designations. Along the western shore, an area of commercial zoning is located within this area along Webster Avenue. The Webster Avenue, Bedford Park and Norwood rezoning completed in 2010 allowed medium-density residential and commercial development along Webster Avenue which is a wide thoroughfare while preserving the low scale neighborhoods to the west of Webster Avenue. Residential uses were previously precluded along Webster Avenue by the heavy commercial zoning designation. North of this area is a large residential zone and Woodlawn Cemetery, which is zoned as open space. Finally, north of East 233rd Street, and extending to the Westchester County line, is an additional area of residential zoning with smaller areas of commercial zoning located along East 233rd Street.

Along the eastern shore of the northern reach of the Bronx River are areas of almost exclusively residential zoning designations. The Williamsbridge Rezoning completed in 2011 allowed modest increase in density along major corridors while preserving the low scale character of the rest of the neighborhood. Figure 2-6 shows zoning within a quarter-mile radius of the Bronx River.

The middle reach of the Bronx River located north of East 180th Street and south of Burke Avenue is comprised almost exclusively of parkland, which encompasses the New York Botanical Gardens. In addition, an area of residential zoning is located west of the New York Botanical Gardens and encompasses Fordham University.

Along the lower (southern) portion of the Bronx River, an extensive area of industrial zoning is located on the western shore and extends further inland. These industrial areas extend from the mouth of the Bronx River northward to Bruckner Expressway. The Hunts Point Market encompasses a large portion of this industrial zoning. Areas of residential zoning are generally located further west of the industrially zoned waterfront areas. The Hunts Point Peninsula contains a 20 block area which is zoned residential. The Special Hunts Point District created in 2008 introduced a buffer zone between the residential and industrial uses. Areas along the lower reach of the Bronx River are designated by the DCP as significant maritime and industrial areas, as well as special natural waterfront areas on the western and eastern shores, respectively, as shown in Figure 2-7.

The manufacturing districts continue along both sides of the Bronx River between Bruckner Expressway and Westchester Avenue and continue on the eastern side of the Bronx River between Westchester Avenue and 172nd Street. The Sheridan Expressway runs along the Bronx River between Bruckner Expressway and the Cross Bronx Expressway creating a physical barrier between the Bronx River and the communities on the western side. The Sheridan Expressway Hunts Point Land Use and Transportation study completed in 2013 recommended the transformation of portions of the expressway into a boulevard. The study also identified the waterfront parcels between Westchester Avenue and 172nd Street as an area suitable for rezoning from manufacturing to residential districts. Other areas identified for future rezoning included the manufacturing district along Whitlock Avenue and Westchester Avenue on the western side of the Bronx River.

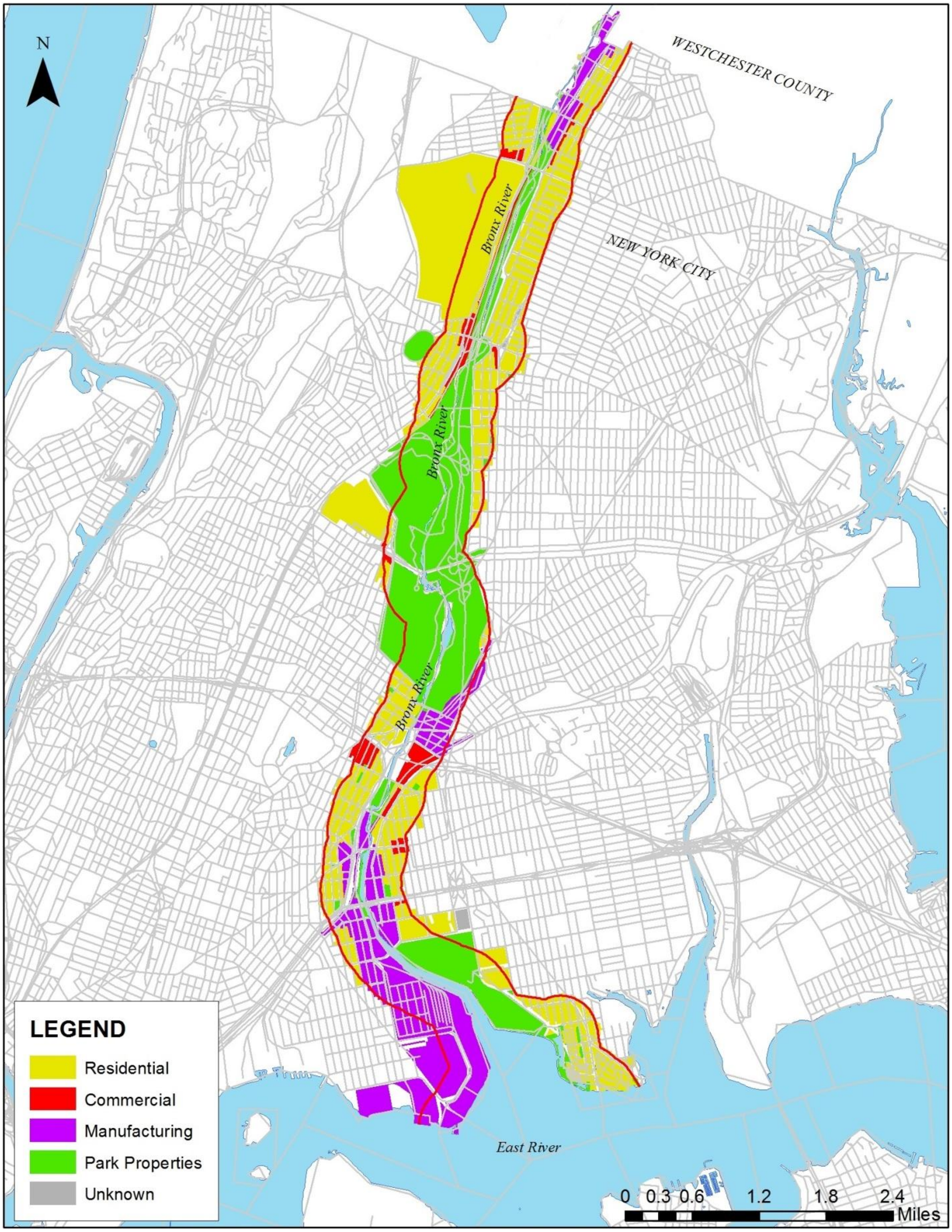

Figure 2-6. Zoning in the NYC Bronx River Riparian Watershed (1/4 mile radius)

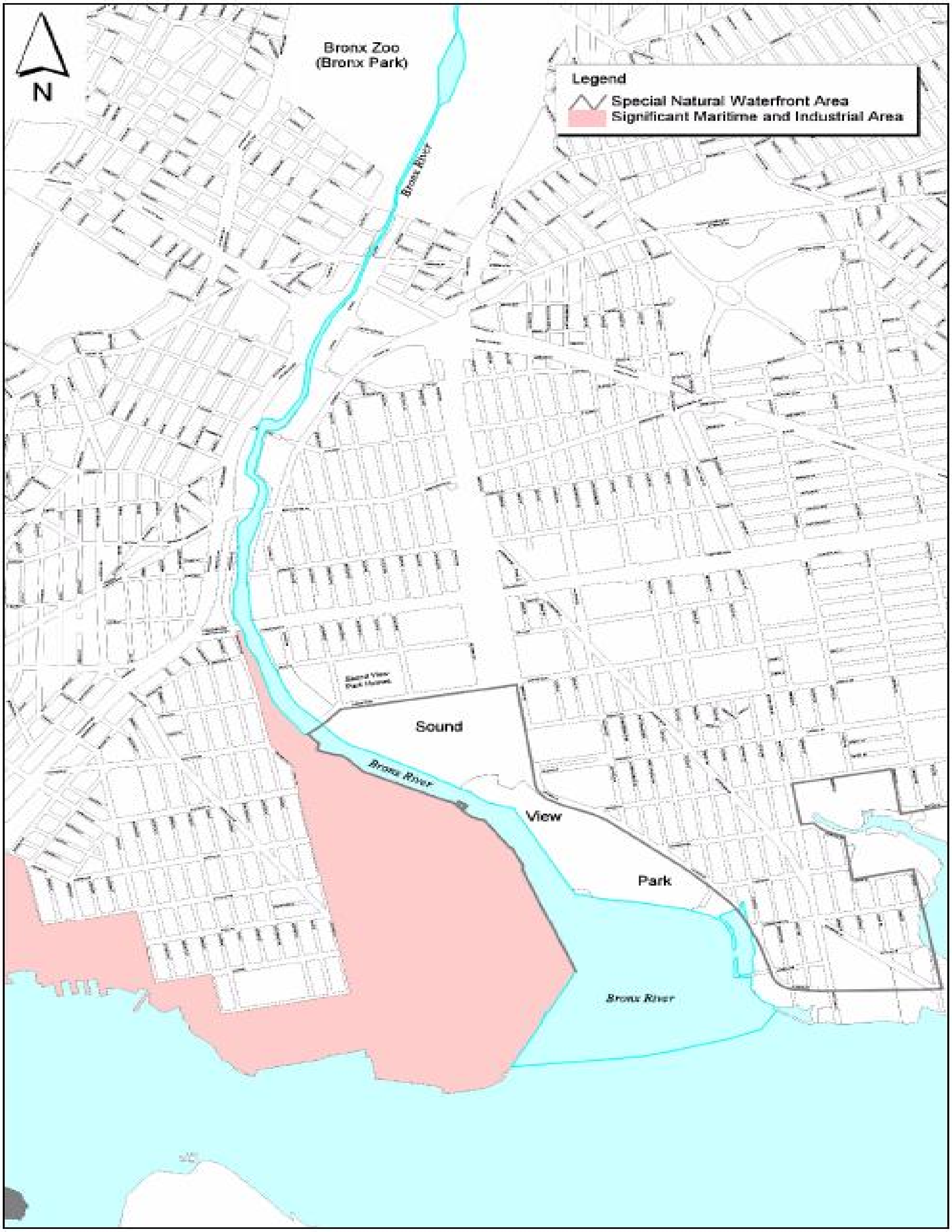

Figure 2-7. Significant Maritime and Industrial and Special Natural Waterfront Areas Along the Southern Reach of the Bronx River

The area to the west of the Bronx River between Bruckner Expressway and the New York Botanical Garden spans the neighborhoods of Crotona Park East and West Farms and is mostly zoned residential with commercial overlays along Southern Boulevard and Tremont Avenue. A commercial zoning district occupied by a shopping center is located between 174th Street and Cross Bronx Expressway, one block west of the Bronx River.

Along the eastern shore of the lower reach of the Bronx River is a large area of residential zoning that extends south of Patterson Avenue. This is the Harding Park neighborhood whose border with the Bronx River is city parkland also named Harding Park. This neighborhood was studied as part of DCP's neighborhood resiliency. Changes to the R3A zoning designation were not recommended as part of this study. North of this area is Soundview Park, which extends to Lafayette Avenue. Beyond Soundview Park an area of residential zoning extends northward to the New York Botanical Gardens. An area of commercial zoning is located along Westchester Avenue.

2.1.a.2 Permitted Discharges

In addition to the Hunts Point WWTP, and several permitted stormwater discharge points discussed in more detail in Section 2.1.c.1, a number of other entities hold industrial SPDES permits in the Bronx River watershed. Based on data available on-line at the date of submittal of this LTCP, it was determined that a total of six state-significant industrial SPDES permit holders operate facilities located in the watershed. These permit holders are located on the eastern and western banks of the freshwater section within Westchester County. Table 2-4 lists these permits, their owners and location.

Table 2-4. Industrial SPDES Permits within the Bronx River Watershed

Permit Number	Owner	Location
NY0264270	MTA Metro-North White Plains Repair Facility	24 Fisher Lane, North White Plains
NY0265039	White Plains Substation	9 New St, White Plains
NY0270831	Hillview Reservoir	Kimball Ave at Hillview Ave, Yonkers
NY0250929	Dunwoodie Central Substation	Marco and Smart Ave, Yonkers
NY0251291	Sprain Brook Central Substation	Tuckahoe & Grassy Sprain Rd, Yonkers
NY0105937	Ampacet Corp	250 S. Terrace Ave, Mount Vernon

2.1.a.3 Impervious Cover Analysis

Impervious surfaces within a watershed are those characterized by an artificial surface, such as concrete, asphalt, rock, or rooftop. Rainfall occurring on an impervious surface will experience a small initial loss through ponding and seasonal evaporation on that surface, with the remaining rainfall volume becoming overland runoff that flows directly into the CSS and/or separate stormwater system. The impervious surface is important when characterizing a watershed and CSS performance, as well as when constructing hydraulic models used to simulate the performance of the CSS.

A representation of the impervious cover was made in the 13 NYC WWTPs combined area drainage models developed in 2007 to support the several WWFPs that were submitted to DEC in 2009. As described below, efforts to update the model and the impervious surface representation were recently completed.

As NYC began to focus attention on the use of GI to manage street runoff of stormwater by either slowing it down prior to entering the combined sewer network, or preventing it from entering the network entirely, it became clear that a more detailed evaluation of the impervious cover would be beneficial. In addition, NYC realized that it would be important to distinguish between impervious surfaces that directly introduce storm runoff to the sewer system (Directly Connected Impervious Areas, or DCIA) from those impervious surfaces that may not contribute runoff directly to the sewers. For example, a rooftop with roof drains directly connected to the combined sewers (as required by the NYC Plumbing Code) would be an impervious surface that is directly connected. However, a sidewalk or impervious surface adjacent to parkland may not contribute storm runoff to the CSS and, as such, would not be considered directly connected.

In 2009 and 2010, DEP invested in the development of high quality satellite measurements of impervious surfaces required to conduct the analyses that improved the differentiation between pervious and impervious surfaces, as well as the different types of impervious surfaces. The data and the approach used are described in detail in the IW Citywide Model Recalibration Report (DEP, 2012a).

The result of this effort yielded an updated model representation of the areas that contribute runoff to the CSS. This improved set of data aided in model recalibration, and provided DEP with a better idea of where GI can be deployed to reduce the runoff contributions from impervious surfaces that contribute flow to the collection system.

2.1.a.4 Population Growth and Projected Flows

DEP routinely develops water consumption and dry-weather wastewater flow projections for DEP planning purposes. In 2012, DEP projected an average per capita water demand of 75 gallons per day that was representative of future uses. The year 2040 was established as the planning horizon, and populations for that time were developed by the New York City Department of Capital Planning and the New York Transportation Metropolitan Council.

The 2040 population projection figures were then used with the dry-weather per capita sewage flows to establish the dry-weather sewage flows contained in the IW model for the Hunts Point WWTP sewershed. This was accomplished by using Geographical Information System (GIS) tools to proportion the 2040 populations locally from the 2010 census information for each landside subcatchment tributary to each CSO outfall. Per capita dry-weather sanitary sewage flows for these landside model subcatchments were established as the ratio of two factors: the year per capita dry-weather sanitary sewage flow; and 2040 estimated population for the landside model subcatchment within the Hunts Point WWTP service area.

2.1.a.5 Update Landside Modeling

Within NYC, the Bronx River watershed is part of the overall Hunts Point WWTP system model (Hunts Point model). Several modifications to the collection system have occurred since the model was calibrated in 2007. Given that the Hunts Point model has been used for analyses associated with the annual reporting requirements of the SPDES permit best management practices (BMPs), many of these changes have already been incorporated into the model. Major changes to the modeled representation of the collection system that have been made since the 2007 update include:

- Updated representation of HP-009 (Regulator R-13) via survey
- Updated hydrology upstream of HP-009 based on CSO Pilot Monitoring Program
- Removed demonstration inflatable dams (Metcalf, Lafayette)
- Updated hydrology in Hutchinson River drainage area
- Updated stormwater piping in Hutchinson River drainage area
- Removed Regulator CSO 28 baffle, and raised weir 8 inches
- Included additional details for HP-011 and HP-013 outfall piping
- Updated Westchester County portion of model upstream of Hutchinson River
- Updated CSO Regulator 29 and 29A improvements per "Engineering Design Services for Westchester Creek CSO Modifications"
- Updated Pugsley improvements per "Basis of Design Report for Pugsley Creek Relief Sewer"

In addition to changes made to the modeled representation of the collection system configuration, other changes include:

Runoff Generation Methodology, including the identification of pervious and impervious surfaces. As described in Section 2.1.a.3 above, the impervious surfaces were also categorized into DCIAs and impervious runoff surfaces that do not contribute runoff to the collection system.

GIS Aligned Model Networks. Historical IW models were constructed using record drawings, maps, plans, and studies. Over the last decade, DEP has been developing a GIS system that will provide the most up-to-date information available on the existing sewers, regulators, outfalls, and pump stations. Part of the update and model recalibration utilized data from the GIS repository for interceptor sewers.

Interceptor Sediment Cleaning Data. Between April 2009 and May 2011, DEP undertook a citywide interceptor sediment inspection and cleaning program over approximately 136 miles of NYC's interceptor sewers. Data on the average and maximum sediment in the inspected interceptors were available for use in the model as part of the update and recalibration process. Multiple sediment depths available from sonar inspections were spatially averaged to represent depths for individual interceptor segments included in the model not yet cleaned.

Evapotranspiration Data. Evapotranspiration (ET) is a meteorological input to the hydrology module of the IW model that represents the rate at which depression storage (surface ponding) is depleted and available for use for additional surface ponding during subsequent rainfall events. In previous versions of the model, an average rate of 0.1 inches/hour (in/hr) was used for the model calibration, while no evaporation rate was used as a conservative measure during alternatives analyses. During the update of the model, hourly ET estimates obtained from four National Oceanic and Atmospheric Administration (NOAA) climate stations (John F. Kennedy [JFK], Newark [EWR], Central Park [CPK], and LaGuardia [LGA]) for an 11-year period were reviewed. These data were used to calculate monthly average ETs, which were then used in the updated model. The monthly variations enabled the model simulation to account for seasonal variations in ET rates, which are typically higher in the summer months.

Upstream Freshwater River Boundary. Freshwater flow enters the NYC portion of the Bronx River at the city line. The drainage area upstream of the city line contributes dry- and wet-weather flow and associated loadings to the Bronx River within NYC from some 23,000 acres of both developed and undeveloped surfaces in Westchester County. This portion of the drainage area is not included within the IW Models.

Downstream Saline Boundary Conditions at CSO Outfalls. Tidal stage can affect CSO discharges when tidal backwater in a CSO outfall reduces the ability of that outfall to relieve excess flow. Model updates took into account this variable boundary condition at CSO outfalls that were influenced by tides. Water elevation based on the tides was developed using a customized interpolation tool that assisted in the computation of meteorologically-adjusted astronomical tides at each CSO outfall in the New York Harbor complex.

Dry-Weather Sanitary Sewage Flows. Dry-weather sewage flows were developed as discussed in Section 2.1.a.4 above. Hourly dry-weather flow (DWF) data for 2011 were used to develop the hourly diurnal variation patterns at each plant. Based on the calibration period, the appropriate DWFs for 2005 or 2006 or another calendar year, were used.

In 2012, 13 of NYC's IW landside models underwent recalibration in addition to the updates and enhancements listed above. This effort is summarized with the calibration results in the IW Citywide Model Recalibration Report (DEP, 2012a) required by the 2012 CSO Order on Consent. Following this report, DEP submitted to DEC a Hydraulic Analysis Report in December 2012 (DEP, 2012b). The general approach followed was to recalibrate the model in a stepwise fashion beginning with the hydrology module (runoff). The following summarizes the overall approach to model update and recalibration:

Site Scale Calibration (Hydrology)**.** The first step was to focus on the hydrologic component of the model, which had been modified since 2007. Using updated satellite data, flow monitoring data were collected in upland areas of the collection systems, remote from (and thus largely unaffected by) tidal influences and in-system flow regulation, for use in understanding the runoff characteristics of the impervious surfaces. Data were collected in two phases – Phase 1 in the Fall of 2009, and Phase 2 in the Fall of 2010. These areas ranged from 15 to 400 acres. A range of areas with different land-use mixes was selected to support the development of standardized sets of coefficients that can be applied to other unmonitored areas of NYC. The primary purpose of this element of the recalibration was to adjust pervious and impervious area runoff coefficients to provide the best fit of the runoff observed at the upland flow monitors.

Area-wide Recalibration (Hydrology and Hydraulics). The next step in the process was to focus on larger areas of the modeled systems where historical flow metering data were available, and which were neither impacted by tidal backwater conditions nor subjected to flow regulation. Where necessary, runoff coefficients were further adjusted to provide reasonable simulation of flow measurements made at the downstream end of these larger areas. The calibration process then moved downstream further into the collection system, where flow data were available in portions of the conveyance system where tidal backwater conditions could exist, as well as potential backwater conditions from throttling at the WWTPs. The flow measured in these downstream locations would further be impacted by regulation at in-system control points (regulator, internal reliefs, etc.). During this step in the recalibration, minimal changes were made to runoff coefficients.

The result of this effort is a model with better representation of the collection system and its tributary area for the Hunts Point WWTP basin. This updated model is used for the alternative analysis as part of this LTCP. A comprehensive discussion of the recalibration effort can be found in the IW Citywide Recalibration Report (DEP, 2012).

2.1.a.6 Water Quality Modeling

Water quality models were used to aid in the assessment of water quality benefits associated with LTCP CSO control alternatives. Bronx River water quality was simulated using a combination the ERTM for the saltwater/tidal section (Figure 2-8) and the SWMM model (Figure 2-9) for the freshwater/free-flowing section of the Bronx River. The SWMM model was originally developed to assess flooding in the Westchester County portion of the Bronx River. The model was expanded to include sections of NYC for this project. ERTM was originally developed and applied as part of DEP's waterbody/watershed facility planning work in 2007. The model was developed expressly to assess water quality issues and the efficacy of CSO control alternatives for several principal tributaries of the Upper East River and western Long Island Sound, including Flushing Bay and Flushing Creek, Westchester Creek, Little Neck Bay and Alley Creek, and the Hutchinson River. As part of this LTCP work, the models were validated against the LTCP, DEP, Citizen Testing Group and Bronx River Alliance data with input from the validated InfoWorks model. Details of the model validation effort can be found in the Bronx River LTCP Sewer System and Water Quality Modeling report (NYCDEP 2015).

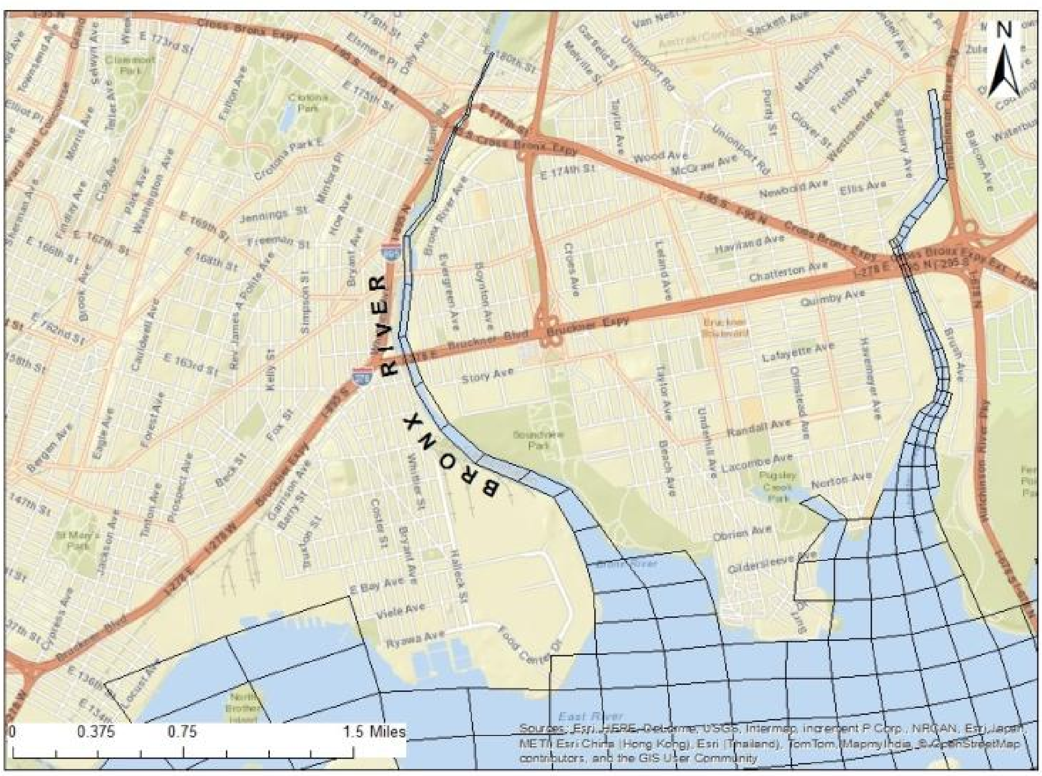

Figure 2-8. ERTM Model for the Saline Portion of the Bronx River

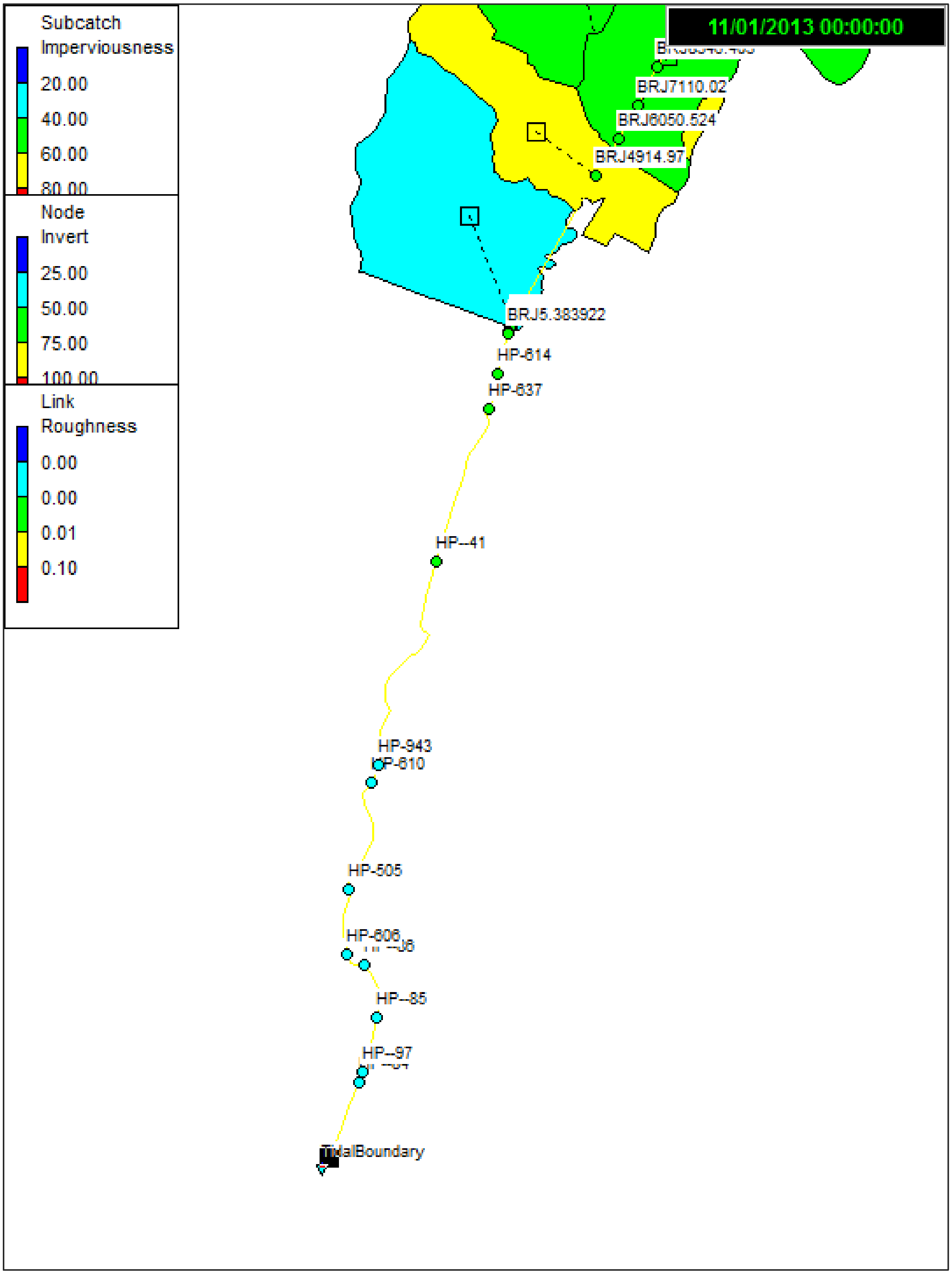

Figure 2-9. SWMM Model to the Freshwater Portion of the Bronx River

2.1.b Review and Confirm Adequacy of Design Rainfall Year

DEP has been consistently applying the 1988 annual precipitation characteristics to the landside IW models to develop loads from combined and separately sewered drainage areas. To-date, 1988 has been considered to be representative of long-term average conditions. Therefore, that year has been used to analyze facilities where "typical" rather than extreme conditions serve as the basis of design, in accordance with EPA CSO Control Policy of using an "average annual basis" for analyses. However, in light of increasing concerns over climate change, with the potential for more extreme and possibly more frequent storm events, the selection of 1988 as the average condition was re-considered. Recent landside modeling analyses in NYC have used the 2008 precipitation pattern to drive the runoff-conveyance processes, together with the 2008 tide observations. Because it also included some extreme storms, DEP now believes 2008 to be more representative than 1988 conditions.

While the WWFPs for the NYC waterbodies were based on 1988 rainfall conditions, future baseline conditions runs are now being performed using 2008 as the typical precipitation year. A comparison of these rainfall years, which led to the selection of 2008 as the typical year for this LTCP, is provided in Table 2-5. For 10-year simulations, the period of 2002-2011 is used (see Section 6).

Table 2-5. Comparison of Rainfall Years to Support Evaluation of Alternatives

Parameter	WWFP JFK 1988	Present Day Average 1969-2010	Present Best Fit JFK 2008
Annual Rainfall (in)	40.7	45.5	46.3
July Rainfall (in)	6.7	4.3	3.3
November Rainfall (in)	6.3	3.7	3.3
Number of Very Wet Days (>2.0 in)	3	2.4	3
Average Peak Storm Intensity (in/hr)	0.15	0.15	0.15

2.1.c Description of Sewer System

The Bronx River forms in Davis Brook and Kensico Dam. It then flows 20 miles south through Westchester County, NY and into and through the Borough of the Bronx in NYC until it reaches the Upper East River. As such, the Bronx River is divided between two major political jurisdictions: (1) Westchester County, NY to the north; and (2) the Borough of the Bronx within NYC, to the south. Figure 2-10 depicts the Bronx River watershed.

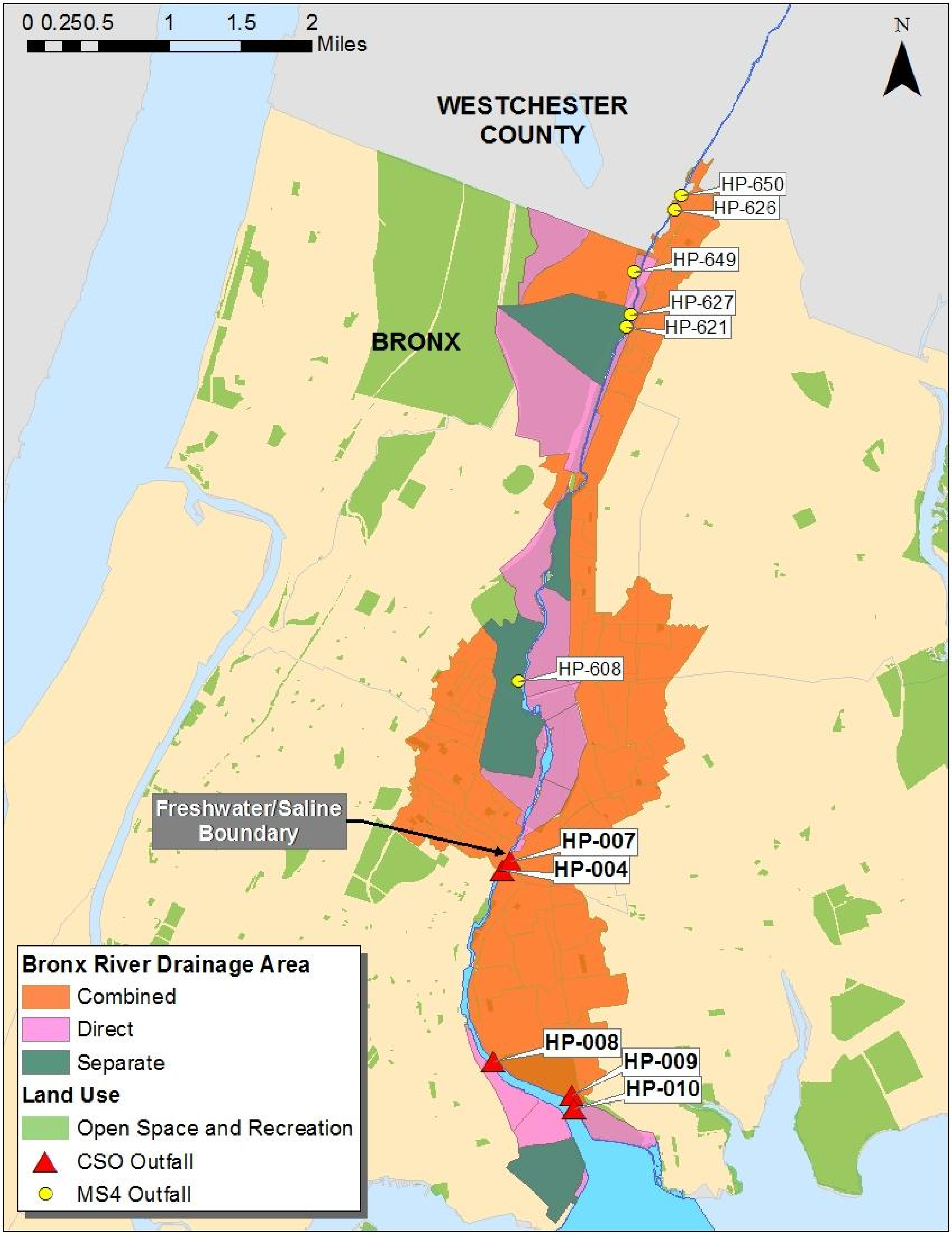

Figure 2-10. Bronx River Watershed

The watershed tributary to the Bronx River in NYC includes combined, separate sewer service areas and direct drainage within the Hunts Point collection system. In addition, as noted in Figure 2-1, there are many other sources of wet-weather flow to the Bronx River. The separate service areas are predominantly tributary to the freshwater section of the Bronx River within NYC and the combined service areas contribute exclusively to the saline section of the Bronx River, south of East Tremont Ave. Rainfall that lands in direct drainage areas (typically coastal parks, undeveloped or underdeveloped areas) will infiltrate into the ground, eventually generate shallow sheet flow over the land and ultimately discharge to the Bronx River at random locations, thus making the assessment of the corresponding concentrations extremely difficult. Figure 2-10 depicts the locations of the various types of drainage areas in the watershed.

2.1.c.1 Overview of Drainage Area and Sewer System

The Bronx River watershed is served by the Hunts Point WWTP. The facility is located at 1270 Ryawa Avenue in the Hunts Point section of the Bronx, on a 45-acre site adjacent to the Upper East River located between Halleck Street and Manida Street. The Hunts Point WWTP serves an area of 16,664 acres in the east side of the Bronx, including the communities of City Island, Throgs Neck, Edgewater Park, Schuylerville, Country Club, Pelham Bay, Westchester Square, Clason Point, Castle Hill, Union Port, Soundview, Parkchester, Van Nest, Co-op City, Morris Park, Pelham Parkway, Pelham Gardens, Baychester, Olinville, Williamsbridge, Edenwald, Eastchester, Hunts Point, Woodlawn, Wakefield, East Tremont, West Farms, and Longwood. The total sewer length, including sanitary, combined, and interceptor sewers, that feeds into the Hunts Point WWTP is 424 miles.

The Hunts Point WWTP has been providing full secondary treatment since 1978. Processes include primary screening, raw sewage pumping, grit removal and primary settling, air activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. The Hunts Point WWTP has a design dry-weather flow (DDWF) capacity of 200 MGD and is designed to receive a maximum flow of 400 MGD (2xDDWF) with up to 260 MGD receiving secondary treatment (1.3 times DDWF to protect the biological nutrient removal [BNR] control processes). Flows over 260 MGD receive primary treatment and disinfection. A total of 15 pumping stations are located in the Hunts Point WWTP drainage area. Twelve handle combined sewage and three pump stormwater only. The developed areas in the Bronx River drainage area are all sewered.

Figure 2-11 presents the sewer system schematic for the Hunts Point drainage area. Table 2-6 presents acreage per type of drainage area within the Bronx River watershed.

Table 2-6. Bronx River Drainage Area: Acreage of Contributing Jurisdiction and System

Sewer Area Description	Area (acres)
Westchester County	23,020
NYC Combined	2,760
NYC Non-Combined • Fully separated • Watershed separately sewered, but with sanitary sewage subsequently flowing into a combined interceptor and stormwater either discharging directly to receiving water or into storm drains • Overland flow (parks, cemetery, other) • Non-MS4 outfalls (DOT, Private, unknown)	1,558
TOTAL	**27,338**

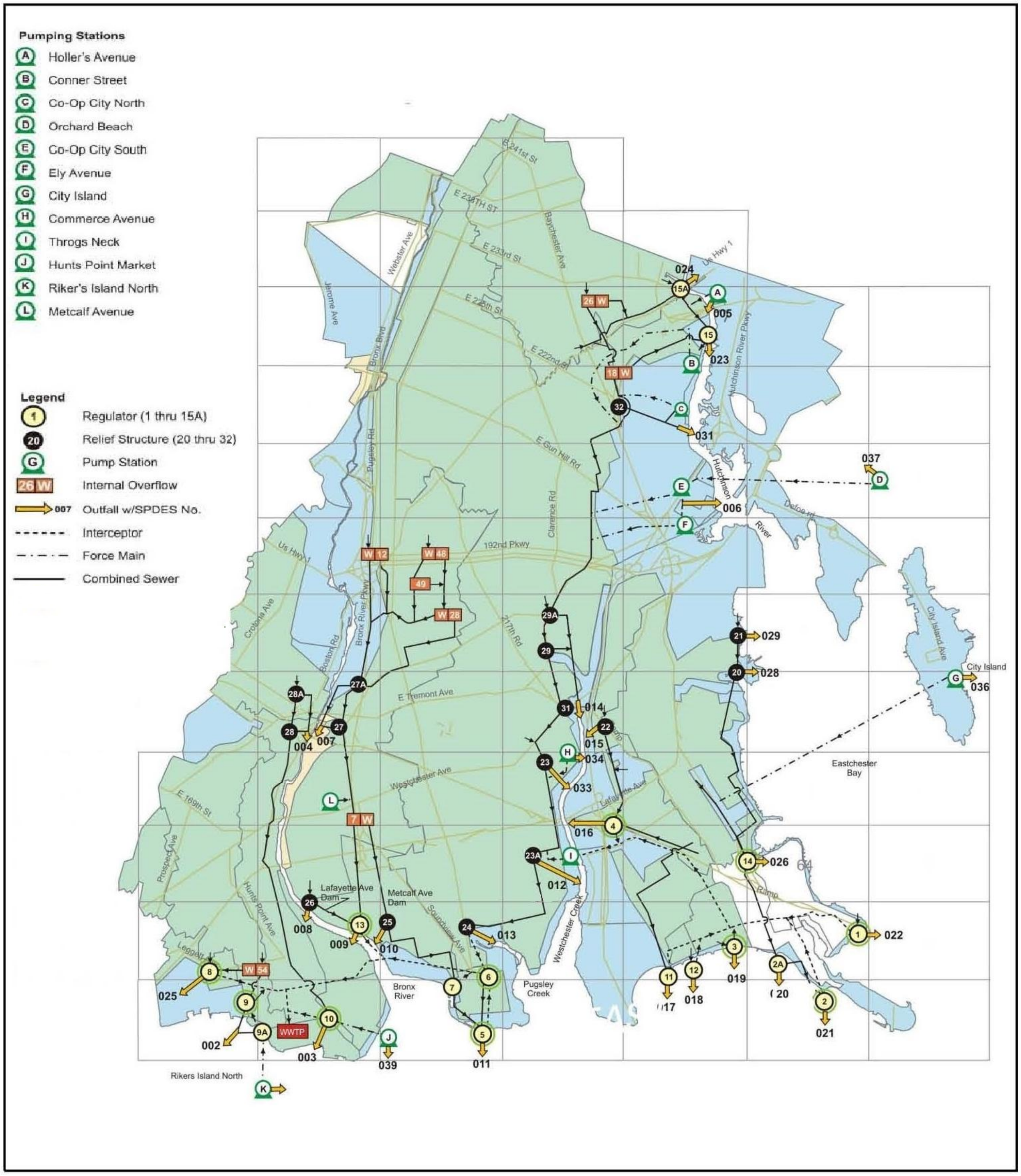

Figure 2-11. Sewer System Schematic for Hunts Point Service Area

Hunts Point Combined Sewer System

Combined sewers serve about 2,760 acres of the Bronx River drainage area. During wet-weather events combined sewers may discharge to the Bronx River at five CSOs in the saline reach (HP-004, HP-007 and HP-008, HP-009 and HP-019). HP-004 has a drainage area of 806 acres, HP-007 has a drainage area of 1,831 acres, HP-008 has a drainage area of 257 acres, HP-009 has a drainage area of 436 acres and HP-010 has a drainage area of 123 acres.

The Bronx River drainage area includes one regulator structure, designated Regulator 13, upstream of Outfall HP-009 and six CSO relief structures. Table 2-7 summarizes the location, characteristics, as well as CSO outfall and drainage area associated with each structure.

Table 2-7. Bronx River Drainage Area: Permitted CSO Outfalls and Regulators

SPDES Outfall No.	Permitted Outfall Location	Outfall Size (W x H)	Structure(s)	Structure(s) Location	Drainage Area (Acres)
HP-004	West Farm Rd. (CSO-28, 28A)	12' X 8'	CSO28 & CSO28A	CSO28 - West Farms Rd. e/o East Tremont Ave. CSO28A - 178th St. & Boston Rd.	806
HP-007	E. 177th St. (CSO-27, 27A)	DOUBLE 11'-6"x 6'-6"	CSO27 & CSO27A	CSO27 - Van Buren St. & Bronx Park Ave. CSO27A - E. 177th St. & Bronx Park Ave.	1,831
HP-008	Lafayette Ave. (CSO-26)	54" DIA	CSO26	Lafayette Ave. & Colgate Ave.	257
HP-009	Metcalf Ave. (REG #13)	14' X 8'	HP-013	Metcalf Ave. & Soundview Park	436
HP-010	Lacombe Ave. (CSO-25)	9' X 6'	CSO25	Randall Ave. & Metcalf Ave.	123

Hunts Point Stormwater Outfalls

A few small areas within NYC are served by separate stormwater systems in the Bronx River sewershed and discharge to the freshwater section of the Bronx River. Four of the six separately sewered areas are located west on the west bank of the Bronx River. These drainage areas discharge through Outfalls HP-650, HP-626, HP-649, HP-627, HP-621 and HP-608. The MS4 permitted outfalls are shown in Figure 2-12.

Examination of the population densities in the 14 NYC sewer districts indicated that the sewer districts could be characterized and grouped into two categories of residential populations – "low density urban" and "high density urban." The Hunts Point drainage area including MS4 stormwater Outfalls HP-626, HP-627, HP-608, HP-621, HP-649 and HP-650 was classified as "high density urban" or a sewer district that has densities greater than 20,000 persons/mi^2.

Figure 2-12. Bronx River CSO and MS4 Discharge Locations

2.1.c.2 Stormwater and Wastewater Characteristics

The concentrations found in wastewater, combined sewage and stormwater can vary based on a number of factors including flow rate, runoff contribution, and the matrix of the waste discharged to the system from domestic and non-domestic customers. Because the matrix of these waste streams can vary, it can be challenging to identify a single concentration to use for analyzing the impact of discharges from these systems to receiving waters.

Data collected from sampling events were used to estimate concentrations for biochemical oxygen demand (BOD), total suspended solids (TSS), total coliform bacteria, fecal coliform bacteria and enterococci. Table 2-8 shows both the sanitary and stormwater concentrations for the Bronx River watershed. Sanitary concentrations were developed based on sampling of sanitary flows during dry-weather periods at the regulators that during wet-weather conditions contribute to the CSO outfalls discharging to the Bronx River (DEP, 2014). Stormwater concentrations were developed based on geometric mean values based on waterbody-specific sampling results collected in 2014, as well as earlier sampling conducted citywide as part of the Inner Harbor Facility Planning Study (DEP, 1994), and sampling conducted citywide by the DEP for the EPA Harbor Estuary Program (HydroQual, 2005a).

Table 2-8. Sanitary and Stormwater Discharge Concentrations, Baseline Condition

Constituent	Sanitary Concentration	Stormwater Concentration	
CBOD (mg/L)[1]	110	15	
TSS (mg/L)[1]	110	15	
Total Coliform Bacteria (cfu/100mL)[2,5]	25,000,000	300,000	
Fecal Coliform Bacteria (cfu/100mL)	2,200,000 [3,4]	NYC[2,3]	Westchester County[2,3]
		120,000	120,000
Enterococci (cfu/100mL)	400,000[3,4]	NYC[2,3]	Westchester County[23]
		50,000	50,000

Notes:
(1) HydroQual, 2005b.
(2) HydroQual Memo to DEP, 2005a.
(3) DEP (LTCP), 2014.
(4) Bacterial concentrations expressed as "colonies forming units" (cfu) per 100mL.

A sampling program targeting CSO and other sources contributing to the Bronx River was implemented as part of this LTCP. Data were collected to supplement existing information on the flows/volumes and concentrations of various sources to the Bronx River.

Wet-weather flow monitoring was conducted at various CSO and stormwater outfalls, namely HP-007, HP-009, HP-627 and HP-608. This latter outfall discharges the outflows from Cope Lake. The Bronx River flow entering NYC was monitored as well from May 7, 2014 to August 18, 2014 for dry- and wet-weather conditions. The series of flow records were used to calibrate the collection system and WQ models as described in Section 6.0.

CSO concentrations can be extremely variable and are a function of many factors. Generally, CSO concentrations are a function of local sanitary sewage and runoff entering the combined sewers. For the modeling analyses, CSO concentrations for Outfalls HP-004 and HP-008 were calculated based on a mass balance of the sanitary sewage concentrations and event mean concentration (EMC) stormwater runoff concentrations during each hour of each storm event. Influent dry-weather sanitary sampling bacteria concentration results collected in the nearby collection system in 2014 were used to model sanitary concentrations (DEP, 2014). These sanitary sewage influent concentrations are summarized in Table 2-8. The concentrations of the stormwater entering the CSS were taken as those values shown in the same table. The IW model is run in the water quality mode and traces the amount of sanitary sewage and the amount of stormwater at each location within the model. When there is a CSO discharge, its concentrations will have the calculated mix of sanitary sewage and storm runoff for each hour of overflow. CSO concentrations were measured in 2014 to provide site-specific information and support a Monte Carlo randomization of the CSO concentrations to assign to the major CSO outfalls contributing to the Bronx River (i.e., HP-007 and HP-009). The CSO overflow bacteria concentrations were characterized by direct measurements of these outfalls (four overflow events at HP-009 and three at HP-007) during various storm events in late 2013/early 2014. These concentrations are shown in Figures 2-13 and 2-14, showing cumulative frequency distribution graphics. Individual sample points are shown, as well as the trend line that best fits the data distribution. For the HP-007 CSO discharges, measured fecal coliform concentrations are log-normally distributed as is typical for this type of data and values range from 51,000 to 1,200,000 cfu/100mL (Figure 2-13). Similarly, enterococci concentrations are also log-normally distributed and range from 40,000 to 336,000 cfu/100mL (Figure 2-13). For the HP-009 overflows, measured fecal coliform concentrations are log-normally distributed as is typical for this type of data and values range from 72,700 to 2,700,000 cfu/100mL (Figure 2-14). Similarly, enterococci concentrations are also log-normally distributed and range from 30,000 to 530,000 cfu/100mL (Figure 2-14). Additionally, it is noted that HP-009 overflows have higher bacteria concentration than HP-007 overflows, due to the larger stormwater contribution to the system upstream of Outfall HP-007.

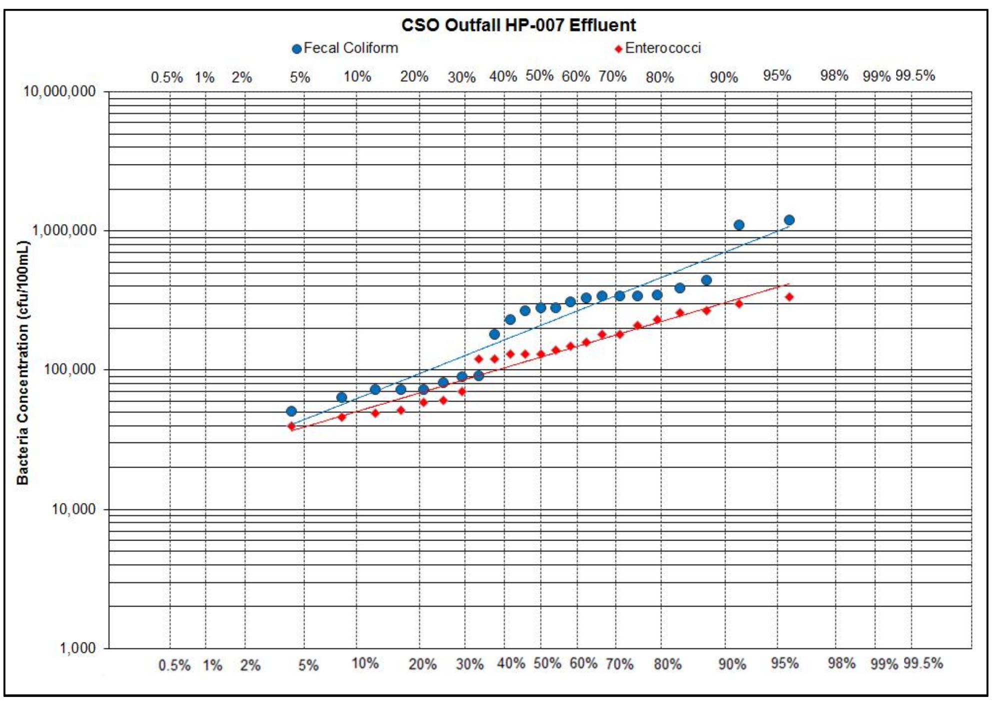

Figure 2-13. HP-007 Effluent Bacteria Concentrations

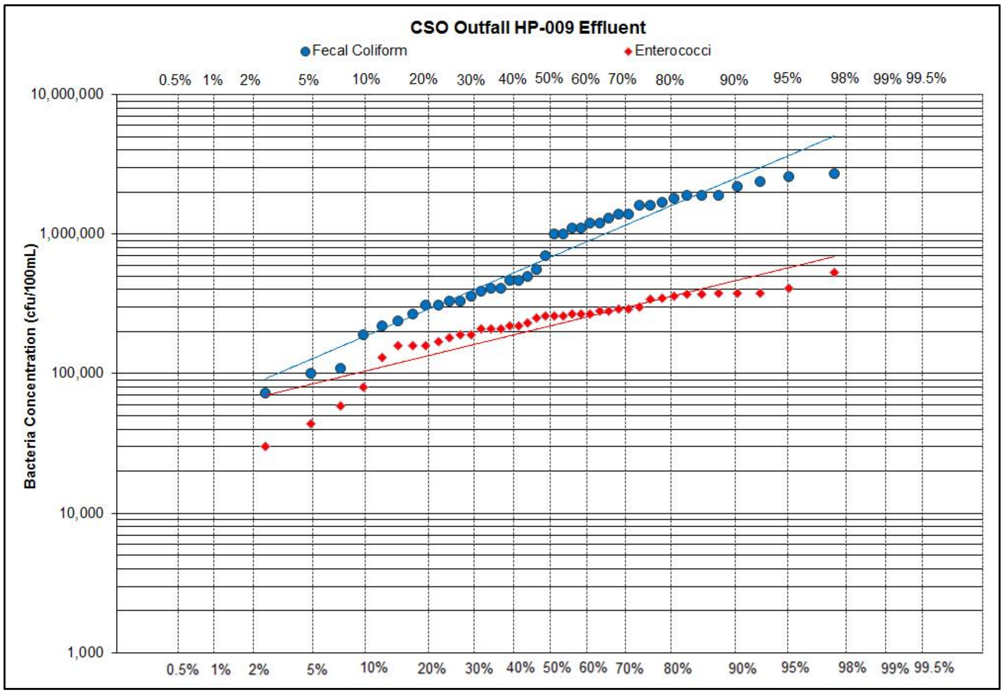

Figure 2-14. HP-009 Effluent Bacteria Concentrations

Stormwater discharge concentrations are assigned an EMC for inclusion in the water quality model calibration and LTCP baseline analyses. Historical information and data collected from sampling events were used to guide the selection of concentrations of BOD, TSS, total coliform, fecal coliform, and enterococci to use in calculating loadings from the various sources. Table 2-9 shows EMC stormwater concentrations for NYC stormwater discharges to the Bronx River from the separate stormwater collection systems associated with Hunts Point WWTP service area. Stormwater data collected in 2014 (DEP) as well as previously collected citywide sampling data from Inner Harbor CSO Facility Planning Study (DEP, 1994) was combined with data for the EPA Harbor Estuary Program (HydroQual, 2005a) to develop these stormwater concentrations. The IW sewer system model (Section 2.1.a.5) used to generate the flows from NYC storm sewer outfalls and concentrations noted in Table 2-9 are associated with the flows used to develop loadings.

Table 2-9. Bronx River Source Loadings Characteristics

Source	Source of Calculated Flow	Enterococci (cfu./100mL)	Fecal Coliform (cfu/100mL)	BOD-5 (mg/L)
Stormwater	IW	50,000	120,000	15
Sanitary	IW	400,000	2,200,000	110
Direct Drainage	IW	6,000	4,000	15
CSOs (HP-007 and HP-009)	IW	Monte Carlo	Monte Carlo	Mass Balance
CSOs (HP-004 and HP-008)	IW	Mass Balance	Mass Balance	Mass Balance
Bronx River at freshwater-saline boundary	SWMM	Mass Balance	Mass Balance	Mass Balance
Cope Lake DW	SWMM	Monte Carlo	Monte Carlo	N/A

A previously developed Bronx River SWMM model (EPA Stormwater Management Model) was used to simulate both flow and pathogens crossing the NYC line. The SWMM model was originally developed by Westchester County to assess flooding in the Westchester County portion of the Bronx River. The model was expanded, herein, to include sections of NYC for this project. SWMM is a dynamic rainfall-runoff simulation model that can be used to assess runoff quantity and quality from areas with varying land uses. The runoff component of SWMM uses a series of subcatchment areas on which precipitation falls and runoff is calculated. The routing portion of SWMM transports runoff through a conveyance system of pipes, channels, storage/treatment devices, pumps, and regulators. SWMM tracks the quantity and quality of runoff generated within each subcatchment, and the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period. The original SWMM Bronx River model was developed for an application in Westchester County, but was extended into NYC so that the United States Geological Survey (USGS) gauge at the Botanical Gardens could be used as part of the calibration process.

Characteristics of Other Background Sources

Additionally, flows were continuously monitored in the vicinity of the border with Westchester County at Oak Street for a period of approximately five months from June through October 2014. Bacteria water quality parameters were also measured concurrently twice per week at Oak Street and East 233rd Street, arbitrarily depicting dry- and wet-weather conditions. The sampled bacteria concentrations are discussed in Section 2.2.a.6.

2.1.c.3 Hydraulic Analysis of Sewer System

A citywide hydraulic analysis was completed in December 2012 to provide further insight into the hydraulic capacities of key system components and system responses to various wet-weather conditions. The IW model was updated in the Bronx River drainage area after this effort was completed. Thus, the model results reported in this subsection, while relevant for their intended use to document overall system-wide performance beyond the Bronx River watershed, may differ slightly from results reported in the remainder of this LTCP. The hydraulic analyses can be divided into the following major components:

- Annual simulations to estimate the number of annual hours that the WWTP is predicted to receive and treat up to 2xDDWF for rainfall years 2008, and with projected 2040 DWFs; and

- Estimation of peak conduit/pipe flow rates that would result from a significant single event with projected 2040 DWFs.

Detailed presentations of the data were contained in the December 2012 Hydraulic Analysis Report submitted to DEC. The objective of each evaluation and the specific approach undertaken are briefly described in the following paragraphs.

Annual Hours at 2xDDWF for 2008 with Projected 2040 DWFs

Model simulations were conducted to estimate the annual number of hours that the Hunts Point WWTP would be expected to treat 2xDDWF for the 2008 precipitation year, which contained a total precipitation of 46.26 inches, as measured at JFK Airport. These simulations were conducted using projected 2040 DWFs for the re-calibrated model conditions as described in the December 2012 IW Citywide Model Recalibration Report. For these simulations, the primary input conditions applied were as follows:

- Projected 2040 DWF conditions.
- 2008 tides and precipitation data.
- WWTP at 2xDDWF capacity of 415 MGD.
- No sediment in the combined sewers (i.e., clean conditions).
- Sediment in interceptors representing the sediment conditions after the inspection and cleaning program undertaken in 2011 and 2012.
- No green infrastructure.

For the Hunts Point service area, the simulation of the 2008 annual rainfall year resulted in a prediction that the Hunts Point WWTP would operate at or over its 2xDDWF capacity 59 hours throughout the year.

Estimation of Peak Conduit/Pipe Flow Rates

Model output tables containing information on several pipe characteristics were prepared, coupled with calculation of the theoretical, non-surcharged, full-pipe flow capacity of each sewer included in the model. To test the conveyance system response under what would be considered a large storm event condition, a single-event storm that was estimated to approximate a five-year return period (in terms of peak hourly intensity as well as total depth) was selected from the historical record.

The selected single event was simulated in the model for WWFP conditions implemented. The maximum flow rates and maximum depths predicted by the model for each modeled sewer segment were retrieved and aligned with the other pipe characteristics. Columns in the tabulations were added to indicate whether the maximum flow predicted for each conduit exceeded the non-surcharged, full-pipe flow, along with a calculation of the maximum depth in the sewer as a percentage of the pipe full height. It was suspected that potentially, several of the sewer segments could be flowing full, even though the maximum flow may not have reached the theoretical maximum full-pipe flow rate for reasons such as: downstream tidal backwater; interceptor surcharge; or other capacity-limiting reasons. The resulting data were then scanned to identify the likelihood of such capacity-limiting conditions, and also to provide insight into potential areas of available capacity, even under large storm event conditions. Key observations/ findings of this analysis are described below.

- Capacity exceedances for each sewer segment were evaluated in two ways for both interceptors and combined sewers:
  - Full flow exceedances, where the maximum predicted flow rate exceeded the full-pipe non-surcharged flow rate. This could be indicative of a conveyance limitation.
  - Full depth exceedances, where the maximum depth was greater than the height of the sewer segment. This could be indicative of either a conveyance limitation or a backwater condition.
- About 94 percent (by length) of the interceptors were predicted to flow at full depth or higher. Between 53 and 55 percent (by length) of the combined sewers were also predicted to flow at full depth, and 76 percent of the combined sewers flowed at least 75 percent full.
- The results for the system condition with WWFP improvements showed that the overall peak plant inflow and hydraulic grade line (HGL) near the plant improved slightly, in comparison to the non-WWFP conditions in the Hunts Point WWTP service area.

- About 76 percent of the combined sewers (by length) reached a depth of at least 75 percent under the WWFP simulations. This indicates that limited additional potential exists for in-line storage capability in the Hunts Point system.

2.1.c.4 Identification of Sewer System Bottlenecks, Areas Prone to Flooding and History of Sewer Back-ups

There are no known system bottlenecks and areas prone to flooding in the Bronx River watershed. DEP conducts regular sewer inspections and cleaning as reported in the SPDES BMP Annual reports. Figure 2-15 shows the sewers inspected and cleaned throughout 2014 in the Borough of the Bronx, which encompasses the entire watershed of the Bronx River within NYC.

DEP recently conducted a sediment accumulation analysis to quantify levels of sediments in the CSSs. For this analysis, the normal approximation to the hypergeometric distribution was used to randomly select a sample subset of sewers representative of the modeled systems as a whole, with a confidence level commensurate to that of the IW watershed models. Field crews investigated each location, and estimated sediment depth using a rod and tape. Field crews also verified sewer pipe sizes shown on maps, and noted physical conditions of the sewers. The data were then used to estimate the sediment levels as a percentage of overall sewer area. The aggregate mean for the entire NYC was approximately 1.25 percent, with a standard deviation of 2.02 percent.

2.1.c.5 Findings from Interceptor Inspections

In the last decade, DEP has implemented technologies and procedures to enhance its use of proactive sewer maintenance practices. DEP has many programs and staff devoted to sewer maintenance, inspection and analysis. GIS and Computerized Maintenance and Management System (CMMS) provide DEP with expanded data tracking and mapping capabilities, and can facilitate identification of trends to allow provision of better service to its customers. As referenced above, reactive and proactive system inspections result in maintenance including cleaning and repair as necessary. According to DEP's 2014 BMP report, 13,990 feet of Hunts Point WWTP intercepting sewers were inspected leading to a removal of 306 cubic yards of sediment. Citywide, 145,668 feet of intercepting sewers were inspected leading to a removal of 11,038 cubic yards of sediment.

2.1.c.6 Status of Receiving Wastewater Treatment Plants (WWTPs)

The Bronx River watershed within NYC is entirely served by the Hunts Point WWTP. The plant is undergoing miscellaneous improvements to existing facilities. These works do not impact the hydraulic capacity of the plant.

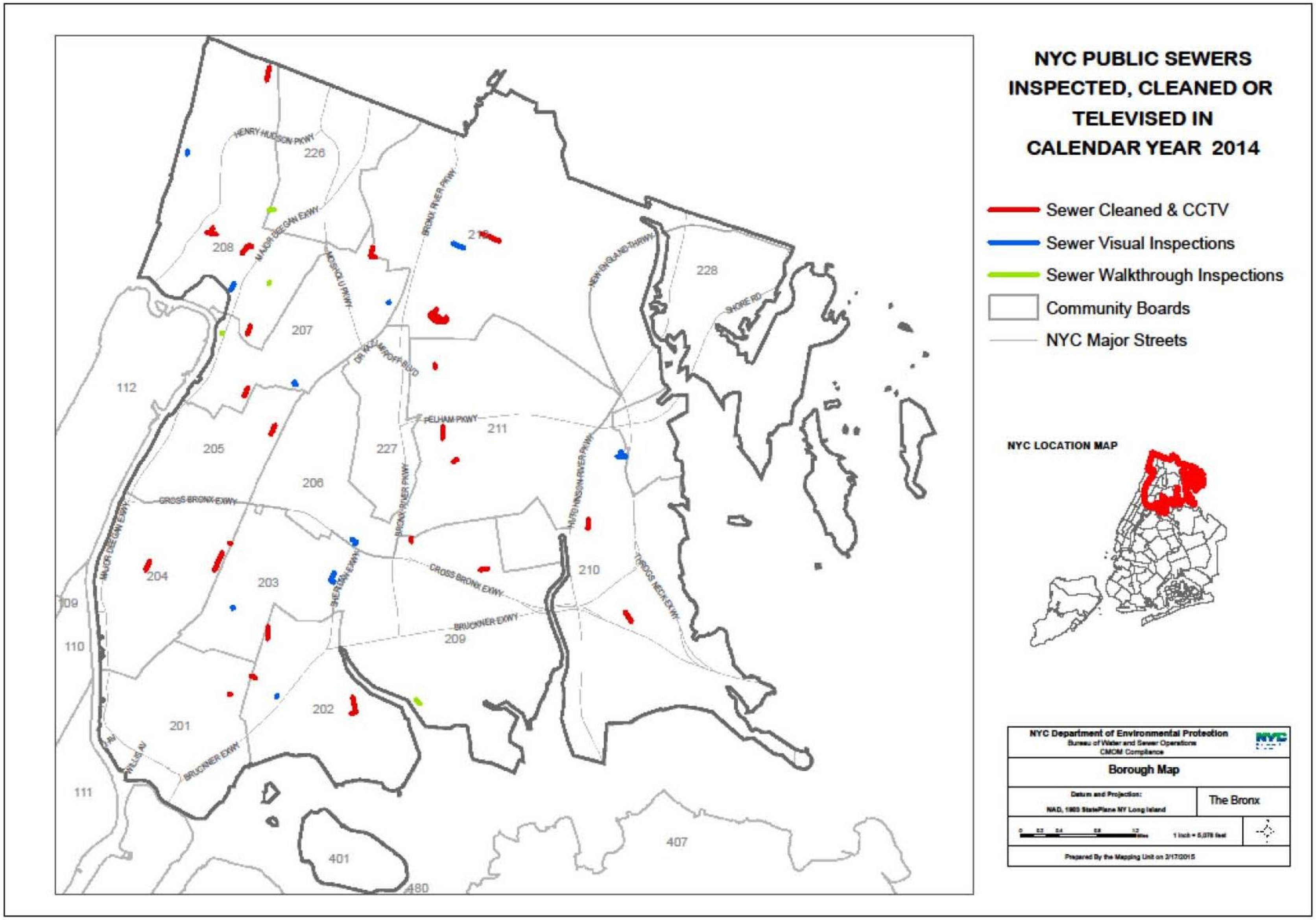

Figure 2-15. Sewers Inspected and Cleaned in the Bronx Throughout 2014

2.2 Waterbody Characteristics

The Bronx River is a complex waterbody with a saline section and an upstream freshwater section. The Bronx River begins in Westchester County and flows into NYC. As described earlier, multiple sources impact the water quality of the Bronx River, including municipal stormwater and dry-weather discharges from municipalities in Westchester County, as well as CSOs and stormwater from NYC. This section of the report describes the features and attributes of the Bronx River. Characterization of the waterbody provides basic information for assessing the impact of wet-weather inputs as well as the conceptualization of approaches and solutions that mitigate the impacts from wet-weather discharges.

2.2.a Description of Waterbody

The Bronx River is classified as a tidal tributary to the Upper East River. Freshwater flows come from CSO and stormwater discharges from Westchester County, NY. The Bronx River flows 20 miles southwards from Davis Brook and Kensico Dam, through Westchester County and the Bronx in NYC until it empties into the Upper East River.

The Bronx River estuary portion has a diurnal tidal cycle with a tidal amplitude of approximately 7.0 feet at Westchester Avenue Bridge. Depths at the mouth of the Bronx River range from 16 to 2 feet at Mean Lower Low Water (MLLW). Widths range from 30 to 40 feet at the head end to 4,300 feet at the mouth.

2.2.a.1 Current Waterbody Classification(s) and Water Quality Standards

New York State Policies and Regulations

In accordance with the provisions of the CWA, NYS has established WQS for all navigable waters within its jurisdiction. The State has developed a system of waterbody classifications based on designated uses that include five classifications for saline waters. DEC considers the Class SA and Class SB classifications to fulfill the CWA goals. Class SC supports aquatic life and recreation, but the primary and secondary recreational uses of the waterbody are limited due to other factors. Class I supports the CWA goal of aquatic life protection, as well as secondary contact recreation. SD waters shall be suitable only for fish, shellfish and wildlife survival because natural or man-made conditions limit the attainment of higher standards. DEC has classified the saline CSO impacted section of the Bronx River as Class I.

Numerical standards corresponding to these waterbody classifications are shown in Table 2-10. DO is the numerical standard that DEC uses to establish whether a waterbody supports aquatic life uses. Total and fecal coliform bacteria concentrations are the numerical standards that DEC uses to establish whether a waterbody supports recreational uses. In addition to numerical standards, NYS has narrative criteria to protect aesthetics in all waters within its jurisdiction, regardless of classification (see Section 1.2.c.). As indicated in Table 2-11, these narrative criteria apply to all five classes of saline waters.

Table 2-10. New York State Numerical Surface WQS (Saline)

Class	Usage	Dissolved Oxygen (mg/L)	Total Coliform (MPN/100mL)	Fecal Coliform (MPN/100mL)	Enterococci (MPN/100mL)(7)
SA	Shellfishing for market purposes, primary and secondary contact recreation and fishing. Suitable for fish, shellfish and wildlife propagation and survival.	≥ 4.8(1) ≥ 3.0(2)	≤ 70(3)	N/A	
SB	Primary and secondary contact recreation and fishing. Suitable for fish, shellfish and wildlife propagation and survival.	≥ 4.8(1) ≥ 3.0(2)	≤ 2,400(4) ≤ 5,000(5)	≤ 200(6)	≤ 35(8)
SC	Limited primary and secondary contact recreation and fishing. Suitable for fish, shellfish and wildlife propagation and survival.	≥ 4.8(1) ≥ 3.0(2)	≤ 2,400(4) ≤ 5,000(5)	≤ 200(6)	N/A
I(9)	Secondary Contact recreation and fishing. Suitable for fish, shellfish and wildlife propagation and survival.	≥ 4.0	≤ 10,000(6)	≤ 2,000(6)	N/A
SD(9)	Fishing. Suitable for fish, shellfish and wildlife survival. Waters with natural or man-made conditions limiting attainment of higher standards.	≥ 3.0	N/A	N/A	N/A

Notes:

(1) Chronic standard based on daily average. The DO concentration may fall below 4.8 mg/L for a limited number of days, as defined by the formula:

$$DO_i = \frac{13.0}{2.80 + 1.84e^{-0.1t_i}}$$

where DO_i = DO concentration in mg/L between 3.0 – 4.8 mg/L and t_i = time in days. This equation is applied by dividing the DO range of 3.0 – 4.8 mg/L into a number of equal intervals. DO_i is the lower bound of each interval (i) and t_i is the allowable number of days that the DO concentration can be within that interval. The actual number of days that the measured DO concentration falls within each interval (i) is divided by the allowable number of days that the DO can fall within interval (t_i). The sum of the quotients of all intervals (i …n) cannot exceed 1.0: i.e.,

$$\sum_{i=1}^{n} \frac{t_i(actual)}{t_i(allowed)} < 1.0$$

(2) Acute standard (never less than 3.0 mg/L).
(3) Median most probable number (MPN) value in any series of representative samples.
(4) Monthly median value of five or more samples.
(5) Monthly 80th percentile of five or more samples.
(6) Monthly geometric mean of five or more samples.
(7) This standard, although not promulgated by DEC, is now an enforceable standard in New York State because EPA established January 1, 2005 as the date upon which the criteria must be adopted for all coastal recreational waters.
(8) 30-day moving geometric mean.
(9) DEC has publicly noticed a proposed rulemaking which, if promulgated, would amend 6 NYCRR Part 701 to require that the quality of Class I and Class SD waters be suitable for “primary contact recreation” and to adopt corresponding total and fecal coliform standards in 6 NYCRR Part 703.

Table 2-11. New York State Narrative WQS

Parameters	Classes	Standard
Taste-, color-, and odor-producing toxic and other deleterious substances	SA, SB, SC, I, SD A, B, C, D	None in amounts that will adversely affect the taste, color or odor thereof, or impair the waters for their best usages.
Turbidity	SA, SB, SC, I, SD A, B, C, D	No increase that will cause a substantial visible contrast to natural conditions.
Suspended, colloidal and settleable solids	SA, SB, SC, I, SD A, B, C, D	None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.
Oil and floating substances	SA, SB, SC, I, SD A, B, C, D	No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.
Garbage, cinders, ashes, oils, sludge and other refuse	SA, SB, SC, I, SD A, B, C, D	None in any amounts.
Phosphorus and nitrogen	SA, SB, SC, I, SD A, B, C, D	None in any amounts that will result in growth of algae, weeds and slimes that will impair the waters for their best usages.

Note that the enterococci criterion of 35 cfu/100mL listed in Table 2-10, although not promulgated by DEC, is now an enforceable standard in NYS, as EPA established January 1, 2005 as the date upon which the criteria must be adopted for all coastal recreational waters. According to DEC's interpretation of the BEACH Act, the criterion applies on a 30-day moving GM basis during recreational season (May 1st through October 31st). Furthermore, this criterion is not applicable to the tributaries of the Long Island Sound and the East River tributaries and therefore would not apply to the saline section of the Bronx River under current water quality classifications.

Currently, DEC is conducting its federally-mandated "triennial review" of the NYS WQS. DEC has publicly noticed a proposed rulemaking to amend 6 NYCRR Parts 701 and 703. The proposed total and fecal coliform standards for Class I are the same as the existing standards for Class SC waters.

The Bronx River LTCP evaluates compliance with various primary contact WQ numerical limits including the primary contact fecal coliform WQ criteria (Class SC WQS). With DEC's December 3, 2014 proposed rulemaking to change Class I fecal coliform bacteria criteria to 200 cfu/100mL, Class SC and proposed Class I fecal coliform criteria would both impose the 200 cfu/100mL limitation.

Interstate Environmental Commission

The States of New York, New Jersey, and Connecticut are signatory to the Tri-State Compact that designated the Interstate Environmental District and created the IEC. The IEC includes all tidal waters of greater NYC. The Bronx River is interstate water and is regulated by IEC as Class B-1 water. Numerical standards for IEC regulated waterbodies are shown in Table 2-12, while narrative standards are shown in Table 2-13.

Table 2-12. Interstate Environmental Commission Numeric Water Quality Standards

Class	Usage	DO (mg/L)	Waterbodies
A	All forms of primary and secondary contact recreation, fish propagation, and shellfish harvesting in designated areas.	≥ 5.0	East River east of the Whitestone Bridge; Hudson River north of confluence with the Harlem River; Raritan River east of the Victory Bridge into Raritan Bay; Sandy Hook Bay; lower New York Bay; Atlantic Ocean.
B-1	Fishing and secondary contact recreation, growth and maintenance of fish and other forms of marine life naturally occurring therein, but may not be suitable for fish propagation.	≥ 4.0	Hudson River south of confluence with Harlem River; upper New York Harbor; East River from the Battery to the Whitestone Bridge; Harlem River; Arthur Kill between Raritan Bay and Outerbridge Crossing.
B-2	Passage of anadromous fish, maintenance of fish life.	≥ 3.0	Arthur Kill north of Outerbridge Crossing; Newark Bay; Kill Van Kull.

Table 2-13. Interstate Environmental Commission Narrative Regulations

Classes	Standard
A, B-1, B-2	All waters of the Interstate Environmental District (whether of Class A, Class B, or any subclass thereof) shall be of such quality and condition that they will be free from floating solids, settleable solids, oil, grease, sludge deposits, colors or turbidity to the extent that none of the foregoing shall be noticeable in the water or deposited along the shore or an aquatic substrata in quantities detrimental to the natural biota; nor shall any of the foregoing be present in quantities that would render the waters in question unsuitable for use in accordance with their respective classifications.
A, B-1, B-2	No toxic or deleterious substances shall be present, either alone or in combination with other substances, in such concentrations as to be detrimental to fish or inhibit their natural migration or that will be offensive to humans or which would produce offensive tastes or odors or be unhealthful in biota used for human consumption.
A, B-1, B-2	No sewage or other polluting matters shall be discharged or permitted to flow into, or be placed in, or permitted to fall or move into the waters of the District, except in conformity with these regulations.

The IEC also restricts CSO discharges to within 24 hours of a precipitation event, consistent with the DEC definition of a prohibited dry-weather discharge. IEC effluent quality regulations do not apply to CSOs if the CSS is being operated with reasonable care, maintenance and efficiency. Although IEC regulations are intended to be consistent with NYS WQS, the three-tiered IEC system and the five NYS saline classifications in New York Harbor do not spatially overlap exactly.

EPA Policies and Regulations

For designated bathing beach areas, the EPA has established an enterococci reference level of 104 cfu/100mL to be used by agencies for announcing bathing advisories or beach closings in response to pollution events. The New York City Department of Health and Mental Hygiene (DOHMH) uses a 30-day moving GM of 35 cfu/100mL to trigger such closures. If the GM exceeds that value, the beach is closed pending additional analysis. Enterococci of 104 cfu/100mL are an advisory upper limit used by DOHMH. If beach enterococci data are greater than 104 cfu/100mL, a pollution advisory is posted on the

DOHMH website, additional sampling is initiated, and the advisory is removed when water quality is acceptable for primary contact recreation. Advisories are posted at the beach and on the agency website.

For non-designated beach areas of primary contact recreation, which are used infrequently for primary contact, the EPA has established an enterococci reference level of 501 cfu/100mL be considered indicative of pollution events. The Bronx River is classified I (secondary contact recreation use). The Bronx River is used for non-designated primary contact recreation. According to EPA documents these reference levels are not regulatory criteria, but, rather, are to be used as determined by the State agencies to make decisions related to recreational uses and pollution control needs. For bathing beaches, these reference levels are to be used for announcing beach advisories or beach closings in response to pollution events. There are no areas of the Bronx River shoreline authorized by the DOHMH for operation of a bathing beach.

In December 2012, the EPA released RWQC recommendations that are designed to protect human health in coastal and non-coastal waters designed for primary recreational use. These recommendations were based on a comprehensive review of research and science that evaluated the link between illness and fecal contamination in recreational waters. The recommendations are intended as guidance to States, territories, and authorized tribes in developing or updating WQS to protect swimmers from exposure to pathogens found in water with fecal contamination.

The 2012 RWQC recommends two sets of numeric concentration thresholds, as listed in Table 2-14, and includes limits for both the GM (30-day) and a STV based on exceeding a 90th percentile value associated with the geometric mean. The STV is a new limit, and is intended to be a value that should not be exceeded by more than 10 percent of the samples taken.

Table 2-14. 2012 RWQC Recommendations

Criteria Elements	Recommendation 1 (estimated illness rate 36/1,000)		Recommendation 2 (estimated illness rate 32/1,000)	
Indicator	GM (cfu/100mL)	STV (cfu/100mL)	GM (cfu/100mL)	STV (cfu/100mL)
Enterococci (saline and fresh)	35	130	30	110
E. coli (fresh)	126	410	100	320

It is not known at this time how DEC will implement the 2012 EPA RWQC. It is DEP's understanding that DEC intends to follow Recommendation 2 to update water quality criteria. The LTCP analyses for the Bronx River were therefore based on the enterococci numerical criteria associated with EPA's RWQC Recommendation 2.

2.2.a.2 Physical Waterbody Characteristics

The Bronx River, a tributary to the East River, runs 20 miles south from Davis Brook and Kensico Dam, through Westchester County and western Bronx, until it empties into the Upper East River. For the purposes of this report, the study area includes only the portion of the Bronx River within NYC.

Shoreline Physical Characterization

The Bronx River exhibits diverse characteristics throughout its reaches. Most of the shoreline of the freshwater reach is natural, whereas the shorelines along the saline section are predominantly engineered or altered. Figure 2-16 depicts the type of shoreline that can be found along the Bronx River. Natural areas located mainly in the freshwater reach of the Bronx River are comprised of vegetated parkland. Altered areas consist primarily of rip-rap and bulkhead. The shorelines along the saline reach are generally altered, with the main exception being Soundview Park. Figures 2-17 and 2-18 depict typical characteristics of the shoreline of freshwater and saline sections of the Bronx River, respectively.

Figure 2-16. Types of Shoreline Along the Bronx River Within NYC

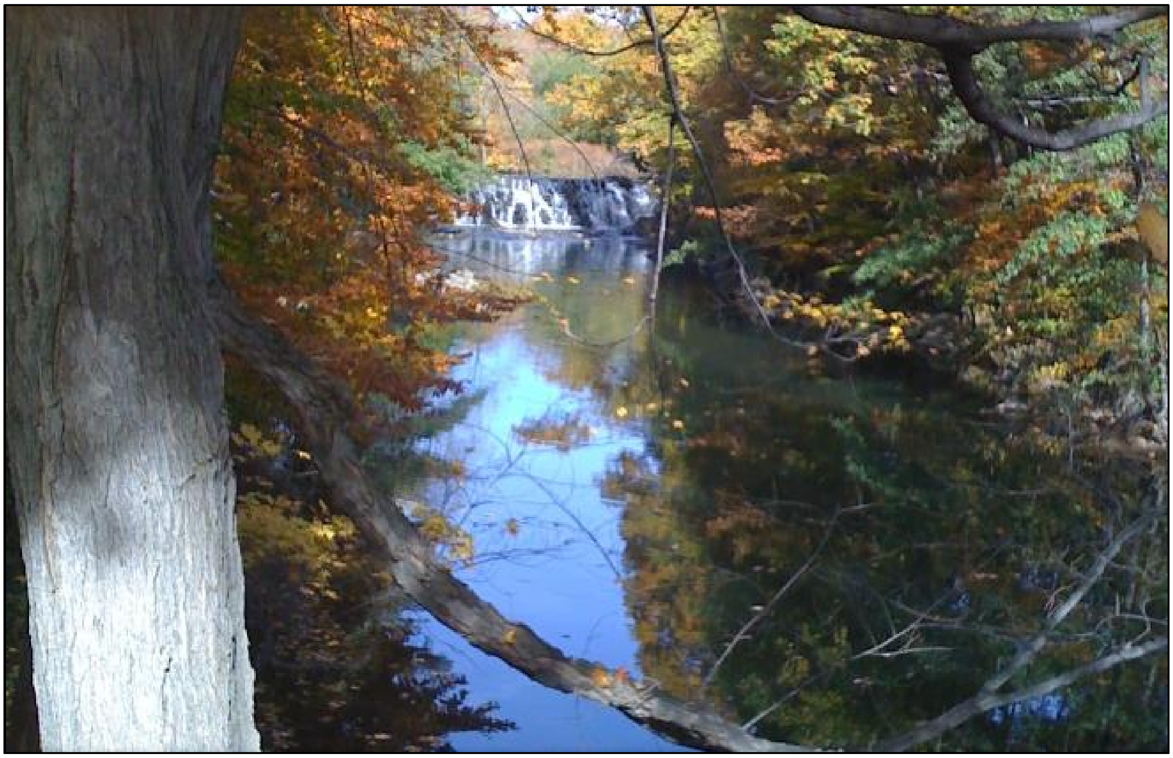

Figure 2-17. Typical Shoreline of the Freshwater Section of the Bronx River Within NYC – at the Bronx Zoo

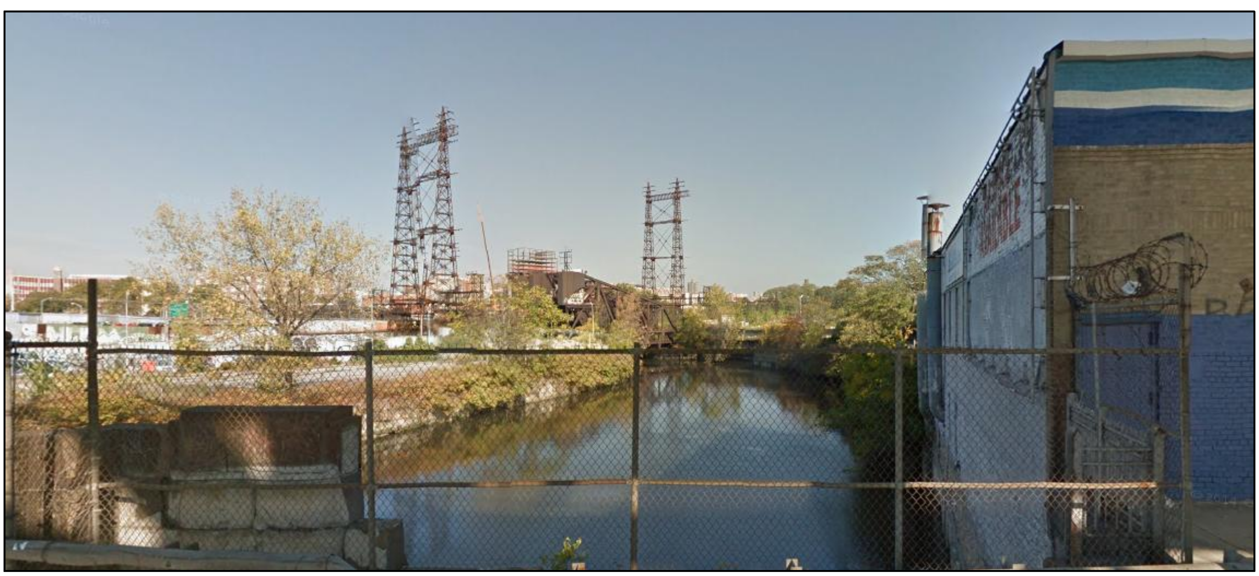

Figure 2-18. Shoreline of the Saline Section of the Bronx River – at Westchester Avenue Bridge

Shoreline Slope

The slope of the majority of the Bronx River shoreline ranges from gentle (less than 5 degrees) to intermediate (from 5 degrees up to 20 degrees) except at two short subsections of the freshwater section of the Bronx River in the vicinity of East Gun Hill Road and within the Bronx Zoo, as shown in Figure 2-19.

Waterbody Sediment Surficial Geology/Substrata

The saline Bronx River riverbed composition varies with location, although it is generally sand or mud/silt/clay, with some areas of cobble and bedrock as shown on Figure 2-20. The primary source of information utilized to identify riverbed composition is from observations of riverbed characteristics and prior benthic sampling programs using a Ponar® dredge. The freshwater Bronx River riverbed composition also varies with location. Qualitative descriptions of the riverbed were made by HydroQual during water quality sampling, geometry measurements and sediment oxygen demand sampling during prior sampling efforts.

Figure 2-19. Bronx River Shoreline Slope

Figure 2-20. Bronx River Surficial Geology

Waterbody Type

Based on Title 6 NYCRR, Chapter X, Part 935, the Bronx River boundary between fresh and saline surface waters is at East Tremont Avenue. The Bronx River north of the East Tremont Avenue Bridge is classified as a minor river – freshwater source. South of the East Tremont Avenue Bridge, the Bronx River is classified as a tidal tributary influenced by the waters of the East River.

Freshwater Systems

A review of DEC Freshwater Wetland Maps indicates that there are no freshwater wetlands located within 150 feet of the Bronx River. National Wetlands Inventory (NWI) maps, however, define numerous freshwater wetland systems along the shorelines of the freshwater section of the Bronx River, many associated with impoundments behind the dams in the Bronx River. From East 174th Street to the dam north of East 180th Street, NWI classifies the shorelines as riverine, lower perennial, open water/unknown bottom, permanent (R20WH). (This NWI designation overlaps the DEC littoral zone designation between 174th Street and East Tremont Avenue.) Further north, the impounded area behind the East 180th Street dam is classified as lacustrine, limnetic, open water/unknown bottom, permanent, diked/impounded (L1OWHh). The shoreline just south of the dam within the Bronx Zoo is classified as R2OWH, while the impounded area behind the dam is classified as palustrine, open water/unknown bottom, permanent, diked/impounded (POWHh), palustrine, scrub/shrub, broad-leaved deciduous, temporary (PSS1A) and palustrine, emergent, narrow-leaved persistent, temporary (PEM5A). North of this impounded area, from Fordham Road to Britton Street, the waterbody consists of R2OWH. Further north between Britton Street and Adee Avenue, the shorelines are classified as palustrine, forested, broad-leaved deciduous, temporary (PFO1A). In addition, an area of palustrine, open water/unknown bottom, intermittent/exposed permanent, diked/impounded (POWZh) is located to the west of the PFO1A area, within 150 feet of the Bronx River. North of Adee Avenue to the Bronx-Westchester County line, the shoreline is classified as R2OWH.

Upland Habitat

Bronx River upland habitat can generally be divided into two separate and distinct areas. The first area stretches from the mouth of the Bronx River to East 180th Street, and can generally be described as altered, with the only major exception being Soundview Park. Upland habitat in the immediate vicinity of Soundview Park along the eastern shore of the Bronx River is generally natural and composed of herbaceous communities. Within the Soundview Park there is a composting facility operated by the New York City Department of Sanitation (DSNY). The second upland area is located between East 180th Street and the Bronx-Westchester County line and generally consists of natural, woodland areas. The vast majority of upland habitat within this portion of the Bronx River is located within areas of parkland. These upland park habitats are natural in the sense that they tend to support vegetation and possess few significant man-made developments. Many of these areas, however, may have been modified historically or are actively maintained and managed.

Intertidal/Estuarine Wetlands

The U.S. Fish and Wildlife Service (USFWS) NWI maps show limited tidal/estuarine wetlands throughout the saline Bronx River study area. The NWI mapped wetlands are shown in Figure 2-21 and Table 2-15 summarizes the classifications shown.

Table 2-15. NWI Classification Codes

NWI Classification	Description
PEM1A	Palustrine, emergent, persistent, temporarily flooded
PUBHx	Palustrine, unconsolidated bottom, permanently flooded, excavated

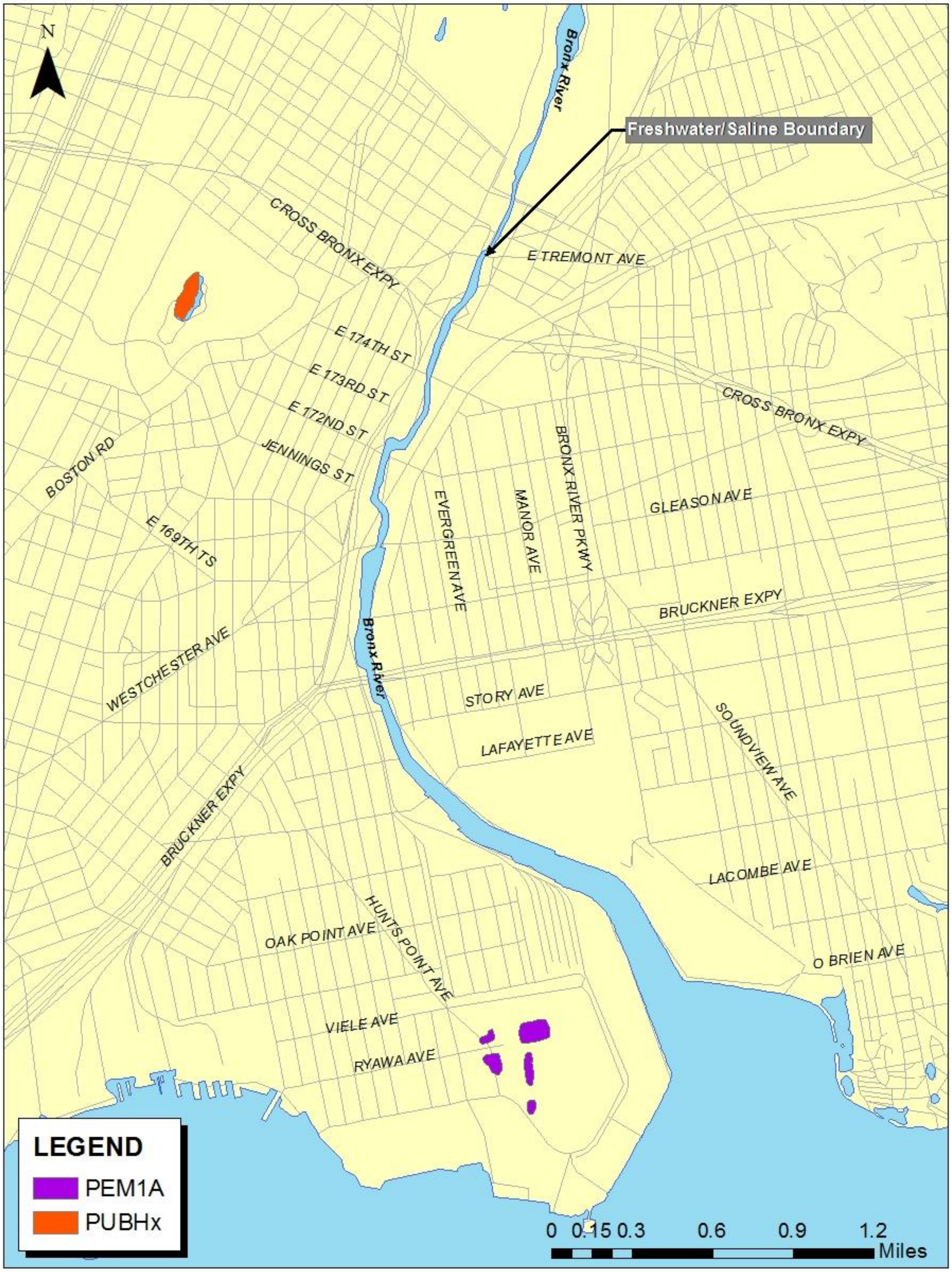

Figure 2-21. Wetlands Along the Saline Bronx River Shoreline

Aquatic and Terrestrial Communities

The use of Bronx River by aquatic life is partially limited by its degraded physical habitat. Even with DO near or above the regulatory limit, the loss of extensive fringing wetlands, diverse natural shorelines, and benthic habitat suitable for colonization have substantially reduced biological diversity. Improvement in DO and a reduction in the discharge of organic matter would result in an improvement in the sediments through reduction of the percentage of sediment total organic carbon (TOC). A reduction in TOC has been shown to correlate well with an increase in benthic diversity in the substrate (DEP, 2004). However, as long as the substrate is dominated by fine grain material, many invertebrate species will be excluded. Although the productivity of soft sediments can be high, because of lack of diversity in the benthic community, many species will make limited use of the habitat due to a lack of their preferred prey.

The attainment of enhanced aquatic life usage in Bronx River is contingent upon a diverse physical habitat to support a variety of fish and benthic life. If such conditions could be attained, reproduction and growth would probably be enhanced, which would contribute to a more balanced estuarine community.

Based on the results of previous sampling efforts by DEP during the years of 2000 through 2002, the eggs and larvae of structure oriented species such as cunner, tautog and fourbeard rockling dominated the ichthyoplankton community found in Bronx River.

Regarding the epibenthic community, 14 taxa were identified. The taxa collected in the highest total weight included barnacles (Balanus eberneus), Bryozoa, the polychaete worm (Neries succinea), and the Tunicate (Molgula manhattensis). Some plates contained amphipods (Gammaridae), sand shrimp (Crangon septemspinosa), grass shrimp (Palaemontes sp.) and Hydroida.

A total of 79 species of phytoplankton were collected in the mouth of Bronx River over the course of a prior sampling effort by DEP during the years of 2000 through 2002. Diatoms were the dominant class of phytoplankton, followed by dinoflagellates and green algae. The most frequently collected species were Nannochloris atomus (green algae), Skeletonema costatum (diatom), Rhizosolenia delicatula (diatom), Thallassoionema nitzchoides (diatom), and Peridnium sp. (dinoflagellate). A total of 15 zooplankton taxa were collected in the mouth of the Bronx River. Protozoans and copepods comprised the zooplankton community. Tintinnopsis sp. (Protozoa) and copepod nauplii were the most frequently collected forms.

The fish community in the mouth of the Bronx River was sampled throughout 2000-2002 during the summer because this is the time of year when bottom water DO concentrations are at their lowest.

A total of 16 taxa were collected from the Bronx River. Weakfish dominated the catch accounting for 61 percent of the total catch. Blueback herring were the second most abundant species accounting for 17 percent of the total catch. Weakfish are generally associated with structure while blueback herring are pelagic. Demersal species, such as winter flounder and summer flounder were also collected, suggesting that juvenile and adult fishes are using the entire water column in the Bronx River as habitat. The fact that the majority of the adult and juvenile fish were collected during the month of August, when DO is typically at its lowest, suggests that DO is not limiting use of the mouth of the Bronx River by these species.

A more detailed discussion on the taxonomy of the Bronx River is presented in the Bronx River WWFP (DEP, 2010a).

Freshwater Systems Biological Systems

No NYS regulated freshwater wetlands are located in the watershed of the saline Bronx River (i.e., freshwater wetlands greater than 12.4 contiguous acres).

2.2.a.3 Current Public Access and Uses

The waterfront area surrounding the saline Bronx River is predominantly altered on the eastern banks, except the shoreline along Soundview Park on the eastern shore, near the mouth of the Bronx River. The formal and informal River access points along the Bronx River supporting secondary contact recreation activities are shown in Figure 2-22 and Figure 2-23. Most notably, the kayak launch at Starlight Park shown in Figure 2-24 supporting secondary contact recreation.

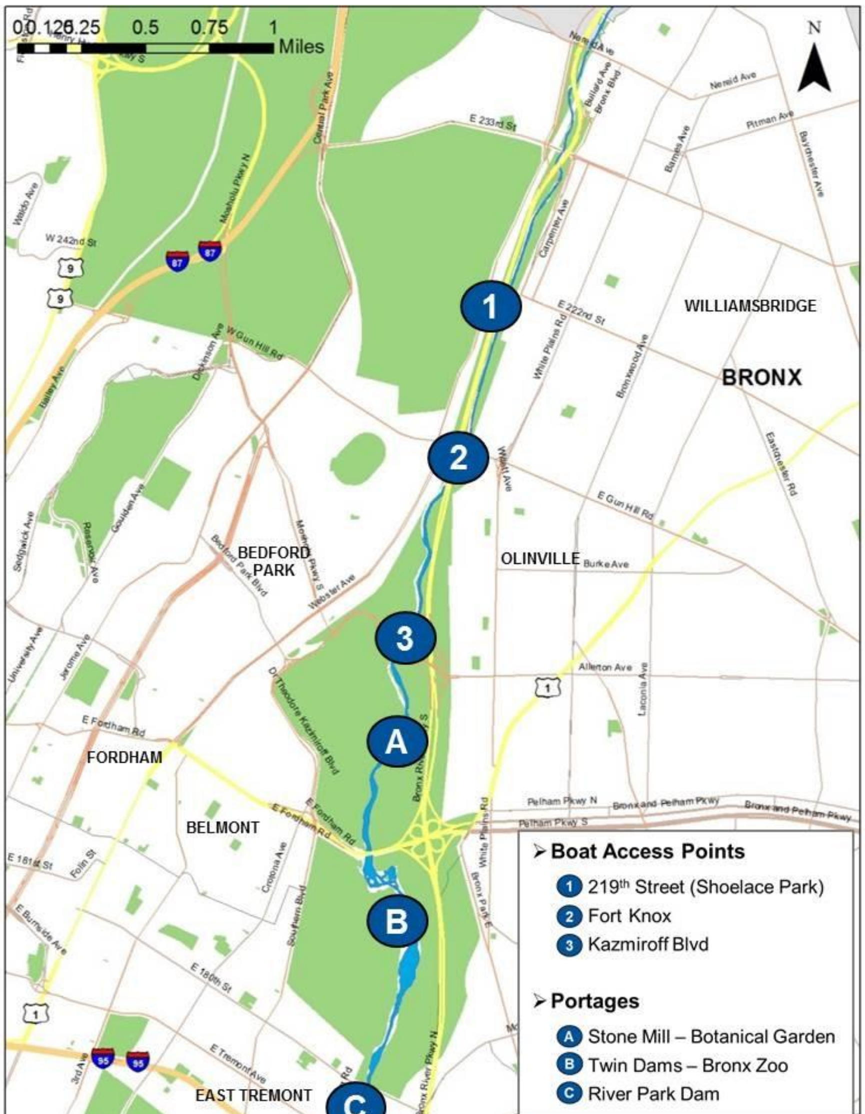

Figure 2-22. Access Points to the Freshwater Section of the Bronx River

Figure 2-23. Access Points to the Saline Section of the Bronx River

AECOM

Figure 2-24. Bronx River Kayak Launch at Starlight Park

2.2.a.4 Identification of Sensitive Areas

Federal CSO Policy requires that the long term CSO control plan give the highest priority to controlling overflows to sensitive areas. The policy defines sensitive areas as:

- Waters designated as Outstanding National Resource Waters (ONRW)
- National Marine Sanctuaries
- Public drinking water intakes
- Waters designated as protected areas for public water supply intakes
- Shellfish beds
- Waters with primary contact recreation
- Waters with threatened or endangered species and their habitat
- Additional areas determined by the Permitting Authority (i.e., DEC)

General Assessment of Sensitive Areas

An analysis of the waters of the Bronx River with respect to the CSO Policy was conducted and is summarized in Table 2-16.

Table 2-16. Sensitive Areas in the Bronx River

CSO Discharge Receiving Water Segments	Current Uses Classification of Waters Receiving CSO Discharges Compared to Sensitive Areas Classifications or Designations (1)						
	ONRW	National Marine Sanctuaries	Threatened or Endangered Species of Habitat	Primary Contact Recreation	Public Water Supply Intake	PWS Protected Area	Shellfish Bed
Bronx River	None	None(2)	No(3)	No(4)	None(5)	None(5)	Experimental oyster reefs (6)

Notes:
(1) Classifications or Designations per CSO Policy.
(2) As shown at http://www.sanctuaries.noaa.gov/oms/omsmaplarge.html.
(3) No endangered or threatened animals per correspondence from the U.S. Fish and Wildlife Service and the National Marine Fisheries Services (NOAA Fisheries).
(4) Existing uses include secondary contact recreation and fishing.
(5) These waterbodies contain salt water.
(6) In-stream bio-treatment performance evaluation pilot. Not for consumption.

There are no sensitive areas in the Bronx River assessment area, based on the following information:

- There are no ONRW waters, National Marine Sanctuaries, or public water supplies in or near the waters of New York Harbor;
- There are no designated shellfishing areas within the Bronx River or the Upper East River. However, there is an experimental oyster reef near the mouth of the Bronx River, as shown in Figure 2-25;
- There are no bathing beaches in or near the Bronx River. Bathing beaches are explicitly prohibited by local law in the Upper East River and its tributaries;
- There are no threatened or endangered marine animal species or their designated habitat in the Bronx River according to responses to Freedom of Information Act (FOIA) letter requests to the New York Natural Heritage Program, the National Marine Fisheries Service, and the USFWS; and
- None of the items specifically listed by DEC are within or adjacent to the Bronx River study area.

2.2.a.5 Tidal Flow and Background Harbor Conditions and Water Quality

DEP has been collecting New York Harbor water quality data since 1909. These data are utilized by regulators, scientists, educators and citizens to assess impacts, trends, and improvements in the water quality of New York Harbor.

The HSM has been the responsibility of DEP's Marine Sciences Section (MSS) for the past 27 years. These initial surveys were performed in response to public complaints about quality of life near polluted waterways. The initial effort has grown into a survey that consists of 72 stations distributed throughout the open waters of the Harbor and smaller tributaries within NYC. The number of water quality parameters measured has also increased from five in 1909 to over 20 at present.

Harbor water quality has improved drastically since the initial surveys. Infrastructure improvements and the capture and treatment of virtually all dry-weather sewage are the primary reasons for this improvement. During the last decade, water quality in New York Harbor has improved to the point that the waters are now utilized for recreation and commerce throughout the year. Still, impacted areas remain within the Harbor and the LTCP process has begun to focus on those areas. The LTCP program will look at ten waterbodies and their drainage basins and will develop a comprehensive plan for each waterbody.

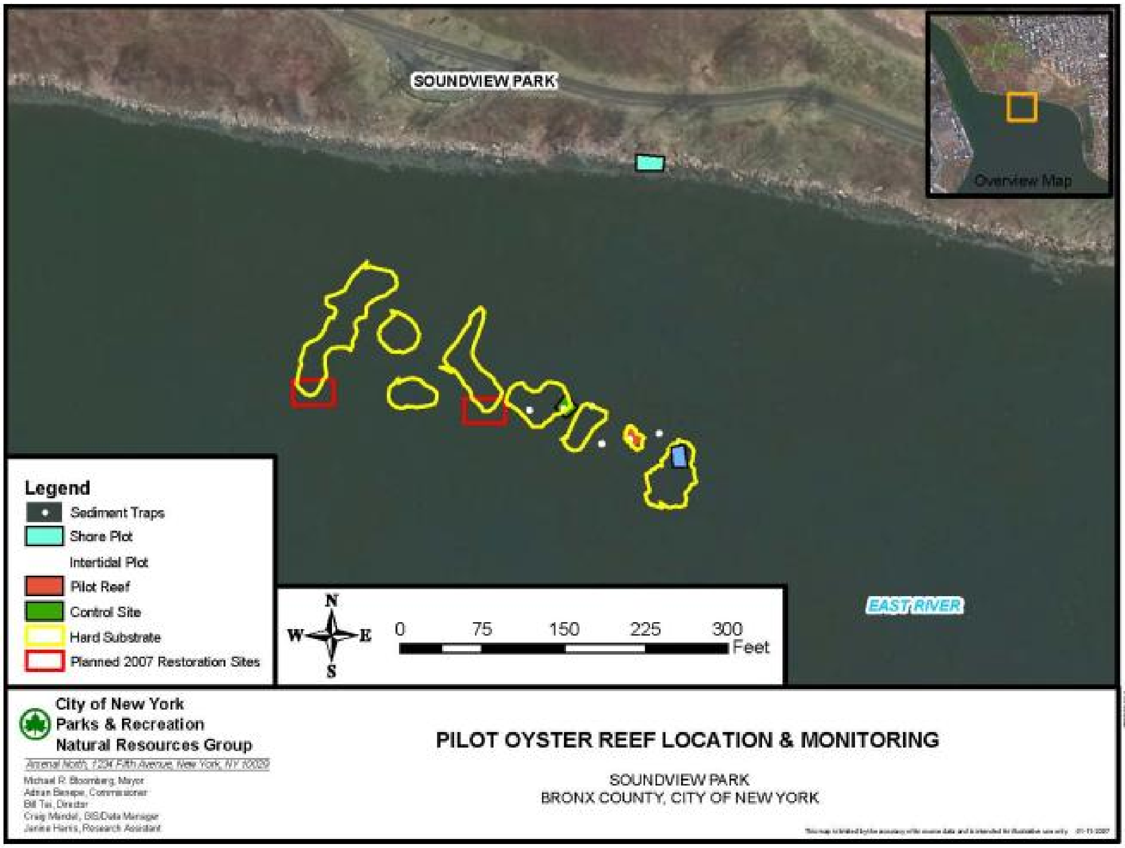

Figure 2-25. Soundview Park Pilot Oyster Reef Locations, 2007.

The 2012 State of the Harbor Report (DEP, 2012c) focuses on the most recent water quality data collected by DEP. Fecal coliform bacteria, DO, chlorophyll 'a' and Secchi transparency are the water quality parameters used in the Harbor Water Quality Study. Data are presented in four sections, each delineating a geographic region within the Harbor. The Bronx River is included in the Upper East River/Western Long Island Sound (UER-WLIS) section. This area contains nine open water monitoring stations and five tributary sites as shown in Figure 2-26. Until recently, none of the sites were located in the Bronx River. The closest station was E14 in the Upper East River.

2.2.a.6 Compilation and Analysis of Existing Water Quality Data

DEP Harbor Survey Monitoring Data

As mentioned above, no recent data had been collected within the Bronx River as part of routine sampling conducted by DEP up until 2011. The Harbor Survey Program started collecting samples in the Bronx River in May 2011 following its methods and procedures. Water quality data has been collected for the stations shown in Figures 2-27 and 2-28.

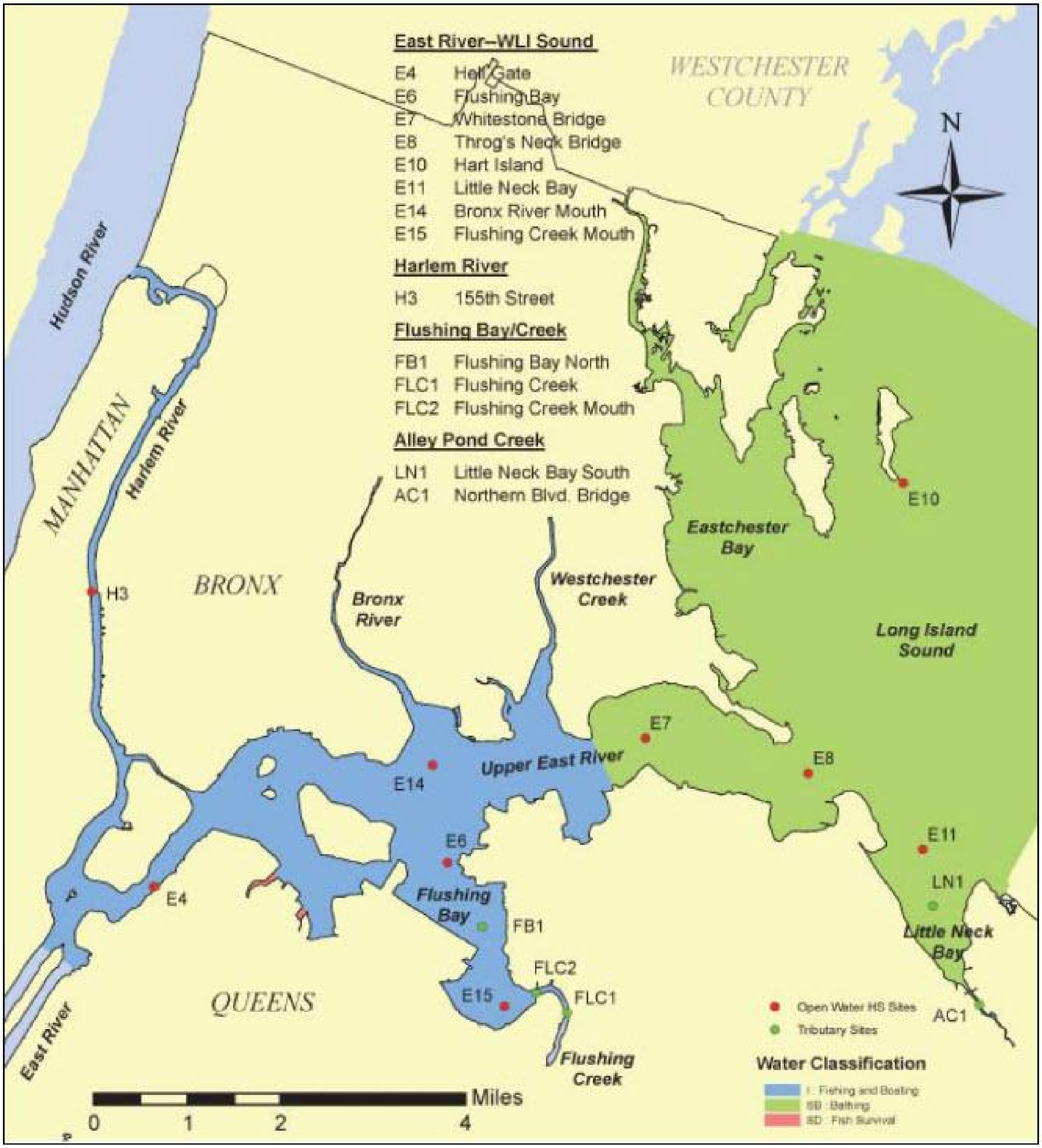

Figure 2-26. Harbor Survey UER-WLIS Region

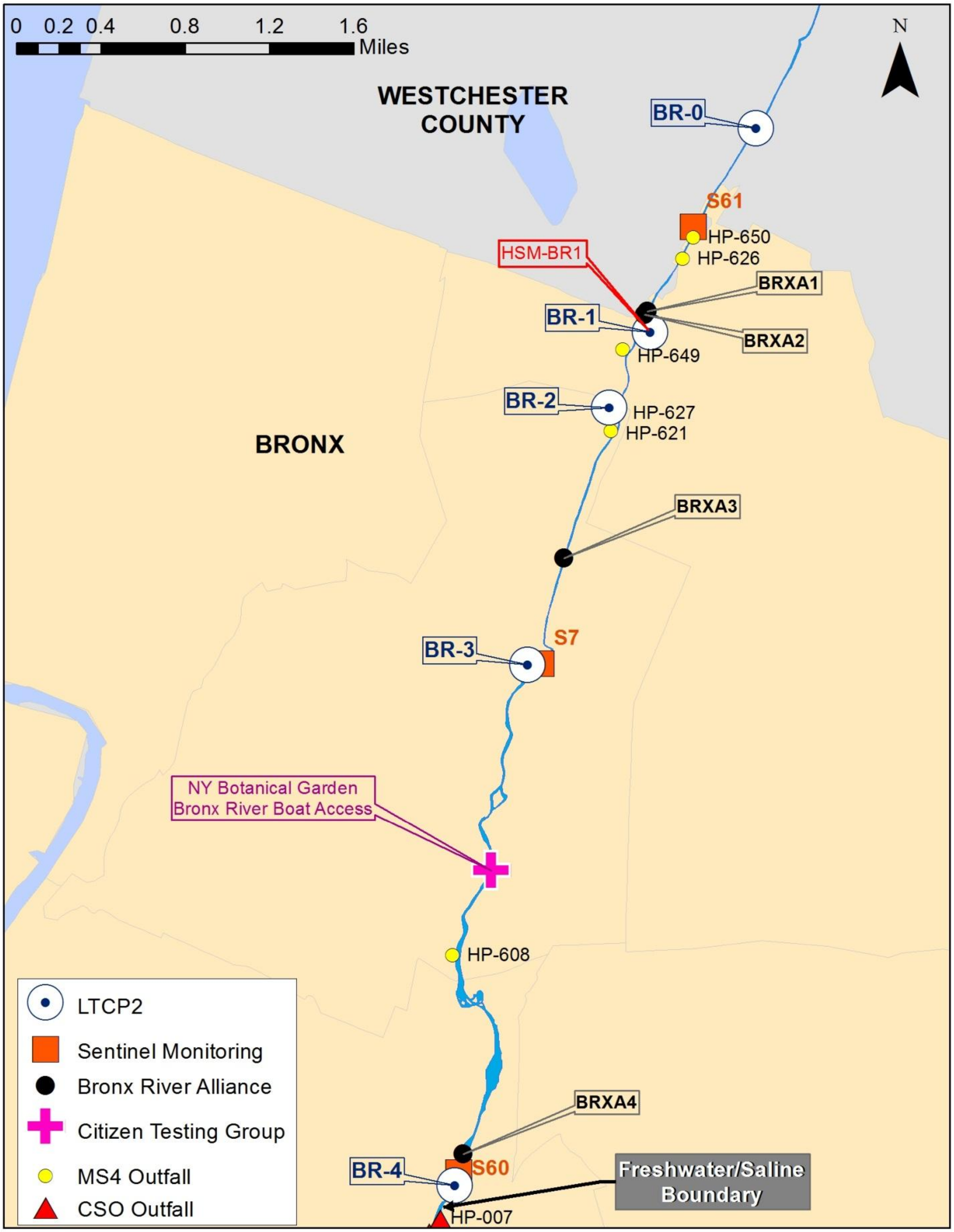

Figure 2-27. Sampling Stations of Various Sampling Programs (Freshwater Section)

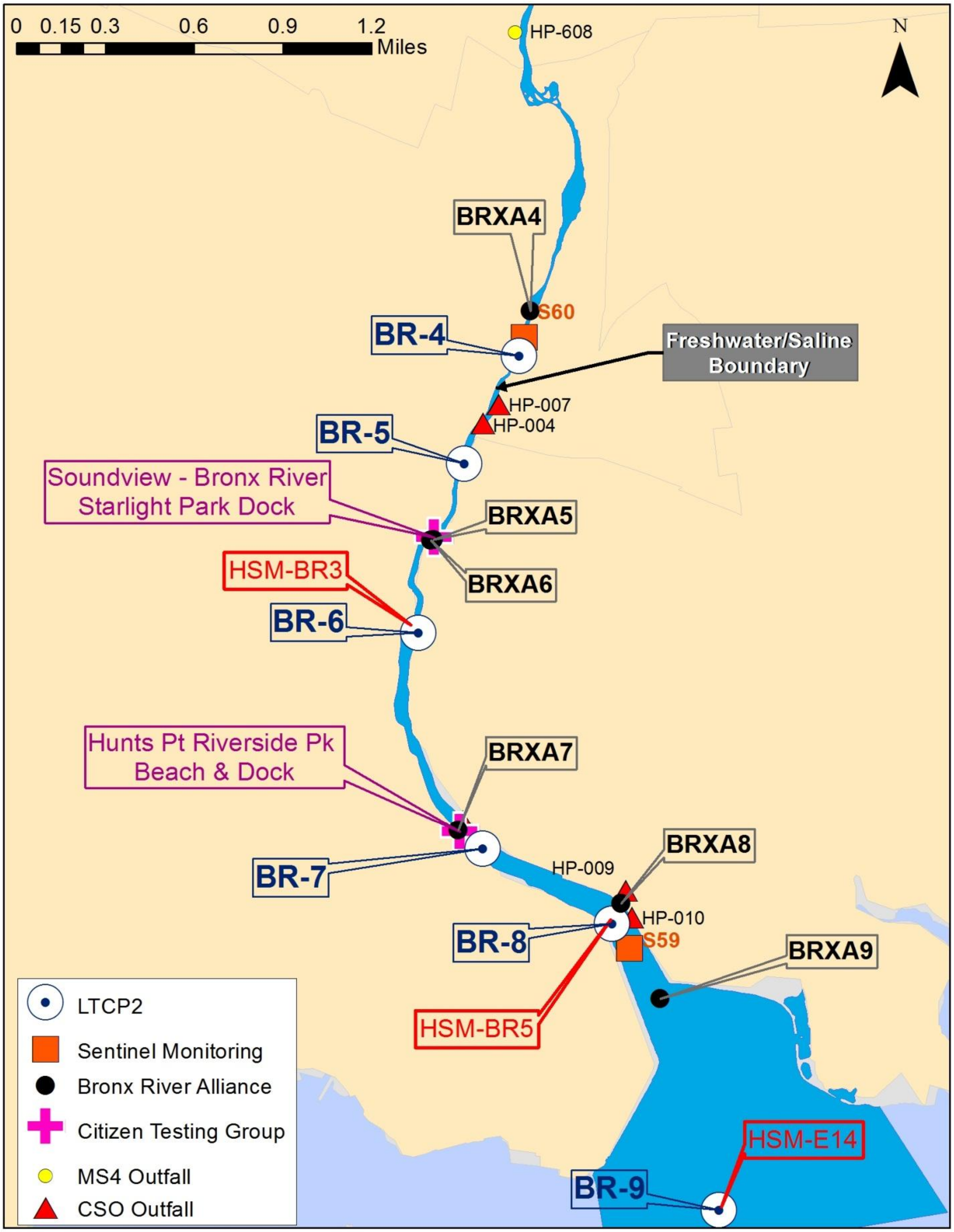

Figure 2-28. Sampling Stations of Various Sampling Programs (Saline Section)

Sentinel Monitoring Program

DEP conducts routine sampling at 71 locations in NYC waters in dry-weather to inform the agency of potential illicit discharges to their MS4 storm sewers. If elevated fecal coliform levels are detected during the quarterly dry-weather sampling, DEP deploys its internal staff to investigate and eliminate the sources. The Sentinel Monitoring Program sampling Stations S-61, S-7, S-60 and S-59 in the Bronx River are located in the vicinity of the LTCP monitoring Stations BR-0, BR-3, BR-4 and BR-8, respectively, as shown in Figures 2-27 and 2-28.

Third Party Data

The Citizen Testing Group collects only enterococci samples within the Bronx River at the New York Botanical Gardens, the Hunts Point Riverside Park and the Soundview Starlight Park near the LTCP sampling locations BR-3, BR-5 and BR-7, respectively, as shown in Figures 2-27 and 2-28.

The Bronx River Alliance organization collects only enterococci samples within the Bronx River at Stations BRXA-1 through BRXA-9, as shown in Figures 2-27 and 2-28. This organization has been granted funds to expand the scope of their current monitoring program to include monitoring and maintenance of a floatables retention boom in the vicinity of the county border with Westchester County.

Neither of these groups collects fecal coliform data which is the current water quality criterion.

Data Discussion

The LTCP receiving water quality Stations BR-0 through BR-9 and equivalent sampling stations of other programs are depicted in Figures 2-27 and 2-28.

The number of bacteria samples for the concurrent time period (May 2014 through July 2014) with the LTCP sampling program is shown in Table 2-17.

Table 2-17. Number of Bacteria Samples Collected for the Period of May – July 2014

Sampling Program	Fecal Coliform No. of samples	Enterococci No. of samples
LTCP	344	343
Harbor Survey Monitoring	27	27
Sentinel Monitoring	1	0
Third Party Data	0	90

Figures 2-29 and 2-30 present a number of statistical parameters of the LTCP, HSM, Sentinel Monitoring (SM), Citizen Testing Group and Bronx River Alliance bacteria data sets for fecal coliform and enterococci, respectively, over the concurrent period (May 2014 through July 2014). Shown on these figures are the site GMs over the noted period, along with data ranges (minimum to maximum and 25th percentile to 75th percentile). Due to the proximity of some of the HSM, SM, Citizen Testing Group and Bronx River Alliance sampling stations to those of the LTCP, as described earlier, and the overall consistency among the various data sets, the bacteria results gathered by these programs were included in the computation of the statistics of the corresponding LTCP water quality stations, where applicable.

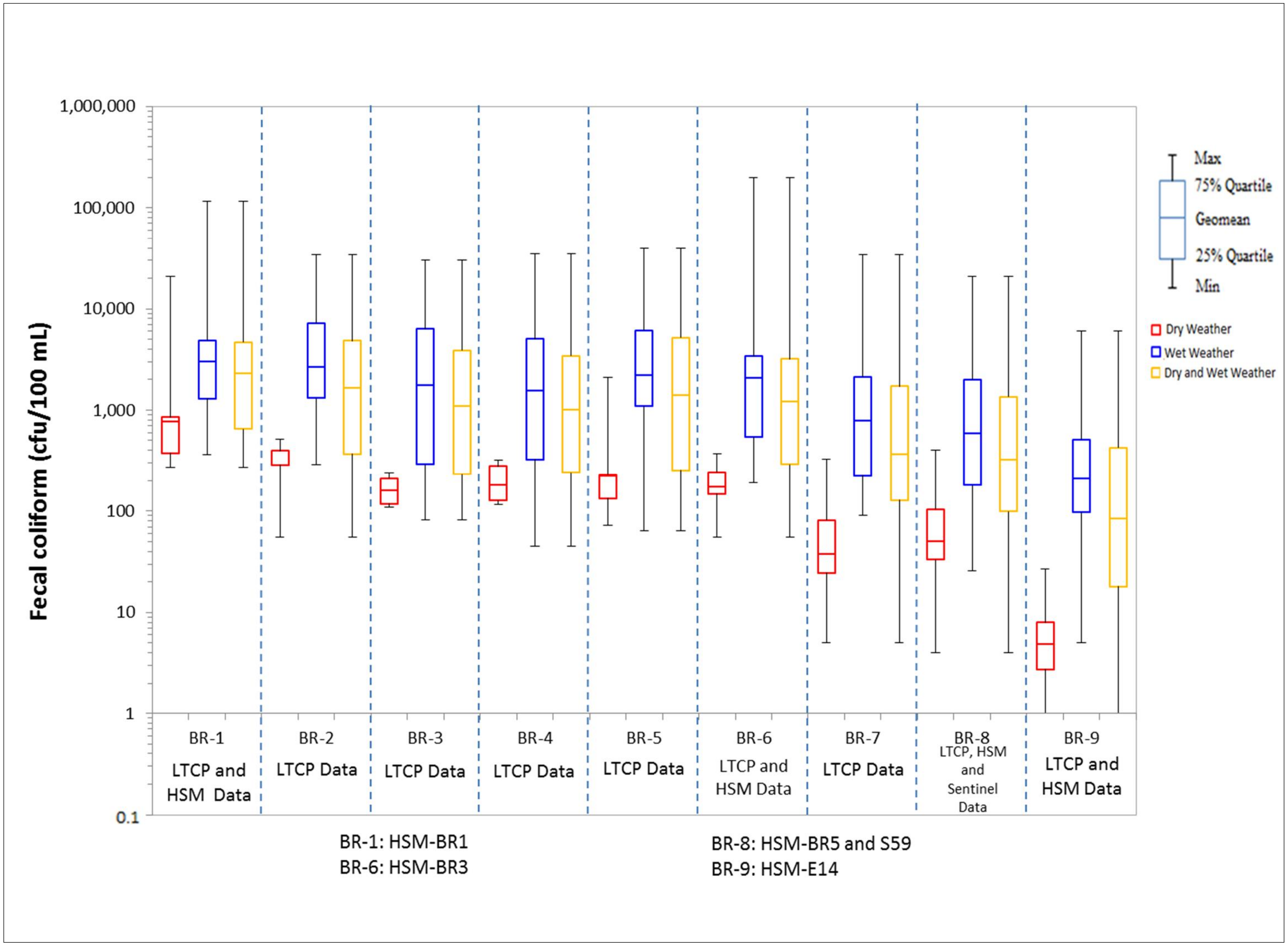

Figure 2-29. Fecal Coliform Data from LTCP, HSM and SM – Bronx River, May – July 2014

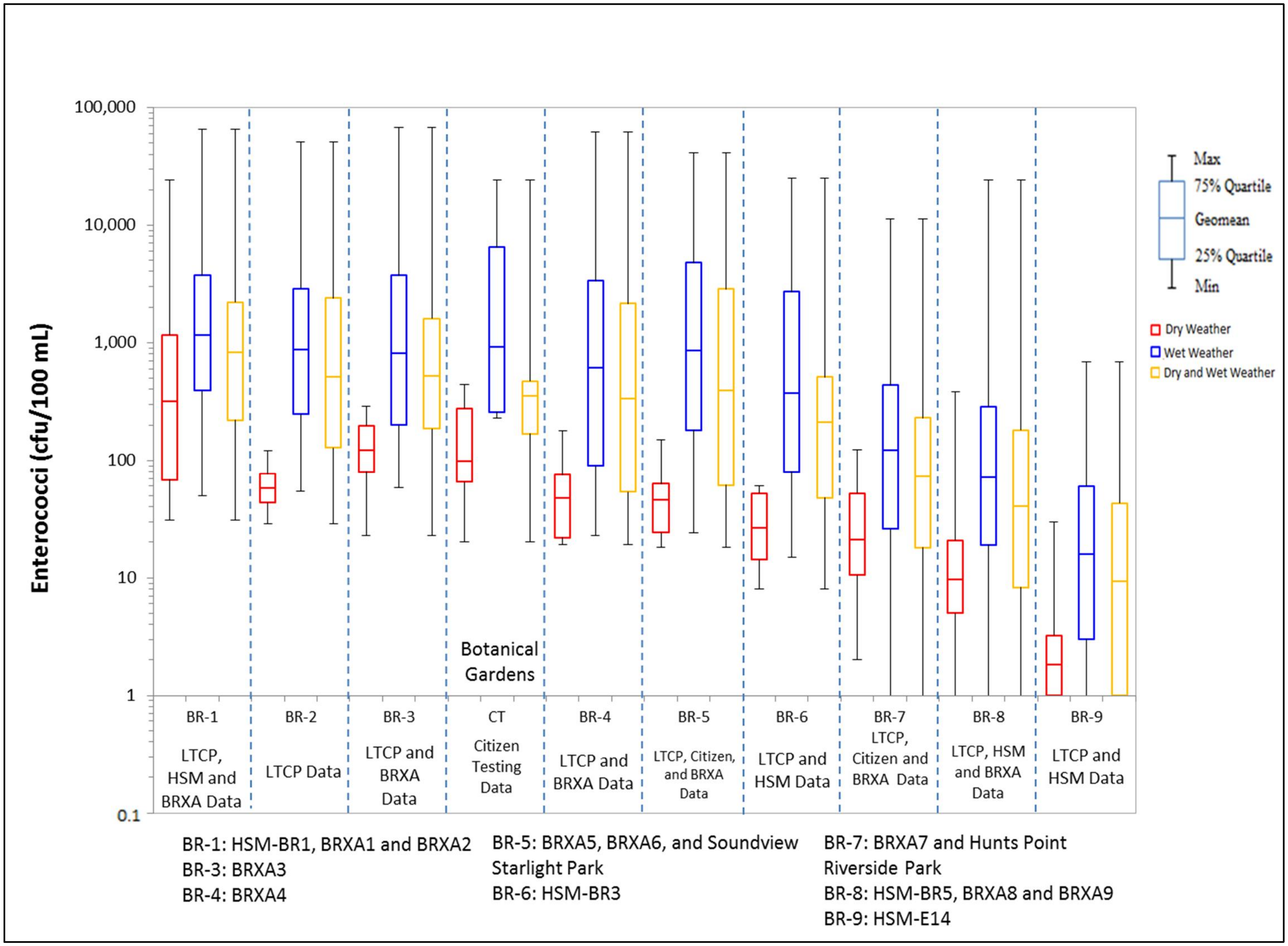

Figure 2-30. Enterococci Data from LTCP, HSM, Citizen Testing Group and Bronx River Alliance – Bronx River, May – July 2014

In support of this LTCP, receiving water sampling during dry- and wet-weather (May 2014 through July 2014) was conducted at the nine locations designated as BR-1 to BR-9 in Figures 2-27 and 2-28. The intent of the sampling was to confirm existing water quality conditions, and to provide data to support calibration of the water quality models of the Bronx River. The results in terms of dry- and wet-weather GM for enterococci and fecal coliform bacteria are summarized in Table 2-18.

Table 2-18. Geometric Means of In-stream Bacteria Samples (LTCP Program Data, May 2014- July 2014)

Water Quality Station	Dry-Weather		Wet-Weather	
	Fecal Coliform (cfu/100mL)	Enterococci (cfu/100mL)	Fecal Coliform (cfu/100mL)	Enterococci (cfu/100mL)
BR-1	489	110	2,631	931
BR-2	262	58	2,651	876
BR-3	159	98	1,763	684
BR-4	180	36	1,543	496
BR-5	223	43	2,232	616
BR-6	157	30	2,019	391
BR-7	38	13	794	77
BR-8	38	9	617	52
BR-9	5	2	220	16

As indicated in Table 2-18, significantly higher concentrations of enterococci and fecal coliform bacteria were found in the dry- and wet-weather samples at in-stream Station BR-1, near the border with Westchester County, and progressively lower bacteria concentrations were detected towards the mouth of the Bronx River.

Beyond the four wet- and three dry-weather sampling events conducted in support of this LTCP, flows were continuously monitored in the vicinity of the border with Westchester County at Oak Street for a period of approximately five months from June through October 2014 and bacteria water quality parameters were measured concurrently twice per week in average at Oak Street (Water Quality Station BR-0) and East 233rd Street (Water Quality Station BR-1), representative of dry- and wet-weather conditions. The sampled bacteria concentrations ranged from 81 to 20,000 cfu/100mL for fecal coliform and from 24 to 16,000 cfu/100mL for enterococci, considering the aggregate of bacteria measurements at both locations, for dry- and wet-weather. The GMs of the bacteria concentrations representative of the waters entering NYC are shown in Table 2-19.

Table 2-19. Geometric Means of In-stream Bacteria Samples at County Border (LTCP Program County Line Data, June 2014- October 2014)

Geometric Mean	Fecal Coliform (cfu/100mL)		Enterococci (cfu/100mL)	
	Dry	Wet	Dry	Wet
BR-0	672	701	139	315
BR-1	1366	2458	287	607

The Cope Lake was constructed to be a natural treatment system to handle direct drainage from the Bronx Zoo. Its dry-weather outflow was measured and sampled at the outlet in the Bronx Zoo for a period of approximately 3 months, as well. The Cope Lake dry-weather base flow bacteria concentration GMs were computed at 380 cfu/100mL for fecal coliform and 88 cfu/100mL for enterococci. The measured dry- and wet-weather concentrations and flow rates indicate that Cope Lake has the potential to impact the water quality of the downstream portion of the freshwater section of the Bronx River. It is noted that the Bronx Zoo has been implementing stormwater drainage system improvements aiming at reducing the impacts to the Bronx River from the runoff originated within the zoo property, in response to earlier enforcement actions.

These are continuous sources of flow and potential vectors of contamination to the saline Bronx River. Both the entities jurisdictionally responsible for these sources have been issued notifications as a result of prior enforcement actions. These bacteria concentrations support the calibration of the EPA-SWMM model used to characterize the freshwater section loadings entering the saline portion of the Bronx River at the freshwater-saline boundary, at East Tremont Avenue, as later discussed in Section 6. Sampling, data analyses and freshwater water quality modeling calibration resulted in the assignment of flows and loadings to these sources for inclusion in the calibration of the saline reach water quality model for the 2013 and 2014 period and establishment of the loadings to include in the evaluation of the performance of CSO reduction alternatives.

DO levels are measured recurrently under the HSM program since 2011 and were also measured under the LTCP sampling program from May to July of 2014. Figure 2-31 presents the aggregate statistics derived from DO measurements taken in 2013 and 2014 at various water quality stations along the Bronx River. In terms of average, the figure shows improved DO levels in 2014 at WQ Station HSM-BR3/LTCP-BR-6 and a slight decline at WQ Stations HSM-BR5/LTCP-BR-8 and HSM-E14/LTCP-BR-9. It is also noted that there is a slight decline in DO levels measured at Station HSM-BR1/LTCP-BR-1 in comparison to those measured in 2013. When the analysis is conducted based on the 25th percentile, it is noted that the DO levels improved in 2014 for all WQ stations shown, except at WQ Station HSM-BR1/LTCP-BR-1, which had a slight decrease in DO levels associated with this statistic parameter. Regarding the minimum measured DO throughout both years, reflecting the typically lower DO levels measured during the summer period, Figure 2-31 shows that the minimum recorded DO levels dropped in 2014 at all WQ stations shown. The most pronounced decrease in DO from the 2013 minimum level is observed at WQ Station HSM-BR5/LTCP-BR-8, in which the minimum DO dropped by approximately 1.0 mg/L. Minimum recorded DO levels were consistently below 2 mg/L in both years at WQ Station HSM-BR3/LTCP-BR-6.

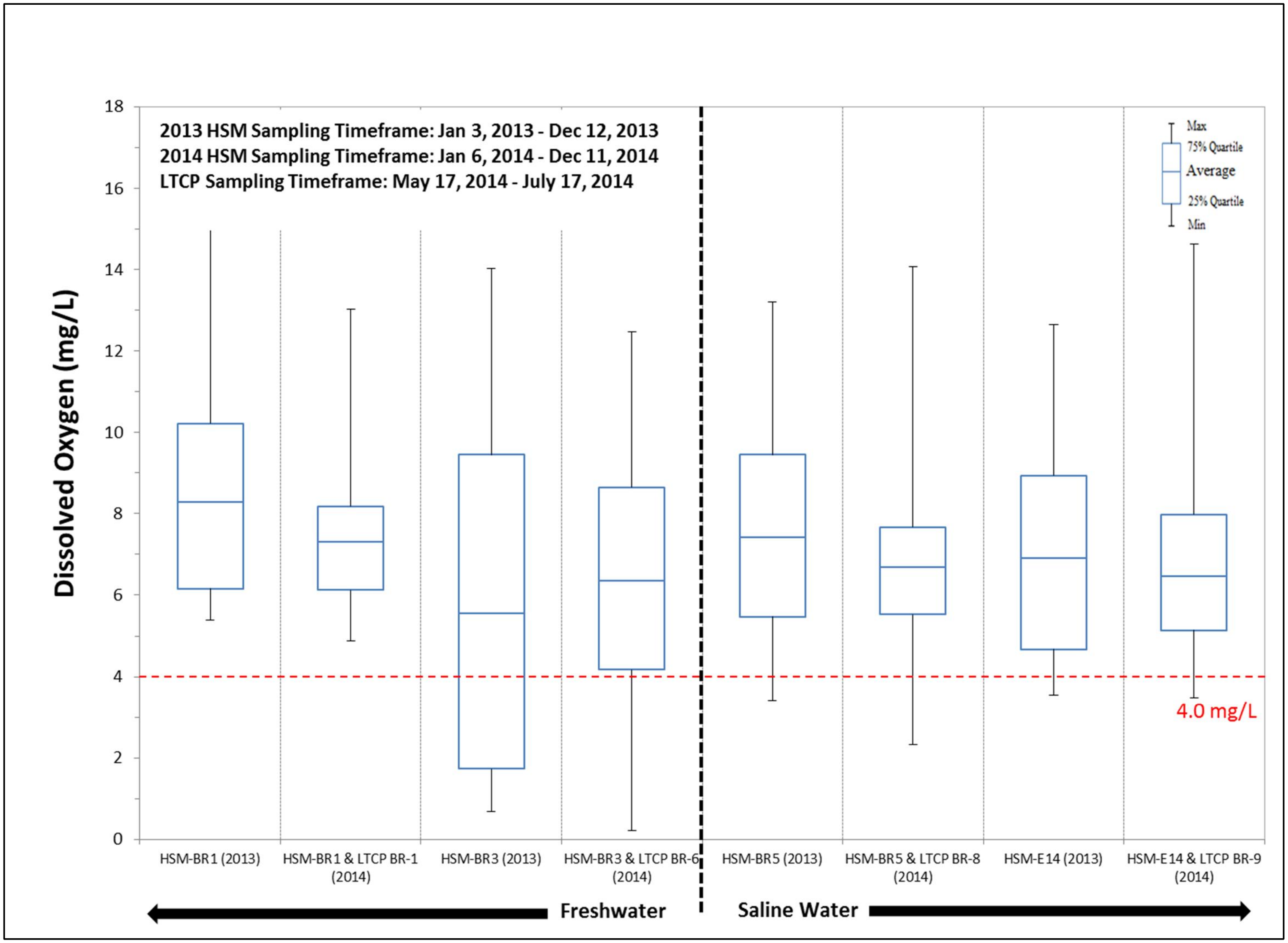

Figure 2-31. Recent DO Levels Measured Along the Bronx River

3.0 CSO BEST MANAGEMENT PRACTICES

The SPDES permits for all 14 WWTPs in NYC require DEP to report annually on the progress of the following 13 CSO BMPs:

1. CSO Maintenance and Inspection Program
2. Maximum Use of Collection Systems for Storage
3. Maximize Flow to Publicly Owned Treatment Plant (POTW)
4. Wet Weather Operating Plan (WWOP)
5. Prohibition of Dry Weather Flow (DWF)
6. Industrial Pretreatment
7. Control of Floatable and Settleable Solids
8. Combined Sewer Replacement
9. Combined Sewer Extension
10. Sewer Connection and Extension Prohibitions
11. Septage and Hauled Waste
12. Control of Runoff
13. Public Notification

These BMPs are equivalent to the Nine Minimum Controls (NMCs) required under the EPA National CSO Policy and were developed by the EPA to represent BMPs that would serve as technology-based CSO controls. The BMP's were intended to be "determined on a best professional judgment basis by the NPDES permitting authority" and to be the best available technology-based controls that could be implemented within two years by permittees. EPA developed two guidance manuals that embodied the underlying intent of the NMCs for permit writers and municipalities, offering suggested language for SPDES permits and programmatic controls that may accomplish the goals of the NMCs (EPA, 1995a, 1995b). A comparison of the EPA's NMCs to the 13 SPDES BMPs is shown in Table 3-1.

On May 8, 2014 DEP and the DEC entered into an administrative Consent Order[1], referred to as the 2014 CSO BMP Order on Consent, which extends and replaces the 2010 CSO BMP Order. The 2014 CSO BMP Order on Consent addresses remaining milestones from the 2010 CSO BMP Order by including an updated Schedule of Compliance identifying both new milestones and milestones that already have been met. Upcoming 2014 CSO BMP Order on Consent tasks include, but are not limited to:

- Issuing Notice to Proceed to Construction for repair, rehab or replacement of interceptors;

[1] 2014 CSO BMP Order on Consent. DEC File No. R2-20140203-112.

- Post-construction compliance monitoring;
- Maximizing flow at WWTPs;
- CSO monitoring and equipment at key regulators;
- Updating WWOPs with throttling protocols and updating critical equipment lists;
- Bypass reporting;
- Key regulator monitoring reporting;
- Regulators with CSO monitoring equipment identification program reporting; and
- Hydraulic modeling verification.

This section is based on the practices summarized in the 2014 Best Management Practices Annual Report (2014 BMP Annual Report) and the 2014 CSO BMP Order on Consent.

Table 3-1. Comparison of EPA NMCs with SPDES Permit BMPs

EPA Nine Minimum Controls	SPDES Permit Best Management Practices
NMC 1: Proper Operations and Regular Maintenance Programs for the Sewer System and the CSOs	BMP 1: CSO Maintenance and Inspection Program BMP 4: Wet Weather Operating Plan BMP 8: Combined Sewer Replacement BMP 9: Combined Sewer Extension BMP 10: Sewer Connection and Extension Prohibitions BMP 11: Septage and Hauled Waste
NMC 2: Maximum Use of the Collection System for Storage	BMP 2: Maximum Use of Collection Systems for Storage
NMC 3: Review and Modification of Pretreatment Requirements to Assure CSO Impacts are Minimized	BMP 6: Industrial Pretreatment
NMC 4: Maximization of Flow to the Publicly Owned Treatment Works for Treatment	BMP 3: Maximize Wet Flow to POTW BMP 4: Wet Weather Operating Plan
NMC 5: Prohibition of CSOs During Dry Weather	BMP 5: Prohibition of Dry Weather Overflow
NMC 6: Control of Solid and Floatable Material in CSOs	BMP 7: Control of Floatables and Settleable Solids
NMC 7: Pollution Prevention	BMP 6: Industrial Pretreatment BMP 7: Control of Floatables and Settleable Solids BMP 12: Control of Runoff
NMC 8: Public Notification to Ensure that the Public Receives Adequate Notification of CSO Occurrences and CSO Impacts	BMP 13: Public Notification
NMC 9: Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls	BMP 1: CSO Maintenance and Inspection Program BMP 5: Prohibition of Dry Weather Overflow BMP 6: Industrial Pretreatment BMP 7: Control of Floatables and Settleable Solids

This section presents a brief summary of each BMP and its respective relationship to the federal NMCs. In general, the BMPs address operation and maintenance procedures, maximum use of existing systems and facilities, and related planning efforts to maximize capture of CSO and reduce contaminants in the CSS, thereby reducing water quality impacts.

3.1 Collection System Maintenance and Inspection Program

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and the CSOs) and NMC 9 (Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls). Through regularly scheduled inspections of the CSO regulator structures and the performance of required repair, cleaning, and maintenance work, dry-weather overflows and leakage can be prevented and flow to the WWTP can be maximized. Specific components of this BMP include:

- Inspection and maintenance of CSO tide gates;
- Telemetering of regulators;
- Reporting of regulator telemetry results;
- Recording and reporting of events that cause discharge at outfalls during dry-weather; and,
- DEC review of inspection program reports.

Details of recent preventative and corrective maintenance reports can be found in the appendices of the BMP Annual Reports.

3.2 Maximizing Use of Collection System for Storage

This BMP addresses NMC 2 (Maximum Use of the Collection System for Storage) and requires cleaning and flushing to remove and prevent solids deposition within the collection system, and an evaluation of hydraulic capacity. These practices enable regulators and weirs to be adjusted to maximize the use of system capacity for CSO storage, which reduces the amount of overflow. DEP provides general information in the 2014 BMP Annual Report, describing the status of citywide Supervisory Control and Data Acquisition (SCADA), regulators, tide gates, interceptors, in-line storage projects, and collection-system inspections and cleaning.

Additional data gathered in accordance with the requirements of the 2014 CSO BMP Order on Consent, such as CSO monitoring, will be used to verify and/or further calibrate the hydraulic model developed for the CSO LTCPs.

3.3 Maximizing Wet Weather Flow to WWTPs

This BMP addresses NMC 4 (Maximization of Flow to the Publicly Owned Treatment Works for Treatment), and reiterates the WWTP operating targets established by the SPDES permits regarding the ability of the WWTP to receive and treat minimum flows during wet-weather. The WWTP must be physically capable of receiving a minimum of 2xDDWF through the plant headworks; a minimum of 2xDDWF through the primary treatment works (and disinfection works, if applicable); and a minimum of one and one-half times design dry-weather flow (1.5xDDWF) through the secondary treatment works during wet-weather. The actual process control set points may be established by the WWOP required in BMP 4.

NYC's WWTPs are physically capable of receiving a minimum of twice their permit-rated design flow through primary treatment and disinfection in accordance with their DEC-approved WWOPs. However, the maximum flow that can reach a particular WWTP is controlled by a number of factors including:

hydraulic capacities of the upstream flow regulators; storm intensities within different areas of the collection system; and plant operators, who can restrict flow using "throttling" gates located at the WWTP entrance to protect the WWTP from flooding and process upsets. DEP's operations staff is trained in how to maximize pumped flows without impacting the treatment process, critical infrastructure, or public safety. For guidance, DEP's operations staff follow their plant's DEC-approved WWOP, which specifies the "actual Process Control Set Points," including average flow, in accordance with Sections VIII (3) and (4) of the SPDES permits. Analyses presented in the 2014 BMP Annual Report indicate that DEP's WWTPs generally complied with this BMP during 2014.

The 2014 CSO BMP Order on Consent has a number of requirements related to maximizing wet-weather flows to WWTPs including, but not limited to:

- An enforceable compliance schedule to ensure that DEP maximizes flow to and through the WWTP during wet-weather events;
- Incorporating throttling protocol and guidance at the WWTPs;
- Updating the critical equipment lists for WWTPs, which includes screening facilities at pump stations that deliver flow directly to the WWTP and at WWTP headworks; and,
- Reporting bypasses to the DEC per the 2014 CSO BMP Order on Consent.

3.4 Wet Weather Operating Plan

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and the CSOs) and NMC 4 (Maximization of Flow to the Publicly Owned Treatment Works for Treatment). To maximize treatment during wet-weather events, WWOPs were developed for each WWTP drainage area in accordance with the DEC publication entitled *Wet Weather Operating Practices for POTWs with Combined Sewers*. Components of the WWOPs include:

- Unit process operating procedures;
- CSO retention/treatment facility operating procedures, if relevant for that drainage area; and,
- Process control procedures and set points to maintain the stability and efficiency of BNR processes, if required.

The Hunts Point WWTP WWOP, dated August 2010, was approved by DEC in October 2010.

3.5 Prohibition of Dry Weather Overflows

This BMP addresses NMC 5 (Prohibition of CSOs during Dry Weather) and NMC 9 (Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls), and requires that any dry-weather overflow event be promptly abated and reported to DEC within 24 hours. A written report must follow within 14 days and contain the information required by the corresponding SPDES permit. The status of the shoreline survey, the Dry Weather Discharge Investigation report, and a summary of the total bypasses from the treatment and collection system are provided in the BMP Annual Reports.

Dry-weather overflows from the CSS are prohibited and DEP's goal is to reduce and/or eliminate dry-weather bypasses. The data for for Hunts Point regulators, pump stations and WWTP's revealed the following 2014 occurrence:

- Bypass at Conner Street PS, 0.367 MG, 8.25 hours, electrical utility failure

3.6 Industrial Pretreatment Program

This BMP addresses three NMCs: NMC 3 (Review and Modification of Pretreatment Requirements to Assure CSO Impacts are Minimized); NMC 7 (Pollution Prevention); and NMC 9 (Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls). By regulating the discharges of toxic pollutants from unregulated, relocated, or new Significant Industrial Users (SIUs) tributary to CSOs, this BMP addresses the maximization of persistent toxics treatment from industrial sources upstream of CSOs. Specific components of this BMP include:

- Consideration of CSOs in the calculation of local limits for indirect discharges of toxic pollutants;
- Scheduled discharge during conditions of non-CSO, if appropriate for batch discharges of industrial wastewater;
- Analysis of system capacity to maximize delivery of industrial wastewater to the WWTP, especially for continuous discharges;
- Exclusion of non-contact cooling water from the CSS and permitting of direct discharges of cooling water; and
- Prioritization of industrial waste containing toxic pollutants for capture and treatment by the WWTP over residential/commercial service areas.

Since 2000, the average total industrial metals loading to NYC WWTPs has been declining. As described in the 2014 BMP Annual Report, the average total metals discharged by all regulated industries to the WWTPs was 12.2 lbs/day, and the total amount of metals discharged by regulated industrial users remained very low. Applying the same percentage of CSO bypass (1.5 percent) from the CSO report to the current data, it appears that, on average, less than 0.181 lbs/day of total metals from regulated industries bypassed to CSOs in 2014 (DEP, 2015).

3.7 Control of Floatables and Settleable Solids

This BMP addresses NMC 6 (Control of Solid and Floatable Material in CSOs), NMC 7 (Pollution Prevention), and NMC 9 (Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls), by requiring the implementation of the following four practices to eliminate or minimize the discharge of floating solids, oil and grease, or solids of sewage origin that cause deposition in receiving waters.

- Catch Basin Repair and Maintenance: This practice includes inspection and maintenance scheduled to ensure proper operations of basins.

- Catch Basin Retrofitting: By upgrading basins with obsolete designs to contemporary designs with appropriate street litter capture capability; this program is intended to increase the control of floatable and settleable solids citywide.

- Booming, Skimming and Netting: This practice implements floatables containment systems within the receiving waterbody associated with applicable CSO outfalls. Requirements for system inspection, service and maintenance are also established.

- Institutional, Regulatory, and Public Education: The report must also include recommendations for alternative NYC programs and an implementation schedule to reduce the water quality impacts of street and toilet litter.

3.8 Combined Sewer Replacement

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer Systems and the CSO's), requiring all combined sewer replacements to be approved by the New York State Department of Health (DOH) and to be specified within the DEP's Master Plan for Sewage and Drainage. Whenever possible, separate sanitary and storm sewers should be used to replace combined sewers. Each BMP Annual Report describes the citywide plan, and addresses specific projects occurring in the reporting year. No projects are reported for the Hunts Point WWTP service area in the 2014 BMP Annual Report.

3.9 Combined Sewer Extension

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and the CSOs). A brief status report is provided in the 2014 BMP Annual Report. According to the report, DEP completed five private sewer extensions in 2014. To minimize stormwater entering the CSS, this BMP requires combined sewer extensions to be accomplished using separate sewers whenever possible. If separate sewers must be extended from combined sewers, analyses must be performed to demonstrate that the sewage system and treatment plant are able to convey and treat the increased dry-weather flows with minimal impact on receiving water quality.

3.10 Sewer Connection & Extension Prohibitions

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and the CSOs), and prohibits sewer connections and extensions that would exacerbate recurrent instances of either sewer back-up or manhole overflows upon letter notification from DEC. Wastewater connections to the CSS downstream of the last regulator or diversion chamber are also prohibited. Each BMP Annual Report contains a brief status report for this BMP and provides details pertaining to chronic sewer back-up and manhole overflow notifications submitted to DEC when necessary. For the calendar year 2014, conditions did not require DEP to prohibit additional sewer connections or sewer extensions.

3.11 Septage and Hauled Waste

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and the CSOs). The discharge or release of septage or hauled waste upstream of a CSO (e.g., scavenger waste) is prohibited under this BMP. Scavenger wastes may only be discharged at designated manholes that never drain into a CSO, and only with a valid permit. The 2008 BMP Annual Report summarizes the three scavenger waste acceptance facilities controlled by DEP, and the regulations governing discharge of such material at the facilities. The facilities are located in the Hunts Point, Oakwood Beach, and 26th Ward WWTP service areas. The program remained unchanged through the 2014 BMP Annual Report.

3.12 Control of Runoff

This BMP addresses NMC 7 (Pollution Prevention) by requiring all sewer certifications for new development to follow DEP rules and regulations, to be consistent with the DEP Master Plan for Sewers and Drainage, and to be permitted by the DEP. This BMP ensures that only allowable flow is discharged into the combined or storm sewer system.

A rule to “reduce the release rate of storm flow from new developments to 10 percent of the drainage plan allowable or 0.25 cfs per impervious acre, whichever is higher (for cases when the allowable storm flow is more than 0.25 cfs per impervious acre),” was promulgated on January 4, 2012, and became effective on July 4, 2012.

3.13 Public Notification

BMP 13 addresses NMC 8 (Public Notification to Ensure that the Public Receives Adequate Notification of CSO Occurrences and CSO Impacts) as well as NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and the CSOs) and NMC 9 (Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls).

This BMP requires easy-to-read identification signage to be placed at or near CSO outfalls, with contact information for DEP, to allow the public to report observed dry-weather overflows. All signage information and appearance must comply with the Discharge Notification Requirements listed in the SPDES permit. This BMP also requires that a system be in place to determine the nature and duration of an overflow event, and that potential users of the receiving waters are notified of any resulting, potentially harmful conditions. The BMP allows the DOHMH to implement and manage the notification program. Accordingly, the Wet Weather Advisories, Pollution Advisories and Closures are tabulated for all NYC public and private beaches. There are no bathing beaches in or near Bronx River. Bathing beaches are explicitly prohibited in the upper East River and its tributaries by Local Law.

3.14 Characterization and Monitoring

Previous studies have characterized and described the Hunts Point WWTP collection system and the water quality for Bronx River (see Chapters 3 and 4 of the Bronx River WWFP, 2010). Additional data werecollected and is analyzed in this LTCP (see Section 2.2). Continuing monitoring occurs under a variety of DEP initiatives, such as floatables monitoring programs and DEP Harbor Monitoring Survey, and is reported in the BMP Annual Reports under SPDES BMPs 1, 5, 6 and 7, as described above.

Future monitoring includes the installation of CSO monitoring equipment (Doppler sensors in the telemetry system and inclinometers where feasible) at key regulators for the purpose of detecting CSO discharges (2014 CSO BMP Order on Consent). Following installation of the CSO monitoring equipment, a monthly report of all known or suspected CSO discharges from key regulators, outside the period of a critical wet-weather event, will be submitted to DEC. Additional quarterly reports and one comprehensive report summarizing one year of known or suspected CSO discharges will be submitted to DEC describing the cause of each discharge and providing options to reduce or eliminate similar future events with an implementation schedule.

3.15 CSO BMP Report Summaries

In accordance with the SPDES permit requirements, annual reports summarizing the citywide implementation of the 13 BMPs described above are submitted to DEC. DEP has submitted 12 annual reports to date, covering calendar years 2003 through 2014. Typical reports are divided into 13 sections, one for each of the BMPs in the SPDES permits. Each section of the annual report describes ongoing DEP programs, provides statistics for initiatives occurring during the preceding calendar year, and discusses overall environmental improvements.

4.0 GREY INFRASTRUCTURE

4.1 Status of Grey Infrastructure Projects Recommended in Facility Plans

CSO facility planning in the Bronx River began under the East River CSO Facility Planning Project. This planning focused on quantifying and assessing the impacts of CSO discharges to the Upper East River and certain tributaries, including the Hutchinson River, Westchester Creek, and the Bronx River. Initial recommendations for the Bronx River were made in September 2003 and included an off-line underground CSO conveyance/storage conduit of 4.0 MG serving Outfall HP-7. As part of the plan, Outfall HP-7 was to be relocated downstream of its existing location to a site south of East 177th Street, beneath the property of both the Metropolitan Transit Authority-New York City (MTA) and the New York State Department of Transportation (NYSDOT).

4.1.a Completed Projects

The facility planning activities through 2003 did not reflect the watershed planning approach that has more recently been determined by the EPA to be the most appropriate to assessing water quality improvements. In addition, the efforts showed that the proposed facility plan would not result in compliance with the current WQS. Therefore, the proposed 2003 Bronx River CSO Facility Plan was re-evaluated as part of the DEP Use and Standards Attainment (USA) Project. The July 2010 Bronx River WWFP furthered this re-evaluation to provide greater water quality benefit to the Bronx River at a lower overall cost. The recommended plan included floatables control facilities as described in Section 4.2, but no other grey infrastructure projects were recommended in the facility plans.

4.1.b Ongoing Projects

There are no ongoing grey infrastructure projects in the Bronx River planning area.

4.1.c Planned Projects

There are no grey infrastructure projects planned by NYC to impact the Bronx River.

4.2 Other Water Quality Improvement Measures Recommended in Facility Plans (Dredging, Floatables, Aeration)

The floatables control facilities recommended in 2003 became operational in October 2012 and were accepted by DEC in June 2013. The construction cost for these facilities was $29.0M. Floatables are controlled for the three outfalls at four locations:

- An in-line netting facility for HP-4 located along West Farms Road;
- An in-line netting facility for HP-9 located in Soundview Park; and
- Mechanical screens retrofitted onto CSO-27 and CSO-27A (two sites along the southern end of the Bronx Zoo), which discharge to HP-7.

All facilities were constructed largely underground, and are designed to treat the 1-year maximum flow, and bypass the remaining flow up to the DEP drainage plan criteria (5-year storm). Bypasses were included and/or weirs lengthened so that the new facilities would remain hydraulically neutral compared to the pre-construction condition.

4.3 Post-Construction Monitoring

The PCM Program is integral to the optimization of the Bronx River LTCP, providing data for model validation and feedback on system performance. Each year's data set will be compiled and evaluated to refine the understanding of the interaction between the Bronx River and the actions identified in this LTCP, with the ultimate goal of fully attaining compliance with current WQS or supporting a UAA to revise such standards, as appropriate. The data collection monitoring contains three basic components:

1. Evaluation of the inflows and loads from Westchester County at the boundary entering the Bronx portion of the Bronx River;
2. Receiving water data collection in the Bronx River using DEP HSM locations; and
3. Modeling of the collection system and receiving waters to characterize water quality using the existing IW and ERTM, respectively.

The details provided herein are limited to the Bronx River PCM and may be modified as the DEP's CSO program advances through the completion of other LTCPs, including the citywide LTCP in 2017.

PCM in the Bronx River commenced before the WWFP elements became operational, and will precede any additional CSO control measures proposed under this LTCP becoming operational. Build-out of any GI would be factored into the final scheduling. Monitoring will continue for several years after the controls are in place in order to quantify the difference between the expected and actual performance. Any gap identified by the monitoring program can then be addressed through operations adjustments, retrofitting additional controls, or through the implementation of additional technically feasible and cost-effective alternatives. If it becomes clear that CSO control will not result in full attainment of applicable WQS, DEP will pursue the necessary regulatory mechanism for a UAA.

4.3.a Collection and Monitoring of Water Quality in the Receiving Waters

PCM sampling in the Bronx River commenced in 2011 upon DEC approval of the WWFP, with all stations being sampled a minimum of twice per month from May through September then monthly during the remainder of the year.

Measured parameters relating to water quality include: DO, fecal coliform, enterococci, chlorophyll 'a', and Secchi depth. With the exception of enterococci, the City has used these parameters for decades to identify historical and spatial trends in water quality throughout New York Harbor.

Dissolved oxygen and chlorophyll 'a' are collected and analyzed at surface and bottom locations; the remaining parameters are measured at the surface only.

Results from the PCM for this waterbody have not been reported formally as part of the citywide PCM Annual Report because these data are being collected as part of the pre-control baseline. Monitoring will continue for several years after the actions identified in this LTCP are in place, as part of the adaptive management approach, to assess the extent of water quality improvements and their similarity to those predicted by the models (i.e. difference between the projected and actual performance). Build-out of GI will factor into this schedule as well.

4.3.b CSO Facilities Operations – Flow Monitoring and Effluent Quality

Any flow and effluent quality monitoring program would be dependent on the types and sizes of proposed CSO controls implemented under this LTCP. Effluent quality data is not expected to be collected routinely at an unmanned facility, nor is routine CSO flow and effluent quality data anticipated to be collected on outfalls for which no controls have been provided. If the implemented control is permitted under the SPDES, the conditions of that permit regarding effluent monitoring would be followed.

4.3.c Assessment of Performance Criteria

CSO controls implemented under this LTCP will be designed to achieve a specific set of water quality and/or CSO reduction goals as established in this LTCP, and as directed in the subsequent basis of design report (BODR) that informs the design process. If no additional CSO controls are proposed, then affirmation of water quality projections would be necessary. In both cases, the PCM data, coupled with the modeling framework used for annual reporting, will be used to assess the performance of the CSO controls implemented in comparison to the water quality goals.

Differences between actual overflows and model-predicted overflows are often attributable to the fact that the model results are based on the rainfall measured at a single NOAA rain gauge being taken to represent the rainfall over the entire drainage area. In reality, storms move through the area and are variable so that the rainfall actually varies over time and space. Because rainfall patterns tend to even out over the area over time, the practice of using the rainfall measured at one nearby location typically provides good agreement with long-term performance for the collection system as a whole; however, model results for any particular storm may vary somewhat from observations.

Given the uncertainty associated with potentially widely varying precipitation conditions, rainfall analysis is an essential component of the PCM. For the Bronx River, the most representative long-term rainfall data record is available from the National Weather Service's LGA gauge. Rain data for each calendar year of the PCM program will be compared to the 10-year model period (2002-2011) and to the JFK 2008 rain data used for alternative evaluations. Statistics, including number of storms, duration, total annual and monthly depths, and relative and peak intensities, will be used to classify the particular reporting year as wet or dry relative to the time series on which the concept was based. Uncertainty in the analysis may be supplemented with radar rainfall data where there is evidence of large spatial variations.

The reporting year will be modeled utilizing the existing IW/ERTM framework using the reporting year tides and precipitation. The resulting CSO discharges and water quality attainment will then be compared with available PCM data for the year as a means of validating model output. The level of attainment will be calculated from the modeling results and coupled with the precipitation analysis to determine relative improvement and the existence of any gap. Three successive years of evaluation will be necessary before capital improvements are considered, but operational adjustments will be considered throughout operation and reporting.

5.0 GREEN INFRASTRUCTURE

By capturing stormwater runoff and managing it through the processes of volume retention, infiltration, evapotranspiration, and re-use, GI can reduce stormwater flow into CSS.[1] In 2010, the DEP wrote and adopted the *NYC Green Infrastructure Plan: A Sustainable Strategy for Clean Waterways* ("GI Plan"), which was subsequently incorporated into the 2012 CSO Order on Consent.

The 2012 CSO Order on Consent requires DEP to control the equivalent of stormwater generated by one inch of precipitation on 1.5 percent of impervious surfaces in combined areas citywide by December 31, 2015. If DEP fails to attain the initial citywide GI application rate of 1.5 percent and associated CSO volume reduction by December 31, 2015, DEP must certify that $187M has been encumbered for the purpose of GI and submit an approvable contingency plan to the DEC by June 30, 2016. For 2020 and 2025 there are specific incremental increases required and by 2030, DEP is required to control the equivalent of stormwater generated by one inch of precipitation on 10 percent of impervious surfaces citywide in combined sewer areas. Over the next 20 years, DEP is planning for $2.4B in public and private funding for targeted GI installations, and $2.9B in cost-effective grey infrastructure upgrades to reduce CSOs. The Green Infrastructure Program, including citywide and CSO tributary area-specific implementation, is described below. Pursuant to the 2012 CSO Order on Consent, DEP publishes the *Green Infrastructure Annual Report* every April 30th to provide details on GI implementation and related efforts. These reports can be found at http://www.nyc.gov/html/dep/ html/ stormwater/nyc_green_ infrastructure_plan.shtml.

5.1 NYC Green Infrastructure Plan (GI Plan)

The GI Plan presents an alternative approach to improving water quality through additional CSO volume reductions by outlining strategies to implement decentralized stormwater source controls. An initial estimate, produced in 2010, was based on a hybrid green/grey infrastructure approach that indicated DEP could reduce CSO volume by an additional 3.8 billion gallons per year (BGY), or approximately 2 BGY more than by implementing an all-grey strategy. In addition to its primary objective, enhancing water quality in NYC, the GI Plan will yield co-benefits which include, but are not limited to, improved air quality, urban heat island mitigation, carbon sequestration, increased shade, and increased urban habitat for pollinators and wildlife.

In January 2011, DEP created the Office of Green Infrastructure (OGI) to implement the goals of the GI Plan, and committed $1.5B through 2030, including $5M in Environmental Benefit Project (EBP) funds.[2] OGI, in conjunction with other DEP Bureaus and partner NYC agencies, is tasked with designing and constructing GI practices that capture and manage, by infiltration and evapotranspiration, stormwater runoff before it reaches the CSS. The OGI has developed design standards for Right-of-Way GI Practices, such as Bioswales (ROWBs), Stormwater Greenstreets (SGSs), and Rain Gardens (ROWRGs), and has designed other projects on NYC-owned properties that include pervious pavement,

[1] U.S. EPA, March 2014. *Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control.*
[2] EBP projects are undertaken in connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State law and DEC regulations.

rain gardens, retention/detention systems and green and blue roofs. The Area-wide implementation strategy and other implementation details initiated by OGI to achieve the milestones in the 2012 CSO Order on Consent are described in more detail below, and in the 2012 and 2013 *Green Infrastructure Annual Report,* available on DEP's website.

5.2 Citywide Coordination and Implementation

To meet the GI goals of the 2012 CSO Order on Consent, DEP has identified several target CSO tributary areas (target areas) for GI implementation based on the following criteria: annual CSO volume; frequency of CSO events; other CSO control projects undertaken through the WWFPs; and other grey system improvements planned for the future. DEP also notes outfalls in close proximity to existing and future public access locations. Over the course of the 20-year Green Infrastructure Program, DEP will continue to review and expand the number of targeted areas to comply with the 2012 CSO Order on Consent milestones (also see Section 5.4c). The current target areas are shown in Figure 5-1. DEP employs adaptive management principles in the implementation of the Green Infrastructure Program, which allows for factoring in field conditions, costs, and other challenges as it proceeds toward each milestone.

The identification of target areas enables DEP to focus resources on specific outfall CSO Tributary Drainage Areas (TDAs) in order to analyze all potential GI opportunities, saturate these areas with GI practices to the extent possible, and achieve efficiencies in design and construction. This Area-wide strategy is made possible by DEP's standardized GI designs and procedures that enable systematic implementation of GI. This strategy also provides an opportunity to measure and evaluate the CSO benefits of Area-wide GI implementation at the outfall level.

DEP utilizes the Area-wide strategy for all public property retrofits, as described in more detail in the *2013 Green Infrastructure Annual Report*. DEP works directly with its partner agencies on retrofit projects at public schools, public housing, parkland, and other NYC-owned property within the target areas. DEP coordinates on a regular basis with partner agencies to review designs for new projects and to gather current capital plan information to identify opportunities to integrate GI into planned public projects.

DEP manages several of its own design and construction contracts for right-of-way and on-site GI practices. Additionally, the New York City Economic Development Corporation (EDC), DPR, and Department of Design and Construction (DDC) manage the design and construction of several of these Area-wide contracts on behalf of DEP.

5.2.a Community Engagement

Stakeholder participation is a critical success factor for the effective implementation of decentralized GI projects. To this end, DEP engages and educates local neighborhoods, community groups, and other environmental and urban planning stakeholders about their role in the management of stormwater. DEP's outreach efforts involve presentations and coordination with elected officials, community boards, stormwater advocacy organizations, green job non-profits, environmental justice organizations, schools and universities, Citizens Advisory Committees (CACs), civic organizations, and other NYC agencies.

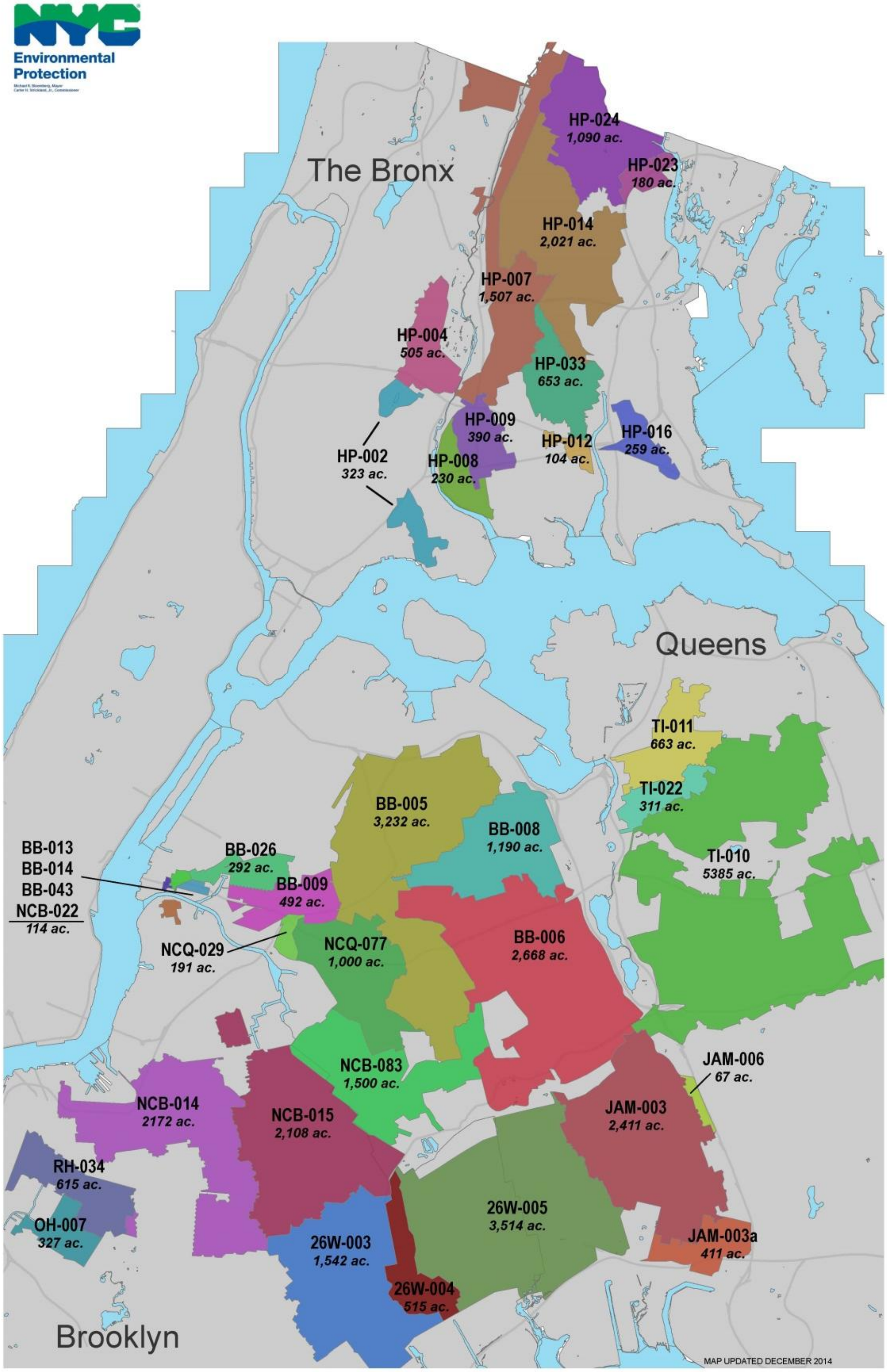

Figure 5-1. Target CSO Tributary Areas for Green Infrastructure Implementation

DEP launched its new website at www.nyc.gov/dep in 2013. As part of this update, DEP reorganized and added new content to the GI pages at www.nyc.gov/dep/greeninfrastructure. Users can now easily access more information on the Green Infrastructure Program, including Standard Designs for ROW GI practices. Users can also view a map of the target areas to learn whether GI is coming to their neighborhood.

DEP also created an educational video on the Green Infrastructure Program. This video gives a brief explanation of the environmental challenges posed by CSOs, while featuring GI technologies such as retention/detention systems, green/blue roofs, rain gardens, porous paving and permeable pavers. The video is available at DEP's YouTube page.

To provide more information about the Green Infrastructure Program, DEP developed an informational brochure that describes the site selection and construction process for projects in the ROW. The brochure also includes frequently asked questions and answers, and explains the co-benefits of GI.

DEP notifies abutting property owners in advance of ROW GI construction projects. In each contract area, DEP and its partner agencies provide construction liaison staff to be present during construction. The contact information for the construction liaison is affixed to the door hangers for use if the need to alert NYC to a problem which arises during construction.

As part of its ongoing outreach efforts, DEP continues to make presentations to elected officials and their staffs, community boards, and other civic and environmental organizations about the Green Infrastructure Program, upcoming construction schedules, and final GI locations.

5.3 Completed Green Infrastructure to Reduce CSOs (Citywide and Watershed)

The *Green Infrastructure Annual Reports* contain the most up-to-date information on completed projects and can be found on the DEP website. Reporting on completed projects on a citywide and watershed basis by April 30th is a requirement of the 2012 CSO Order on Consent. In addition, Quarterly Progress Reports are posted on the DEP LTCP webpage: http://www.nyc.gov/html/dep/html/cso_long_term_control_plan/index.shtml.

5.3.a Green Infrastructure Demonstration and Pilot Projects

The Green Infrastructure Program applies an adaptive management approach, based on information collected and evaluated from Demonstration Projects and on pilot monitoring results. In particular, accumulated information will be used to develop a GI performance metrics report by 2016 relating the benefits of CSO reduction with the number of GI practices constructed.

Pilot Site Monitoring Program

DEP initiated site selection and design of its Pilot Monitoring Program in 2009. This program has provided DEP opportunities to test different designs and monitoring techniques, and to determine the most cost-effective, adaptable, and efficient GI strategies that can be implemented citywide. Specifically, the pilot monitoring aimed to assess the effectiveness of each of the evaluated source controls at reducing the volume and/or rate of stormwater runoff from the drainage area by measuring quantitative aspects (e.g., source control inflow and outflow rates), as well as qualitative issues (e.g., maintenance requirements, appearance and community perception). Since 2010, more than 30 individual pilot GI practices have been constructed and monitored as part of the citywide pilot program for GI. These practices include: ROW GI such as bioswale rain gardens; rooftop practices such as blue roofs and green roofs; subsurface detention/retention systems with open bottoms for infiltration; porous pavement; and bioretention facilities. Data collection began in 2010, as construction for each of the monitoring sites was completed. Pilot Monitoring Program results will assist in validating modeling methods and parameters. Results are discussed further in Section 5.3.e.

Neighborhood Demonstration Area Projects

The 2012 CSO Order on Consent includes design, construction, and monitoring milestones for three Neighborhood Demonstration Area Projects (Demonstration Projects), which DEP met in 2012 and 2013. DEP has completed construction of GI practices within a total of 66 acres of tributary area in Hutchinson River, Newtown Creek and Jamaica Bay CSO TDAs. DEP has monitored these GI practices to study the benefits of GI application on a neighborhood scale and from a variety of techniques. A PCM Report was submitted to DEC in August 2014. DEP received requests for clarification from DEC regarding the PCM Report and submitted an updated PCM Report in January 2015. The results obtained from the Demonstration Projects, including monitoring, will be incorporated into the 2016 Performance Metrics Report, which will model the CSO reductions from GI projects. The approximately one-year pre-construction monitoring for all three Demonstration Projects started in fall 2011, and the approximately one-year PCM continued throughout 2013.

Construction of ROWBs as part of the Hutchinson River Green Infrastructure Demonstration Project was completed in April 2013 by DPR. There were 22 ROWBs installed within the 24-acre tributary area, and the design and construction costs were approximately $625,000. In the 23-acre Jamaica Bay Green Infrastructure Demonstration Project, DEP completed 31 ROW GI installations in 2012 and the permeable pavement retrofit projects at New York City Housing Authority's (NYCHA) Seth Low Houses in 2013. The total design and construction costs were approximately $1.5M. In the 19-acre Newtown Creek Green Infrastructure Demonstration Project, DEP constructed 19 ROWBs, two rain gardens, and a subsurface storm chamber system on the site of NYCHA's Hope Gardens Houses. The projects were completed in 2013, and costs totaled approximately $1.6M for design and construction. For more detailed information on the Demonstration Projects, see the *2012 Green Infrastructure Annual Report.*

While DEP's Pilot Monitoring Program provides performance data for individual GI installations, the Demonstration Projects provided standardized methods and information for calculating, tracking, and reporting derived stormwater volume reductions, impervious area managed, and other benefits associated with both multiple installations within identified sub-TDAs. The data collected from each of the three demonstration areas will enhance DEP's understanding of the benefits of GI relative to runoff control and resulting CSO reduction. The results will then be extrapolated for calculating and modeling water quality and cost-benefit information on a citywide and waterbody basis in the 2016 Performance Metrics Report.

5.3.b Public Projects

Green Infrastructure Schoolyards

The "Schoolyards to Playgrounds" program, one of PlaNYC 2030's initiatives aimed at ensuring that all New Yorkers live within a ten-minute walk from a park, is a collaboration between the non-profit Trust for Public Land (TPL), DPR, New York City Department of Education (DOE), and New York City School

Construction Authority (SCA) to renovate public school playgrounds and extend playground access to surrounding neighborhoods. In 2011, DEP joined TPL, SCA, and DOE funding up to $5M for construction of up to ten GI schoolyards each year for the next four years. The partnership is a successful component of DEP's strategy to leverage public-private partnerships to improve public property using GI retrofits.

See the Green Infrastructure Annual Reports, "Citywide Coordination and Implementation," for up-to-date information on completed public property retrofit projects.

5.3.c Performance Standard for New Development

DEP's stormwater performance standard ("stormwater rule") enables NYC to manage discharges to the CSS from new developments or major site alterations. Promulgated in July 2012,[3] the stormwater rule requires any new premises or any requests for sewer site connections to NYC's CSS to comply with stricter stormwater release rates, effectively requiring greater on-site detention. DEP's companion document, *Guidelines for the Design and Construction of Stormwater Management Systems,*[4] assists the development community and licensed professionals in the selection, planning, design, and construction of on-site source controls that comply with the stormwater rule.

The stormwater rule applies to new development or the alteration of an existing development in combined sewer areas of NYC. For a new development, the stormwater release rate[5] is required to be 0.25 cubic feet per second (cfs) or 10 percent of the drainage plan allowable flow, whichever is greater.[6] If the allowable flow is less than 0.25 cfs, then the stormwater release rate shall be equal to the allowable flow. For alterations, the stormwater release rate for the altered area will be directly proportional to the ratio of the altered area to the total site area, and no new points of discharge are permitted.[7] As discussed in Section 5.4.c. below, DEP anticipates that the stormwater rule will contribute to CSO reduction in each priority watershed.

5.3.d Other Private Projects (Grant Program)

Green Infrastructure Grant Program

Since its introduction in 2011, the Grant Program has sought to strengthen public-private partnerships and public engagement in regard to the design, construction and maintenance of GI.

The 2012 CSO Order on Consent requires the Green Infrastructure Grant Program to commit $3M of EBP funds[8] to projects by 2015. DEP met this commitment in 2014.

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[3] See Chapter 31 of Title 15 of the *Rules of the City of New York Governing House/Site Connections to the Sewer System*. (New York City, N.Y., Rules, Tit. 15, § 31).
[4] The *Guidelines* are available at DEP's website, at http://www.nyc.gov/html/dep/pdf/green_infrastructure/ stormwater_guidelines_ 2012_final.pdf.
[5] New York City, N.Y., Rules, Tit. 15, § 31-01(b)
[6] Allowable flow is defined as the storm flow from developments based on existing sewer design criteria that can be released into an existing storm or combined sewer.
[7] New York City, N.Y., Rules, Tit. 15, § 31-03(a)(2)
[8] EBP Projects are undertaken by DEP in connection with the settlement of an enforcement action taken by New York State and the New York State Department of Environmental Conservation for violations of New York State law and DEC regulations.

Green Roof Property Tax Abatement

The NYC Green Roof Tax Abatement (GRTA) has provided a fiscal incentive to install green roofs on private property since 2008. DEP has worked with the Mayor's Office of Long Term Planning and Sustainability (OLTPS), the DOB, the Department of Finance (DOF) and the Office of Management and Budget (OMB), as well as environmental advocates and green roof designers, to modify and extend the GRTA through 2018. DEP has met with stakeholders and incorporated much of their feedback to improve the next version to help increase the number of green roofs in NYC. Additionally, DEP funded an outreach position to educate applicants and assist them through the abatement process to help facilitate application approval and respond to issues that may arise.

The tax abatement includes an increase to the value of the abatement from $4.50 to $5.23 per square foot, to continue offsetting construction costs by roughly the same value as the original tax abatement. Also, given that rooftop farms tend to be larger than typical green roofs (approximately one acre in size), the abatement value cap was also increased from $100,000 to $200,000 to allow such applicants to receive the full value of the abatement. Finally, based on the amount allocated for this abatement, the total annual amount available for applicants (i.e. in the aggregate) is $750,000 in the first year, and $1,000,000 in each subsequent year through March 15, 2018. The aggregate amount of abatements will be allocated by the DOF on a pro rata basis. See the *2013 Green Infrastructure Annual Report* for up-to-date information on the Green Roof Property Tax Abatement.

5.3.e Projected vs. Monitoring Results

Pilot Site Monitoring Program

As mentioned above, more than 30 pilot GI practices have been constructed and monitored as part of the pilot program for GI. Quantitative monitoring parameters included:

- Water quantity: inflow, outflow, infiltration, soil moisture and stage.
- Weather: evaporation, rainfall, wind, relative humidity and solar radiation.
- Water/soil quality: diesel/gas, nutrients, TSS, TOC, salts, metals, soil sampling and infiltrated water sampling.

Quantitative monitoring was conducted primarily through remote monitoring equipment, such as pressure transducer water level loggers in conjunction with weirs or flumes to measure flows, monitoring aspects of source control performance at five-minute intervals. On-site testing and calibration efforts included infiltration tests and metered discharges to calibrate flow monitoring equipment and assess the validity of assumptions used in pilot performance analysis.

Monitoring efforts focused on the functionality of the GI practices and their impact on runoff rates and volumes, along with water and soil quality and typical maintenance requirements. Monitoring activities largely involved remote monitoring equipment that measured water level or flows at a regular interval, supporting analysis of numerous storms throughout at each site.

Monitoring analyses through 2013 demonstrated that all pilot GI practices are providing effective stormwater management, particularly for storms with depths of one inch or less. All GI practices have provided benefits for storms greater than one inch, with specific impacts varying based upon location and type. In many cases, bioretention practices have fully retained the volume of one inch storms they received.

Monitoring activities will be discontinued at several sites that have multiple years of performance data and have exhibited relatively consistent performance throughout that period. Further monitoring at these locations may be resumed in the future to further examine long term performance. Monitoring data for these locations is included in the *2012 Pilot Monitoring Report*. In addition, up-to-date information on the Pilot Monitoring Program can be found in the *2013 Green Infrastructure Annual Report*.

Neighborhood Demonstration Area Projects

As previously discussed, the objective of DEP's Demonstration Projects is to maximize the management and control of stormwater runoff near where it is generated, and then monitor the reduction of combined sewage originating from identified sub-TDAs. DEP's PCM Report documented the performance of installed GI practices in the demonstration areas and was submitted to DEC in August 2014. After receiving comments from DEC, the report was resubmitted in January 2015. The 2016 Performance Metrics Report will relate the benefits of CSO reduction associated with the type and number of GI constructed, and detail methods by which DEP will calculate the CSO reduction benefits in the future.

The three Demonstration Projects were selected because the existing sewers flow in a single combined sewer pipe of a certain size to a receiving manhole where monitoring could take place. In each of the Demonstration Projects, DEP identified GI opportunities in the ROW as well as on-site at NYC-owned property.

The combined sewer flow reductions achieved by built GI practices were monitored through the collection of high quality flow monitoring data at the point at which the combined sewer system exits the Demonstration Project area's delineated sub-drainage tributary area. Monitoring activities consisted of recording combined flow and depth and using meters placed within a key outlet sewer at a manhole. Data acquisition was continuous, with measurements recorded at 15-minute intervals.

Data collection continued for approximately one-year each for pre- and post-construction. Subsequent analysis involved a review of changes in pervious and impervious surface coverage between pre- and post-construction conditions, consisting of several elements, including statistical analyses. This statistical analysis will enable DEP to determine the overall amount of combined flow reduction within the Demonstration Project's tributary area and the impervious area managed associated with GI practices implemented at scale.

Project data collected will be used to calibrate the IW computer model to the monitored flows for pre- and post-construction conditions. Post-construction performance data will be used to ensure that retention modeling techniques adequately account for the degree of flow reduction within TDAs with planned GI and equivalent CSO volume reductions.

5.4 Future Green Infrastructure in the Watershed

5.4.a Relationship Between Stormwater Capture and CSO Reduction

The modeling approach described here outlines how CSO reductions are projected for waterbody-specific projected GI penetration rates (see Section 6). Potential CSO reduction, and load reduction, through stormwater capture in the Bronx River was evaluated using the landside model, developed in IW modeling software, based on the extent of GI (retention and detention) practices in combined sewer areas. The extent of stormwater capture from GI projects is configured in terms of a percent of impervious cover where one inch of stormwater is managed through different types of GI practices. Due to their distributed locations within a TDA, retention for different GI practices is lumped on a sub-TDA level in the landside model. This is also due to the fact that the landside model does not include small combined sewers and cannot model them in a distributed manner. Retention is modeled with the applicable storage and/or infiltration elements. Similarly, the distributed detention locations within a TDA are represented as a lumped detention tank, with the applicable storage volume and constricted outlet configured based on allowable peak flows from their respective TDA. Modeling methods designed during the development of DEP's GI Plan have been refined over time to better characterize the retention and detention functions.

5.4.b Opportunities for Cost-Effective CSO Reduction Analysis

For each LTCP, the citywide target for managing one inch of rain on 10 percent impervious area in combined sewered areas has been broken out into estimated targets for each waterbody and used to calculate the baseline CSO reductions from GI projects. The estimated targets for each waterbody are the best information available because the GI implementation is being carried out simultaneously as the LTCPs are developed. At this time, there are no additional GI projects identified in the watershed that would exceed the baseline target rate (as described above and below). The Green Infrastructure Program will be implemented through 2030 and the final penetration rate will be reassessed as part of the adaptive management approach.

5.4.c Watershed Planning to Determine 20 Year Penetration Rate for Inclusion in Baseline Performance

To meet the 1.5-, 4-, 7-, and 10-percent citywide GI penetration rates by 2015, 2020, 2025 and 2030, respectively, DEP has developed a waterbody prioritization system described above in Section 5.2. This approach has provided an opportunity to build upon existing data and make informed estimates available.

Waterbody-specific penetration rates for GI are estimated based on the best available information from modeling efforts. Specific WWFPs, the Green Infrastructure Plan, CSO outfall tiers data, and historic building permit information were reviewed to better assess waterbody-specific GI penetration rates.

The following criteria were applied to compare and prioritize watersheds in order to determine waterbody-specific GI penetration rates:

- WQS
  - Fecal Coliform
  - Total Coliform
  - Dissolved Oxygen

- Cost-effective grey investments
  - Planned/constructed grey investments
  - Projected CSO volume reductions
  - Remaining CSO volumes
  - Total capital costs

- Additional considerations:
  - Background water quality conditions
  - Public concerns and demand for recreational uses
  - Site-specific limitations (i.e., groundwater, bedrock, soil types, etc.)
  - Presence of high frequency outfalls
  - Eliminated or deferred CSO storage facilities
  - Additional planned CSO controls not captured in WWFPs or 2012 CSO Order on Consent (i.e., high level storm sewers [HLSS])

The overall goal for this prioritization is to saturate GI implementation rates within the priority watersheds, such that the total managed impervious acres will be maximized based on the specific opportunities and field conditions in the Bronx River, as well as costs.

Green Infrastructure Baseline Penetration Rate – Bronx River

Based on the above criteria, Bronx River's characterization ultimately determined that the waterbody is a target area for the Green Infrastructure Program. This particular waterbody has a total tributary combined sewer impervious area of 2,331 acres. DEP projects that GI penetration rates would manage 14 percent of the impervious surfaces within the Bronx River combined sewer service area by 2030. This accounts for ROW practices, public property retrofits, GI implementation on private properties, and includes conservatively estimated new development trends based on DOB building permit data to account for compliance with the stormwater performance standard during the years 2013-2030. The model has predicted a reduction in annual overflow volume of 41 MG from this GI implementation based on the 2008 baseline rainfall condition.

Furthermore, as LTCPs are developed, baseline GI penetration rates for specific watersheds may be adjusted based on the adaptive management approach as described above in Section 5.2. DEP anticipates that the Green Infrastructure Program will meet the citywide requirements to manage the equivalent of one inch of rain on 10 percent of impervious surfaces in the combined sewer area as set forth in the 2012 CSO Order on Consent. Figure 5-2 below shows the current contracts in progress in Bronx River that will be accounted for as the Green Infrastructure Program progresses toward the 2030 goal. The current Area-wide contracts in the Bronx River CSO TDA are in HP-004, HP-002, HP-007, HP-008 and HP-009. As more information on field conditions, feasibility, and costs becomes known, and GI projects progress, DEP will continue to model the GI penetration rates and make the necessary adjustments at that time.

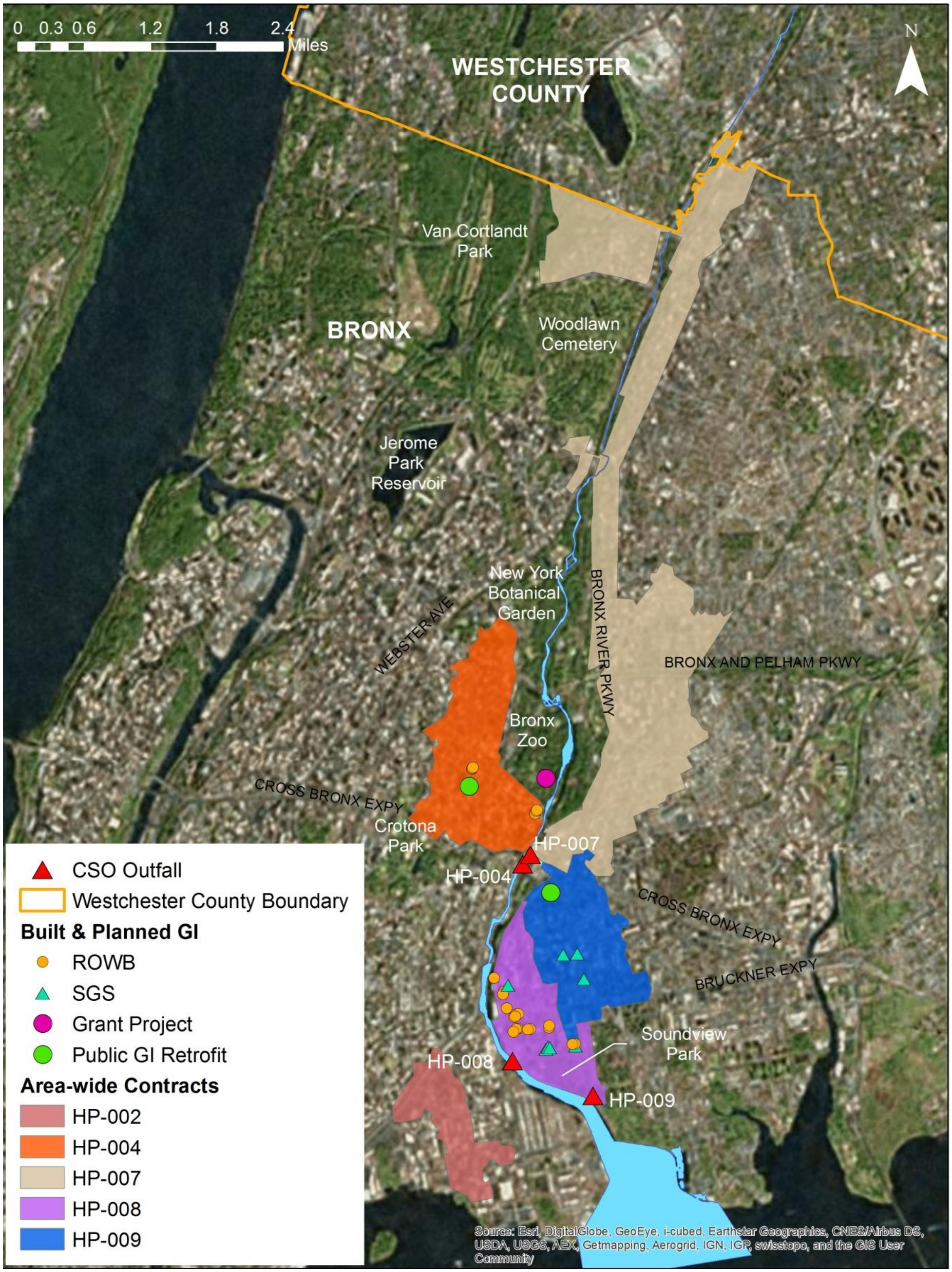

Figure 5-2. Green Infrastructure Projects in Bronx River

6.0 BASELINE CONDITIONS AND PERFORMANCE GAP

Key to development of the Bronx River LTCP is the assessment of water quality using applicable WQS within the waterbody. Water quality was assessed using the Westchester County Storm Water Management Model (WC SWMM) and the ERTM water quality model, verified with both Harbor Survey and the synoptic water quality data collected in 2014. The IW sewer system model was used to provide flows and loads from intermittent wet-weather sources as input to the ERTM model.

The assessment of water quality described herein starts with a baseline condition simulation to determine the future bacterial levels without CSO controls. Next a simulation was performed to determine bacteria levels under the assumption of 100% CSO control. The baseline condition was then compared to a 100% CSO control simulation. The gap between the two scenarios was then compared to assess whether bacteria criteria can be attained through application of CSO controls. Continuous water quality simulations were performed to evaluate the gap between the calculated baseline bacteria and DO levels and both the Existing WQ Criteria and the Potential Future Primary Contact WQ Criteria. As detailed below, a one-year simulation using 2008 JFK Airport rainfall was performed for bacteria and DO. This simulation served as a basis for evaluating of the control alternatives presented in Section 8.0.

This section of the LTCP describes the baseline conditions, the bacteria concentrations and loads calculated by the IW model, and the resulting bacteria concentrations calculated by the ERTM water quality model. It further describes the gap between calculated baseline bacteria concentrations and both the existing and potential future WQS. The section also assesses whether the gap can be closed through CSO reductions alone (100% CSO control).

6.1 Define Baseline Conditions

Establishing baseline conditions is an important step in the LTCP process, because the baseline conditions will be used to compare and contrast the effectiveness of CSO controls and to predict whether water quality goals would be attained after the identified preferred alternative LTCP is implemented. Baseline conditions for this LTCP were established in accordance with guidance set forth by the DEC to represent future conditions. Specifically, these conditions included the following assumptions:

- Dry-weather flow and loads to the WWTP are based on CY2040 projections.
- The Hunts Point WWTP can accept and treat peak flows at two times design weather flow (2xDDWF).
- GI in 14 percent of the impervious surfaces within the CSS service area.
- The freshwater portion of the Bronx River is in compliance with the Class B water quality criteria at the Westchester County/NYC border.

Mathematical modeling tools were used to calculate the CSO volume and loads and their impacts on water quality. The performance gap between calculated WQS was assessed herein by comparing the baseline conditions with WQS. In addition, complete removal or control of CSO loadings was evaluated. Further analyses were conducted for CSO control alternatives as presented in Section 8.0.

The WC SWMM model was used to develop the flow and bacteria concentrations for the Westchester County portion of the Bronx River. The IW model was used to develop stormwater flows, conveyance system flows and CSO volumes within NYC for a defined set of future or baseline conditions. For the Bronx River LTCP, the baseline conditions were developed in a manner consistent with the earlier WWFPs for other waterbodies. However, based on more recent data, as well as the public comments received on those WWFPs, it was recognized that some of the baseline condition model input data needed to be updated to reflect more recent meteorological conditions, as well as the current operating characteristics of various collection and conveyance system components. Furthermore, the mathematical models were updated from their configurations and levels of calibration developed and documented prior to this LTCP. IW model modifications reflected a better understanding of sources, catchment areas and new or upgraded physical components of the system. In addition, a model recalibration report was issued in 2012 (*InfoWorks Citywide Recalibration Report, June 2012a*) that used improved impervious surface satellite data. Water quality modeling was conducted using WC SWMM and ERTM rather than a stand-alone model used for the Bronx River WWFP. Updates to the IW model and the water quality model are described in *Bronx River LTCP Sewer System and Water Quality Modeling Report (DEP, 2015).* The updated IW model network was then used to estimate CSO volumes and loads for the baseline conditions. It also was used as a tool to estimate CSO volumes and loads resulting from CSO control alternatives evaluated in Section 8.0.

DEP completed a CSO Flow Monitoring Pilot Program in 2013 that included measurements of discharges at Outfall HP-009, as well as selected outfalls in other watersheds. While the IW models used in the LTCP program typically undergo validation using temporary meter data commonly spanning durations of 10-12 weeks, the portion of the model tributary to Outfall HP-009 benefited from having 12 months of pilot program monitoring data against which to further calibrate model predictions. Thus, the Outfall HP-009 tributary area has been subjected to rigorous calibration with a large amount of metering data; the increased confidence at this location is beneficial since this outfall discharges the highest relative volumes in the Bronx River.

DEP completed a CSO Flow Monitoring Pilot Program in 2013 (published by Water Environment Research Foundation [WERF]) that included measurements of discharges at Outfall HP-009, as well as selected outfalls in other watersheds. While the IW models used in the LTCP program typically undergo validation using temporary meter data commonly spanning durations of 10-12 weeks, the portion of the model tributary to Outfall HP-009 benefited from having 12 months of pilot program monitoring data against which to further calibrate model predictions. Thus, the Outfall HP-009 tributary area has been subjected to rigorous calibration with a large amount of metering data; the increased confidence at this location is beneficial since this outfall discharges the highest relative volumes in the Bronx River.

The baseline modeling conditions primarily related to wet-weather capacity for the Hunts Point WWTP, sewer conditions, loadings and boundary conditions, precipitation conditions and dry-weather flow rates used to fulfill the DEC baseline LTCP guidance are as follows:

- **Wet-Weather Capacity**: The rated wet-weather capacity at the Hunts Point WWTP is 400 MGD (2xDDWF). A project was completed in 2004 to upgrade the treatment plant including the plant headworks and main sewage pumps so that the plant is capable of accepting, pumping and treating combined sewage to a maximum flow of 400 MGD. Effective May 8, 2014, DEC and DEP entered into an administrative consent order for CSO BMP (2014 CSO BMP Order on Consent) that includes an enforceable compliance schedule to ensure that DEP maximizes flow to and through the WWTP during wet-weather events.

- **Sewer Conditions**: The IW model was developed to represent the sewer system on a macro scale, generally including all conveyance elements with equivalent diameters of 48 inches or larger, along with all regulating structures and CSO outfall pipes. Post-Interceptor cleaning levels of sediments were also included for the interceptors in the collection system to better reflect actual conveyance capacities to the WWTPs.

- **Source Loadings:** The Bronx River receives flows and loadings from Westchester County. During 2014, the flow from the Bronx River at the Westchester County/NYC border was sampled on multiple occasions. In addition, Cope Lake, which is located in the Bronx Zoo, was found to discharge into the Bronx River through Outfall HP-608. The Cope Lake flow and dry-weather bacteria concentrations were sampled during 2014. For the baseline conditions, the Bronx River flow at the Westchester/NYC border was assigned to be in attainment of the Class B/C water quality criteria, and the Cope Lake outflow concentrations were assigned as constant concentrations based on geometric means of the sampling data. Illicit dry-weather loadings from Westchester County, although included as part of the model calibration, were not included in the baseline conditions.

6.1.a Hydrological Conditions

For this LTCP, the precipitation characteristics for 2008 were used for the baseline condition, as well as for alternatives evaluations and were considered to be representative of a typical rainfall year. In addition to the 2008 precipitation pattern, the observed tide conditions that existed in 2008 were also applied in the models as the saline boundary conditions at the CSO outfalls that discharge to tidally influenced waterbodies.

6.1.b Flow Conservation

Consistent with previous studies, the dry-weather sanitary sewage flows used in the baseline modeling were escalated to reflect anticipated population growth in NYC. In 2014, DEP completed detailed analysis of water demand and wastewater flow projections. A detailed geographical information system (GIS) analysis was performed to apportion total population among the 14 WWTP drainage areas throughout NYC. For this analysis, Transportation Analysis Zones (TAZ) were overlaid with WWTP drainage areas. Population projections for 2010-2040 were derived from population projections developed by DCP and New York Metropolitan Transportation Council (NYMTC). These analyses used the 2010 census data to reassign population values to the watersheds in the model and project sanitary flows to 2040. These projections also reflect water conservation measures that already have significantly reduced flows to the WWTPs and freed capacity in the conveyance system.

6.1.c Best Management Practices Findings and Optimization

A list of BMPs, along with a brief summary of each and its their respective relationship to the EPA NMC were reported in Section 3.0, as they pertain to Bronx River CSOs. In general, the BMPs address operation and maintenance procedures, maximum use of existing systems and facilities and related planning efforts to maximize capture of CSO and reduce contaminants in the CSS, thereby improving water quality conditions.

The following provides an overview of the specific elements of various DEP, SPDES and BMP activities as they relate to the development of the baseline conditions, specifically in developing and using the IW models to simulate CSO discharges and in establishing non-CSO discharges that impact water quality in the Bronx River:

- Sentinel Monitoring: In accordance with BMPs #1 and #5, DEP collects quarterly samples of bacteria water quality at four locations in the Bronx River (near Stations BR-1, BR-3, BR-4 and BR-8 as established for this LTCP and shown in Figures 2-27 and 2-28) in dry-weather to assess whether dry-weather sewage overflows occur, or whether illicit connections to storm sewers exist. No evidence of illicit sanitary sewer connections was observed in the NYC portion of the Bronx River based on these data. Although illicit sources were included in Westchester County for the water quality model calibration exercises to accurately simulate the observed ambient bacteria concentrations near the Westchester County/NYC border, these sources were excluded from the baseline conditions, to reflect future corrected conditions.

- Interceptor Sediments: Sewer sediment levels determined through the post-cleaning inspections are included in the IW model.

- Combined Sewer Sediments: The IW models assume no sediment in upstream combined trunk sewers in accordance with BMP #2.

- WWTP Flow Maximization: In accordance with the 2014 CSO BMP Order on Consent, the Hunts Point WWTP treats wet-weather flows that are conveyed to the plants, up to 2XDDW. DEP follows the wet-weather operating plan and receives and regularly treats 2xDDWF. Cleaning of the interceptor sediments has increased the ability of the system to convey 2xDDWF to the WWTP.

- WWOP: The Hunts Point WWOP (BMP #4) establishes procedures for pumping at the plant headworks to assure treatment of 2xDDWF.

6.1.d Elements of Facility Plan and GI Plan

DEP has constructed netting and screening facilities that control floatables to CSO Outfalls HP-004, HP-007 and HP-009. Currently these facilities are the only form of grey infrastructure in the Bronx River watershed. As discussed in Section 5.0, the Bronx River watershed is one of the more promising areas for GI build-out in NYC. DEP has projected a 14 percent level of GI implementation, which has been assumed in the baseline model.

6.1.e Non-CSO Discharges

Over the past 30-years or so, DEP has invested heavily in mapping and delineating combined sewer drainage areas and piping systems as part of CSO facility planning and waterbody watershed facility planning efforts. Non-CSO drainage areas have not received the same level of effort. Non-CSO drainage areas were first identified during WWFP activities as land areas that were not contained within the CSO drainage areas. They were labeled as direct drainage and stormwater drainage areas but that distinction had no real meaning since both areas were assigned the same runoff characteristics. As part of the LTCP work, a distinction has been made to further refine these areas. Direct drainage areas (parks, cemeteries, large un-occupied open areas, etc.) are now assigned lower pathogen runoff concentrations than are assigned to more urbanized non-CSO (residential, commercial areas with a separate storm sewer system) drainage areas. In addition, a category of highway runoff has been established but in many cases the highway runoff is lumped together with other stormwater discharges. As a result, it is difficult to differentiate the DEP MS4 loadings from other MS4 and general stormwater loadings. In order to quantify the DEP MS4 loadings, a much more detailed mapping effort for these drainage areas would be required.

In several sections of the Hunts Point WWTP drainage area, runoff drains directly to receiving waters via overland flow, open channels, or privately owned pipes, without entering the combined system or NYC separate storm sewer system. These areas were depicted as “Direct Drainage” in Figure 2-10 (Section 2.0) and were estimated based on topography and the direction of stormwater runoff flow in those areas. In general, shoreline areas adjacent to waterbodies comprise the direct drainage category, as they consist of parks, Bronx Zoo, Botanical Gardens and cemeteries but do also contain industrial properties as well as many sections of highways adjacent to the Bronx River (Bronx River Parkway, Pelham Parkway, etc.). These areas comprise approximately 1,465 acres of the 4,318 acres of drainage area tributary to the Bronx River downstream of the Westchester County border. In addition, the drainage area upstream from the Westchester County border consists of an additional 23,020 acres, all of which are served by separate storm sewers and direct drainage.

As discussed above, although the IW model is used to estimate volume and loads from non-CSO sources in the Bronx River watershed, the current model consolidates the drainage areas so that the MS4 outfalls owned by DEP, non-DEP MS4 outfalls and direct drainage can all be contained within a single IW runoff subcatchment area. The MS4 stormwater areas are poorly defined in the Bronx River watershed. Based on aerial photographs and satellite images the majority of the non-CSO drainage area in the freshwater reach appears to be direct drainage. These areas include the Woodlawn Cemetery, New York Botanical Gardens and the Bronx Zoo. MS4 Outfalls owned and operated by DEP consist of Outfalls HP-650, HP-626, HP-649 and HP-621 which appear to be primarily highway runoff and were classified as such for the calculation of loading. Other DEP Outfalls, HP-608 and HP-627, were the only outfalls that appear to be conventional MS4 outfalls; although even here a portion of the MS4 drainage area to Outfall HP-608 is associated with the Cope Lake portion of the Bronx Zoo. Based on flow measurements, each outfall was assigned an area of 20 acres and concentrations based on sampling data. Monitoring at Cope Lake revealed that it had a relatively constant dry-weather flow of 1.1 MGD during the period of sampling with bacteria concentrations high enough to locally affect the geometric mean bacteria concentrations in the Bronx River. In total, the estimate made herein of the separately sewered urban stormwater outfall drainage area within NYC is about 54 acres.

In summary, the non-CSO subcatchments are only modeled in a simplified way and do not contain any details of the internal storm pipe system and do not have refined delineations of MS4 areas. Therefore, the stormwater flow and loads from NYC separate storm sewer system (MS4) and direct drainage areas are high level estimates. These estimates are subject to revision when more refined delineations of drainage areas become available. It is most reasonable to think of these areas as non-CSO areas.

6.2 Baseline Conditions – Projected CSO Volumes and Loadings after the Facility Plan and GI Plan

As previously noted, the IW model was used to develop CSO volumes for the baseline conditions. It incorporated the implementation of a 14 percent GI build-out and grey infrastructure associated with the screening and netting facilities. Using these overflow volumes, loadings from the CSOs were generated using the enterococci, fecal coliform and BOD concentrations and provided input to the receiving water quality model, ERTM. ERTM was assessed using 2014 monitoring data collected during the Bronx River LTCP as well as 2014 Sentinel Monitoring data. The assessment consisted of comparing the time series and cumulative frequency distributions of 2014 collected concentration data against the time series and cumulative frequency distribution output from the model for storms of similar sizes.

In addition to CSO loadings, storm sewer discharges and direct drainage impact the water quality in the Bronx River. The concentrations assigned to the various sources to Bronx River are summarized in Table 6-1. Concentrations in Table 6-1 represent typical stormwater, direct drainage and sanitary sewage concentrations for the Bronx River drainage area and are based on water quality data collected from the Bronx River area. Cope Lake concentrations were based on geometric means of the dry-weather data collected during 2014. Loads from Westchester County were based on WC SWMM and were then reduced so that compliance with the Class B/C fecal coliform criterion and the Potential Future Primary Contact WQ Criteria (30-day rolling geometric mean [GM] ≤ 30 cfu/100mL) during recreational season (May 1st through October 31st) was achieved at the NYC/Westchester County boundary. For 2008 conditions, this required a 66 percent reduction of the fecal coliform loading and an 84 percent reduction of the enterococci loading upstream of the NYC border in Westchester County. The percentage reduction was based on the worst month (December) during the year and worst 30-day period (early September to early October) during the recreational season (May 1st through October 31st) for fecal coliform and enterococci, respectively. The same percent reductions were applied to the entire year.

For the modeling simulations, CSO concentrations were calculated using the stormwater and sanitary concentrations assigned in Table 6-1, multiplied by the flow calculated by the IW model. The model provides a calculated fraction of flow from stormwater and flow from sanitary sources, as follows:

$C_{cso} = fr_{san}*C_{san} + fr_{sw}*C_{sw}$

where: C_{cso} = CSO concentration

C_{san} = sanitary concentration

C_{sw} = stormwater concentration

fr_{san} = fraction of flow that is sanitary

fr_{sw} = fraction of flow that is stormwater

Table 6-1. Source Concentrations from NYC Sources

Source	Enterococci (cfu/100mL)	Fecal Coliform (cfu/100mL)	BOD_5 (mg/L)
Urban Stormwater(2)	50,000	120,000	15
CSOs (HP-007 and HP-009)(1)	Monte Carlo	Monte Carlo	Mass Balance (Sanitary =115)
Sanitary for Mass Balance CSOs(1)	400,000	2,200,000	Mass Balance (Sanitary=115)
HP-608, HP-627(1)	90,000	90,000	15
Highway Runoff(3)	8,000	20,000	15
Direct Drainage(3)	6,000	4,000	15
Cope Lake DW(1)	100	500	15

Notes:
(1) Bronx River LTCP Sewer System and Water Quality Modeling, 2015.
(2) HydroQual Memo to DEP, 2005a.
(3) Basis – NYS Stormwater Manual, Charles River LTCP, National Stormwater Data Base.

It should be noted that the IW model represents the CSO drainage areas more accurately than the non-CSO drainage areas since these areas were delineated from sewer maps. The non-CSO drainage areas were taken as the land area between the CSO drainage boundary and the waterfront. The DEP Shoreline Survey Program has documented that more than 100 outfall pipes exist along the length of the NYC portion of the Bronx River. These outfalls are represented by 15 non-CSO catchment areas within IW. Figure 6-1 presents the non-CSO IW subcatchments along with the Shoreline Survey outfalls within the freshwater section of the Bronx River. In some cases, DEP MS4 outfalls are grouped with the DOT and private outfalls within the same IW catchment area. These catchment areas were designed in order to capture the entire non-CSO drainage areas, but do not consider the drainage area of each individual outfall.

Typical baseline volumes of CSO, stormwater and direct drainage to the Bronx River are summarized in Table 6-2 for the 2008 year. The specific SPDES permitted outfalls associated with these sources were shown in Figure 2-12. Additional tables that summarize annual volumes and loadings can be found in Appendix A. The information in these tables is provided for the 2008 rainfall condition. Appendix A also includes a table that presents the Shoreline Survey Program outfalls represented by each IW outfall.

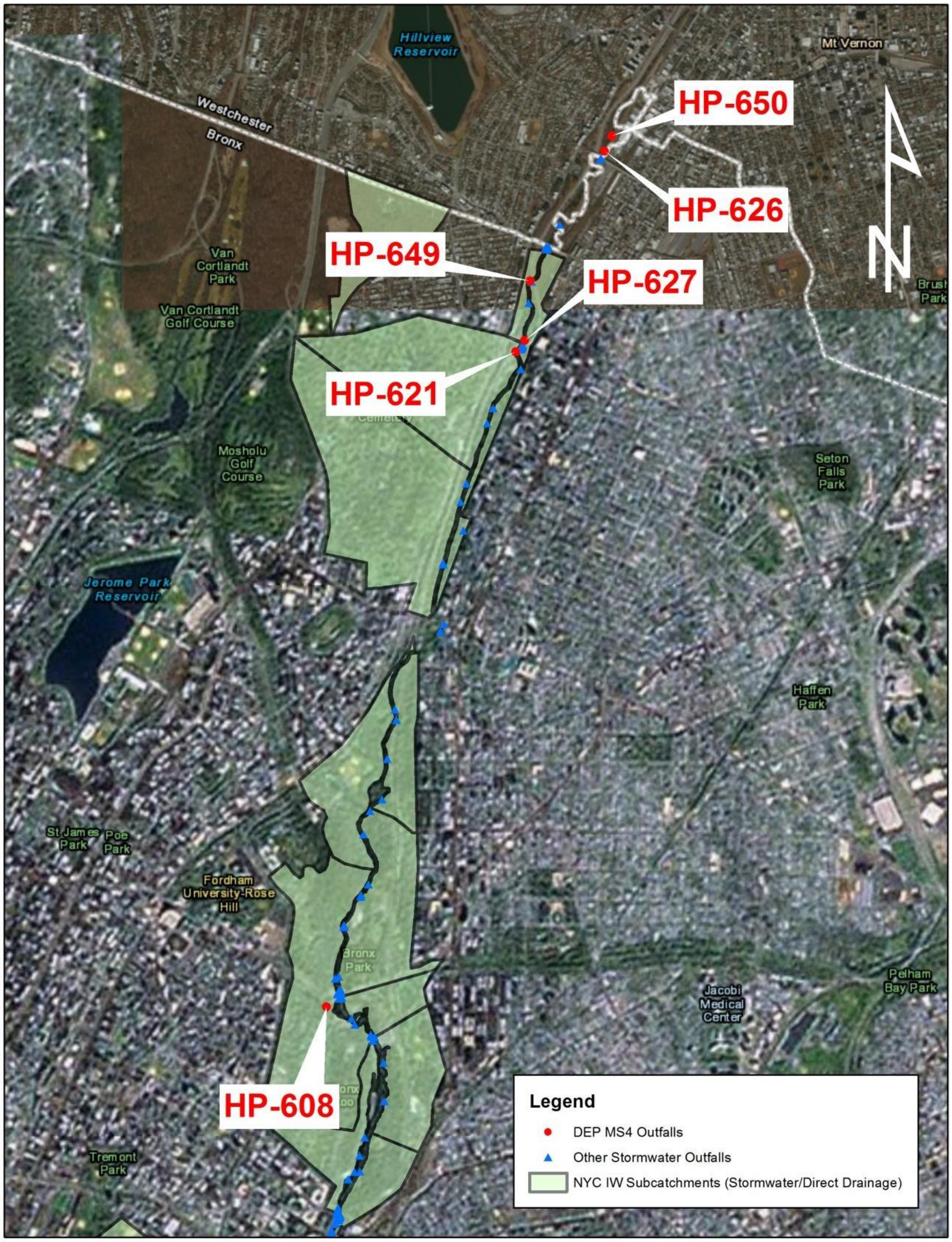

Figure 6-1. InfoWorks Non-CSO Subcatchments within the Freshwater Bronx River

Table 6-2. 2008 Baseline Loading Summary

Totals by Source by Waterbody		Volume	Enterococci	Fecal Coliform	BOD(1)
Waterbody	**Source**	**Total Discharge (MG/yr)**	**Total Org (10^12/yr)**	**Total Org (10^12/yr)**	**Total Lbs/yr**
Bronx River	Westchester County	17,635	501	2,332	247,333(2)
	NYC CSO	454	3,711	16,137	111,202
	NYC Stormwater	7	24	24	876
	NYC Highway	14	4	11	1,751
	NYC Direct Drainage	552	127	85	24,193
	Cope Lake	402	2	8	50,290
Total		**19,064**	**4,369**	**18,597**	**435,645**

Notes:
(1) For saline portion only.
(2) Load into the saline portion from the Bronx River.

Table 6-3. 2008 CSO Volume and Overflows per Year

CSO	Volume(1)	Annual Overflow Events
	Total Discharge (MG/yr)	**Total (No./yr)**
HP-004	9	7
HP-007	32	12
HP-008	1	2
HP-009	413	42
HP-010	0	0
Total	454	-

Notes:
(1) Volumes are rounded to the nearest MG.

The majority of the CSO discharge volume emanates from Outfall HP-009 with 413 MG of the 454 MG of CSO volume under 2008 conditions, as shown in Table 6-3. Outfall HP-009 also discharges more often than the other CSOs, averaging three to four overflow events per month. The other CSOs overflow once per month or less often on average for 2008 conditions. The fraction of the overflow that was calculated by the IW model to be associated with sanitary sewage ranges from approximately 5 percent (Outfall HP-004) to 16 percent (Outfall HP-009), with the remainder being stormwater. The loading for the two largest CSOs was developed using the Monte Carlo approach based on sampling data. For the remaining CSOs, the mass balance approach was used. An example of the IW CSO mass balance concentration calculation for CSO enterococci concentration is presented below using sanitary and storm runoff concentrations from Table 6-1:

$$47{,}500 \text{ cfu/100mL} = 0.05 \times 400{,}000 \text{ cfu/100mL} + 0.95 \times 50{,}000 \text{ cfu/100mL}$$

The total annual volume and average source loadings based on the 2008 year are shown in Table 6-2. The location of the Bronx River SPDES permitted outfalls are depicted in Figure 2-12.

6.3 Performance Gap

Bacteria and DO concentrations in the Bronx River are controlled by a number of factors, including the volumes of all sources into the waterbodies, the concentrations of the respective loadings, the River flow in the non-tidal section, and by the exchange of tidal flow with the East River in the saline section. Because much of the flow and loads discharged into this waterbody are the result of runoff from rainfall events, the frequency, duration and amounts of rainfall strongly influence the Bronx River's water quality. In addition, since the upper portion of the Bronx River is freshwater and flowing, the shorter residence time in that portion of the system also influences water quality.

The Bronx River portion of the ERTM model was used to simulate bacteria and DO concentrations for the baseline conditions using 2008 rainfall and tidal data. Hourly model calculations were saved for post-processing and comparison with the Existing WQ Criteria, Primary Contact Criteria and the Potential Future Primary Contact WQ Criteria, discussed in Section 6.3.c. The performance gap was then developed as the difference between the model-calculated baseline waterbody DO and bacteria concentrations and the applicable numerical WQS. The analysis is developed to address the following three sets of criteria:

- Existing WQ Criteria (Freshwater - Class B, Saline water – Class I);
- Primary Contact WQ Criteria (Freshwater - Class B, Saline water – Class SC), and;
- Potential Future Primary Contact Recreational WQ Criteria (2012 EPA RWQC).

Within the following sections, analyses are described that reflect the differences in attainment both spatially and temporally. Because the gap analysis is meant to assess the impact of CSOs on water quality, the spatial assessment, and therefore the results provided in many of the tables below, focuses on the saline portions of the Bronx River which receives the inflows from NYC sources, as well as a portion of the Westchester County stormwater and the freshwater portion of the Bronx River.

Discharges to the freshwater section are from Westchester County, non-CSO discharges, and outflow from Cope Lake. The temporal assessment focuses on compliance with the applicable fecal coliform water quality criteria over the entire year and in the case of enterococci, during the recreational season of May 1st through October 31st.

A summary of the criteria that were applied is shown in Table 6-4. Analyses in this LTCP were performed using the 30-day rolling GM of 30 cfu/100mL and the STV of 110 cfu/100mL for enterococci.

Table 6-4. Classifications and Standards Applied

<table>
<tr><th>Analysis</th><th colspan="2">Numerical Criteria Applied</th></tr>
<tr><td rowspan="2">Existing WQ Criteria</td><td>Freshwater (Class B)</td><td>Fecal Monthly GM ≤ 200;
Daily Average DO ≥ 5.0 mg/L;
DO never < 4.0 mg/L</td></tr>
<tr><td>Saline Water (Class I)</td><td>Fecal Monthly GM ≤ 2,000
DO never <4.0 mg/L</td></tr>
<tr><td rowspan="2">Primary Contact WQ Criteria(1)</td><td>Freshwater (Class B)</td><td>Fecal Monthly GM ≤ 200
Daily Average DO ≥ 5.0 mg/L;
DO never < 4.0 mg/L</td></tr>
<tr><td>Saline Water (Class SC)</td><td>Fecal Monthly GM ≤ 200
Daily Average DO ≥ 4.8 mg/L;
DO never < 3.0 mg/L</td></tr>
<tr><td>Potential Future Primary Contact WQ Criteria(2)</td><td colspan="2">Entero: rolling 30-d GM – 30 cfu/100mL
Entero: STV – 110 cfu/100mL</td></tr>
</table>

Notes:
GM = Geometric Mean; STV = 90 Percent Statistical Threshold Value
(1) This water quality standard is not currently assigned to the saline Bronx River.
(2) DEC has not yet adopted the Potential Future Primary Contact WQ Criteria.

6.3.a CSO Volumes and Loadings Needed to Attain Current Water Quality Standards

Assessing the performance gap required calculating the Bronx River fecal coliform concentrations under baseline conditions and then to establish whether the gap could be closed through reductions to, or control of, CSO overflows. The assessment was to determine if the Bronx River water quality would comply with Existing WQ Criteria.

2008 Annual Rainfall Simulation – Bacteria

A one-year simulation of bacteria water quality was performed for the 2008 baseline loading conditions, assuming all known dry-weather illicit discharges from Westchester County have been eliminated and that Westchester County portion of the Bronx River was in full attainment with the fecal coliform criteria applicable to Class C waterbodies, and the enterococci rolling 30-day GM ≤ 30 cfu/100mL criteria. The results of these simulations are summarized in Table 6-5. The results shown in this table summarize the highest calculated monthly GM on an annual basis and during the recreational season (May 1st through October 31st). The maximum monthly GM is presented for each sampling location in the Bronx River. The shaded locations (Stations BR-1 to BR-4) shown in Table 6-5 and subsequent tables are the freshwater section of the Bronx River in NYC as per the DEC surface water classifications. The unshaded portions of the table present the results for the tidal or saline section of the Bronx River.

Table 6-5. Calculated 2008 Baseline Fecal Coliform Maximum Monthly GM and Attainment of Existing WQ Criteria

Station			Maximum Monthly Geometric Means		% Attainment	
			Annual	Recreational Season	Annual	Recreational Season
BR-1	Fresh Water (Class B)	Non-Tidal	199	64	100	100
BR-2			199	64	100	100
BR-3			213	64	92	100
BR-4(1)		Tidal	325	183	92	100
BR-5	Saline(Class I)		357	159	100	100
BR-6			439	38	100	100
BR-7			406	29	100	100
BR-8			382	30	100	100
BR-9			242	21	100	100

Notes:
(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

Table 6-5 presents the maximum monthly geometric means (units of cfu/100mL) for the 2008 baseline simulation at each location. The table also presents the annual attainment (percent) of the fecal coliform GM criterion of 200 cfu/100mL in the freshwater section and 2,000 cfu/100mL in the saline section. In the freshwater Class B section of the Bronx River, the month of December is not in attainment with the fecal criterion. The increase in the GM concentration at BR-3 (213 cfu/100mL – fecal coliform) from the GM concentrations at the NYC border (199 cfu/100mL – fecal coliform) is due to the loadings from direct drainage and stormwater within the NYC freshwater region of the Bronx River. The increase in the GM concentration at BR-3 (325 cfu/100mL – fecal coliform) from the GM concentration at Station BR-4 (213 cfu/100mL – fecal coliform) is due to the fact that Station BR-4 is in the tidal section of the Bronx River and is influenced by CSOs (Outfalls HP-004 and HP-007) located a short distance downstream. Table 6-5 also shows the existing Class I criterion (monthly GM of 2,000 cfu/100mL) is met at all locations in the Bronx River and as such there is no gap between the baseline conditions and the calculated bacteria concentrations for the existing criterion.

There is a noticeable increase in the fecal coliform monthly GM downstream of Station BR-3. This is due to the constant loading input from Cope Lake. Downstream of Station BR-4, the fecal coliform GM continues to increase during the critical month. 2008 Annual Rainfall Simulation – Dissolved Oxygen Water quality model simulation DO attainment results are presented in Table 6-6 for year 2008 conditions as calculated for the entire water column. DO was not modeled in the freshwater section because there are no CSO discharges in that section of the Bronx River, so only results in the saline section of the Bronx River are presented. When assessing the water column in its entirety, attainment of the DO criterion is very high. All of the station locations that were assessed have a water column annual attainment of 95 percent or greater for year 2008 conditions.

Table 6-6. Model Calculated Baseline DO Attainment – Existing WQ Criteria (2008)

Station		Annual Attainment (%)
		Entire Water Column
		>=4.0 mg/L
BR-5	Saline (Class I)	99
BR-6		95
BR-7		97
BR-8		99
BR-9		98

Table 6-7 presents a comparison of the Class I DO criterion attainment under baseline and 100% CSO control. The model generally calculates changes of only a few tenths of one percent improvement in attainment with the DO criterion. Thus, CSO loads are not the controlling factor for DO concentrations that are lower than the criterion and CSO controls will not improve DO concentrations substantially. This is not unexpected as the DO in the East River in this area of NYC is influenced by many factors including the nitrogen discharged from WWTPs.

Table 6-7. Model Calculated Baseline and 100% CSO Control DO Attainment – Existing WQ Criteria (2008)

Station		Annual Attainment Percent Attainment (Water Column)	
		Baseline	100% Bronx River CSO Control
BR-5	Saline (Class I)	99	99
BR-6		95	95
BR-7		97	97
BR-8		99	99
BR-9		98	98

6.3.b CSO Volumes and Loadings that would be Needed to Support the Next Highest Use or Swimmable/Fishable Uses

Bacteria

The next highest use for the saline portion of the Bronx River is Class SC with fishing being the best usage. It should also be noted the DEC has introduced a proposed rule to require Class SD and I waterbodies to meet the primary contact (Class SC) bacteria criteria. The Class SC fecal coliform criterion is a monthly GM less than or equal to 200 cfu/100mL. Table 6-8 presents the maximum monthly geometric means for fecal coliform during annual and recreational season (May 1^{st} through October 31^{st}) at each sampling station location. The table also contains the percent attainment of the Class SC criterion for the same periods.

Table 6-8. Calculated 2008 Baseline Fecal Coliform Maximum Monthly GM and Attainment of Primary Contact WQ Criteria

Station			Maximum Monthly Geometric Means (cfu/100mL)		% Attainment	
			Annual	Recreational(1) Season	Annual	Recreational(1) Season
BR-1	Fresh Water (Class B)	Non-Tidal	199	64	100	100
BR-2			199	64	100	100
BR-3			213	64	92	100
BR-4(2)		Tidal	325	183	92	100
BR-5	Saline (Class SC)		357	159	83	100
BR-6			439	38	83	100
BR-7			406	29	83	100
BR-8			382	30	83	100
BR-9			242	21	83	100

Notes:
(1) The Recreational Season is from May 1st through October 31st.
(2) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

The table shows that one to two months of non-attainment occur outside of the recreational season (May 1st through October 31st). For the 2008 baseline conditions, the two months of non-attainment are February and December. Since non-attainment of the Class SC criterion occurs, a gap analysis was performed. The lower percent attainment in the saline portion of the Bronx River is attributable to tidal impacts that result in an increased residence time for the bacteria resulting in elevated monthly geometric mean values. The freshwater portion of the Bronx River has much lower residence times resulting in higher attainment, since the elevated levels of bacteria are only observed during and directly after a wet-weather event and then are quickly transported downstream.

The 2008 baseline condition scenario was rerun with the Bronx River CSO loadings removed. This projection represents the maximum possible reduction of Bronx River CSO loads and is referred to as the 100% CSO control scenario. It should, however, be noted that there are numerous other CSO outfalls that discharge to the East River/Upper East River which remain at baseline conditions for this CSO control scenario. All other conditions from the baseline projection remain unchanged in the 100% CSO control scenario. Table 6-9 presents the maximum monthly fecal coliform GM concentration and the annual attainment of the Class SC criterion for fecal coliform.

Table 6-9. Comparison of the Calculated 2008 Baseline and 100% Bronx River CSO Control Fecal Coliform Maximum Monthly GM and Attainment of Primary Contact WQ Criteria

Station			Maximum Monthly Geometric Means (Annual)		% Attainment (Annual)	
			Baseline	100% CSO Control	Baseline	100% CSO Control
BR-1	Fresh Water (Class B)	Non-Tidal	199	199	100	100
BR-2	Fresh Water (Class B)	Non-Tidal	199	199	100	100
BR-3	Fresh Water (Class B)	Non-Tidal	213	213	92	92
BR-4(1)	Fresh Water (Class B)	Tidal	325	325	92	92
BR-5	Saline (Class SC)	Tidal	357	351	83	83
BR-6	Saline (Class SC)	Tidal	439	382	83	83
BR-7	Saline (Class SC)	Tidal	406	344	83	83
BR-8	Saline (Class SC)	Tidal	382	307	83	83
BR-9	Saline (Class SC)	Tidal	242	231	83	83

Notes:
(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

Table 6-9 shows that the CSOs have the largest impact in the vicinity of Stations BR-6 through BR-8, where the removal of the CSO loading results in a reduction of the maximum monthly fecal coliform GM concentration by 57 to 75 cfu/100mL. The fecal coliform maximum GM concentrations are unchanged in the freshwater section of the Bronx River as they are un-impacted by CSO. The results also indicate there is no change in attainment of the Class SC fecal coliform criterion due to the complete control of Bronx River CSO loadings. Based on these results, the complete control of the Bronx River CSO loadings alone will not close the gap between the 2008 baseline attainment of the Class SC fecal coliform criterion and full attainment. The remaining non-attainment in the saline waters in the non-recreational season (November 1st through April 30th) is attributable to upstream wet-weather loadings from the large drainage area in Westchester County in conjunction with higher residence times of the bacteria in the saline waters due to the tidal impacts that prevent the bacteria from being transported out of the Bronx River.

Dissolved Oxygen

The attainment of the DO Class SC criteria for the entire water column is presented in Table 6-10, respectively, for the baseline and 100% Bronx River CSO control conditions. The attainment of the Primary Contact WQ Criteria is quite high when considering the entire water column. Stations BR-6 through BR-9 remain below the desired 95 percent attainment target, but are close as they range from 92 to 94 percent attainment with the chronic criterion. All of the stations have higher than 95 percent of the acute criterion based on the entire water column. 100% CSO control does not result in significant improvements in attainment of the Class SC criterion, and as such does not close the gap between attainment and non-attainment.

Table 6-10. Model Calculated 2008 Baseline and 100% CSO Control DO Attainment of Primary Contact WQ Criteria

Station		Annual Attainment Percent Attainment (Water Column)			
		Baseline		100% Bronx River CSO Control	
		≥ 4.8 mg/L	≥ 3.0 mg/L	≥ 4.8 mg/L	≥ 3.0 mg/L
BR-5	Saline (Class SC)	100	100	100	100
BR-6		92	97	93	97
BR-7		94	99	94	99
BR-8		94	100	94	100
BR-9		93	100	93	100

6.3.c Potential Future Primary Contact WQ Criteria

As noted in Section 2.0, EPA released its RWQC recommendations in December 2012. These included recommendations for recreational water quality criteria for protecting human health in all coastal and non-coastal waters designated for primary contact recreation use. The standards would include a rolling 30-day GM of either 30 cfu/100mL or 35 cfu/100mL and a 90th percentile STV during the rolling 30-day period of either 110 cfu/100mL or 130 cfu/100mL. An analysis using the 2008 baseline and 100% CSO control condition model simulation results was conducted using both the 30 cfu/100mL GM and 110 cfu/100mL 90th percentile STV criteria, to assess attainment with these potential future RWQC.

6.3.d Load Reductions Needed to Attain the Potential Future Primary Contact WQ Criteria

Additional water quality modeling analyses were performed to assess the extent to which CSO and non-CSO sources impact enterococci concentrations at key locations in the Bronx River. That analysis consisted of first assessing the baseline conditions for enterococci and then determining whether complete Bronx River CSO reduction could close the gap between the baseline conditions and the potential future recreational water quality criterion of a 30-day rolling GM enterococci concentration of 30 cfu/100mL. The results of the analyses are presented in Table 6-11 for the maximum 30-day GM and attainment of the rolling 30-day GM criterion. All results are for the attainment of the Potential Future Primary Contact WQ Criteria during the May 1st through October 31st recreational season defined by the DEC.

Table 6-11. Calculated 2008 Baseline Enterococci Maximum 30-day GM and Attainment of Potential Future Primary Contact Water Quality Criteria

Station			Maximum Recreational Season 30-day Enterococci (cfu/100mL)		% Attainment	
			GM	90th Percentile STV	GM	90th Percentile STV
BR-1	Fresh Water	Non-Tidal	30	1,253	100	5
BR-2	Fresh Water	Non-Tidal	30	1,253	100	5
BR-3	Fresh Water	Non-Tidal	33	1,310	99	4
BR-4(1)	Fresh Water	Tidal	69	1,464	61	2
BR-5	Saline	Tidal	61	1,480	73	2
BR-6	Saline	Tidal	31	479	98	10
BR-7	Saline	Tidal	28	380	100	10
BR-8	Saline	Tidal	31	337	99	11
BR-9	Saline	Tidal	20	135	100	67

Notes:
(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

As previously noted, baseline conditions include water entering the NYC portion of the Bronx River at attainment of the enterococci 30-day rolling GM criterion, but not the 90th percentile STV. As a result, attainment is calculated at Stations BR-1 and BR-2 of the 30-day GM criterion, but attainment of the 90th percentile STV is quite low. As the Bronx River flows further into NYC, the enterococci 30-day GM increases slightly due to input from non-CSO discharges. However, attainment remains very high at Station BR-3. Attainment is lower at Station BR-4, as the contribution of Cope Lake and CSOs increase the enterococci 30-day GMs. Attainment at Stations BR-4 and BR-5 reach only 61 and 73 percent, respectively, on a recreational season (May 1st through October 31st) basis. Further down the Bronx River, saline exchange contributes to additional dilution of the enterococci concentrations to a point where the target of 95 percent attainment is reached for the recreational season. Attainment of the 90th percentile STV is not met throughout the Bronx River.

Water quality modeling analyses conducted to assess attainment of the enterococci criteria with complete removal of the CSO enterococci loadings, as provided in Table 6-12, show marginal increases in attainment of the 30-day GM criterion of 0 to 4 percent. Even with complete Bronx River CSO control, the enterococci criterion of a maximum GM of 30 cfu/100mL is not attained at Stations BR-4 and BR-5 but would be attained in the lower portions of the Bronx River near the East River. There are also small improvements in the attainment of the 90th percentile STV criterion, but not enough to achieve compliance with the standard.

Table 6-12. Calculated 2008 100% CSO Control Enterococci Maximum 30-day GM and Attainment of Potential Future Primary Contact WQ Criteria

Station			Maximum Recreational Season 30-day Enterococci (cfu/100mL)		% Attainment	
			GM	90th Percentile STV	GM	90th Percentile STV
BR-1	Fresh Water	Non-Tidal	30	1,253	100	5
BR-2	Fresh Water	Non-Tidal	30	1,253	100	5
BR-3	Fresh Water	Non-Tidal	33	1,310	99	4
BR-4(1)	Fresh Water	Tidal	69	1,464	61	2
BR-5	Saline	Tidal	58	1,460	75	2
BR-6	Saline	Tidal	27	321	100	13
BR-7	Saline	Tidal	25	233	100	26
BR-8	Saline	Tidal	25	185	100	26
BR-9	Saline	Tidal	20	130	100	70

Notes:
(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

A load source component analysis was conducted for the 2008 baseline condition using JFK Airport rainfall data, to provide a better understanding of how each source type contributes to bacteria concentrations in the Bronx River. The source types include the Bronx River entering NYC at the Westchester County border, non-CSO discharges (stormwater and direct drainage) in the freshwater section of the Bronx River in NYC, non-CSO discharges (believed to be entirely direct drainage) in the saline section of the Bronx River, CSOs, and the East River. The analysis was completed at Stations BR-1, BR-2 and BR-3 using SWMM, and ERTM model is used for BR-4 in the freshwater section and Stations BR-5 through BR-9 in the saline section. The analysis included the calculation of fecal coliform and enterococci bacteria GMs in total and from each component. For fecal coliform, a maximum winter month (February) was analyzed because the decay rate is lower in winter, resulting in generally higher fecal coliform concentrations. Enterococci was evaluated on a recreational season (May 1st through October 31st) basis. The 30-day period chosen for the enterococci component analysis was the 30-day period where the maximum contribution of CSOs to the geometric mean was observed instead of the overall maximum 30-day rolling enterococci GM during the recreational season.

Table 6-13 summarizes the fecal coliform component analysis for the maximum winter month during 2008 based on the saline portion of the Bronx River. The fecal coliform criterion is exceeded during this maximum winter month (February) at all locations from Stations BR-5 through BR-9 as discharges into the East River from various sources outside of the Bronx River increase fecal coliform concentrations during this period. The maximum monthly CSO contribution is 96 cfu/100mL at Station BR-7. If DEP were to fully control the CSOs, there would be no changes from the current non-attainment of the Primary Contact WQ Criteria (Class SC) fecal coliform criterion, as reductions from other sources would still be required.

Table 6-13 also summarizes the enterococci component analysis. In the areas where the 30-day GM is calculated to exceed the Potential Future Primary Contact 30-day rolling GM enterococci criterion, CSOs either do not contribute to the GM, or are minor contributors. In the areas were CSOs have some impact (e.g., Station BR-8), the CSO contribution to the GM is minor. The maximum calculated enterococci GM contribution at any location from CSOs is 7 cfu/100mL. This is because CSOs discharge infrequently relative to other bacteria sources.

Table 6-13. Fecal and Enterococci GM Source Components

Source	Station	Fecal Coliform Contribution (cfu/100mL)	Enterococcus Contribution (cfu/100mL)
		Annual Worst Month February Monthly GM	Max(1) 30-Day Rolling GM during the Recreational Season (May 1st through October 31st)
Bronx River at County Line	BR-1	85	30
NYC Freshwater Non-CSO	BR-1	0	0
NYC Saline Non-CSO	BR-1	0	0
CSO	BR-1	0	0
East River	BR-1	0	0
Total	BR-1	**85**	**30**
Bronx River at County Line	BR-2	85	30
NYC Freshwater Non-CSO	BR-2	0	0
NYC Saline Non-CSO	BR-2	0	0
CSO	BR-2	0	0
East River	BR-2	0	0
Total	BR-2	**85**	**30**
Bronx River at County Line	BR-3	84	29
NYC Freshwater Non-CSO	BR-3	12	4
NYC Saline Non-CSO	BR-3	0	0
CSO	BR-3	0	0
East River	BR-3	0	0
Total	BR-3	**96**	**33**
Bronx River at County Line	BR-4	74	25
NYC Freshwater Non-CSO	BR-4	86	44
NYC Saline Non-CSO	BR-4	0	0
CSO	BR-4	0	0
East River	BR-4	0	0
Total	BR-4	**160**	**69**
Bronx River at County Line	BR-5	80	24
NYC Freshwater Non-CSO	BR-5	83	34
NYC Saline Non-CSO	BR-5	0	0
CSO	BR-5	8	2
East River	BR-5	44	1
Total	BR-5	**215**	**61**
Bronx River at County Line	BR-6	64	9

Table 6-13. Fecal and Enterococci GM Source Components

Source	Station	Fecal Coliform Contribution (cfu/100mL)	Enterococcus Contribution (cfu/100mL)
		Annual Worst Month February Monthly GM	Max(1) 30-Day Rolling GM during the Recreational Season (May 1st through October 31st)
NYC Freshwater Non-CSO	BR-6	21	2
NYC Saline Non-CSO	BR-6	6	1
CSO	BR-6	82	5
East River	BR-6	266	4
Total	BR-6	**439**	**21**
Bronx River at County Line	BR-7	40	7
NYC Freshwater Non-CSO	BR-7	10	1
NYC Saline Non-CSO	BR-7	24	2
CSO	BR-7	96	5
East River	BR-7	212	5
Total	BR-7	**382**	**20**
Bronx River at County Line	BR-8	19	4
NYC Freshwater Non-CSO	BR-8	3	0
NYC Saline Non-CSO	BR-8	18	3
CSO	BR-8	87	7
East River	BR-8	279	7
Total	BR-8	**406**	**21**
Bronx River at County Line	BR-9	3	1
NYC Freshwater Non-CSO	BR-9	0	0
NYC Saline Non-CSO	BR-9	1	0
CSO	BR-9	12	1
East River	BR-9	226	10
Total	BR-9	**242**	**12**

Notes:
(1) Based on the 30-day period with the maximum CSO contribution to the GM.

Table 6-13 indicates that CSO impacts to attainment are limited to the saline portion of the Bronx River, although the extent of CSO contribution varies both spatially and temporally. As such, the alternatives analysis described in Section 8.0 focuses on reduction of the CSO discharges to the saline portion of the Bronx River.

6.3.e Time to Recovery

The analyses provided above examine the long term impacts of wet-weather sources, as is required by Existing and Potential Future Primary Contact WQ Criteria (monthly GM and 30-day GM). Shorter-term impacts are not evaluated using these regulatory criteria. Therefore, to gain insight to the shorter term impacts of wet-weather sources of bacteria, DEP has reviewed the DOH guidelines relative to single sample maximum bacteria concentrations that DOH believes "constitute a potential hazard to health if used for bathing". The presumption is that if the bacteria concentrations are lower than these levels, then the waterbodies do not pose potential hazards if primary contact is practiced.

DOH considers fecal coliform concentrations that exceed 1,000 cfu/100mL to be potential hazards to bathing. Water quality modeling analyses were conducted to assess the amount of time following the end of rainfall required for the saline portion of the Bronx River to recover and return to concentrations of less than 1,000 cfu/100mL.

From NYS DOH

https://www.health.ny.gov/regulations/nycrr/title_10/part_6/subpart_6-2.htm

Operation and Supervision

6-2.15 Water quality monitoring
(a) No bathing beach shall be maintained … to constitute a potential hazard to health if used for bathing. To determine if the water quality constitutes a potential hazard … shall consider one or a combination of any of the following items: results of a sanitary survey; historical water quality model for rainfall and other factors; verified spill or discharge of contaminants affecting the bathing area; and water quality indicator levels specified in this section.

(1) Based on a single sample, the upper value for the density of bacteria shall be: (i) 1,000 fecal coliform bacteria per 100 ml; or …(iii) 104 enterococci per 100 ml for marine water; ….

The LGA rainfall data were first analyzed for the period of 2002-2011. The SYNOP model was used to identify each individual storm and calculate the storm volume, duration and start and end times. Rainfall periods separated by four hours or more were considered separate storms. Statistical analysis of the individual rainfall events for the recreational seasons (May 1st through October 31st) of the 10-year period resulted in a 90th percentile rainfall event of 1.09 inches. Based on this information, a storm approximating the 90th percentile storm was chosen from the 2008 recreational season as a design storm. This design storm was the August 15, 2008 JFK rainfall event, which resulted in 1.02 inches of precipitation. A principal feature of this storm, aside from its volume, was the time until the next rainfall allows concentrations time to reach the fecal coliform target concentration.

Table 6-14 presents the time to recovery for the baseline condition and the 100% Bronx River CSO control scenario. Under the baseline conditions, Stations BR-4 and BR-5 has the longest time to recovery of 27 hours. DEC has indicated that it is desirable to have a time to recovery of less than 24 hours. The other stations in the Bronx River have time to recovery ranging between 4 and 26 hours. It should be noted that when the Bronx River CSO loading is removed the maximum time to recovery remains 27 hours at Stations BR-4 and BR-5, as it is heavily influenced by the freshwater portion of the Bronx River. CSOs do not discharge into the freshwater section of the Bronx River, so CSO controls have no impact in the time to recovery in that portion of the Bronx River. Decreases in the time to recovery are observed in the lower portions of the Bronx River (Stations BR-6 through BR-9) with time reductions of 2 to 8 hours. In the case of time to recovery, the gap between the existing time to recovery and the desired time to recovery cannot be achieved with CSO controls alone.

Table 6-14. Time to Recovery

Station			Time to Recovery (hours) Fecal Threshold (1,000 cfu/100mL)	
			Baseline	**100% CSO Control**
BR-1	Fresh Water	Non-tidal	25	25
BR-2			25	25
BR-3			26	26
BR-4[(1)]		Tidal	27	27
BR-5	Saline		27	27
BR-6			23	15
BR-7			21	13
BR-8			15	11
BR-9			4	2

Notes:

(1) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

In summary, the time to recovery appears to be on the order of DEC's desired target of 24 hours whether CSO discharges are present or not.

7.0 PUBLIC PARTICIPATION AND AGENCY COORDINATION

DEP is committed to implementing a proactive and robust public participation program to inform the public about the development of watershed-specific and citywide LTCPs. Public outreach and public participation are important aspects of plans, which are designed to reduce CSO-related impacts to achieve waterbody-specific WQS, consistent with the Federal CSO Policy and the CWA, and in accordance with EPA and DEC mandates.

DEP's Public Participation Plan was released to the public on June 26, 2012, and describes the tools and activities DEP will use to inform, involve and engage a diverse group of stakeholders and the broader public throughout the LTCP process. The purpose of the Plan is to create a framework for communicating with, and soliciting input from, interested stakeholders and the broader public concerning water quality and the challenges and opportunities for CSO controls. As described in the Public Participation Plan, DEP will strategically and systematically implement activities that meet the information needs of a variety of stakeholders in an effort to meet critical milestones in the overall LTCP schedule outlined in the amended 2012 CSO Order on Consent.

As part of the CSO Quarterly Reports, DEP will report to DEC on public participation activities outlined in the Public Participation Plan. Updates to the Public Participation Plan that are implemented in response to public comments will be posted annually to DEP's website, along with the quarterly summary of public participation activities reported to DEC.

7.1 Local Stakeholder Team

DEP began the public participation process for the Bronx River LTCP by reaching out to the Bronx Community Boards to identify the stakeholders who would be instrumental to the development of this LTCP. Stakeholders identified included both citywide and regional groups, including: environmental organizations (Sustainable South Bronx, Sierra Club, Wildlife Conservatory Society, Bronx River Parkway Conservatory, Bronx River Alliance, Partnership for Parks, Friends of Soundview Park, New York Botanical Garden); community planning organizations (Bronx Community Board #9, Phipps Neighborhood, The Point Community Development Corporation, City Parks Foundation, Metro Plus Health Plan); engineering, energy and economic organizations, (Con Edison, Leonard J. Strandberg and Associates, Major Carter Group, Meta Local Collaborative, Forna Labs); academic and research organizations (Bronx Center of Science and Math, the City College of New York, The Point, Bronx Children Museum); City governmental agencies (NYC Department of Parks and Recreation, Bronx Council of Environmental Quality, NYC Department of City Planning, Bronx District Public Health Office, U.S. Geological Survey, NYS Assemblyman Group).

7.2 Summaries of Stakeholder Meetings

DEP held (two) public meetings and (four) stakeholder group meetings to aid in the development and execution of the LTCP. The objective of the public meetings and a summary of the discussions are presented below:

Public Meetings

- Public Meeting #1: Bronx River LTCP Kickoff Meeting (February 12, 2015)

  Objectives: Provide overview of LTCP process, public participation schedule, watershed characteristics and improvement projects; solicit input on waterbody uses.

  DEP and DEC co-hosted a Public Kickoff Meeting to initiate the water quality planning process for long term control of CSOs in the Bronx River Waterbody. The two-and-half-hour event, held at Casita Maria Center for Arts and Education, Bronx, provided information about DEP's LTCP Program, presented information on the Bronx River watershed characteristics and status of waterbody improvement projects, solicited information from the public about its use of the Bronx River, and described additional opportunities for public input and outreach. The presentation can be found at http://www.nyc.gov/dep/ltcp/. Approximately 78 stakeholders from 36 different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event, as did three media representatives

  The Bronx River LTCP Kickoff Public Meeting was the first opportunity for public participation in the development of this LTCP. As part of the development of the LTCP, and in response to stakeholder comments, DEP provided detailed information about each of the following::

  - CSO reductions and potential existing and future CSO-related projects in Bronx River;
  - Modeling baseline assumptions utilized during LTCP development;
  - Rainfall amounts and other assumptions utilized during LTCP development;
  - Water quality data collection;
  - Existing Bronx River CSO discharges; and
  - Future public meeting announcements.

  Stakeholder comments and DEP's responses are posted to DEP's website and are included in Appendix B, Public Participation Materials.

- Public Meeting #2: Bronx River LTCP Alternatives Review Meeting (May 7, 2015)

  Objectives: Review proposed alternatives, related waterbody uses and water quality conditions.

  On May 7, 2015, DEP hosted a second Public Meeting to continue discussion of the water quality planning process for long term control of CSOs in Bronx River. The purpose of the two-hour event, held at Casita Maria Center for Arts and Education in Bronx, was to describe the alternatives identification and selection processes, and receive public comment on that information. The presentation is on DEP's LTCP Program Website: http://www.nyc.gov/dep/ltcp. Approximately 40 stakeholders from several different non-profit, community planning, environmental, economic development, and governmental organizations, as well as the general public, attended the event..

As part of the development of the LTCP, and n response to stakeholder comments, DEP provided detailed information about each of the following:

- Modeling baseline assumptions utilized during LTCP development, including the rainfall conditions utilized;
- Existing and future predicted CSO discharges;
- Water quality data collection;
- Stormwater inputs/contributions to Bronx River;
- Green infrastructure and grey infrastructure potential alternatives;
- Opportunity to review and comment on the draft Bronx River LTCP; and
- Future public meeting announcements.

Stakeholder comments and DEP's responses are posted on DEP's website, and are included in Appendix B, Public Participation Materials.

- Public Meeting #3: Draft LTCP Review Meeting (not yet scheduled)

  Objectives: Present LTCP after review by DEC

  This meeting will will present the final recommended plan to the public after DEC review. Outcomes of the discussion and a copy of presentation materials will be posted to DEP's website.

Stakeholder Meetings

- Meeting with Combined Borough Board and Borough Services (January 22, 2015)

  DEP staff met with the Deputy Borough President (and staff), the District Managers of all of the Bronx Community Boards, and representatives from various Council Members. Staff from DEP presented information on the LTCP Program, Bronx River water quality and waterbody characteristics, and explained the LTCP planning and alternatives processes.

- Meeting with Riverkeeper and Bronx Alliance (February 9, 2015)

  DEP staff with Riverkeeper and the Bronx Alliance to present sampling data obtained during the LTCP Bronx River sampling programs as well as data from Harbor Survey and Sentinel monitoring.

- Meeting with Environmental Committee of Community Board 2 (April 1, 2015)

  DEP staff met with the Environmental Committee of Community Board 2 to present the Kick-off Meeting presentation given during the February 12, 2015 public meeting.

- Meeting with Riverkeeper, Bronx Alliance and NRDC (May 5, 2015)

  DEP staff met with the Riverkeeper, Bronx Alliance and a representative from the NRDC to present sampling data and alternatives considered during development of the LTCP.

Public Comments Received

DEP received the following comments:

- Bronx River Alliance Comments on DEP's Long Term Control Plan for the Bronx River, March 3, 2015.
- Email from Nandan Hara Shetty. Bronx River CSO LTCP, May 29, 2015.
- Email from Carolyn McLaughlin. Bronx River Long Term Control Plan Comments, June 20, 2015

These comments are posted to DEP's website and are included in Appendix B, Public Participation Materials.

7.3 Coordination with Highest Attainable Use

DEC has designated Bronx River Class B for the freshwater section and Class I for the salinesection. The CSO-impacted Class I portion of the Bronx River is the subject of this LTCP. The best usages of Class I waters are "secondary contact recreation and fishing" (6 New York Code of Rules and Regulations [NYCRR] 701.13). DEC has publicly noticed a proposed rulemaking to amend 6 NYCRR Parts 701 and 703. The proposed total and fecal coliform bacteria criteria of 200 cfu/100mL would be the same for Class SD, Class I and SC waters.

Detailed analyses performed during the Bronx River LTCP concluded that the proposed Primary Contact WQ Criteria (Class SC) in this waterbody would not be attained for both the annual fecal coliform and DO) criteria with implementation of the preferred alternative. These analyses also suggested that the Class SC fecal coliform and DO criteria will not be attained even with the implementation of 100% CSO control. The inability to meet a primary contact bacteria standard is primarily due to direct drainage, CSO and urban runoff. DO levels appear to be related to non-CSO related conditions in the Bronx River. Based upon water quality modeling, DEP projects that with the completion of the grey and green projects listed in this LTCP, improvements in water quality in the Bronx River will be realized. Based on the predicted water quality improvements with the proposed project and the UAA process (presented in Appendix C), it is anticipated that the Bronx River should be upgraded to SC classification (with a wet-weather advisory) during recreational season, although a variance for DO levels would be still be required.

7.4 Internet Accessible Information Outreach and Inquiries

Both traditional and electronic outreach tools are important elements of DEP's overall communication effort. DEP will ensure that outreach tools are accurate, informative, up-to-date and consistent, and are widely distributed and easily accessible. Table 7-1 presents a summary of Bronx River LTCP public participation activities.

Table 7-1. Summary of Bronx River LTCP Public Participation Activities Performed

Category	Mechanisms Utilized	Dates (if applicable) and Comments
Regional LTCP Participation	Citywide LTCP Kickoff Meeting and Open House	• June 26, 2012
	Annual Citywide LTCP Meeting – Modeling Meeting	• February 28, 2013
Waterbody-specific Community Outreach	Public meetings and open houses	• Kickoff Meeting: February 12, 2015 • Meeting #2: May 7, 2015 • Meeting #3: TBD
	Stakeholder meetings and forums	• Borough Board and Borough Services Meeting on January 22, 2015 • Riverkeeper and Bronx Alliance Sampling Data Meeting on February 9, 2015
	Elected officials briefings	• November 18, 2014
Data Collection and Planning	Establish online comment area and process for responding to comments	• Comment area added to website on October 1, 2012 • Online comments receive response within two weeks of receipt
	Update mailing list database	• DEP updates master stakeholder database (700+ stakeholders) before each meeting
Communication Tools	Program Website or Dedicated Page	• LTCP Program website launched June 26, 2012 and frequently updated • Bronx River LTCP web page launched January 30, 2015
	Social Media	• TBD
	Media Outreach	• Published advertisements in newspapers, Caribbean Life and Bronx Times Reporter
	FAQs	• LTCP FAQs developed and disseminated beginning June 2014 via website, meetings and email
Communication Tools	Print Materials	• LTCP FAQs: June 11, 2014 • LTCP Goal Statement: June 26, 2012 • LTCP Public Participation Plan: June 26, 2012 • Bronx River Summary: February 12, 2015 • LTCP Program Brochure: February 12, 2015 • Glossary of Modeling Terms: February 28, 2013 • Meeting advertisements, agendas and presentations • PDFs of poster board displays from meetings • Meeting summaries and responses to

Table 7-1. Summary of Bronx River LTCP Public Participation Activities Performed

Category	Mechanisms Utilized	Dates (if applicable) and Comments
		comments • Quarterly Reports • WWFPs
	Translated Materials	• As-needed basis
	Portable Informational Displays	• Poster board displays at meetings
Student Education	Participate in ongoing education events	• N/A
	Provide specific green and grey infrastructure educational modules	• N/A

DEP launched its LTCP Program website on June 26, 2012. The website provides links to documents related to the LTCP Program, including CSO Orders on Consent, approved WWFPs, CSO Quarterly Reports, links to related programs, such as the Green Infrastructure Plan, and handouts and poster boards distributed and displayed at public meetings and open houses. An LTCP feedback email account was also created to receive LTCP-related feedback, and stakeholders can sign up to receive LTCP Program announcements via email. In general, DEP's LTCP Program Website:

- Describes the LTCP process, CSO-related information and citywide water quality improvement programs to-date;
- Describes waterbody-specific information including historical and existing conditions;
- Provides the public and stakeholders with timely updates and relevant information during the LTCP process, including meeting announcements;
- Broadens DEP's outreach campaign to further engage and educate the public on the LTCP process and related issues; and
- Provides an online portal for submission of comments, letters, suggestions, and other feedback.

A dedicated Bronx River LTCP webpage was created on January 30, 2015, and includes the following information:

- Bronx River public participation and education materials
  - Bronx River Summary Paper
  - LTCP Public Participation Plan
- Bronx River LTCP Meeting Announcements
- Bronx River Kickoff Meeting Documents – February 12, 2015
  - Advertisement
  - Meeting Presentation
  - Meeting Summary and Response to Comments

- Presentation to Bronx Deputy Borough President, Combined Borough Board and Borough Services Meeting – January 22, 2015
- Bronx River Meeting #2 Meeting Documents – May 7, 2015
  - Meeting Advertisement
  - Meeting Presentation
- Meeting Summaries and Responses to Comments

8.0 EVALUATION OF ALTERNATIVES

This section of the LTCP describes the development and evaluation of CSO control measures and watershed-wide alternatives. A CSO control measure is defined as a technology (e.g., treatment or storage), practice (e.g., NMC or BMP), or other method (e.g., source control or GI) of abating CSO discharges or the effects of such discharges on the environment. Alternatives evaluated herein are comprised of a single CSO control measure or a group of control measures that will collectively address the water quality objectives for the Bronx River.

This section contains the following information:

- Process for developing and evaluating CSO control alternatives that reduce CSO discharges and improve water quality (Section 8.1).
- CSO control alternatives and their evaluation (Section 8.2).
- CSO reductions and water quality benefits achieved by the higher-ranked alternatives, as well as their estimated costs (Sections 8.3 and 8.4).
- Cost-performance and water quality attainment assessment for the higher-ranked alternatives to select the preferred alternative (Section 8.5).

Water quality attainment of CSO control alternatives evaluated in this section considered the bacteria WQ criteria presented in Section 6.0, Table 6-3. The preferred alternative is also evaluated in terms of attainment of the existing DO criteria.

8.1 Considerations for LTCP Alternatives Under the Federal CSO Policy

This LTCP addresses the water quality objectives of the CWA, the CSO Control Policy, and the New York State Environmental Conservation Law (ECL). This LTCP also builds upon the conclusions presented in DEPs July 2010 Bronx River WWFP. As required by the 2012 CSO Order on Consent, when the proposed alternative set forth in the LTCP will not achieve Existing WQ Criteria or the Section 101(a)(2) goals, a UAA must be prepared. A UAA is the mechanism to examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State. If deemed necessary under these conditions, the UAA would assess the compliance of the next higher classification that the State would consider in adjusting WQS and developing waterbody-specific criteria.

The remainder of Section 8.1 discusses the development and evaluation of CSO control measures and watershed-wide alternatives to comply with the CWA in general, and with the CSO Control Policy in particular. The evaluation factors considered for each alternative are described, followed by the process for evaluating the alternatives.

8.1.a Performance

Section 6.0 presented evaluations of baseline LTCP conditions, and concluded that no performance gaps exist because baseline conditions attain Existing WQ Criteria (Class I). The analyses presented in Section 6.0 show that the Bronx River cannot attain the Primary Contact WQ Criteria (Class SC) even with 100% CSO control due to limited tidal exchange and flushing, and the presence of other sources being discharged to the freshwater portion of the Bronx River. Discussion of performance for the Bronx River alternatives will focus on bacteria criteria for Existing WQ Criteria (Class I), Primary Contact WQ Criteria (Class SC), and Potential Future Primary Contact WQ Criteria (2012 EPA RWQC).

The analyses in Section 6.0 also showed that the Bronx River cannot attain the designated DO criterion, even with 100% CSO control in place. DO is addressed herein, with the primary focus of the cost-performance analyses is bacteria reduction and WQ attainment of bacteria criteria.

A major focus of the development and evaluation of control alternatives is the ability to achieve bacteria load reduction and to attain applicable water quality criteria. A two-step process is used. First, based upon watershed (IW) model runs for typical year (2008) rainfall, the level of CSO control of each alternative is established, including the reduction of CSO volume, fecal coliform, and enterococci loading. The second step uses the estimated levels of CSO control to project levels of attainment in the receiving waters. This step uses the ERTM water quality model. LTCPs are typically developed with alternatives that span a range of CSO volumetric (and loadings) reductions. Accordingly, this LTCP includes alternatives that consider a wide range of reductions in CSO loadings - up to 100% CSO control - including investments made by DEP through green and grey infrastructure. Intermediate levels of CSO volume control, approximately 25%, 50% and 75%, are also evaluated. However, for some alternative control measures, such as disinfection, there would be no reduction in CSO volume but significant reductions in bacteria loading would result instead. Performance of each control alternative is measured against its ability to meet the CWA and water quality requirements for the 2040 planning horizon as described in Section 6.0.

8.1.b Impact on Sensitive Areas

In developing LTCP alternatives, special effort is made to minimize the impact of construction, to protect existing sensitive areas, and to enhance water quality in sensitive areas. As described in Section 2.0, no sensitive areas exist within the Bronx River, so only construction impacts were considered, as appropriate.

8.1.c Cost

Cost estimates for the alternatives were computed using a costing tool based on parametric costing data. This approach provides an Association for the Advancement of Cost Engineering (AACE) Class 5 estimate (accuracy range of minus 20 to 50 percent to plus 30 to 100 percent), which is typical and appropriate for this type of planning evaluation. For the purpose of this LTCP, all costs are in February 2015 dollars.

For the LTCP alternatives, PBC was used as the estimate of the capital cost. Annual O&M costs are then used to calculate the total or net present worth (NPW) over the projected useful life of the project. A lifecycle of 20 years and an interest rate of three percent were assumed resulting in a Present Worth Factor of 14.877.

To quantify costs and benefits, alternatives are compared based on reductions of both CSO discharge volume and bacteria loading against the total cost of the alternative. These costs are then used to plot the performance and attainment curves. A pronounced inflection point appearing in the resulting graphs, the so-called KOTC point, suggests a potential cost-effective alternative for further consideration. In essence, this would reflect the alternative that achieves the greatest appreciable water quality improvements per unit of cost. However, this may not necessarily be the lowest cost alternative. The final, or preferred, alternative must be capable of improving water quality in a fiscally responsible and affordable manner to ensure that resources are properly allocated across the overall citywide LTCP program. These monetary considerations also must be balanced with non-monetary factors, such as environmental benefits, technical feasibility and operability, which are discussed below.

8.1.d Technical Feasibility

Several factors were considered when evaluating technical feasibility, including:

1. Effectiveness for controlling CSO
2. Reliability
3. Implementability

The effectiveness of CSO control measures was assessed based on their ability to reduce CSO frequency, volume, and load. Reliability is an important operational consideration, and can have an impact on overall effectiveness of a control measure. Therefore, reliability and proven history were used to assess the technical feasibility and cost-effectiveness of a control measure.

Several site-specific factors were considered to evaluate an alternative's implementability, including available space, neighborhood assimilation, impact on parks and green space, and overall practicability of installing - and later maintaining - CSO controls. In addition, the method of construction was factored into the final selection. Some technologies require specialized construction methods that typically incur additional costs.

8.1.e Cost-Effective Expansion

All alternatives evaluated were sized to handle the 2040 design year CSO volume, with the understanding that the predicted and actual flows may differ. To help mitigate the difference between predicted and actual flows, adaptive management was considered for those CSO technologies that can be expanded in the future to capture or treat additional CSO flows or volumes, should it be needed. In some cases, this may have affected where the facility would be constructed, or gave preference to a facility that could be expanded at a later date with minimal cost and disruption of operation.

Breaking construction into segments allowed adjustment of the design of future phases based on the performance of already-constructed phases. Lessons learned during operation of the current facilities can be incorporated into the design of the future facilities. However, phased construction also exposes the local community to a longer construction period. Where applicable, for those alternatives that can be expanded, the LTCP discusses how easily they can be expanded, what additional infrastructure may be required, and if additional land acquisition would be needed.

As regulatory requirements change, other water quality improvements may be required. The ability of a CSO control technology to be retrofitted to handle process improvements improves the assessment of that technology.

8.1.f Long Term Phased Implementation

The recommended implementation steps associated with the preferred alternative are structured in a way that makes them adaptable to change by expansion and modification, in response to new regulatory and/or local drivers. If applicable, the project(s) would be implemented over a multi-year schedule.

Because of this, permitting and approval requirements must be identified prior to selection of the alternative. These were identified along with permit schedules where appropriate. With the exception of GI, which is assumed to occur on both private and public property, most if not all of the CSO grey technologies are limited to NYC-owned property and right-of-way-acquisitions. DEP will work closely with other NYC agencies, and NYS as necessary, to ensure proper coordination with other government entities.

8.1.g Other Environmental Considerations

Impacts on the environment and surrounding neighborhood will be minimized, as much as possible, during construction. These considerations include traffic impacts, site access issues, park and wetland disruption, noise pollution, air quality, and odor emissions. To ensure that environmental impacts are minimized, they will be identified with the selection of the recommended plan and communicated to the public. The specific details on the mitigation of the identified concerns and/or impacts, such as erosion control measures and the rerouting of traffic, for example, will be addressed in a pre-construction environmental assessment.

8.1.h Community Acceptance

As described in Section 7.0, DEP is committed to involving the public, regulators and other stakeholders throughout the planning process. The scope of the LTCP, background and newly collected data, WQS, and the development and evaluation of alternatives, were presented. Community acceptance of the recommended plan is essential to its success. As such, DEP has used the LTCP public participation process to gain that acceptance. The Bronx River LTCP is intended to improve water quality and the public's health and safety are a priority of the LTCP. The goal of raising awareness of, and access to, waterbodies was considered throughout the alternative analysis. Several CSO control measures, such as GI, have been shown to enhance communities while increasing local property values. As such, the benefits of GI were considered in the formation of the baseline and the final recommended plan.

8.1.i Methodology for Ranking Alternatives

The multi-step evaluation process that DEP employed in developing the Bronx River LTCP proposed CSO control measures and watershed-wide alternatives included the following:

1. Evaluating benchmarking scenarios, including baseline and 100% CSO control, to establish the full range of controls within the Bronx River watershed. The results of this step were described in Section 6.0.

2. Using baseline conditions, prioritizing the CSO outfalls for possible controls.

3. Developing a list of promising control measures for further evaluation based in part on the prioritized CSO list.

4. Establishing levels of intermediate CSO control that provide a range between baseline and 100% and conducting receiving water quality simulations of these.

5. Conducting an initial "brainstorming" meeting with DEP staff on January 15, 2015, to review the most promising control measures and to solicit additional options to explore.

6. Conducting a second "brainstorming" meeting on March 24, 2015, to further review additional detail on the most promising control measures and to solicit additional options to further explore.

7. Conducting a broader LTCP workshop on April 2, 2015, during which the water quality benefits, costs and fatal flaws of the alternatives under consideration were evaluated.

The focal points of this process were the meetings and workshops listed above. Prior to the first meeting, the universe of control measures that were evaluated in the 2010 WWFP was revisited from the perspective of the LTCP goal statement and in light of the implemented WWFP. Additional control measures were also identified and assessed. The resultant control measures were introduced at the first meeting. Based on discussions at the first meeting, further additional control measures were identified. A preliminary evaluation of these control measures was then conducted including an initial estimation of costs and water quality impacts. During the second meeting, promising alternatives were reviewed in more detail. The LTCP workshop, where a broader array of DEP operational and engineering staff attended, included updated alternative assessments and a final fatal-flaw analysis.

The range of control measures that were considered fall under the categories of Source Control, System Optimization, CSO Relocation, Water Quality/Ecological Enhancement, Treatment, and Storage, with the following constituents:

1. **Source Control**
   - Additional GI
   - HLSS

2. **System Optimization**
   - Fixed Weirs
   - Parallel Interceptor Sewer
   - Inflatable Dams, Bending Weirs and Control Gates
   - Pump Station (PS) Expansion

3. **CSO Relocation**
   - Gravity Flow Tipping to Other Watersheds
   - Pump Station Modifications
   - Flow Tipping with Conduit/Tunnels and Pumping

4. **Water Quality/Ecological Enhancement**
   - Floatables Control
   - Dredging
   - Dissolved Oxygen Improvement
   - Flushing Tunnel

5. **Treatment**
   - Outfall Disinfection
   - Retention Treatment Basin (RTB)
   - High Rate Clarification (HRC)

6. **Storage**
   - In-System
   - Shaft
   - Tank
   - Tunnel

Figure 8-1 presents these control measures according to their relative cost and level of complexity. The control measures in the upper left hand corner are generally the least costly and least complex to construct and/or operate while those towards the lower right are the most costly and most complex to construct and/or operate. The level of loading removal performance of each measure typically corresponds with the level of cost and complexity.

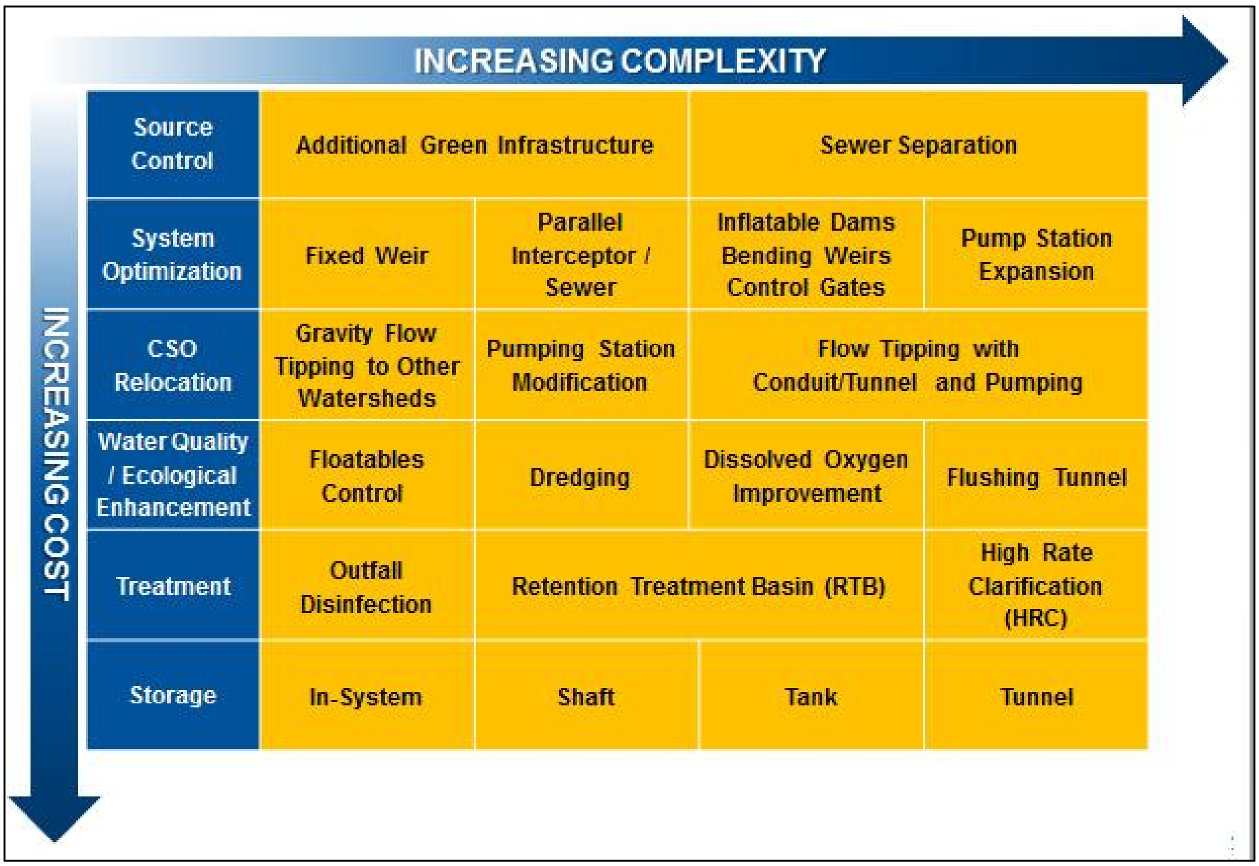

Figure 8-1. Matrix of CSO Control Measures for the Bronx River

During the initial screening meeting, most of the control measures advanced to a second level of evaluation with the exception of the following:

- Pump Station Expansion/Modification: No pump stations were located on the major combined sewers or interceptors in the Bronx River watershed.
- Flow Tipping with Conduit/Tunnel and Pumping: Direct diversion to another watershed was not found to be practical due to the length of required diversion conduits.

- Dredging: Sediment buildup in the Bronx River was not raised as a concern throughout this or previous planning efforts, including the 2010 WWFP.
- Dissolved Oxygen Improvements: Modeling indicated that 100% CSO control would have little to no impact on minimum DO levels in the Bronx River.
- Flushing Tunnel: Because the salt water reach of the Bronx River receives continuous flow from the upstream freshwater reach, a flushing tunnel would have limited benefit.
- High Rate Clarification: Suspended solids and BOD from CSO discharges were not identified as loadings contributing to non-attainment of WQS, thus the higher cost of high rate clarification compared to other treatment technologies would not be justified.

Floatables control, while currently implemented at the major Bronx River outfalls, remained for consideration at Outfall HP-011 which discharges to the East River. As will be noted throughout the remainder of this section, floatables control at Outfall HP-011 has been included in accordance with DEC comments received in January 2015 on the Westchester Creek LTCP.

The evaluation of the retained control measures is described in Section 8.2.

8.2 Matrix of Potential CSO Reduction Alternatives to Close Performance Gap from Baseline

Each control measure was initially evaluated on three of the key considerations described in Section 8.1: (1) benefits, as expressed by level of CSO control and attainment; (2) costs; and (3) challenges, such as siting and operations. Using this methodology, the control measures listed in Section 8.1 were evaluated on a cost-performance basis and used to develop the basin-wide alternatives.

Following the LTCP outline, these control measures are described under the following categories: Other Future Grey Infrastructure, Other Future Green Infrastructure and Hybrid Green/Grey Alternatives, and subsets thereof.

In the LTCP prepared for Westchester Creek, DEP noted that improvements in the Westchester Creek system, notably the Pugsley Relief Sewer, were predicted to result in increases in CSO volume at Outfall HP-011. Since Outfall HP-011 discharges to the East River adjacent to the mouth of the Bronx River and is hydraulically related to the Bronx River system, DEP agreed with DEC that floatables control for Outfall HP-011 would be investigated under the Bronx River LTCP. Because of the potential hydraulic impact of Outfall HP-011 alternatives on the Bronx River system, assessment of the Bronx River alternatives took into account the preferred alternative developed for Outfall HP-011. The assessment of alternatives at HP-011 is presented at the start of Section 8.2.a below, followed by the alternatives for the Bronx River outfalls.

The alternatives evaluations for the Bronx River focus on Outfalls HP-007 and HP-009, the two largest contributing CSOs in the Bronx River watershed. However, other smaller overflows to the Bronx River were also addressed relative to system optimization and floatables control, and whether they could opportunistically be included as part of abatement of the two larger overflows. This latter situation is also addressed with the tunnel alternative.

8.2.a Other Future Grey Infrastructure

For the purpose of this LTCP, "Other Future Grey Infrastructure" refers to potential grey infrastructure beyond existing control measures implemented based on previous planning documents. "Grey infrastructure" refers to systems used to control, reduce or eliminate discharges from CSOs. These are the technologies that have been traditionally employed by DEP and other wastewater utilities in their CSO planning and implementation programs. They include retention tanks, tunnels and treatment facilities, including satellite facilities, and other similar capital-intensive facilities.

Grey infrastructure projects implemented under previous CSO control programs and facility plans, such as the 2010 WWFP, are described in Section 4.0. These include: floatables control facilities at Outfalls HP-004 and HP-009 and Regulators CSO-27 and CSO-27A upstream of Outfall HP-007 and the upgrade of the Hunts Point WWTP to allow 2xDDWF.

HP-011 Floatables Control

As noted above, DEP agreed to evaluate floatables control at Outfall HP-011 as part of the Bronx River LTCP. Figure 8-2 shows the system configuration in the vicinity of Outfall HP-011. The overflow from Regulator 5 discharges directly to Outfall HP-011. The overflow from Regulators 6 and 7 is tributary to Regulator 5. Alternatives considered for floatables control at Outfall HP-011 included in-line nets, end-of-pipe nets, and regulator modifications that included installation of a bending weir and underflow baffle. The two netting alternatives were eliminated during the alternatives screening process due to concerns of siting impacts and the limited feasibility of access to the nets for maintenance. The Outfall HP-011 regulator modifications, designated as Alternative 11-1, entail the construction of a new Regulator 5 chamber with the addition of a 4 foot bending weir and an underflow baffle for floatables control. The layout of this alternative is shown in Figure 8-3.

IW modeling predicts an 11 percent CSO volume reduction at HP-011 (from 604 MGY to 540 MGY) and only a two percent increase at Outfall HP-009 (from 413 MGY to 421 MGY), as a result of the regulator modifications at Outfall HP-011. The bending weir is also predicted to reduce the annual average frequency of overflows at Outfall HP-011 from 44 to 32 overflows per year. This reduction in frequency of overflows is important as Regulator 5 was identified in analyses conducted under the 2014 CSO BMP Order on Consent as a key regulator with the potential to activate outside of the period of a critical wet-weather event as defined in Appendix B to the 2014 CSO BMP Order on Consent. It should be noted, however, that the actual performance in both CSO volume reduction and floatables capture will depend on the selection of the preferred alternative for Outfall HP-009. As described below, Alternatives 9-1 and 9-2 include relief pipes that would convey more flow to the 9 x 10-ft interceptor that conveys flow to the Hunts Point WWTP. The increase in flow to that interceptor is predicted to cause an increase in the discharge of flow at Outfall HP-011. The net impacts of combinations of alternatives on overflows to the Bronx and East Rivers, including water quality impacts at Outfall HP-011, are presented in Section 8.3, below.

Figure 8-2. System Configuration Upstream of Outfall HP-011

Figure 8-3. Layout of Alternative 11-1 – Regulator 5 Modification

Because most of the flow to Regulator 5 comes from Regulator 6, and Regulator 6 will need to be modified as part of the Pugsley Relief Sewer project proposed in the Westchester Creek LTCP, the potential to locate the bending weir and baffle at Regulator 6 instead of Regulator 5 was investigated. However, it was found that the performance in terms of reduction in CSO volume and annual average frequency of overflows was much less with the modifications at Regulator 6 as compared to Regulator 5. Based on the modeling evaluation, the bending weir was predicted to "bend" more often when located at Regulator 6, thereby resulting in more CSO volume. In addition, locating the bending weir at Regulator 5 takes advantage of in-system storage available in the large conduits located between Regulators 6 and 5, contributing to the reduction in frequency of overflows. For these reasons, the bending weir and baffle are proposed for a new structure at Regulator 5, and not in the re-built Regulator 6.

The benefits, costs and challenges associated with the Outfall HP-011 regulator modification alternative are as follows:

Benefits

The primary benefits of the proposed alternative are that it provides floatables control for Outfall HP-011 and is expected to reduce CSO volume and frequency. The bending weir at Outfall HP-011 would also partially mitigate the adverse impacts of some of the proposed alternatives for Outfall HP-009 on CSO volume at Outfall HP-011. Finally, the baffle/bending weir combination would avoid the siting and long term O&M issues associated with netting facilities.

Cost

The estimated NPW for this control measure is $9M. Details of the estimate are presented in Section 8-4.

Challenges

The most pressing challenge for this and any other system optimization measure that involves a significant weir adjustment is to prevent upstream hydraulic impacts. The new structure also has to be large enough to house the required 4 foot bending weir and the floatables baffle.

Conclusion

Based on the assessment presented above, regulator modifications at Regulator 5, including installation of a 4-ft high bending weir and an underflow baffle, was selected as the preferred alternative for providing floatables control at Outfall HP-011.

The remaining sections below focus on alternatives for the Bronx River outfalls, taking into consideration the preferred alternative for floatables control at Outfall HP-011.

8.2.a.1 High Level Sewer Separation

High Level Sewer Separation, also referred to as HLSS, is a form of partial separation that separates the combined sewers only in the streets or other public rights-of way, while leaving roof leaders or other building connections unaltered. In NYC, this is typically accomplished by constructing a new stormwater system and directing flow from street inlets and catch basins to the new storm sewers. Challenges associated with HLSS include constructing new sewers with minimal disruption to the neighborhoods along the proposed alignment, and finding a viable location for necessary new stormwater outfalls.

Separation of sewers minimizes the amount of CSO being discharged to receiving waters, but can also result in increased separate stormwater discharges (which may also carry loadings) to receiving waters.

HLSS was considered in the WWFP. However, as was noted then, the additional and more frequent pollution loadings that would result from the new stormwater discharges are a concern. Typically, DEP implements HLSS projects to control localized flooding. Because localized flooding has not been a documented problem in the watershed, and due to the concern of potential additional stormwater-related pollution, HLSS was not evaluated further.

8.2.a.2 Sewer Enhancements

Sewer enhancements, also known as system optimization, aim to reduce CSO through improved operating procedures or modifications to the existing collection system infrastructure. Examples include: regulator or weir modifications including fixed and bending weirs; control gate modifications; real time control (RTC); and increasing the capacity of select conveyance system components, such as gravity lines, pump stations and/or force mains. Force main relocation or interceptor flow regulation also would fall under this category. These control measures generally retain more of the combined sewage within the collection system during storm events. The benefits of retaining this additional volume must be balanced against the potential for sewer back-ups and flooding, or the relocation of the CSO discharge elsewhere in the watershed or an adjacent watershed. Viability of these control measures is system-specific, depending on existing physical parameters such as pipeline diameter, length, slope and elevation. These control measures were conceptualized for Outfalls HP-007 and HP-009. The location of these outfalls was shown in Figure 2-10.

As part of the control measure review process described in Section 8.1, three system optimization measures passed the initial screening process and were subsequently developed and evaluated for the Bronx River:

- Interceptor relief (parallel sewer) for Outfall HP-007
- Fixed weir modification and interceptor relief (parallel sewer) for Outfall HP-009

Each is described as follows:

Hydraulic Relief - Outfall HP-007

Combined sewer relief for Outfall HP-007, designated as Alternative 7-1 during the review process described in Section 8.1, entails the construction of a 2,700 feet long, 60 inch diameter line beginning at Relief Structure 27 to provide hydraulic relief to the existing 96-inch by 84-inch conduit. The routing of the relief line is shown in Figure 8-4. As indicated on the figure, microtunneling would be used during construction due to the highly congested nature of the route and the crossing of both the Cross Bronx Expressway (I-95) and Bronx River Parkway.

Figure 8-4. Layout of Alternative 7-1 - Hydraulic Relief of CSO Relief 27 at CSO Outfall HP-007

IW modeling predicted a 46 percent reduction in annual CSO volume at Outfall HP-007 (from 31.6 MGY to 17.2 MGY) with this alternative. However, CSO volume was projected to increase by 2 percent at Outfall HP-009 (from 421 MGY to 431 MGY) and by 1 percent at Outfall HP-011 (from 540 MGY to 545 MGY). The net basin-wide CSO volume reduction for the Bronx River was projected at 1 percent (from 462 MGY to 457 MGY). These volumes all assume implementation of the bending weir and underflow baffle at Outfall HP-011. The net impacts of combinations of other alternatives for the Bronx River, along with potential water quality impacts at Outfall HP-011, are described in Section 8.3 below.

The benefits, costs and challenges associated with the Outfall HP-007 relief sewer are as follows:

<u>Benefits</u>

There are three primary benefits associated with this control measure. The first is that the relief sewer would reduce a large volume of annual CSO discharge in the narrow, upper reach of the saline section of the Bronx River. Second, the relief sewer would not present the permanent siting issues associated with treatment or storage facilities, both above and below ground. Finally, as disinfection would not be involved, long term operation of chemical storage and feed equipment would not be required.

<u>Cost</u>

The estimated NPW for this control measure is $70M. Details of the estimate are presented in Section 8-4.

<u>Challenges</u>

There are numerous challenges associated with this relief sewer alternative, first and foremost being the potential conflict with existing utilities, highways, and local streets. While microtunneling would minimize some of these conflicts, siting the shafts would still be challenging. Limited space is available in the existing medians and traffic islands along the route. The reach of the relief sewer through the I-95/Bronx River Parkway interchange would be as much as 50 feet below the surface, therefore requiring relatively deep shafts for microtunneling. Rock would likely be encountered during the excavation for the shafts and microtunnel. Coordination with New York City Department of Transportation (DOT) would be needed to confirm requirements for microtunneling under the highways, and to avoid the bridge supports for I-95. In addition to siting the microtunneling shafts, staging areas would also be required for the general construction activities. Traffic impacts to the busy I-95/Bronx River Parkway interchange would be anticipated as a result of the need for truck access to the microtunneling shaft sites. Finally, while a high percentage of CSO volume reduction would result at Outfall HP-007, increases in CSO volume would occur at Outfalls HP-009 and HP-011, the latter in the East River.

Hydraulic Relief – Outfall HP-009

The hydraulic relief alternatives for Outfall HP-009 were designated as Alternatives 9-1 and 9-2. Both alternatives would entail raising the weir at Regulator 13 by 1 foot, while Alternative 9-1 adds a 6-foot diameter relief line from the regulator to the Bronx River siphon. Alternative 9-2 adds a third 78-inch siphon barrel. These alternatives are shown in Figures 8-5 and 8-6, respectively.

Figure 8-5. Layout of Alternative 9-1 – Hydraulic Relief of Regulator 13

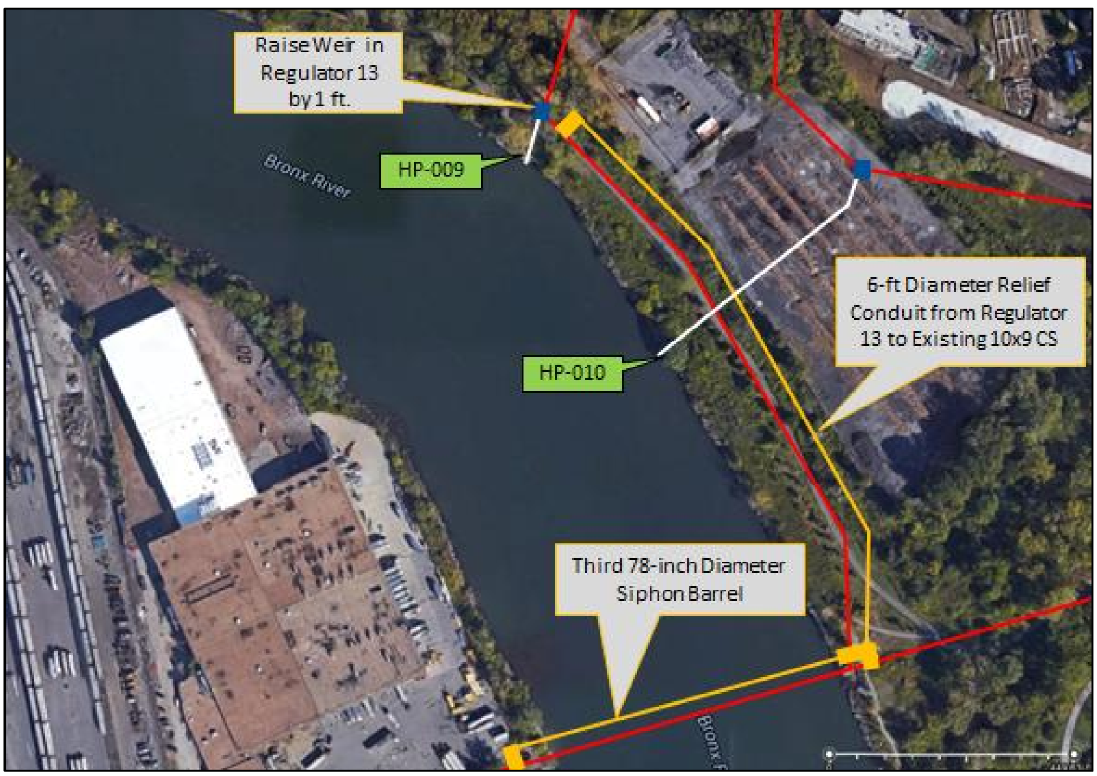

Figure 8-6. Layout of Alternative 9-2 – Hydraulic Relief of Regulator 13 and Additional Siphon Barrel

IW modeling predicted CSO volume reductions at Outfall HP-009 of 40 percent (from 421 to 253 MG) for Alternative 9-1 and 42 percent (from 421 to 243 MG) for Alternative 9-2. However, as with Alternative 7-1, increases in CSO volume resulted at other CSOs, most notably Outfall HP-011 at the East River where an 18 percent increase (from 540 to 635 MG) was predicted with Alternative 9-1 and a 12 percent increase (from 540 to 607 MG) with Alternative 9-2. DEP notes that the impact of the Outfall HP-009 relief alternatives on volumes at Outfall HP-011 is expected to be partially mitigated by the proposed floatables control/bending weir alternative for Outfall HP-011 described above. Without the bending weir at Outfall HP-011, the overflow volume at Outfall HP-011 is predicted to increase by 14 percent (from 604 MGY to 701 MGY) as a result of Alternative 9-1, and by 11 percent (from 604 MGY to 671 MGY) as a result of Alternative 9-2. The impacts of Alternatives 9-1 and 9-2 to volumes and frequency of overflows at outfalls outside of the Bronx River are summarized in Table 8-1. Alternatives 9-1 and 9-2 had no impact on CSO volume at Outfall HP-007. The predicted net impacts of combinations of alternatives for the Bronx River, along with potential water quality impacts at Outfall HP-011, are described in Section 8.3 below.

Table 8-1. Summary of Predicted Outfall Impacts, Alternatives 9-1 and 9-2

Alternative	Outfall HP-009		Outfall HP-025		Outfall HP-002		Outfall HP-003		Outfall HP-011		All Other HP CSO Outfalls	HP WWTP (1)
	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Vol. MGY
LTCP Baseline	413	42	91.9	51	44.8	33	211	39	604	44	1,007	45,459
LTCP Baseline +Outfall HP-011 Bending Weir and Baffle	421	42	92.0	51	44.8	33	211	39	540	32	1,007	45,511
9-1 Relief from Outfall HP-009 to Siphon(2)	253	32	92.2	51	47.5	33	216	39	635	34	1,009	45,577
9-2 Relief from Outfall HP-009 to Siphon and Relief of Siphon(2)	243	30	92.6	51	49.6	33	219	39	607	33	1,009	45,607

Notes:

(1) This column presents the annual treated volume at the Hunts Point WWTP.

(2) Alternative includes bending weir and underflow baffle for HP-011.

The expected benefits, costs and challenges associated with the Outfall HP-009 relief sewer alternatives are as follows:

Benefits

There are three primary benefits associated with this control measure. The first is that the relief sewer is expected to reduce a large volume of annual CSO discharge. Second, the relief sewer would not present the permanent siting issues associated with treatment or storage facilities, both above and below ground. Finally, as disinfection would not be involved, siting of the chemical storage and feed equipment would not be required.

Cost

The estimated NPW for this control measure is $32M for Alternative 9-1 and $56M for Alternative 9-2. Details of the estimates are presented in Section 8-4.

Challenges

There are numerous challenges associated with the relief sewer alternatives. First, they would entail open cut construction in parkland, and the likely need to cut trees along the route. Rock would likely be encountered along the route, and the route would pass under the existing Outfall HP-010 outfall. Construction would need to occur adjacent to the shoreline and wetlands, thus complicating the permitting and the construction work. The operation of the Department of Sanitation composting facility would be impacted during construction. Finally, for Alternative 9-2, the siphon would need to be constructed across the Bronx River.

Sewer Enhancement/Optimization Findings

The sewer optimization alternatives described above, interceptor relief (parallel sewer) for Outfall HP-007, and fixed weir modification and interceptor relief (parallel sewer) for Outfall HP-009, are worthy of being carried forward to the next level of evaluation for possible inclusion in basin-wide alternatives. In addition to the two described above, there were a number of other sewer enhancement alternatives that were identified but were not determined to be appropriate for inclusion in basin-wide alternatives. These alternatives are summarized briefly in the paragraphs below, along with the reasons for not evaluating them further.

Other Sewer Enhancement Alternatives Not Carried Forward

1. Static or Bending Weirs at Relief Structures 27 and 27A. Raising static weirs at Relief Structures 27 and 27A would require excessively long weirs to be installed in order to maintain hydraulic neutrality for the upstream HGL. Providing either raised static weirs or bending weirs would require dismantling and removing the existing floatables control screening systems at the two relief structures. The screening systems would then need to be reconfigured to accommodate the bending weirs. Since other alternatives were identified that provided higher levels of control, these alternatives were not evaluated further.

2. Hydraulic Relief from Outfall HP-007 to Outfall HP-004 System. This alternative involved providing a relief conduit between the combined sewer downstream of Relief Structure 27 (Outfall HP-007) and the combined sewer downstream of Relief Structure 28 (Outfall HP-004). This alternative provided less benefit at Outfall HP-007 than Alternative 7-1 described above, and also resulted in an increase in discharge volume at Outfall HP-004. The relief sewer would have to be installed as a siphon under

the Bronx River, and its intermittent operation during wet-weather periods would create maintenance issues. For these reasons, this alternative was not evaluated further.

3. Hydraulic Relief from Outfall HP-009 to Outfall HP-003 System. This alternative involved providing a relief conduit between the combined sewer downstream of Regulator 13 (Outfall HP-009) and the combined sewer upstream of Regulator 10 (Outfall HP-003). Hydraulic analysis of this alternative indicated that the HGL during wet-weather was higher in the combined sewer upstream of Regulator 10 than in the combined sewer downstream of Regulator 13. As such, the proposed conduit would convey flow towards HP-009 and would likely increase discharge volume at Outfall HP-009. Because this transfer of discharge would counteract the intent of reducing flows at Outfall HP-009, this alternative was not evaluated further.

4. Dedicated Relief Conduit from Regulator 13 to Hunts Point WWTP. This alternative involved providing a dedicated relief pipe running from Regulator 13 directly to the Hunts Point WWTP. The performance of this alternative was marginally better than Alternative 9-1 described above, but the cost and construction impacts of this alternative would be substantially higher. The relief conduit would be approximately 7,300-LF, and would likely encounter numerous utility conflicts along the route between the Bronx River and the WWTP. For these reasons, this alternative was not evaluated further.

5. Hydraulic Relief of the Bronx River Siphon. This alternative involved providing a third siphon barrel across the Bronx River. Hydraulic evaluation of this alternative indicated that it would have minimal impact on CSO volumes in the Bronx River. As such, this alternative was included as a component of Alternative 9-2 described above, but was not evaluated further as a stand-alone alternative.

6. Real Time Control Gates on Interceptor East of the Bronx River Siphon. The intent of this alternative was to throttle flow in the interceptor from Regulators 5, 6 and 7 (Outfall HP-011), to allow more flow into the interceptor from Regulator 13 (Outfall HP-009). A number of potential control scenarios were evaluated, but the overall predicted result was that modest reductions in volume at Outfall HP-009 were offset by much larger increases in discharge volume at Outfall HP-011. As a result, this alternative was not evaluated further.

8.2.a.3 Retention/Treatment Alternatives

A number of the control measures considered for the Bronx River fall under the dual category of treatment and retention. For the purposes of this LTCP, the term “storage” is used in lieu of “retention”. These control measures include in-line or in-system storage and off-line shaft, tank, and deep tunnel storage. Treatment refers to disinfection, in either CSO outfalls or RTBs, and other, more advanced, treatment processes such as high rate clarification.

With respect to off-line storage control measures, due to the limited availability of suitable sites within the Bronx River watershed, only tunnel storage remained after the initial screening process described in Section 8.1. Unlike traditional tank storage, or the newer concept of shaft storage, tunnel storage requires less permanent above-ground property per equivalent unit storage volume. This makes tunnel storage more practical for highly-developed watersheds such as the Bronx River.

Traditional off-line storage tanks were evaluated for both Outfalls HP-007 and HP-009 and were designated as Alternatives 7-5 and 7-6 and Alternatives 9-8 and 9-9, respectively. They are shown in Figures 8-7 through 8-10. As shown in the figures, both localized storage, near the outfalls, and upstream storage were considered for both cases. It soon became apparent, however, that the limitations and constraints associated with these potential sites made all configurations and tank sizes impractical. For example, the largest potential site for tanks near Outfall HP-007 was an actively-used bus facility owned by DOT. A smaller lot adjacent to that site is also owned by DOT, but a tank sized for only 25% CSO control would take up the entire site. The potential site for upstream storage at Outfall HP-007 was in heavily-wooded parkland, where parkland alienation and public opposition would likely be major issues. At Outfall HP-009, both downstream and upstream storage sites would be in parkland, where alienation and public opposition would also likely be major issues. Further complicating the situation was that the tanks needed to be sufficiently large to achieve an acceptable level of volumetric control. The impracticality of constructing off-line storage tanks was further supported by the initial projections of annual performance. The preliminary projected CSO volume reductions for shaft or tank storage were low in relation to the high costs associated with these types of facilities, and when compared to the other alternatives that advanced beyond the initial screening process.

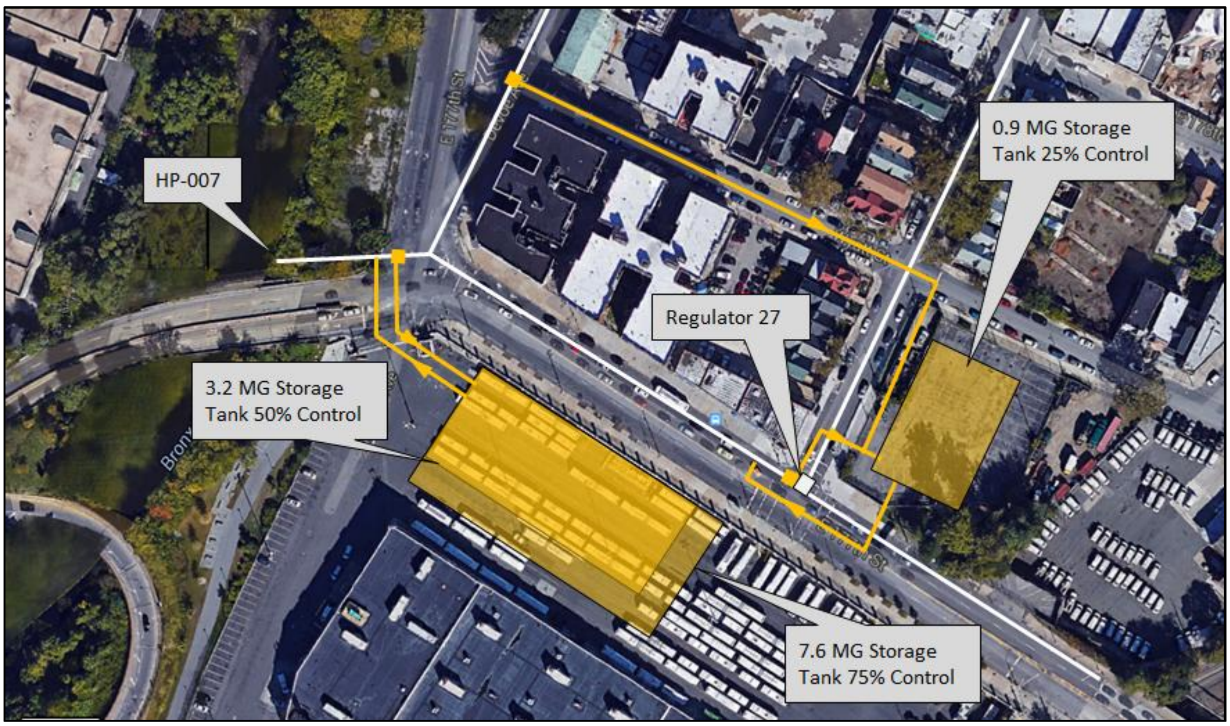

Figure 8-7. Layout of Alternative 7-5 – Outfall HP-007 Local Storage Tank

Figure 8-8. Layout of Alternative 7-6 – Outfall HP-007 Upstream Storage Tank

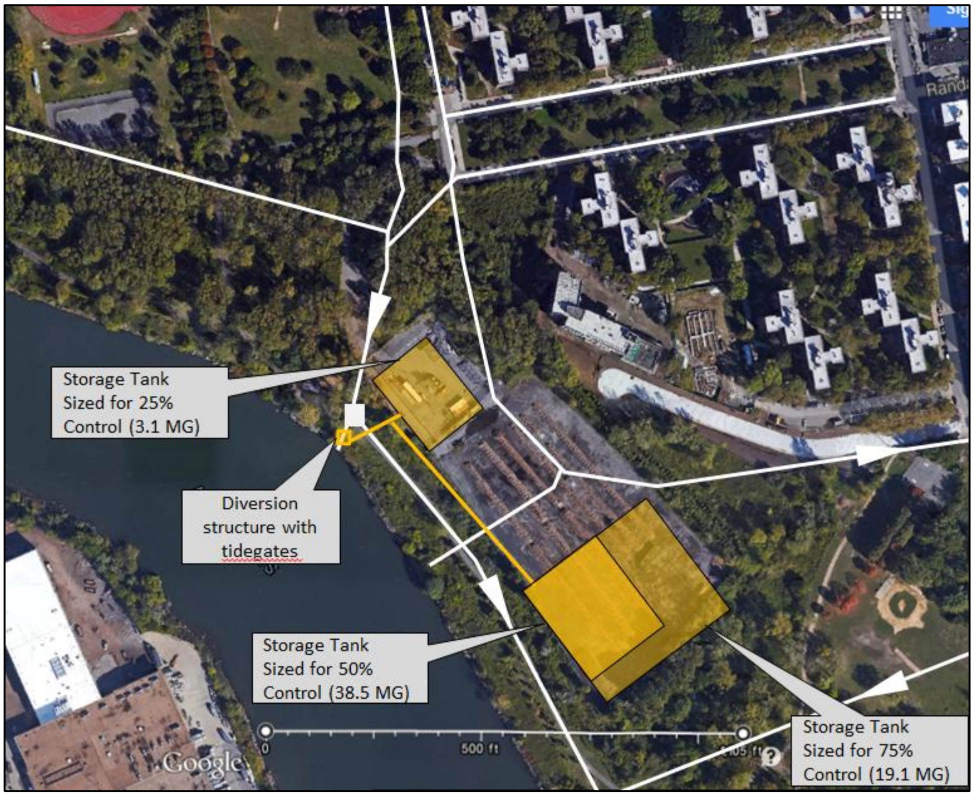

Figure 8-9. Layout of Alternative 9-8 – Outfall HP-009 Local Storage Tank

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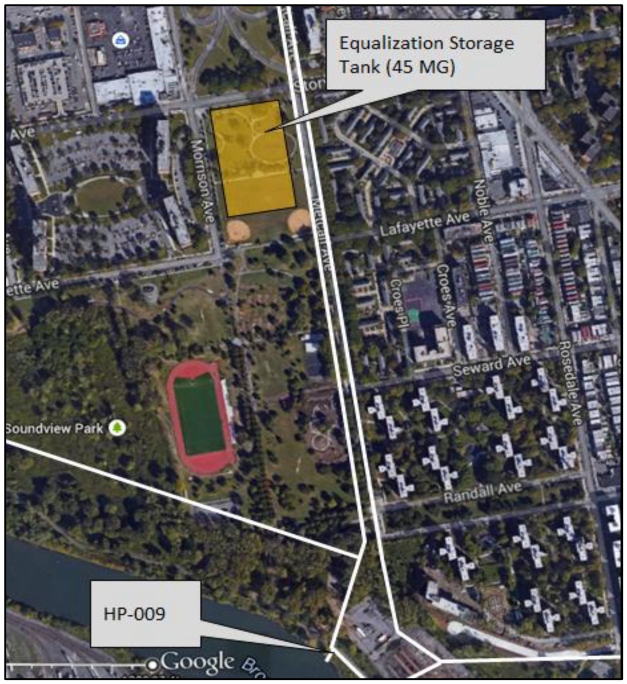


Figure 8-10. Layout of Alternative 9-9 – Outfall HP-009 Upstream Storage Tank

In-line storage was also screened out from further consideration as the existing system has little available capacity beyond what could be realized through the system optimization measures described above for Outfalls HP-007, HP-009 and HP-011.

With respect to treatment measures, outfall disinfection and RTB advanced to the next level of analysis but high rate clarification did not.

In summary, the storage and treatment control measures that did advance past the initial screening steps for further development and evaluation included: tunnel storage for all the Bronx River CSO outfalls; outfall disinfection for HR-007 and HR-009; direct disinfection for Outfall HP-007; and RTB disinfection for Outfalls HP-007 and HP-009. Each is described below

Retention Alternative – Tunnel Storage for Outfalls HP-004, HP-008, HP-007 and HP-009

Tunnel construction involves the boring of a linear storage conduit deep in the ground, typically in bedrock. Shafts are required during both the initial construction, as well as during its operation for filling and O&M access. A dewatering pump station and odor control system is also included with these facilities.

The deep tunnel that was evaluated for the Bronx River watershed would begin at Outfall HP-007 and terminate at Outfall HP-009. Designated as Alternative 7-8, it would be 11,000 feet long and have a 31-foot diameter for 100% CSO control. A 19-foot diameter tunnel would provide 75% CSO control. Both the mining shaft and dewatering pump station would be located at the downstream end of the tunnel at Outfall HP-009. The layout of the tunnel is shown on Figure 8-11 and shows the intermediate shafts to collect flows from Outfalls HP-004 and HP-008 along the route. Table 8-2 contains the features of the two concepts.

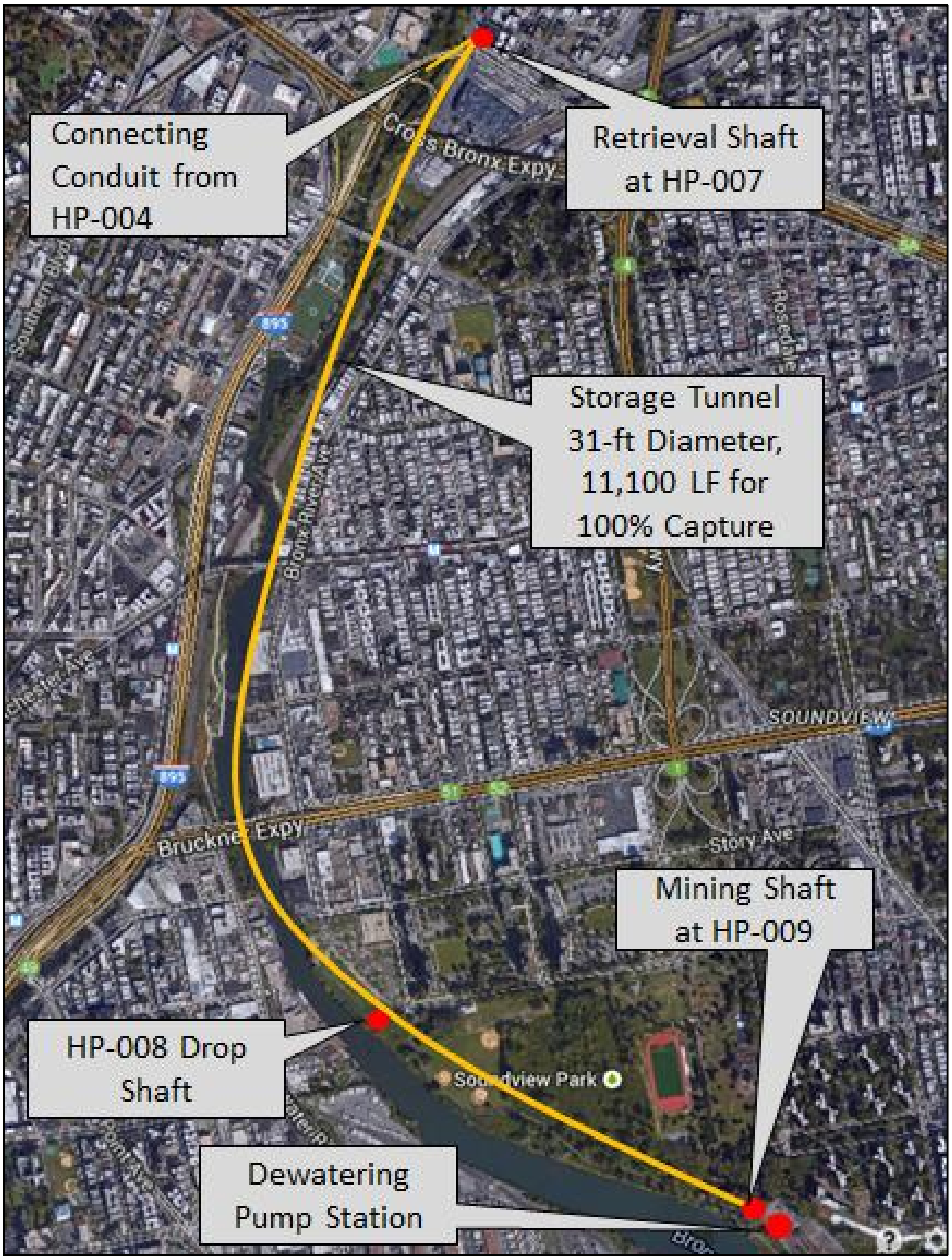


Figure 8-11. Layout of Alternative 7-8 – Tunnel for Outfalls HP-004, HP-007, HP-008 and HP-009

Table 8-2. Deep Tunnel Characteristics

Tunnel Options	Level of Service (CSO Volumetric Capture)	
	75%	100%
Tunnel Volume (MG)	23.5	60.9
Tunnel Length (lf)	11,000	11,100
Tunnel Diameter (ft)	19	31
NPW ($ Millions)	431	692

The benefits, costs and challenges associated with tunnel storage are as follows:

Benefits

The primary benefit of the tunnel storage is the high level of CSO volume reduction with minimal permanent above-ground land requirements. Also, as with the system optimization alternatives, because disinfection would not be involved, siting of the chemical storage and feed equipment would not be required.

Cost

The estimated NPW for this control measure is $431M for the 75% CSO control tunnel and $692M for the 100% CSO control tunnel. Details of the estimates are presented in Section 8-4.

Challenges

One of the major challenges with tunnel storage is the required O&M in deep, confined spaces. Also, DEP has no operating experience with tunnels in its wastewater system. Other challenges include the need to site a shaft in parkland, avoidance of support columns of the Cross Bronx and Bruckner Expressways, railway crossings, sediment deposition in the tunnel, potential for hydraulic surge conditions, unforeseen geotechnical conditions, and operation of the deep tunnel dewatering pump station. Providing electrical power to the mining shaft during construction and permanent power for the dewatering pump station would also present a challenge.

Both of these tunnel alternatives are carried forward to the next level of evaluation for inclusion in basin-wide alternatives.

All of the Retention Alternatives described above require dewatering of the retained CSO volumes after wet-weather events occur. The capacity of the required dewatering systems is shown in Table 8-3 for each of these alternatives based on a two-day dewatering period.

Table 8-3. Dewatering System Capacity of Retention Alternatives Based on Two-Day Dewatering

Alternative		Storage Volume (MG)	PS Capacity (MGD)
Alternative 7-5	25% CSO Control	0.9	0.5
	50% CSO Control	3.2	1.6
	75% CSO Control	7.6	3.8
Alternative 7-6	50% CSO Control	5.6	2.8
Alternative 7-8	75% CSO Control	23.5	11.8
	100% CSO Control	60.9	30.5
Alternative 9-8	25% CSO Control	3.1	1.6
	50% CSO Control	19.1	9.5
	75% CSO Control	38.5	19.3
Alternative 9-9	50% CSO Control	45	22.5

Treatment Alternative – Disinfection at Outfall HP-007

Three variations of CSO disinfection were evaluated for Outfall HP-007: Outfall Disinfection, RTB Disinfection and Direct Disinfection. Each is described below:

Outfall Disinfection – HP-007

Designated as Alternative 7-2, this concept would entail the construction of a new outfall to provide up to 15 minutes of contact time prior to discharge to the Bronx River. Two variations of this alternative were considered: one with a 1,100 foot long, 8 foot diameter line to provide 50% seasonal control of bacteria; and one with a 1,300 foot long, 11 foot diameter line to provide 75% seasonal control of bacteria. The percent seasonal control represents the predicted percent reduction in bacteria load during the recreational season (May 1st through October 31st), based on the assumption of a 2-log (99 percent) bacteria kill for flow rates up to the design flow rate. At the design flow, 15 minutes of contact time would be provided. For 50 percent seasonal control, the design flow rate was 38 MGD, and for 75 percent seasonal capture, the design flow rate was 86 MGD. The layout of Alternative 7-2 is shown in Figure 8-12.

Figure 8-12. Layout of Alternative 7-2 – HP-007 Outfall Conduit Disinfection

Disinfection would be accomplished by dosing chlorine, in the form of sodium hypochlorite, into the new outfall at a new diversion structure. DEP will seek to optimize the sodium hypochlorite dose to achieve a two-log kill (99 percent bacteria reduction) in order to minimize residuals to near non-detect, and avoid the need for dechlorination. Towards this end, DEP has proposed to conduct CSO chlorination studies at the Spring Creek Auxiliary Water Pollution Control Plant (AWPCP). The information collected in that study would be used to support the final design of the Bronx River disinfection facilities. Sodium hypochlorite would be dosed at the disinfection facility during the recreational season (May 1^{st} through October 31^{st}).

A chlorination building would be constructed to house equipment and piping for chemical delivery, storage, and feed. Ancillary electrical, controls and heating, ventilation and air conditioning (HVAC) systems would also be included. As shown on the figure, the facility would be sited in one of two possible locations as close to the dosing point as is practical. Both sites are on the edges of existing Transit Authority parking lots. Should dechlorination be required in the future, such addition has been considered in the conceptual layouts. A downstream weir structure would be constructed to house the necessary hydraulic controls and dewatering pump station. A force main would convey the dewatered flow back to the collection system in the vicinity of Relief Structure 27. Figure 8-13 shows a typical hydraulic longitudinal profile of a CSO outfall used for this purpose.

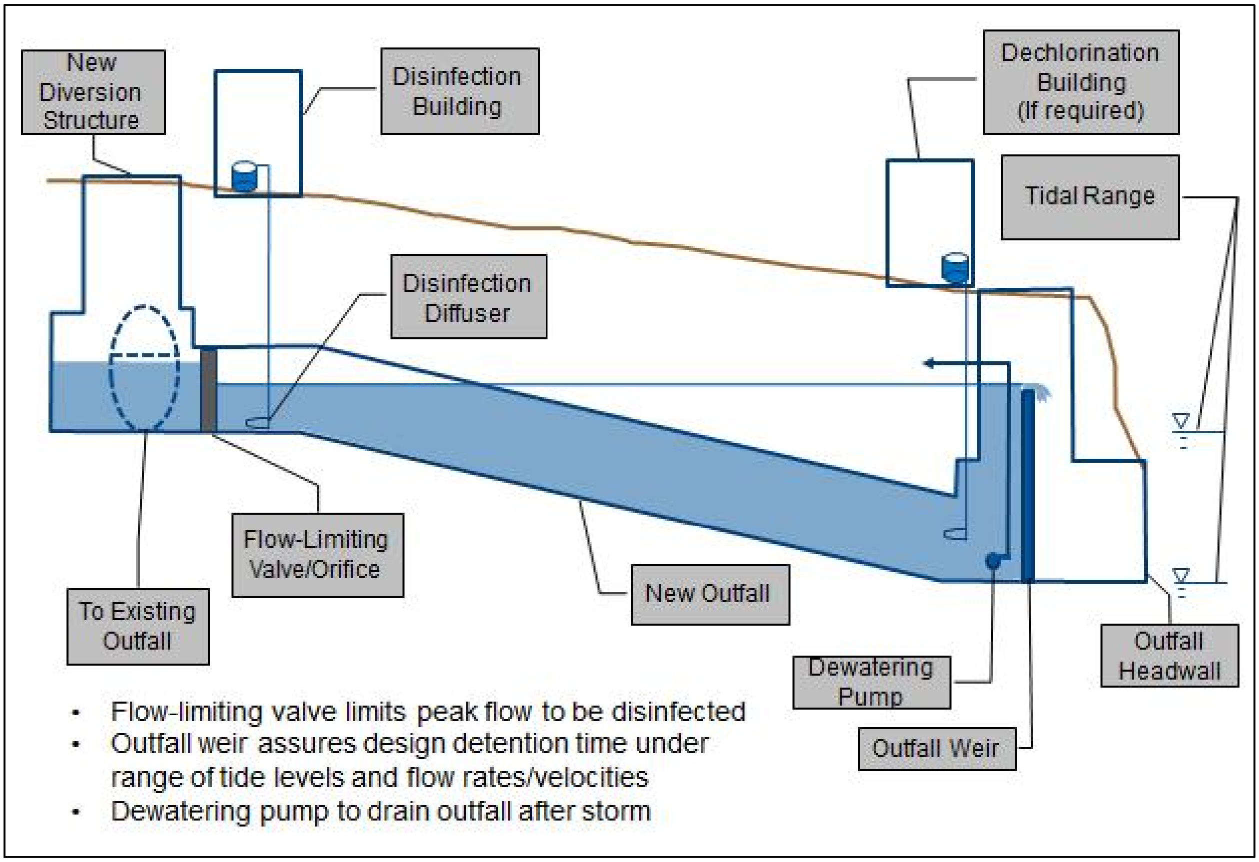


Figure 8-13. Typical Longitudinal Profile of Outfall Disinfection Control Measures

The weir at the downstream end of the new outfall creates the storage volume that provides 15 minutes of contact time for the design flow rate regardless of the Bronx River elevation at the outfall. For the 50% seasonal control alternative, a total of approximately 3.2 MG would be stored in the outfall during the recreational season (May 1st through October 31st) and returned to the interceptor system. For the 75% seasonal control alternative, approximately 6.8 MG would be stored in the outfall during the recreational season (May 1st through October 31st).

The benefits, costs and challenges associated with outfall disinfection are as follows:

<u>Benefits</u>

The primary benefit of outfall disinfection is its estimated high degree of seasonal bacterial control. Another benefit is that less permanent space would be required than if RTB disinfection were employed, particularly in the Transit Authority parking lot. Finally, a modest level of volumetric CSO capture would be realized as described above, resulting in a reduction of the load in the CSO that is captured.

<u>Cost</u>

The estimated NPW for this control measure is $50M for the 50% recreational season (May 1st through October 31st) control and $68M for the 75% recreational season (May 1st through October 31st) control concepts. Details of the estimates are presented in Section 8-4.

Challenges

The specific challenges associated with this alternative include the need to construct a weir structure at the downstream end of the new outfall and the potential for solids deposition. Also, dewatering pumps will be required and electric power will need to be secured. The siting of both this structure and the chemical storage and feed building also present challenges. The construction of the outfall itself will need to avoid the support columns of the Cross Bronx Expressway. The construction could also disrupt parkland and lands adjacent to the Bronx River. While open cut construction may be required in lieu of microtunneling due to the lack of sufficient cover, jacking would be needed under E. 177th St and Cross Bronx Expressway ramps. Rock is also likely to be encountered. Finally, the seasonal operation of the chemical system presents O&M challenges.

RTB Disinfection – Outfall HP-007

Designated as Alternative 7-3, this concept would entail the construction of an RTB tank to provide up to 15 minutes of contact time prior to discharge to the Bronx River through the existing Outfall HP-007 outfall. The RTB tank would be sized at 0.9 MG to provide 75% seasonal control of bacteria. At the design flow (86 MGD), 15 minutes of contact time would be provided. The layout of Alternative 7-3 is shown in Figure 8-14.

Figure 8-14. Layout of Alternative 7-3 – Outfall HP-007 Disinfection with RTB Contact Tank

Disinfection would be accomplished by dosing sodium hypochlorite just upstream of the tank. As discussed earlier for Alternative 7-2, DEP will seek to optimize the sodium hypochlorite dose to achieve a two-log kill (99 percent bacteria reduction) in order to minimize residuals to near non-detect, and avoid the need for dechlorination. Towards this end, DEP has proposed to conduct CSO chlorination studies at the Spring Creek AWPCP. The information collected in that study would be used to support the final design of the Bronx River disinfection facilities. Sodium hypochlorite would be dosed at the disinfection facility during the recreational season (May 1st through October 31st). Following the event, the tank would be dewatered and cleaned and made ready for the next event. Thus, dewatering pumps would be required but made integral to the RTB facilities.

A chlorination building would be constructed to house equipment and piping for chemical delivery, storage, and feed. Ancillary electrical, controls and HVAC systems would also be included. With this concept, the facility would be made integral to the RTB tank. The most practical location of the facility would be the Transit Authority parking lot as shown on the figure. Should dechlorination be required in the future, such addition has been considered in the conceptual layouts.

The benefits, costs and challenges associated with RTB disinfection are as follows:

Benefits

As with outfall disinfection, the primary benefit of RTB disinfection is its estimated high degree of seasonal bacterial control. Finally, as with outfall disinfection, a similar level of volumetric CSO capture would be realized, along with a reduction in other CSO loads associated with that volume captured.

Cost

The estimated NPW for this control measure is $63M. Details of the estimate are presented in Section 8-4.

Challenges

The major challenges with this alternative are the siting of the facility within Transit Authority property and disruption caused by the permanent above-ground features. Other challenges include likely encountering rock during construction and the need to dewater and clean the tank following each event. Finally, the seasonal operation of the chemical system presents O&M challenges.

Direct Disinfection – Outfall HP-007

Designated as Alternative 7-4, this concept would entail the dosing of sodium hypochlorite to both the outfall sewer and directly to the combined sewer downstream of Relief Structure 27A. As shown in Figures 8-15 and 8-16, the outfall sewer is a 10 foot by 8 foot conduit and the combined sewer is a 9.25 foot by 8 foot conduit. The disinfected flow would discharge to the Bronx River though the existing HP-007 outfall. Disinfection would be accomplished by dosing sodium hypochlorite at Relief Structure 27A, as shown in Figure 8-17.

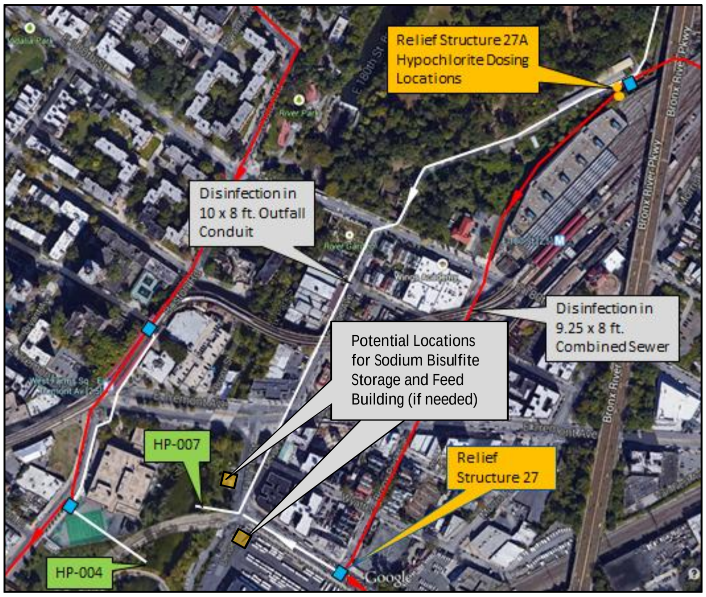


Figure 8-15. Layout of Alternative 7-4 – Outfall HP-007 Direct Disinfection

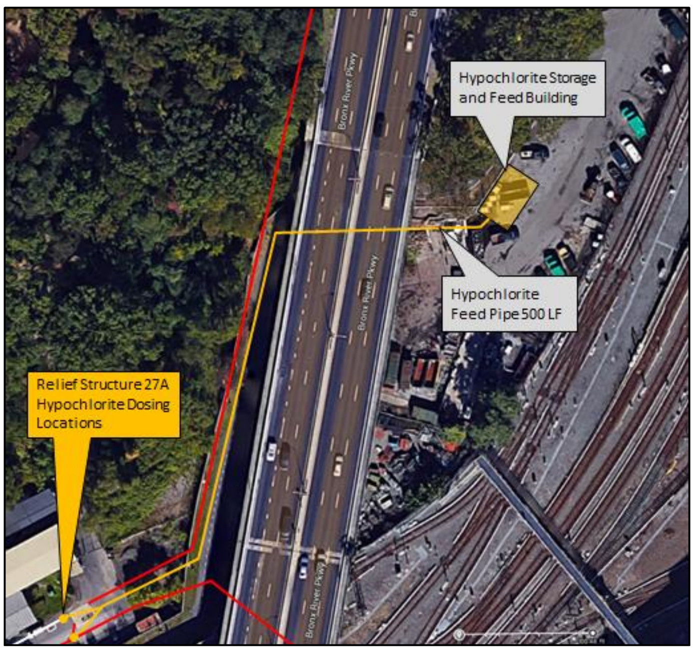


**Figure 8-16. Layout of Alternative 7-4 –
Outfall HP-007 Direct Disinfection- Chlorination System Layout**

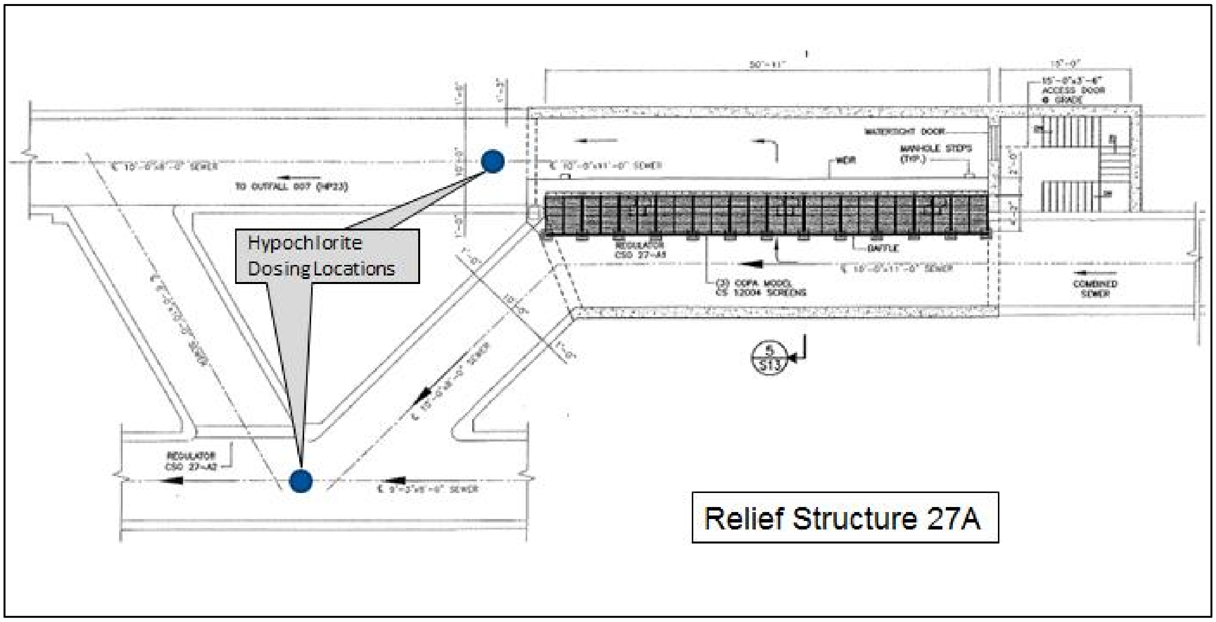


Figure 8-17. Alternative 7-4 – Dosing Locations Within CSO Relief Structure 27A

Unlike the previous two Outfall HP-007 disinfection alternatives, the predicted effective contact time would be less than 15 minutes for most parts of most storms in the recreational season (May 1st through October 31st). However, in this case, slightly less than 90 percent of the volume discharged is predicted to have at least 5 minutes of detention time. Approximately 63 acres of combined sewer tributary area tie into the combined sewer between the hypochlorite dosing location at Relief Structure 27A and the overflow weir at Relief Structure 27. This tributary flow would be subject to an even shorter detention time. However, because the 63 acres represents only 4 percent of the area tributary to Relief Structure 27A, the volume from this area represents a small percentage of the total volume discharged from Outfall HP-007.

It is expected that induction mixers would not last very long at the Relief Structure 27A dosing location given the types of materials and large objects that could be carried in the combined sewer flow and the likelihood that one would hit the diffuser and disable it. A simpler, more robust diffuser system would be required. Given the shorter detention times and the infeasibility of induction mixers, the bacteria kill achieved by this alternative was conservatively estimated at 90 percent or a 1 log reduction. Dosing at a slightly higher rate, particularly during the first flush, could potentially improve the performance. However, DEP will seek to optimize the sodium hypochlorite dose in order to minimize residuals to near non-detect, and avoid the need for dechlorination. Towards this end, DEP has proposed to conduct CSO chlorination studies at the Spring Creek AWPCP. The information collected in that study would be used to support the final design of the Bronx River disinfection facilities. Sodium hypochlorite would be dosed at the disinfection facility during the recreational season (May 1st through October 31st).

A chlorination building would be constructed to house equipment and piping for chemical delivery, storage, and feed. Ancillary electrical, controls and HVAC systems would also be included. With this concept, the facility would be made integral to the RTB tank. The most practical location of the facility would be on Transit Authority property. Should dechlorination be required in the future, such addition has been considered in the conceptual layouts.

The benefits, costs and challenges associated with direct disinfection are as follows:

Benefits

The primary benefit of direct disinfection is its predicted high degree of seasonal bacterial control for many storms during the recreational season (May 1st through October 31st). Another benefit is that DEP would be maximizing use of existing infrastructure to accomplish CSO disinfection: additional tanks or outfall lines are not required, nor are downstream controls and dewatering pumps.

Cost

The estimated NPW for this control measure is $24M. Details of the estimate are presented in Section 8-4.

Challenges

Unlike the other two Outfall HP-007 disinfection alternatives, direct disinfection would result in lower contact times for the disinfection process, on the order of 5 minutes versus 15 minutes. Thus, the effectiveness of the process could be less than optimal but still capable of attaining high levels of bacteria kills. Also, the combined sewer downstream of Relief Structure 27A also picks up other smaller lines between Relief Structures 27A and Relief Structure 27 which would also reduce effectiveness. While there are fewer siting issues with this direct disinfection alternative over outfall and RTB disinfection, the chemical storage and feed building would still require the permanent taking of land. The proposed site for the chemical storage and feed building is approximately 500 feet from the dosing location. Finally, the seasonal operation of the chemical system presents O&M challenges.

Comparison of Outfall HP-007 Disinfection Alternatives

Table 8-4 contains a comparison of the three disinfection alternatives for Outfall HP-007.

Table 8-4. Comparison of Disinfection Alternatives for Outfall HP-007

Alternative/ Description	Outfall HP-007 Volumetric Control (%)		Outfall HP-007 Bacteria Control (%)		Total Bronx River Bacteria Control (%)		Dewatering PS Capacity (MGD)	NPW ($ Millions)
	Annual(1)	Seasonal	Annual	Seasonal	Annual	Seasonal		
7-2 – Outfall – 50%	10	12	41	50	2	3	0.4	50
7-2 – Outfall – 75%	22	26	62	75	3	4	0.9	68
7-3 - RTB	22	26	62	75	3	4	0.9	63
7-4 - Direct	0	0	74	90	3	5	N/A	24

Notes:
(1) The provided storage is bypassed during the non-recreational season (November 1st through April 30th).

All three of these Outfall HP-007 disinfection alternatives are worthy of being further evaluated for possible inclusion in basin-wide alternatives.

Treatment Alternative – Disinfection at Outfall HP-009

Two disinfection alternatives made it past the initial screening process described in Section 8.1. Each is described below:

Outfall Disinfection – HP-009

Designated as Alternative 9-3, this concept would entail the construction of a new 9 foot diameter, 1,900 foot long outfall sewer to provide up to 15 minutes of contact time prior to discharge to the Bronx River. It would provide 75% seasonal control of bacteria. The percent seasonal control represents the percent reduction in bacteria load during the recreational season (May 1st through October 31st), based on the assumption of a 2-log (99 percent) bacteria kill for flow rates up to the design flow rate (82 MGD). The layout of Alternative 9-3 is shown in Figure 8-18.

Figure 8-18. Alternative 9-3 – HP-009 Outfall Conduit Disinfection

Disinfection would be accomplished by dosing sodium hypochlorite into the new outfall at a new diversion structure, equipped with tide gates. DEP will seek to optimize the sodium hypochlorite dose to achieve a two-log kill (99 percent bacteria reduction) in order to minimize residuals to near non-detectable levels, and avoid the need for dechlorination. Towards this end, DEP has proposed to conduct CSO chlorination studies at the Spring Creek AWPCP. The information collected in that study would be used to support the final design of the Bronx River disinfection facilities. Sodium hypochlorite would be dosed at the disinfection facility during the recreational season (May 1st through October 31st).

A chlorination building would be constructed to house equipment and piping for chemical delivery, storage, and feed. Ancillary electrical, controls and HVAC systems would also be included. As shown on the figure, the facility would be sited at the Sanitation Department composting facility. The land, however, is owned by the Parks Department which could involve park alienation issues. Should dechlorination be required in the future, such addition has been considered in the conceptual layouts. A downstream weir structure would be constructed to house the necessary hydraulic controls and dewatering pump station. A force main would convey the dewatered flow back to the collection system. The dewatering pumps and force main would be sized to minimize the duration that the combined sewage remained in the outfall after a storm, to minimize potential for odors. Figure 8-13 from the Outfall HP-007 discussion, shows a typical profile of a CSO outfall used for this purpose. For Outfall HP-009, the outfall disinfection alternative would temporarily store a total of approximately 18 MG during the recreational season (May 1st through October 31st).

The benefits, costs and challenges associated with outfall disinfection are as follows:

<u>Benefits</u>

The primary benefit of outfall disinfection is its estimated high degree of seasonal bacterial control. Also, using the new outfall for contact time uses less permanent land at the composting facility than would RTB disinfection. In addition, a nominal level of volumetric CSO capture would be realized, along with a reduction in other CSO loads associated with that volume captured.

<u>Cost</u>

The estimated NPW for this control measure is $120M. Details of the estimates are presented in Section 8-4.

<u>Challenges</u>

One of the major challenges with this alternative is the siting of permanent facilities at the Sanitation Department composting operation that is owned by the Parks Department. This raised park alienation issues. A new weir structure needs to be constructed at the downstream end of the new outfall adjacent to the Bronx River. Dewatering pumps will be required and electric power will need to be secured. The construction of the new outfall would be in both parkland and adjacent to the Bronx River. The new outfall also has to pass under an existing 10 foot by 9 foot sewer, and rock is likely to be encountered. Finally, the seasonal operation of the chemical system and overall maintenance of the facility presents O&M challenges.

RTB Disinfection – Outfall HP-009

Designated as Alternative 9-4, this concept would entail the construction of an RTB tank to provide up to 15 minutes of contact time prior to discharge to the Bronx River through a new outfall. The RTB tank would be sized at 0.85 MG to provide 75% seasonal control of bacteria. At the design flow (82 MGD), 15 minutes of contact time would be provided. The layout of Alternative 8-4 is shown in Figure 8-19.

Disinfection would be accomplished by dosing sodium hypochlorite just upstream of the tank. DEP will seek to optimize the sodium hypochlorite dose to achieve a two-log kill (99 percent bacteria reduction) in order to minimize residuals to near non-detect, and avoid the need for dechlorination. Towards this end, DEP has proposed to conduct CSO chlorination studies at the Spring Creek AWPCP. The information collected in that study would be used to support the final design of the Bronx River disinfection facilities.

Sodium hypochlorite would be dosed at the disinfection facility during the recreational season (May 1st through October 31st). Following the event, the tank would be dewatered and cleaned and made ready for the next event. Thus, dewatering pumps would be required but made integral to the RTB facilities.

A chlorination building would be constructed to house equipment and piping for chemical delivery, storage, and feed. Ancillary electrical, controls and HVAC systems would also be included. With this concept, the facility would be made integral to the RTB tank. The most practical location for the facility is the site of the Sanitation Department composting facility. As noted above for outfall disinfection, the land is owned by the Parks Department which could involve park alienation issues. Should dechlorination be required in the future, such addition has been considered in the conceptual layouts.

Figure 8-19. Alternative 9-3 – Outfall HP-009 Disinfection With RTB Contact Tank

The benefits, costs and challenges associated with RTB disinfection are as follows:

Benefits

As with outfall disinfection, the primary benefit of RTB disinfection is its predicted high degree of seasonal bacterial control. Finally, as with outfall disinfection, a similar level of volumetric CSO capture would be realized, along with a reduction in other CSO loads associated with that volume captured.

Cost

The estimated NPW for this control measure is $52M. Details of the estimate are presented in Section 8-4.

Challenges

One of the major challenges with this alternative is the siting of permanent facilities at the Sanitation Department composting operation that is owned by the Parks Department. In addition to park alienation issues, the construction and future operation of the facilities could interfere with the composting operation. Other challenges include the likely encounter with rock during construction and the need to dewater and clean the tank following each event. This alternative also includes a new outfall to the Bronx River. Finally, the seasonal operation of the chemical system presents O&M challenges.

Comparison of Outfall HP-009 Disinfection Alternatives

Table 8-5 contains a comparison of the two disinfection alternatives for Outfall HP-009.

Table 8-5. Comparison of Disinfection Alternatives for Outfall HP-009

Alternative/ Description	Outfall HP-009 Volumetric Control (%)		Outfall HP-009 Bacteria Control (%)		Total Bronx River Bacteria Control (%)		Dewatering PS Capacity (MGD)	NPW ($ Millions)
	Annual(1)	Seasonal	Annual	Seasonal	Annual	Seasonal		
9-3 – Outfall	4	7	62	75	40	66	0.5	120
9-4 - RTB	4	7	62	75	40	66	0.5	52

Notes:
(1) The provided storage is bypassed during the non-recreational season (November 1st through April 30th).

Both of these Outfall HP-009 disinfection alternatives are worthy of being carried forward to the next level of evaluation for inclusion in basin-wide alternatives.

8.2.b Other Future Green Infrastructure (Various Levels of Penetration)

As discussed in Section 5.0, DEP projects that GI penetration rates would manage 14 percent of the impervious surfaces within the Bronx River portion of the Hunts Point combined sewer service area. This GI has been included as part of the baseline model projections, and is thus not categorized as an LTCP alternative.

For the purpose of this LTCP, “Other Future Green Infrastructure” is defined as GI alternatives that are in addition to those implemented under previous facility plans and those included in the baseline conditions. Because DEP is working on the implementation of GI area-wide contracts in the Bronx River watershed, additional GI beyond the baseline is not being considered for this LTCP at this time. DEP intends to saturate each target tributary drainage area with as much GI as feasible, as discussed in Section 5.0. Should conditions show favorable feasibility for penetration rates above the current targets, DEP will seek to take advantage of those opportunities as they become known.

8.2.c Hybrid Green/Grey Alternatives

Hybrid green/grey alternatives are those that combine traditional grey control measures with GI control measures, to achieve the benefits of both. However, as discussed above, development of the baseline GI projects for this watershed is already underway and further GI is not planned at this time. Therefore, no controls in this category are proposed for the Bronx River LTCP.

8.2.d Retained Alternatives

The intended outcome of the previous evaluations was the development of a list of retained control measures for Outfalls HP-007 and HP-009 at the Bronx River and HP-011 at the East River. These, whether individually or in combination, will form the basis of basin-wide alternatives that will be assessed using the more rigorous cost-performance and cost-attainment analyses. That list is presented in Table 8-6. The reasons for excluding the non-retained control measures from further consideration are also noted in the table.

Table 8-6. Summary of Next Level of Control Measure Screening

Control Measure	Category	Retained for Further Analysis?	Remarks
HLSS	Source Control	NO	No identified localized flooding to address and concern of resulting stormwater-related pollution.
Sewer Enhancements	System Optimization	YES	Designated as Alternatives 7-1, 9-1 and 9-2.
In-line Storage	Storage	NO	No available capacity beyond what could be realized through System Optimization.
Off-line Storage (Tanks)	Storage	NO	Limited space for local or upstream tanks and low ratio of benefit to cost.
Off-line Storage (Shafts)	Storage	NO	Limited space for local or upstream shafts and low ratio of benefit to cost.
Off-line Storage (Tunnels)	Storage	YES	Designated as Alternative 7-8 and would include HR-4, 7, 8 and 9.
Retention/Treatment Basins	Treatment	YES	Designated as Alternatives 7-3 and 9-4.
Outfall and Direct Disinfection	Treatment	YES	Designated as Alternatives 7-2, 7-4 and 9-3.
High Rate Clarification	Treatment	NO	BOD and TSS have not been identified as a source of non-attainment. Other control measures provide similar levels of bacteria reduction at a lower cost.
In-Stream Aeration	WQ/ Ecological Enhancement	NO	Not a CSO control measure, and average DO levels are in attainment.
Floatables Control	Floatables Control	YES	Designated as Alternative 11-2. Already implemented at Outfalls HP-004, HP-007 and HP-009.

Table 8-6. Summary of Next Level of Control Measure Screening

Control Measure	Category	Retained for Further Analysis?	Remarks
Additional GI Build-out	Source Control	NO	Planned 14% GI build-out in the watershed (included in the baseline) is in development; additional available sites unlikely to be identified.

As shown, the retained control measures include sewer system enhancements/optimization, deep tunnel storage, and a variety of disinfection measures for the two largest outfalls, HP-007 and HP-009. Floatables control is also included for Outfall HP-011 in accordance with DEC comments on the Westchester Creek LTCP; floatables control is already installed at Outfalls HP-004, HP-007 and HP-009.

Table 8-7 presents the resulting basin-wide alternatives along with their new sequential numbering system. As shown, seven basin-wide alternatives were included, with a focus on the largest, most active outfalls, HP-007 and HP-009. However, as previously discussed, floatables control for Outfall HP-011 has been included with all seven basin-wide alternatives. Also, the tunnel alternatives address the smaller CSOs as well as Outfalls HP-007 and HP-009.

Table 8-7. Basin-Wide Alternatives with New Sequential Numbering

Alternative	Description
1. Combination of Former Alts. 7-4 (Outfall HP-007 Direct Disinfection) and 9-1 (Outfall HP-009 Relief)	Outfall HP-007 • Direct Disinfection Outfall HP-009 • Raise weir at Regulator 13 • Relief pipe between Regulator 13 and the Bronx River siphon Outfall HP-011 • Floatables Control
2. Combination of Former Alts. 7-1 (Outfall HP-007 Relief) and 9-1 (Outfall HP-009 Relief)	Outfall HP-007 • 2,700-ft interceptor relief at Relief Structure 27 Outfall HP-009 • Raise weir at Regulator 13 • Relief pipe between Regulator 13 and the Bronx River siphon Outfall HP-011 • Floatables Control
3. Former Alt. 9-1 (Outfall HP-009 Relief)	Outfall HP-009 • Raise weir at Regulator 13 • Relief pipe between Regulator 13 and the Bronx River siphon Outfall HP-011 • Floatables Control

Table 8-7. Basin-Wide Alternatives with New Sequential Numbering

Alternative	Description
4. Combination of Former Alts. 7-4 (Outfall HP-007 Direct Disinfection) and 9-3 (Outfall HP-009 Outfall Disinfection)	Outfall HP-007 • Direct Disinfection Outfall HP-009 • Outfall disinfection Outfall HP-011 • Floatables Control
5. Combination of former Alts. 7-4 (Outfall HP-007 Direct Disinfection) and 9-4 (Outfall HP-009 RTB with Disinfection)	Outfall HP-007 • Direct Disinfection Outfall HP-009 • RTB with Disinfection Outfall HP-011 • Floatables Control
6. 75% CSO Control Tunnel	• 11,000-LF long, 19-ft diameter tunnel • 23.5 MG storage • Floatables Control at Outfall HP-011
7. 100% CSO Control Tunnel	• 11,100-LF long, 31-ft diameter tunnel • 61 MG storage • Floatables Control at Outfall HP-011

These seven Bronx River retained basin-wide alternatives, Alternatives 1 through 7, were then analyzed on the basis of their cost-effectiveness in reducing loads and improving water quality. These more advanced analyses are described in Sections 8.3 through 8.5.

8.3 CSO Reductions and Water Quality Impact of Retained Alternatives

To evaluate their effects on the loadings and water quality impacts, the retained basin-wide alternatives listed in Table 8-4 were analyzed using both the Bronx River watershed (IW) and receiving water/waterbody or water quality (ERTM) models. Evaluations of levels of CSO control for each alternative are presented below. In all cases, the predicted reductions shown are relative to the baseline conditions using 2008 JFK rainfall as described in Section 6.0. The baseline assumptions were described in detail in Section 6.0 and assume that the grey infrastructure projects from the WWFP have been implemented, along with the 14 percent GI penetration.

8.3.a CSO Volume and Bacteria Loading Reductions of Retained Alternatives

Table 8-8 summarizes the projected Bronx River untreated CSO volumes, and percent reductions in untreated CSO volume and bacteria loads for the retained alternatives. These data are plotted on Figure 8-20. The bacteria loading reductions shown in Table 8-8 were computed on an annual basis. Later in the section, both annual and recreational season (May 1st through October 31st) reductions are evaluated.

Table 8-8. Bronx River Retained Alternatives Summary (2008 Rainfall)

Alternative[1]	Untreated CSO Volume (MGY)	Untreated CSO Volume Reduction (%)	Fecal Coliform Reduction[2] (%)	Enterococci Reduction (%)[2]
Baseline Conditions[3]	455	-	-	-
1. Combination Outfall HP-007 Direct Disinfection + Outfall HP-009 Relief	263	42	40	40
2. Combination Outfall HP-007 Relief + Outfall HP-009 Relief	285	37	39	39
3. Outfall HP-009 Relief	295	35	35	35
4. Combination Outfall HP-007 Direct Disinfection + Outfall HP-009 Outfall Disinfection	237	47	45	45
5. Combination Outfall HP-007 Direct Disinfection + Outfall HP-009 RTB Disinfection	237	47	45	45
6. 75% CSO Control Tunnel	114	75	75	75
7. 100% CSO Control Tunnel	0	100	100	100

Notes:

(1) The seven alternatives listed all include floatables control at HP-011 (underflow baffle + bending weir)
(2) Bacteria reduction computed on an annual basis.
(3) Differs from results reported in Section 6.0, which were based on 10 year simulations.

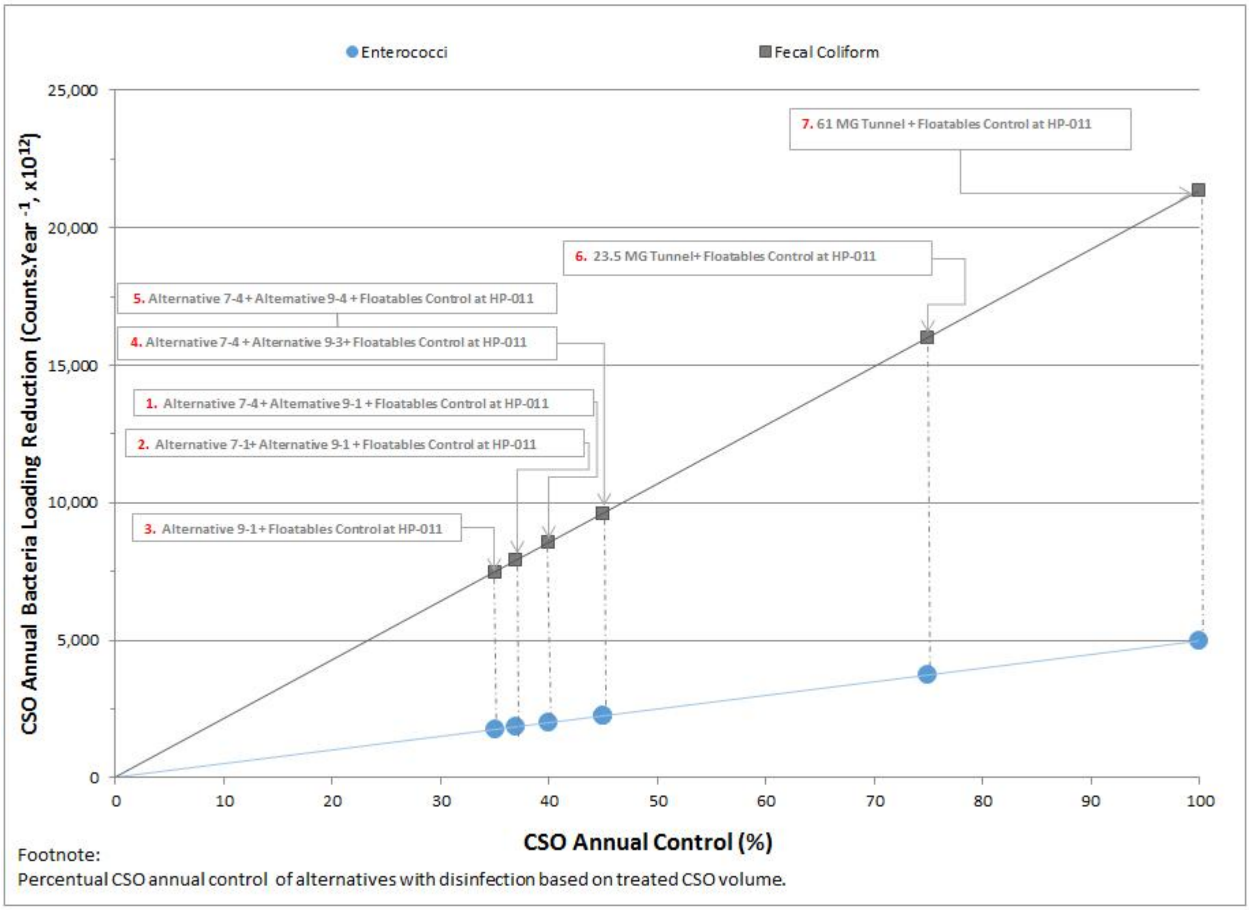


Figure 8-20. CSO Volume Reductions vs. Annual CSO Bacteria Loading Reduction (2008 Rainfall)

Because the Bronx River alternatives serve outfalls in predominantly combined areas, the predicted bacteria loading reductions of the alternatives are aligned with their projected CSO volume reductions.

Table 8-9 presents the total CSO volumes (treated and untreated) for the Bronx River, the CSO volumes and frequency of overflows at outfalls in the Hunts Point system outside of the Bronx River, and the treated volumes at the Hunts Point WWTP for baseline conditions and the retained alternatives. This table quantifies the impacts of the combinations of the Bronx River alternatives (and floatables control at Outfall HP-011) on outfalls outside of the Bronx River. Table 8-10 presents the percent change in volume from baseline conditions for the categories of outfalls shown in Table 8-9.

Table 8-9. Summary of Outfall Predicted Impacts for Retained Alternatives – CSO Volumes and Frequency of CSO Overflows

Alternative	Bronx River CSOs[1]		Outfall HP-025[3]		Outfall HP-002[3]		Outfall HP-003[3]		Outfall HP-011[3]		All Other HP CSO Outfalls	HP WWTP[4]
	Vol. MGY	Max. Annual Act.[2]	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Annual Act.	Vol. MGY	Vol. MGY
Baseline	455	42	91.9	51	44.8	33	211	39	604	44	1,007	45,459
1. Outfall HP-007 Direct Disinfection + Outfall HP-009 Relief	295	32	92.2	51	47.5	33	216	39	635	34	1,009	45,577
2. Outfall HP-007 Relief + Outfall HP-009 Relief	285	31	92.2	51	47.9	33	216	39	640	34	1,009	45,578
3. Outfall HP-009 Relief	295	32	92.2	51	47.5	33	216	39	635	34	1,009	45,577
4. Outfall HP-007 Direct Disinfection + Outfall HP-009 Outfall Disinfection	437	29	92.0	51	44.8	33	211	39	540	32	1,007	45,529
5. Outfall HP-007 Direct Disinfection + Outfall HP-009 RTB Disinfection	437	29	92.0	51	44.8	33	211	39	540	32	1,007	45,529
6. 75% CSO Control Tunnel	114	6	91.9	51	44.8	33	211	39	540	32	1,007	45,996
7. 100% CSO Control Tunnel	0.0	0	91.9	51	44.8	33	211	39	540	32	1,007	45,996

Notes:

(1) Total reflects sum of treated and untreated CSO volumes discharged to the Bronx River.
(2) Frequency of CSO overflows at Outfall HP-009.
(3) Outfalls HP-025, HP-002, and HP-003 are located along the East River west of the Bronx River; Outfall HP-011 is located on the East River east of the Bronx River.
(4) This column presents the annual treated volume at the Hunts Point WWTP.

Table 8-10. Summary of Outfall Predicted Impacts for Retained Alternatives - Percent Change in Volume vs. Baseline

Alternative	% Change in Annual Volume vs. Baseline						
	Bronx River CSOs(1) (%)	Outfall HP-025(2)	Outfall HP-002(2) (%)	Outfall HP-003(2) (%)	Outfall HP-011(2) (%)	All Other HP CSO Outfalls (%)	HP WWTP(3) (%)
Outfall HP-007 Direct Disinfection + Outfall HP-009 Relief	-35	-	+6	+2	+5	+0.2	+0.3
Outfall HP-007 Relief + Outfall HP-009 Relief	-37	-	+7	+2	+6	+0.2	+0.3
Outfall HP-009 Relief	-35	-	+6	+2	+5	+0.2	+0.3
Outfall HP-007 Direct Disinfection + Outfall HP-009 Outfall Disinfection	-4	-	-	-	-11	-	+0.1
Outfall HP-007 Direct Disinfection + Outfall HP-009 RTB Disinfection	-4	-	-	-	-11	-	+0.1
75% CSO Control Tunnel	-75	-	-	-	-11	-	+1
100% CSO Control Tunnel	-100	-	-	-	-11	-	+1

Notes:

(1) Includes treated and untreated CSO volumes discharged to the Bronx River.
(2) Outfalls HP-025, HP-002, and HP-003 are located along the East River west of the Bronx River; Outfall HP-011 is located on the East River east of the Bronx River.
(3) This column presents the change in annual treated volume at the Hunts Point WWTP.

8.3.b Water Quality Impacts

This section describes the levels of attainment with applicable current and possible future bacteria criteria within the Bronx River that would be achieved through implementation of the retained CSO control alternatives listed in Table 8-7. The previous discussion focused on the predicted level of volumetric or bacteria pollution reductions.

The tidal or saline portion of the Bronx River is a Class I waterbody. Based on the analysis presented in Section 6.0, and supported by the 10 year ERTM runs, historic and recent water quality monitoring, along with baseline condition modeling, it was revealed that all locations along this portion of the waterbody are currently in attainment with the Class I fecal coliform criterion. When the attainment is assessed using the Primary Contact WQ Criteria of Class SC, none of the alternatives would result in full annual attainment. As explained in the gap analysis presented in Section 6.3, bacteria loadings from other sources, particularly the tidal exchange with the Upper East River, the Bronx River baseflow from Westchester County and stormwater, direct drainage and other urban wet-weather discharges to the freshwater reach of the Bronx River within NYC, influence the fecal and enterococci concentrations to the extent that even the removal or control of 100 percent of the CSO discharges to the saline reach of the Bronx River would not result in full attainment of the Class SC criteria on an annual basis. However, as was shown in Section 6.0, the recreational season (May 1st through October 31st) attainment of the fecal coliform Primary Contact WQ Criterion is already met under baseline conditions 100 percent of the time. The relationship between levels of CSO control through implementation of the retained alternatives, including 100 percent, and predicted levels of WQS attainment are discussed in greater detail in Section 8.5. Unlike the previously described analyses based on the 10 year ERTM runs, these latter analyses are based on 2008 typical year ERTM runs.

As noted above, retained Alternatives 1 (Outfall HP-007 Direct Disinfection + Outfall HP-009 Relief), 2 (Outfall HP-007 Relief + Outfall HP-009 Relief), and 3 (Outfall HP-009 Relief) were predicted to result in increases in volume discharged at Outfall HP-011. The sensitivity of water quality in the vicinity of Outfall HP-011 to the increases in volume at Outfall HP-011 was assessed using the 10-year ERTM model run. The sensitivity evaluation was conducted by comparing the baseline percent attainment at HP-011 to the percent attainment for retained Alternative 2 (Outfall HP-007 Relief + Outfall HP-009 Relief), where the volume at Outfall HP-011 was predicted to increase by 6 percent (from 604 to 640 MGY). The East River at Outfall HP-011 is currently a Class I waterbody. For the purposes of the sensitivity analysis, impact on attainment of Primary Contact WQ Contact (Class SC) and Potential Future Primary Contact WQ Criteria for bacteria was assessed.

Table 8-11 presents the 10-year percent attainment at Outfall HP-011 for baseline conditions compared to retained alternative 2. As indicated in Table 8-11, despite the predicted 36 MG increase in annual CSO volume, the percent attainment of the water quality criteria listed was predicted to be slightly better for Alternative 2 compared to the baseline.

Table 8-11. Predicted 10-Year Percent Attainment at Outfall HP-011 for Alternative 2 – (Outfall HP-007 Relief + Outfall HP-009 Relief)

Criterion	10-Year % Attainment	
	LTCP Baseline	Alternative 2 (HP-007 Relief + HP-009 Relief)
FC Monthly GM $\leq$ 200 cfu/100mL	93.0	95.0
Entero 30-day rolling GM $\leq$ 30 cfu/100mL	93.1	96.0
Entero 30-day rolling 90th percentile $\leq$ 110 cfu/100mL	42.4	52.6

Although Alternative 2 was predicted to increase the volume at Outfall HP-011 by 36 MGY, the frequency of overflows at Outfall HP-011 was predicted to decrease from 44 to 34 per year. Based on the model, the total duration of discharge at Outfall HP-011 was also predicted to decrease from 381 to 186 hours. The reduction in frequency of overflows and duration is due to the impact of the proposed bending weir. The bending weir would create in-system storage, reducing discharge at the start and end of the storms, and fully capturing smaller storms. The percent attainment at this location appears to be more sensitive to the reduction in frequency and duration of discharge than to the increase in volume of discharge.

8.4 Cost Estimates for Retained Alternatives

Evaluation of the retained alternatives requires cost estimation. The methodology for developing these costs is dependent upon the type of technology and its O&M requirements. The capital costs were developed as PBC and the total net present worth costs were determined using the PBC estimated and then adding the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 20-year life cycle. All costs are in February 2015 dollars. The present worth reported for the alternatives presented below include $9M associated with the implementation of floatables control at CSO Outfall HP-011, on the East River.

8.4.a Alternative 1 - Combination of Alternatives 7-4 and 9-1

Costs for Alternative 1 include planning-level estimates of the costs to construct the various components of direct disinfection at CSO Relief Structure 27A, conveyance relief between Regulator 13 and the Bronx River siphon, as well as the implementation of floatables control at CSO Outfall HP-011 on the East River. These alternatives are described in detail in Section 8.2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative 1 is $65M as shown in Table 8-12.

Table 8-12. Costs for Alternative 1 – Combination of Alternatives 7-4 (Outfall HP-007) and 9-1 (Outfall HP-009)

Item	February 2015 Cost ($ Million)
Capital Costs	59.1
Annual O&M	0.38
Total Present Worth	64.7

8.4.b Alternative 2 - Combination of Alternatives 7-1 and 9-1

Costs for Alternative 2 include planning-level estimates of the costs to construct the various components of increased conveyance downstream of CSO Relief Structure 27, conveyance relief between Regulator 13 and the Bronx River siphon, as well as the implementation of floatables control at CSO Outfall HP-011 on the East River. These alternatives are described in detail in Section 8.2. Site acquisition costs are not included. The total cost for Alternative 2 is $111M as shown in Table 8-13.

Table 8-13. Costs for Alternative 2 – Combination of Alternatives 7-1 (Outfall HP-007) and 9-1 (Outfall HP-009)

Item	February 2015 Cost ($ Million)
Capital Costs	110.1
Annual O&M	0.05
Total Present Worth	110.9

8.4.c Alternative 3 – Alternative 9-1

Costs for Alternative 3 include planning-level estimates of the costs to construct the various components of increased conveyance between Regulator 13 and the Bronx River siphon, as well as the implementation of floatables control at CSO Outfall HP-011. These alternatives are described in detail in Section 8.2. Site acquisition costs are not included. The total cost for Alternative 3 is $41M as shown in Table 8-14.

Table 8-14. Costs for Alternative 3 – Alternative 9-1 (Outfall HP-009)

Item	February 2015 Cost ($ Million)
Capital Costs	39.9
Annual O&M	0.05
Total Present Worth	40.7

8.4.d Alternative 4 - Combination of Alternatives 7-4 and 9-3

Costs for Alternative 4 include planning-level estimates of the costs to construct the various components of direct disinfection at CSO Relief Structure 27A, outfall disinfection at Outfall HP-009, as well as the implementation of floatables control at CSO Outfall HP-011. These alternatives are described in detail in Section 8.2. Site acquisition costs are not included. The total cost for Alternative 4 is $153M as shown in Table 8-15.

Table 8-15. Costs for Alternative 4 – Combination of Alternatives 7-4 (Outfall HP-007) and 9-3 (Outfall HP-009)

Item	February 2015 Cost ($ Million)
Capital Costs	143.0
Annual O&M	0.70
Total Present Worth	153.4

8.4.d Alternative 5 – Combination of Alternatives 7-4 and 9-4

Costs for Alternative 5 include planning-level estimates of the costs to construct the various components of direct disinfection at CSO Relief Structure 27A, RTB disinfection at Outfall HP-009, as well as the implementation of floatables control at CSO Outfall HP-011. These alternatives are described in detail in Section 8.2. Site acquisition costs are not included. The total cost for Alternative 5 is $85M as shown in Table 8-16.

Table 8-16. Costs for Alternative 5 – Combination of Alternatives 7-4 (Outfall HP-007) and 9-4 (Outfall HP-009)

Item	February 2015 Cost ($ Million)
Capital Costs	75.2
Annual O&M	0.65
Total Present Worth	84.8

8.4.e Alternatives 6 and 7 –75% and 100% CSO Control Tunnels

Cost estimates for 75% CSO control and 100% CSO control tunnels, Alternatives 6 and 7, respectively, are summarized in Table 8-17. The estimated total NPW ranges between $440M to $701M for the smallest and largest tunnel, respectively. These costs include the boring of the deep tunnel, multiple shafts, dewatering pump stations, odor control systems and other ancillary facilities as described in Section 8.2. Site acquisition costs are not included.

Table 8-17. Tunnel Alternatives Costs

Tunnel Control Level	75% Tunnel (Alternative 6)	100% Tunnel (Alternative 7)
February 2015 PBC ($ Million)	418.1	660.0
Annual O&M Cost ($ Million)	1.5	2.7
Total Present Worth ($ Million)	439.8	700.8

The cost estimates of these retained alternatives are summarized below in Table 8-18 and are then used in the development of the cost-performance and cost- attainment plots presented in Section 8.5.

Table 8-18. Cost of Retained Alternatives(1)

Alternative	PBC ($ Million)	Annual O&M Cost ($ Million)	Total Present Worth ($ Million)
1. Combination of former Alts. 7-4 and 9-1	59.1	0.38	65
2. Combination of former Alts. 7-1 and 9-1	110.1	0.05	111
3. Former Alt. 9-1	39.9	0.05	41
4. Combination of former Alts. 7-4 and 9-3	143.0	0.70	153
5. Combination of former Alts. 7-4 and 9-4	75.2	0.65	85
6. 75% CSO Control Tunnel	418.1	1.5	440
7. 100% CSO Control Tunnel	660.0	2.7	701

Notes:
(1) Includes $9M associated with the implementation of floatables control at CSO Outfall HP-011, on the East River.

8.5 Cost-Attainment Curves for Retained Alternatives

The final step of the analysis is to evaluate the cost-effectiveness of the alternatives based on their NPW and projected impact on CSO loadings and attainment of applicable WQS.

8.5.a Cost-Performance Curves

Cost-performance curves were developed by plotting the costs of the retained alternatives against their predicted level of CSO control. For the purposes of this section, CSO control is defined as the degree or rate of bacteria reduction through volumetric capture, disinfection or combinations of the two. Both the cost-performance and subsequent cost-attainment analyses focus on bacteria loadings and bacteria WQ criteria.

A linear best-fit cost curve was developed based on those alternatives judged most cost-effective for a defined level of CSO control as estimated by IW modeling for the typical year rainfall (2008). The retained alternatives included some with recreational season (May 1st through October 31st) disinfection, some with year-round volumetric reduction and combinations thereof. Therefore, the best-fit lines were based on annual levels of control for those with year-round volumetric reduction exclusively and annual equivalent levels of control for the remainder.

The goal of the LTCP is to reduce CSO bacteria loadings to the waterbody to the extent that such loadings are responsible for non-attainment of applicable WQS. Figure 8-21 shows the volumetric reductions achieved by each alternative whereas bacteria reduction plots are presented in Figures 8-22 and 8-23. These latter curves plot the cost of the alternatives against their associated projected annual CSO enterococci and fecal coliform loading reductions, respectively. The primary vertical axis shows percent CSO bacteria loading reductions. The secondary vertical axis shows the corresponding total bacteria loading reductions, as a percentage, when loadings from other non-CSO sources of bacteria are included.

As shown on Figures 8-21 through 8-23, Alternative 5 (Alternative 7-4 + Alternative 9-4 + Floatables Control at Outfall HP-011) reflects the cost-effectiveness of treatment based CSO controls, as illustrated by the analysis of the retained basin-wide alternatives. An analysis focusing on the basin-wide alternatives that do not include treatment as means of controlling CSO, reveals that Alternative 2 (Alternative 7-1 + Alternative 9-1 + Floatables Control at Outfall HP-011) realizes the greatest CSO volumetric reduction within the range of costs below $400M.

Predicted enterococci and fecal coliform CSO loading reductions range from a low of 35 percent for Alternative 3 – Conveyance Relief of Regulator 13 (Outfall HP-009), to a high of 100 percent for Alternative 7 – 100% CSO Control Tunnel. When total loadings are considered, including other non-CSO sources of bacteria, these reductions span from 21 percent to 61 percent for enterococci and from 26 percent to 76 percent for fecal coliform.

8.5.b Cost-Attainment Curves

The cost-performance plots shown in Figures 8-21 through 8-23 indicate that most of the retained alternatives represent incremental gains in marginal performance. The retained alternatives that do not show incremental gains in performance (shown in red in the figures) include Alternatives 2 and 4.

This section evaluates the relationship of the costs of the retained alternatives versus their expected level of attainment of Existing WQ Criteria (Class I), Primary Contact WQ Contact (Class SC) and Potential Future Primary Contact WQ Criteria and their associated bacteria criteria as modeled using ERTM with 2008 rainfall. Those retained alternatives that did not show incremental gains in marginal performance on the cost-performance curves are not included in the cost-attainment curves as they were deemed to be not cost-effective relative to other alternatives.

In addition to the current Class I WQS, the cost-attainment analysis considered other standards and bacteria criteria, including: Class SC which represents the existing Primary Contact WQ Criteria; and Potential Future Primary Contact WQ Criteria. As was noted in Section 2.0, under the BEACH Act of 2000, enterococci criteria do not apply to tributaries, such as the Bronx River. The Class SC evaluations thus only considered the fecal coliform criterion, specifically the monthly GM of 200 cfu/100mL both on an annual and recreational season (May 1^{st} through October 31^{st}) basis. The resultant curves for all of the applicable standards and relevant criteria are presented as Figures 8-24 through 8-28 for five locations along the saline or tidal reach of the Bronx River for Stations BR-5 through BR-9.

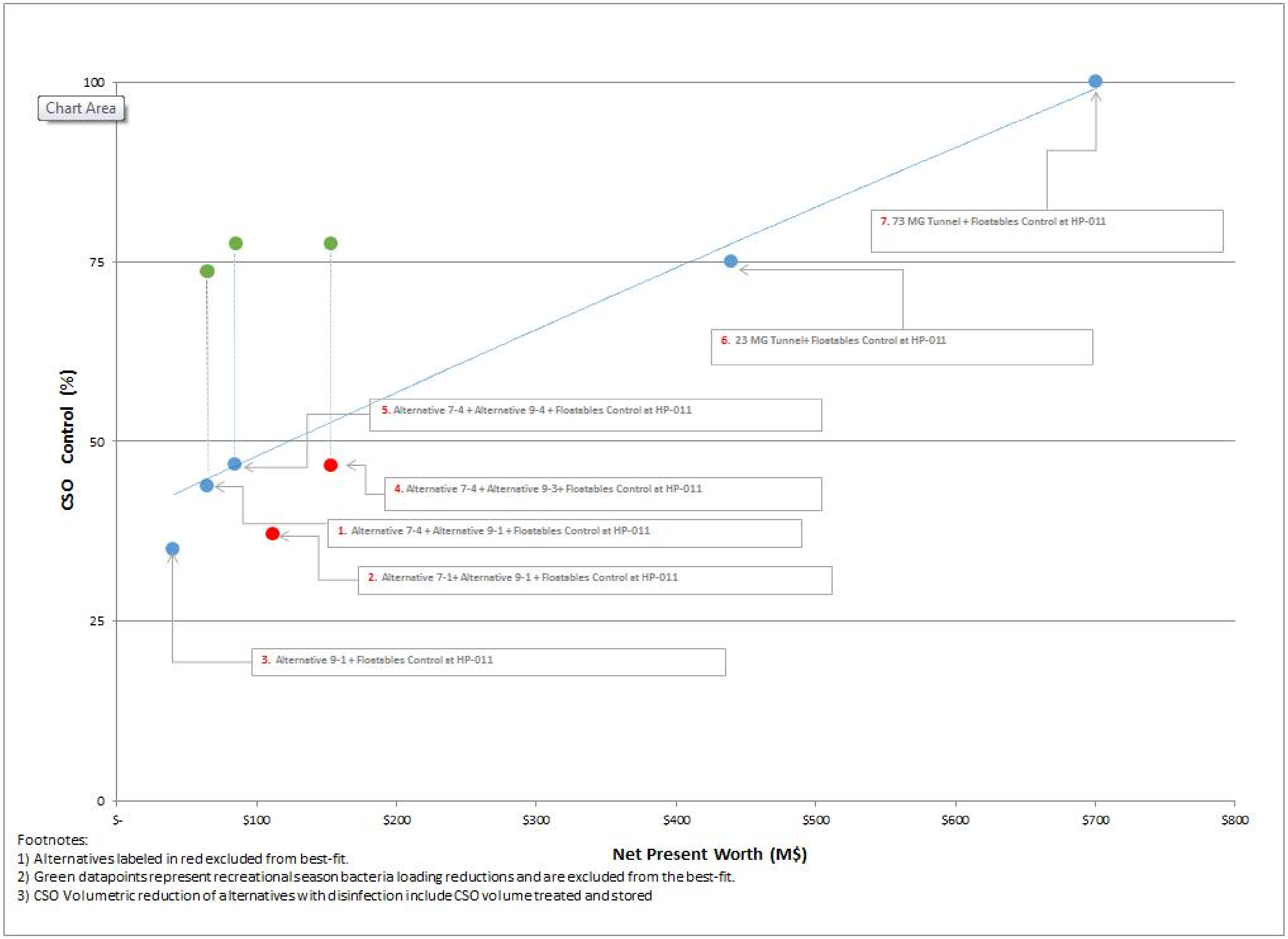


Figure 8-21.Cost vs. CSO Control (2008 Rainfall)

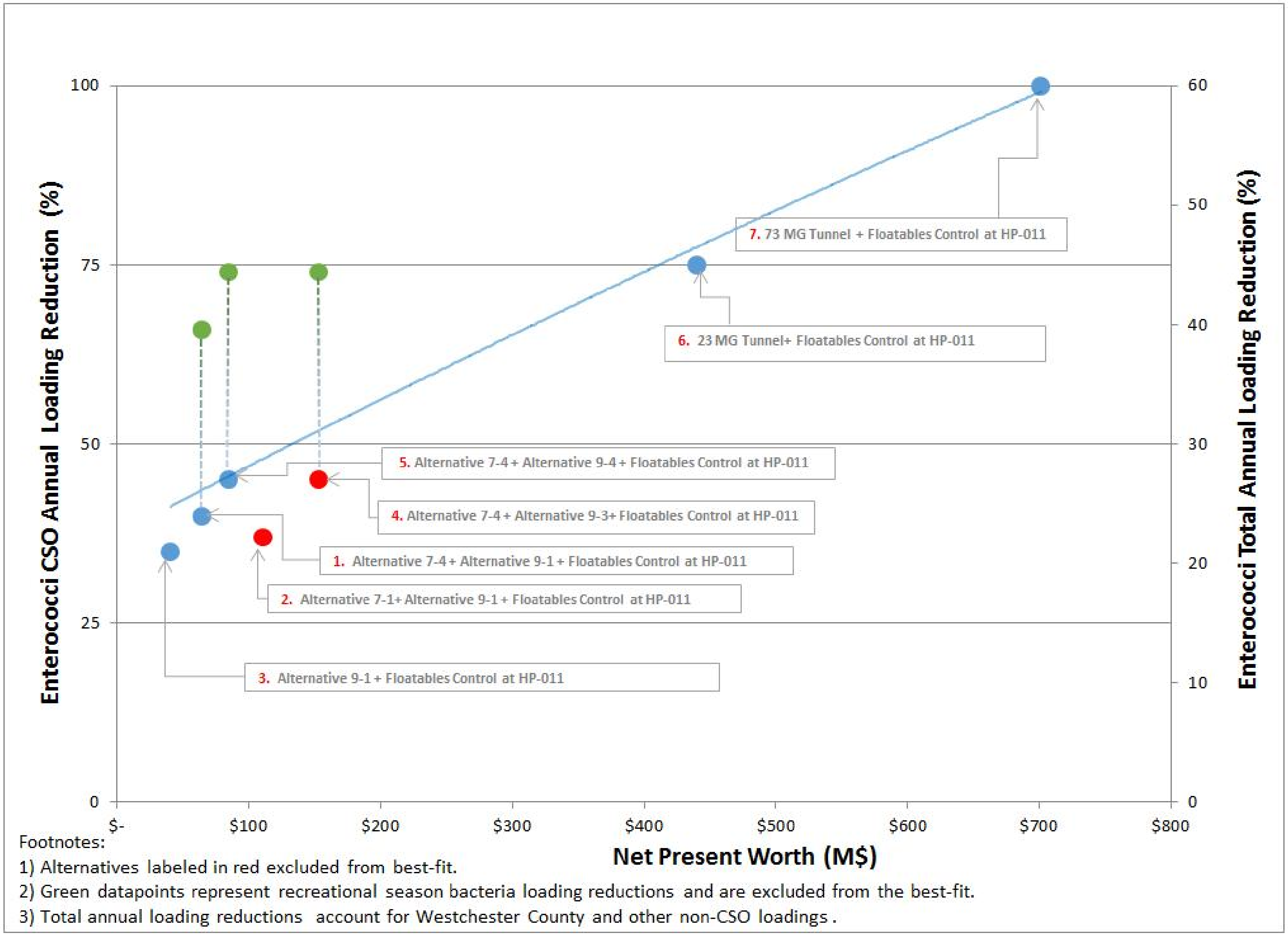
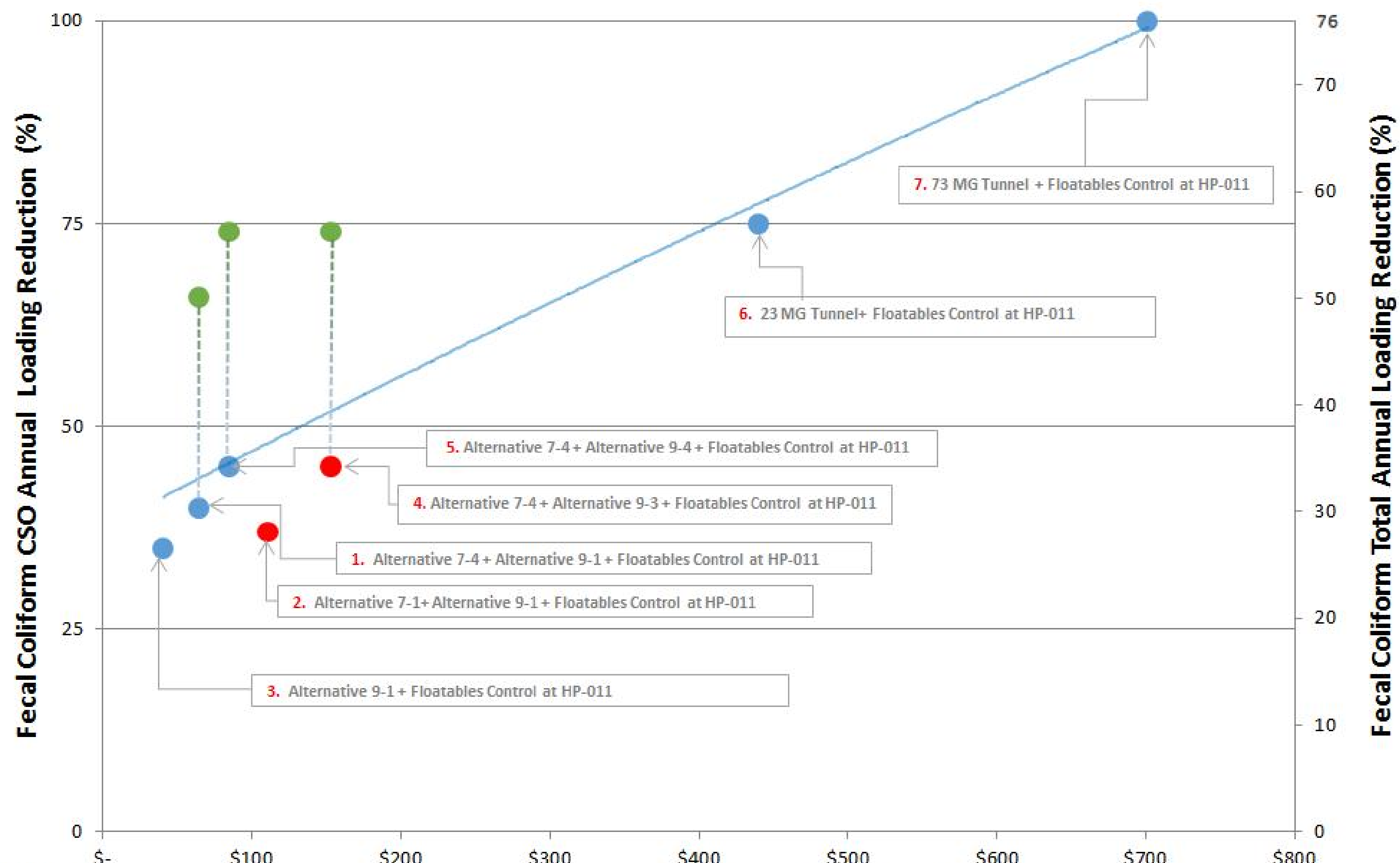


Figure 8-22. Cost vs. Enterococci Loading Reduction (2008 Rainfall)



Footnotes:
1) Alternatives labeled in red excluded from best-fit.
2) Green datapoints represent recreational season bacteria loading reductions and are excluded from the best-fit.
3) Total annual loading reductions account for Westchester County land other non-CSO loadings.

Figure 8-23. Cost vs. Fecal Coliform Loading Reduction (2008 Rainfall)

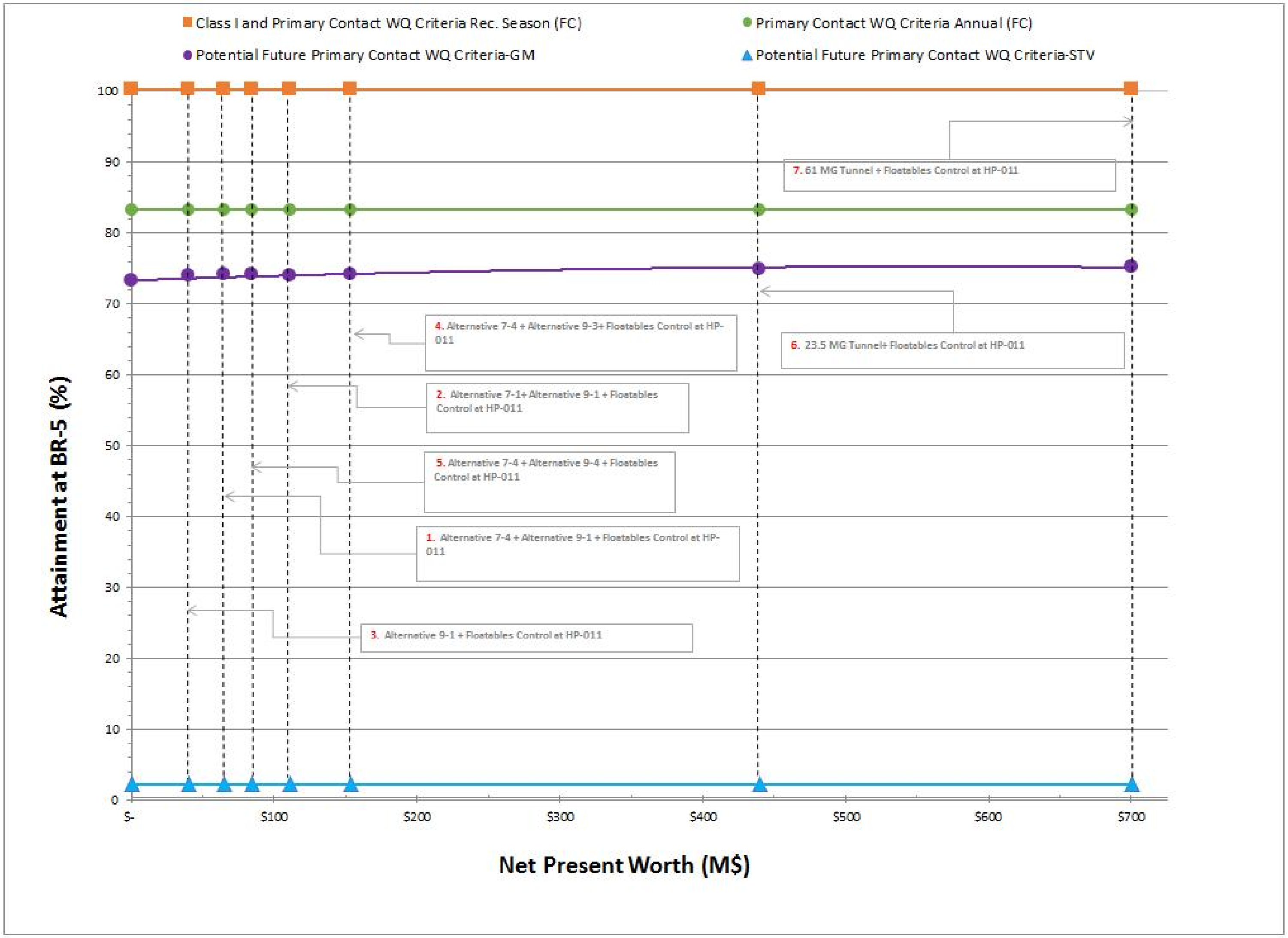


Figure 8-24. Cost vs. Bacteria Attainment at Station BR-5 (2008 Rainfall)

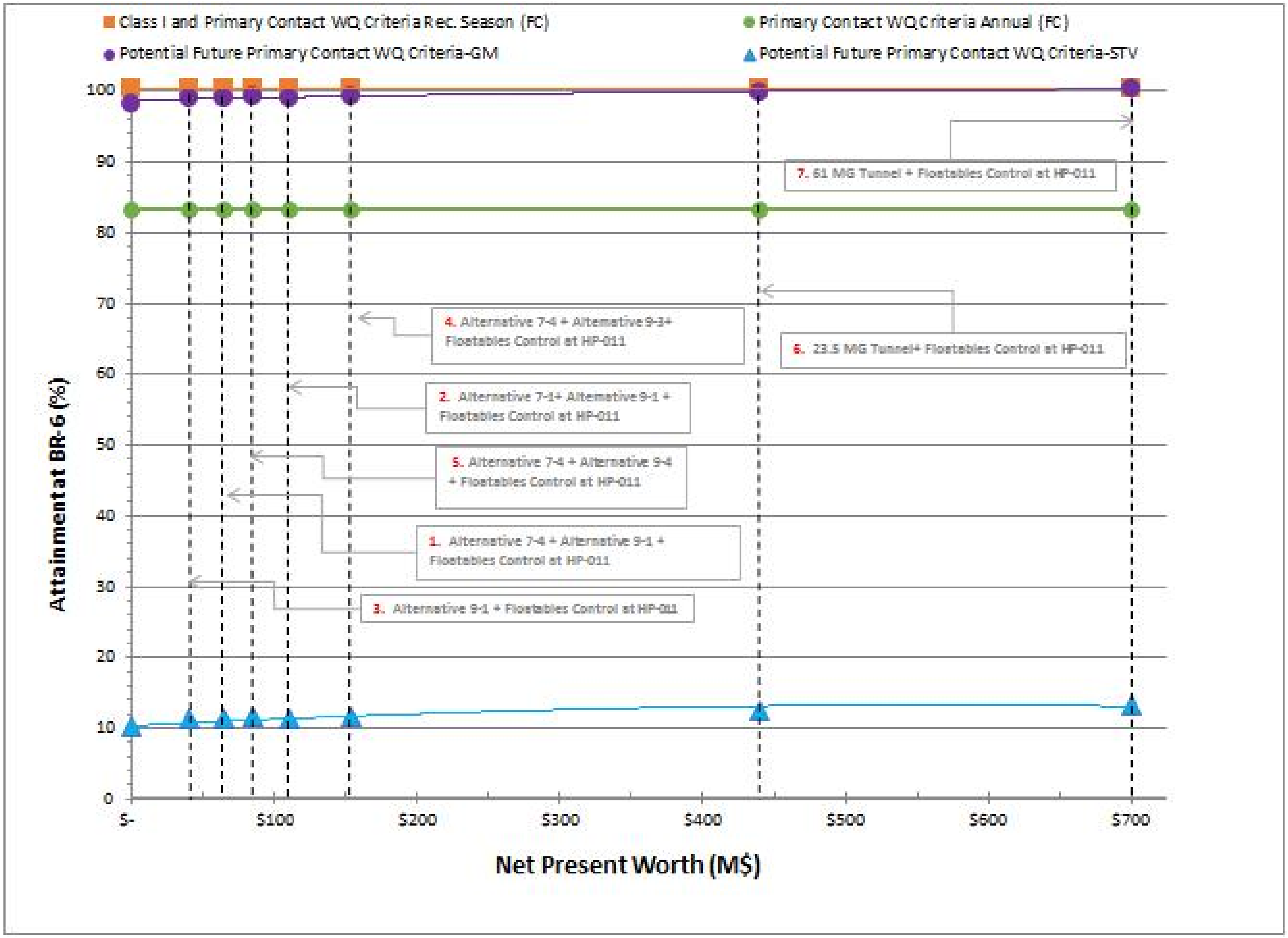


Figure 8-25. Cost vs. Bacteria Attainment at Station BR-6 (2008 Rainfall)

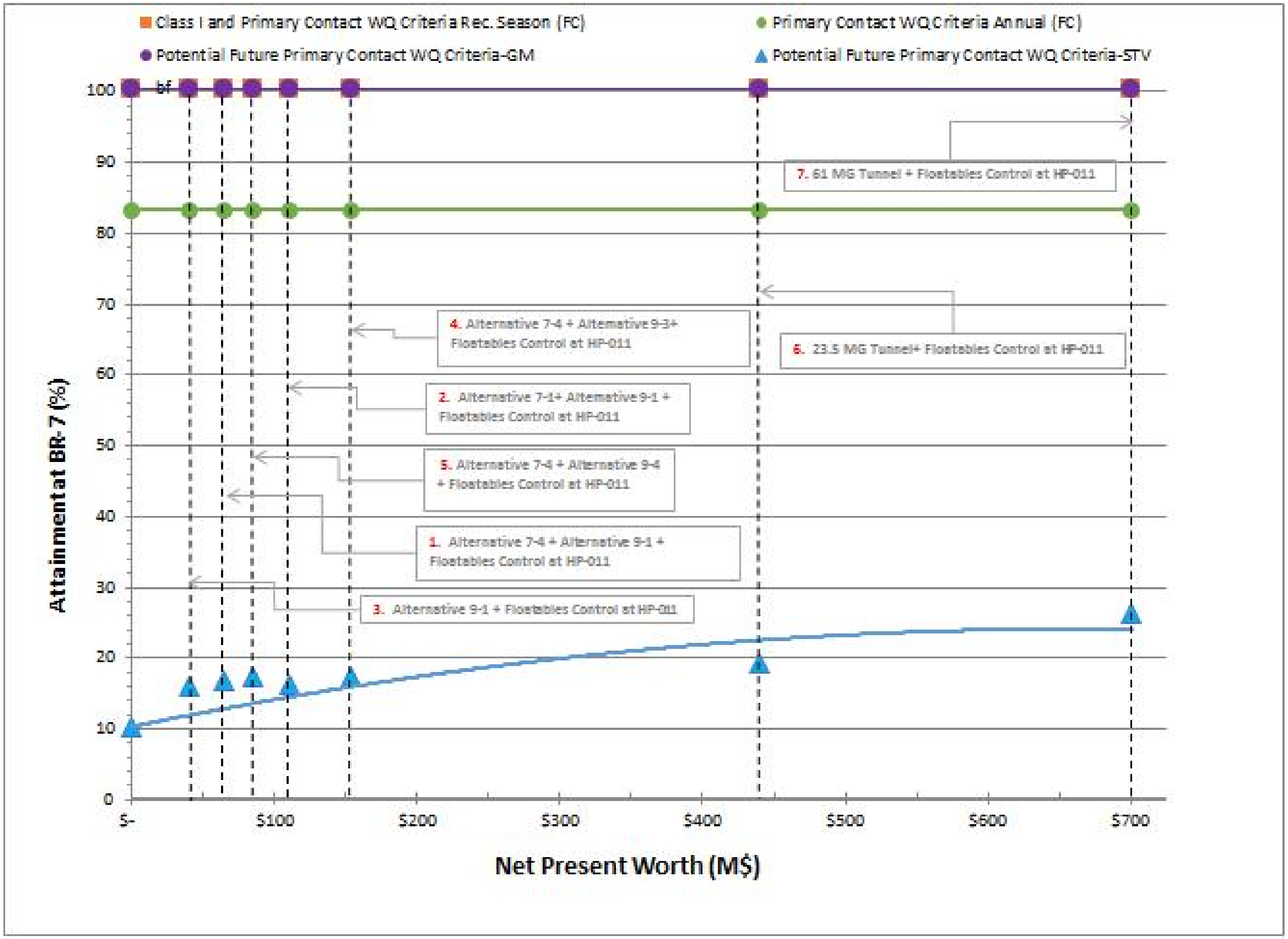


Figure 8-26. Cost vs. Bacteria Attainment at Station BR-7 (2008 Rainfall)

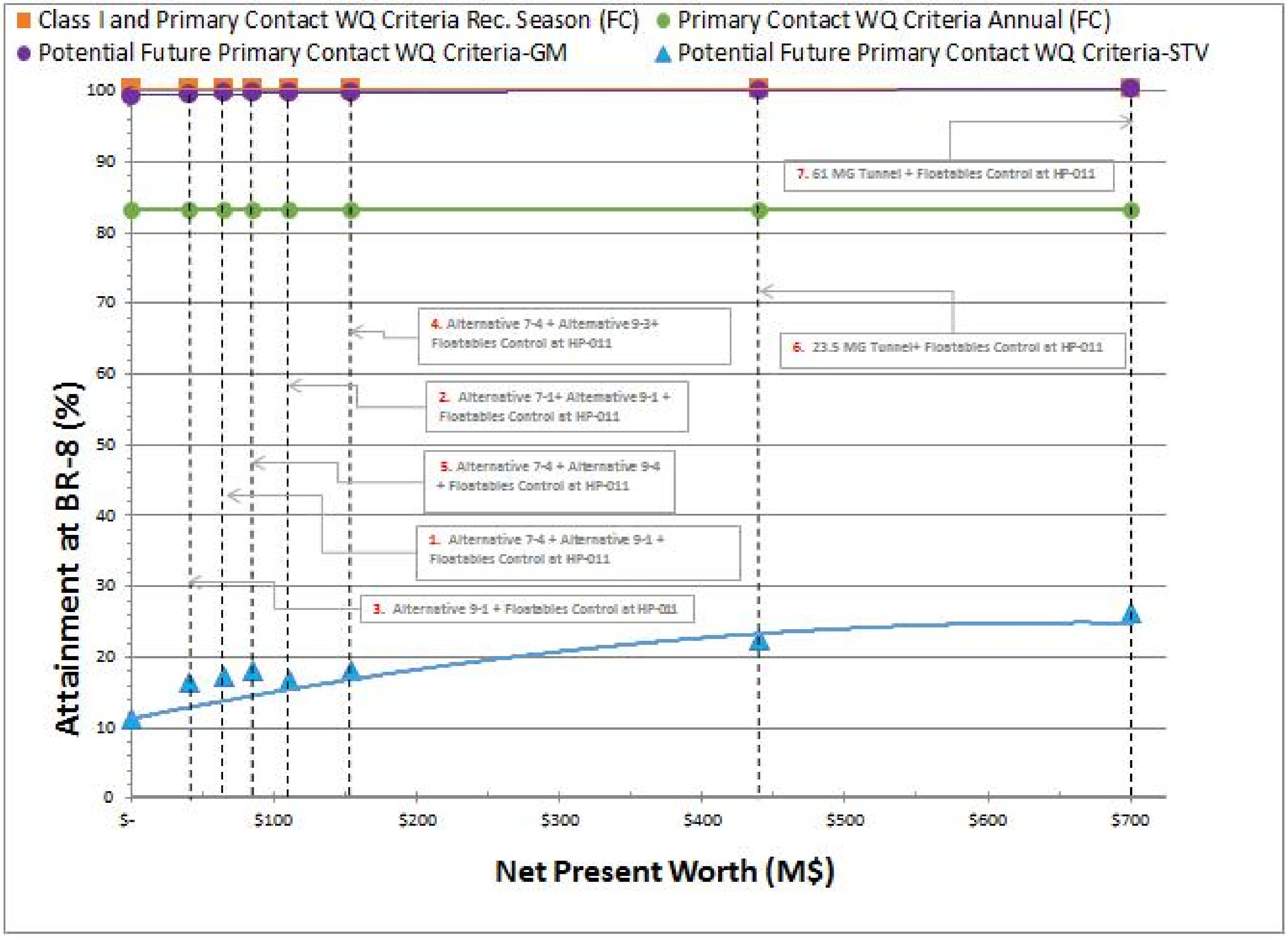


Figure 8-27. Cost vs. Bacteria Attainment at Station BR-8 (2008 Rainfall

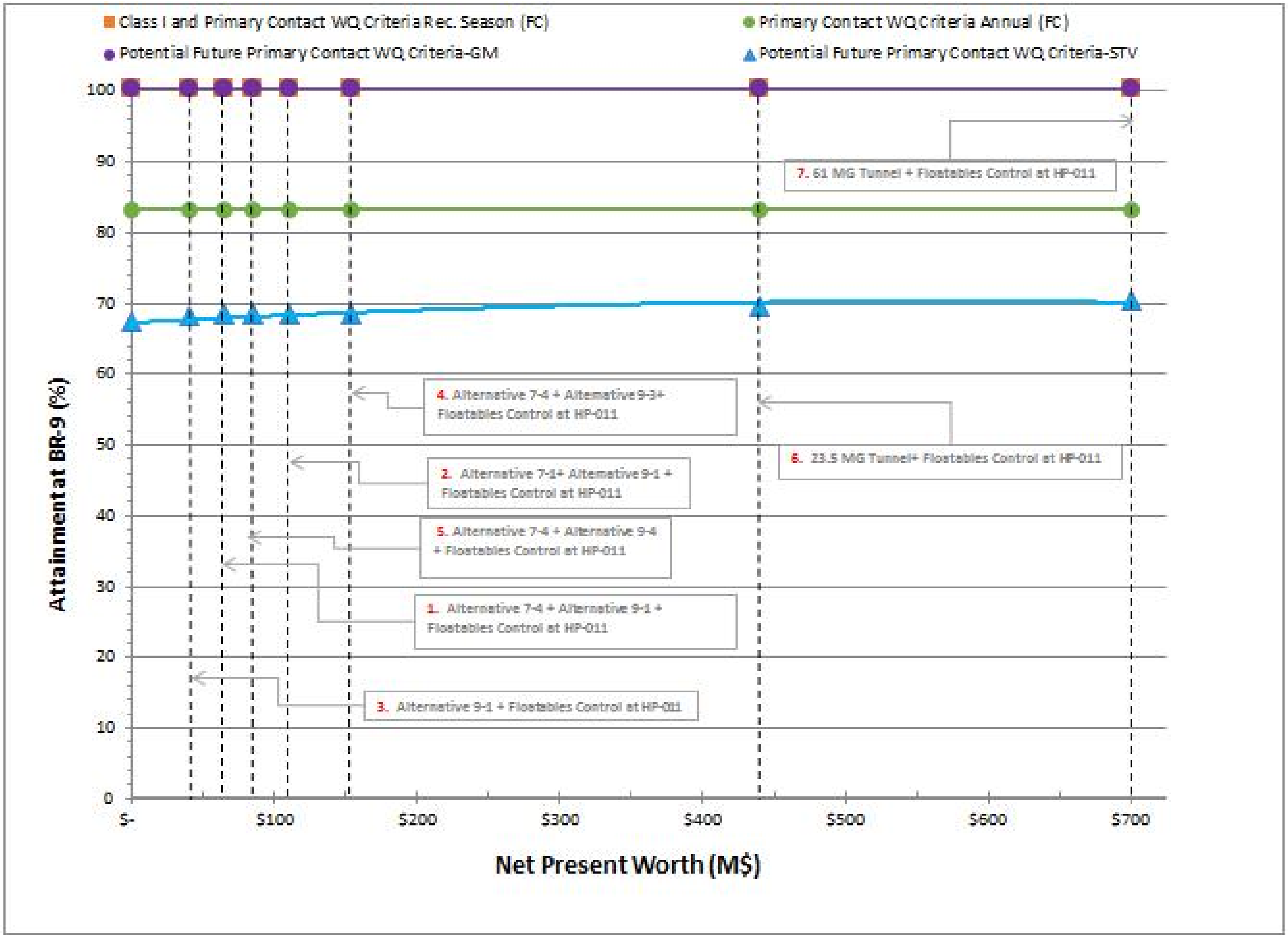


Figure 8-28. Cost vs. Bacteria Attainment at Station BR-9 (2008 Rainfall)

Attainment of the Existing WQ Criterion (Class I) for fecal coliform is met for a high percentage of the time (greater than 95 percent) at all stations and thus the Bronx River is in compliance with the designated criterion.

Based on the 2008 typical year WQ simulations, annual attainment of the Primary Contact WQ Criteria (Class SC) under baseline conditions are somewhat lower than with Class I, with the highest levels of attainment being roughly 83 percent. However, this criterion is fully attained at all stations during the recreational season (May 1st through October 31st). As shown on Figures 8-24 through 8-28, the seasonal Primary Contact WQ Criteria (Class SC) attainment is already achieved under baseline conditions and even the implementation of 100% CSO control would not bring the waterbody into compliance with this criterion on an annual basis.

The most tangible benefits of a hypothetical implementation of 100% CSO control within the Bronx River watershed would be realized at Station BR-7 in regards to attainment of the STV Potential Future Primary Contact WQ Criteria. In this case attainment would increase from 10 percent under baseline conditions, to 26 percent with CSO discharges fully eliminated under typical year rainfall conditions. The required level of control to realize such minor improvements in attainment of WQS comes at a cost of about $700M.

All the retained alternatives that offer intermediate levels of CSO control are projected to realize even less improvements in attainment of WQS.

8.5.c Conclusion on Preferred Alternative

The selection of the Preferred Alternative for the Bronx River LTCP included multiple considerations including public input, predicted environmental and water quality benefits, and costs. The following discussion includes the rationale for selecting the retained alternative that was deemed the most preferred alternative.

The previous sections described the results of the cost-performance and cost-attainment analyses that were performed on the retained alternatives for the Bronx River LTCP. The former analysis, the cost-performance curves, shows Alternative 5 as a cost-effective alternative with respect to the level of CSO control. Alternative 5, along with some of the other retained alternatives, includes a CSO disinfection component. As demonstrated in Figures 8-21, 8-22 and 8-23, CSO disinfection is an effective method of reducing bacteria loads to the waterway and provides benefits during the recreational season (May 1st through October 31st) that the other alternatives do not provide.

The LTCP alternatives were presented to the general public and stakeholders by DEP during the public participation process described in Section 7.0. During these public meetings, comments were made that disinfection was a less desirable CSO control measure than those involving volumetric reduction. One of the stated reasons for this included the desire of not having chemicals stored in the neighborhoods which would require new facilities and result in additional heavy commercial traffic. Another was the opposition to the concept of seasonally adding a disinfectant to the Bronx River when nearly the same levels of annual equivalent loading reduction could be achieved through year-round volumetric control. In addition, the public noted that the Bronx River has an experimental in-stream bio-treatment pilot project consisting of oyster reefs at the mouth of the Bronx River. The oyster reefs, first noted in Section 2.0, constitute an area within the waterbody that may benefit from the year-round bacteria and CSO volume reduction alternative, whereas the seasonal disinfection alternative may have a negative impact on the oysters and/or on oyster spat.

DEP also considered the difference in attainment levels between the retained alternatives. As shown in Figures 8-24 through 8-28, there is virtually no difference in the level of attainment between the alternatives that include disinfection versus those that do not.

While DEP strives to implement the most cost-effective CSO abatement strategy for each waterbody, in the case of the Bronx River, the preferred alternative, Alternative 2, has a total present worth of $111M which is 30 percent more costly than Alternative 5. Alternative 2 provides additional benefits that warrant the additional investment, namely a high level of volumetric control throughout the year without the need for disinfection which the stakeholders want to avoid. Finally, as an added benefit to DEP, Alternative 2 will be easier and less costly to operate once constructed. Therefore DEP has selected Alternative 2 as the preferred alternative. This preferred alternative has an estimated construction cost of $110M and a NPW cost of $111M. The annual O&M costs for this alternative were estimated to be $53,000.

The ERTM WQ model was used to characterize WQS attainment for this preferred alternative by running the model for the full 10-year (2002-2011) simulation period. During this simulation period it was assumed that the flow entering the NYC waters from Westchester County was in attainment of the Primary Contact WQ Criteria and the Potential Future Primary Contact WQ Criteria, with the exception of the 90th percentile STV enterococci criterion. The results of these runs are summarized in Tables 8-19 through 8-23 for the Existing WQ Criteria, Primary Contact WQ Criteria, and the Potential Future Primary Contact WQ Criteria. Results are present for fecal coliform and DO on an annual basis. Fecal coliform and enterococci results relative to primary contact are presented on a recreational season (May 1st through October 31st) basis as well.

Portions of the freshwater section of the Bronx River are calculated not to achieve attainment of the existing Class B WQ criteria, but this portion of the Bronx River is not impacted by CSOs. The projected attainment in the portion of the Bronx River affected by CSOs, the saline portion, indicates that both the fecal coliform and DO concentrations would attain existing WQS as shown in Tables 8-19 and 8-20. As noted above, 95 percent attainment of applicable water quality criteria is what DEC has stated is the target for compliance with the WQS. When compared to the Primary Contact WQ Criteria (Tables 8-21 and 8-22), portions of the Bronx River fall below the 95 percent attainment threshold. In the saline portion of the Bronx River, Stations BR-5 through BR-8 are calculated to have less than 95 percent attainment on an annual basis, and Station BR-5 is calculated to reach 87 percent attainment during the recreational season (May 1st through October 31st). The dissolved oxygen attainment of the chronic DO standard (daily average ≥ 4.8 mg/L) is calculated to range between 92 and 94 percent at Stations BR-6 through BR-9. With the exception of Station BR-9, all of the saline water stations would not meet the 30-day rolling GM Potential Future Primary Contact WQ Criterion (Table 8-23), although the majority of these locations have greater than 90 percent attainment. Attainment of the 90th percentile STV criterion is quite low.

Table 8-19. Calculated 10-year Preferred Alternative Attainment of Existing WQ Criteria

Station[1]			Fecal Coliform % Attainment	
			Annual	Recreational Season[2]
BR-1	Fresh Water (Class B - GM<200)	Non-Tidal	100	100
BR-2			100	100
BR-3			93	93
BR-4[3]		Tidal	83	80
BR-5	Saline(Class I – GM<2000)		100	100
BR-6			100	100
BR-7			100	100
BR-8			100	100
BR-9			100	100

Notes:

(1) Freshwater stations are not affected by the Bronx River CSOs, which are all located in the saline section of the Bronx River.
(2) The Recreational Season is from May 1st through October 31st.
(3) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

Table 8-20. Model Calculated Preferred Alternative DO Attainment – Existing WQ Criteria (2008)

Station		DO Annual Attainment (%)
		Entire Water Column
		≥ 4.0 mg/L
BR-5	Saline (Class I)	99
BR-6		95
BR-7		97
BR-8		99
BR-9		98

Table 8-21. Calculated 10-year Preferred Alternative Attainment of Primary Contact WQ Criteria

Station[1]			Fecal Coliform % Attainment (GM <200 cfu/100mL)	
			Annual	Recreational[2] Season
BR-1	Fresh Water	Non-Tidal	100	100
BR-2	Fresh Water	Non-Tidal	100	100
BR-3	Fresh Water	Non-Tidal	93	93
BR-4[3]	Fresh Water	Tidal	83	80
BR-5	Saline	Tidal	83	87
BR-6	Saline	Tidal	90	98
BR-7	Saline	Tidal	90	98
BR-8	Saline	Tidal	90	98
BR-9	Saline	Tidal	96	100

Notes:

(1) Freshwater stations are not affected by the Bronx River CSOs, which are all located in the saline section of the Bronx River.

(2) The Recreational Season is from May 1st through October 31st.

(3) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

Table 8-22. Model Calculated 2008 Preferred Alternative DO Attainment of Primary Contact WQ Criteria

Station		DO Annual % Attainment (Water Column)	
		Preferred Alternative	
		≥ 4.8 mg/L	≥ 3.0 mg/L
BR-5	Saline	100	100
BR-6	Saline	92	97
BR-7	Saline	94	99
BR-8	Saline	94	100
BR-9	Saline	93	100

Table 8-23. Calculated 10-year Preferred Alternative Attainment of Potential Future Primary Contact Water Quality Criteria

<table>
<tr><th colspan="3" rowspan="2">Station[1]</th><th colspan="2">Enterococci
% Attainment</th></tr>
<tr><th>GM <30</th><th>90th Percentile
STV <110</th></tr>
<tr><td>BR-1</td><td rowspan="4">Fresh Water</td><td rowspan="3">Non-Tidal</td><td>100</td><td>18</td></tr>
<tr><td>BR-2</td><td>100</td><td>18</td></tr>
<tr><td>BR-3</td><td>97</td><td>10</td></tr>
<tr><td>BR-4[2]</td><td rowspan="6">Tidal</td><td>73</td><td>9</td></tr>
<tr><td>BR-5</td><td rowspan="5">Saline</td><td>77</td><td>8</td></tr>
<tr><td>BR-6</td><td>93</td><td>25</td></tr>
<tr><td>BR-7</td><td>93</td><td>30</td></tr>
<tr><td>BR-8</td><td>92</td><td>32</td></tr>
<tr><td>BR-9</td><td>96</td><td>52</td></tr>
</table>

Notes:
(1) Freshwater stations are not affected by the Bronx River CSOs, which are all located in the saline section of the Bronx River.
(2) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

The preferred alternative is based on multiple considerations including public input, environmental and water quality benefits, and costs. This preferred alternative is projected to result in very high seasonal attainment with existing pathogen criteria even with the large bacteria loadings from the freshwater portion of the Bronx River. During the months of the year when the Bronx River flow crosses the Westchester County/NYC border at or near the monthly GM criteria limit, any additional loading downstream of the border will elevate the monthly GM above the criteria. In addition, Cope Lake discharges approximately 1.1 MGD (based on limited sampling) between Stations BR-3 and BR-4. This constant source of bacteria loading contributes to the lower attainment levels calculated at Stations BR-4 and BR-5. Thus, these discharges into the freshwater section of the Bronx River are contributing to the majority of the non-attainment being calculated by the model, rather than input from CSOs.

The preferred alternatives for the Bronx River LTCP will reduce CSO discharges from 455 MG/year to 286 MG/year in the saline portion and will include construction of the elements included in Alternative 2, namely:

Outfall HP-007
- 2,700-ft. interceptor relief at Relief Structure 27

Outfall HP-009
- Raise weir at Regulator 13
- Relief pipe between Regulator 13 and the Bronx River siphon

Outfall HP-011
- Floatables Control

The implementation of these elements has a NPW of $111M, reflecting $50,000 of annual O&M over the course of 20 years.

A description of the alternatives is presented in Figures 8-29, 8-30 and 8-31.

The proposed schedule for the implementation of Alternative 2 is presented in Section 9.2.

8.6 Use Attainability Analysis

The 2012 CSO Order on Consent requires that a UAA be included in an LTCP "where existing WQS do not meet the Section 101(a)(2) goals of the CWA, or where the proposed alternative set forth in the LTCP will not achieve existing WQS or the Section 101(a)(2) goals". The UAA shall "examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State." The UAA process specifies that States can remove a designated use which is not an existing use if the scientific assessment can demonstrate that attaining the designated use is not feasible for at least one of six reasons:

1. Naturally occurring loading concentrations prevent the attainment of the use; or
2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or
5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

As part of the LTCP, elements of a UAA, including the six conditions presented above, will be used to determine if changes to the designated use are warranted, considering a potential adjustment to the designated use classification as appropriate. Because the saline CSO impacted section of the Bronx River does not currently, and is not projected to attain the Primary Contact WQ Criteria, even with 100% CSO control, a UAA is attached hereto as Appendix C.

Figure 8-29. Layout of Alternative 7-1 - Hydraulic Relief of CSO Relief 27 at CSO Outfall HP-007

Figure 8-30. Layout of Alternative 9-1 – Hydraulic Relief of Regulator 13

Figure 8-31. Layout of Alternative 11-1 – Regulator 5 Modification

8.6.a Use Attainability Analysis Elements

The objectives of the CWA include providing for the protection and propagation of fish, shellfish, wildlife, and recreation in and on the water. Cost-effectively maximizing the water quality benefits associated with CSO reduction is a cornerstone of this LTCP.

To simplify this process, DEP and DEC have developed a framework that outlines the steps taken under the LTCP in two possible scenarios:

1. Waterbody meets WQ requirements. This may either be the existing WQS (where primary contact is already designated) or assess for an upgrade to the Primary Contact WQ Criteria (where the existing standard is not a Primary Contact WQ Criteria). In either case, a high-level assessment of the factors that define a given designated use is performed, and if the level of control required to meet this goal can be reasonably implemented, a change in designation may be pursued following implementation of CSO controls and post-construction compliance monitoring.

2. Waterbody does not meet WQ requirements. In this case, if a higher level of control is not feasible, the UAA must justify the shortcoming using at least one of the six criteria (see Section 8.6 above). It is assumed that if 100 percent elimination of CSO sources does not result in attainment, the UAA would include factor number 3 at a minimum as justification (human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied, or would cause more environmental damage to correct than to leave in place).

As discussed in Section 2.0 and 6.0, Westchester County sources, NYC CSOs, NYC stormwater, direct drainage and other urban sources of pathogens contribute to bacteria levels in the Bronx River. As noted in Table 6-13 of Section 6.0, Westchester County sources contribute all of the fecal coliform and enterococci bacteria to the freshwater section of the Bronx River closest to the county line, at Station BR-1. The region of the Bronx River that tends to have the lowest level of WQS attainment and highest fecal coliform and enterococci 30-day GMs is between Stations BR-4 and BR-6. The 2008 component analysis presented in Table 6-13 of Section 6.0 also indicates that the 100 percent removal of CSOs would not result in complete attainment of the Primary Contact WQ Criterion for fecal coliform. While the preferred alternative results in a significant reduction of bacteria loading to the saline portion of the Bronx River, other sources contribute to the non-attainment of Primary Contact WQS criteria.

To reduce bacteria loads to the Bronx River, Westchester County municipalities will be required to eliminate dry-weather discharges and illicit connections. However, even when these sources are abated, Westchester County will continue to contribute bacteria to the Bronx River via other sources. Thus, while DEP has proposed a plan to invest additional resources to reduce bacteria discharged from the Bronx River CSOs, there will continue to be other sources of bacteria that will preclude attainment of the existing and future WQ criteria within portions of the Bronx River.

8.6.b Fishable/Swimmable Waters

The goal of this LTCP is to identify appropriate CSO controls necessary to achieve waterbody-specific WQS, consistent with EPA's CSO Control Policy and subsequent guidance. DEC considers the SA and SB classifications as fulfillment of the CWA's fishable/swimmable goal.

The preferred alternative summarized in Section 8.5 results in the levels of attainment with fishable/swimmable criterion as follows.

Water quality modeling analyses, conducted for the freshwater Bronx River and summarized in Tables 8-19 and 8-20, shows that portions of the freshwater section of the Bronx River are not predicted to comply with the Existing WQ Criteria (Class B) monthly fecal coliform criterion of 200 cfu/100mL during the 10-year simulation period. In the saline portion of the Bronx River (Class I), annual fecal coliform attainment is calculated to be 100 percent over the entire length of the Bronx River, on average, during the 10-year simulation period. For the recreational season (May 1st through October 31st), the freshwater section has 80 to 100 percent attainment. The annual attainment of the proposed primary contact fecal coliform criterion of 200 cfu/100mL is 83 to 96 percent, and 87 to 100 percent on a recreational season (May 1st through October 31st) basis.

Compliance with the Potential Future Primary Contact WQ Criteria of 30 cfu/100mL for enterococci is predicted (Table 8-23) to be lower than attainment of the proposed fecal coliform criterion. Attainment of the enterococci 30-day rolling GM during the recreational season (May 1st through October 31st) is 73 to 100 percent in the freshwater section and between 77 and 96 percent from Station BR-5 to BR-9. Attainment of the 110 cfu/100mL STV concentration during the recreational season (May 1st through October 31st) is 9 to 18 percent in the freshwater section and between 8 and 52 percent from Stations BR-5 to BR-9.

As noted, DEP is proposing Alternative 2 so as to reduce the human source of bacteria during the year. Even with the level CSO volume reduction achieved with Alternative 2, the results are not predicted to change the Bronx River compliance sufficiently enough to attain Primary Contact WQ Criteria 100 percent of the time throughout the entire Bronx River because of the remaining bacteria sources. Since the Primary Contact WQ Criteria are projected to be un-attainable, a UAA is required at this time for the Bronx River.

A UAA is required to justify this based on the relevant criteria listed above. Since the analyses proved that even 100 percent elimination of CSO sources does not result in attainment, the UAA includes a discussion of factor number 3 as justification (human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied, or would cause more environmental damage to correct than to leave in place). The UAA also cites factors 3 and 5 associated with the inability to attain the dissolved oxygen criteria at least 95 percent of the time.

The modeling analysis assessed whether the preferred alternative would improve water quality to allow for primary contact recreation, both annually and during the recreational season (May 1st through October 31st), as well as for the Potential Future Primary WQ Criteria during the recreational season (May 1st through October 31st). As shown in Tables 8-21 through 8-22, fecal coliform bacteria levels do not attain the fecal coliform Primary Contact WQ Criterion with construction of the preferred alternative and planned GI on an annual basis. The Bronx River cannot fully attain the Primary Contact Class B/SC fecal coliform criterion along the entire length of the Bronx River or the Potential Future Primary WQ enterococci criteria through CSO controls alone.

8.6.c Assessment of Highest Attainable Use

The analyses contained herein, as noted above in Section 8.5.c and summarized in Table 8-21, indicate that the Primary Contact WQ Criteria is not projected to be attained 100 percent of the time annually within the saline reach of the Bronx River with the recommended alternative. For the purpose of this LTCP, compliance with the standards was considered for 95 percent attainment or higher. The modeling analysis assessed whether the recommended plan would improve water quality to allow for the Primary Contact WQ Criteria, both annually and during the recreational season (May 1st through October 31st). As shown in Table 8-21, fecal coliform bacteria levels meet the criterion seasonally at all but one location (BR-5) within the saline reach but still do not attain the criterion on annual basis at all but one location closer to the East River (BR-9). This means that a UAA will be required for the saline reach of the Bronx River. Table 8-24 summarizes the compliance for the identified plan.

Table 8-24. Recommended Plan Compliance with Bacteria Water Quality Criteria

Location	Meets Existing WQ Criteria(1) (Class I)	Meets Primary Contact WQ Criteria	Meets Potential Future Primary Contact WQ Criteria(2)
Saline Bronx River	YES	NO(2)	NO

Note:
YES indicates attainment is calculated to occur ≥ 95 percent of time.
NO indicates attainment is calculated to be less ≤ 95 percent of time.
(1) Annual attainment.
(2) Criteria not met annually or during the recreational season (May 1st through October 31st).

8.7 Water Quality Goals

8.7.a Existing Water Quality

Based on the analyses of the Bronx River, and the WQS associated with the designated uses, the following conclusions can be drawn:

- The Bronx River is a highly productive Class I waterbody that can fully support existing uses, kayaking and wildlife propagation assuming that Westchester County municipalities can achieve attainment of the existing Class C WQ criteria.
- Should the Westchester County portion of the Bronx River achieve attainment of existing Class C WQ criteria, the Primary Contact WQ Criteria could be considered for the recreational period in the Bronx River, with a wet-weather advisory (see below). However, DO conditions are not met for the existing standard under the existing classification, or under the alternatives that are being considered. DO levels appear to be related to non-CSO related conditions in the Bronx River. Therefore, a variance for DO levels would be still be required.

8.7.b Potential Future Water Quality Criteria

DEP is committed to improving water quality in the Bronx River. Toward that end, DEP has identified instruments for the Bronx River that will allow DEP to continue to improve water quality in the system over time. Wet-weather advisories based on time to recovery analysis are recommended for consideration while advancing towards the numerical criteria established, or others under consideration by DEC, including existing Primary Contact WQ Criteria and Potential Future Primary Contact WQ Criteria consistent with the 2012 EPA RWQC.

Also as noted above, DEP does not believe that adoption of the STV portions of the proposed 2012 EPA RWQC is warranted at this time. Analyses presented herein clearly show that attainment of the STV value of 110 cfu/100mL is not possible through CSO control alone.

8.7.c Time to Recovery

Although the Bronx River could possibly be upgraded to Primary Contact WQ Criteria (limited primary contact) during the recreational season (May 1st through October 31st), it will not be capable of supporting primary contact 100 percent of the time. Even with anticipated reductions in CSO overflows resulting from grey and green infrastructure, the waterbody cannot support primary contact during and following rainfall events. Toward the goal of maximizing the amount of time that the Bronx River can achieve water quality levels to support primary contact, DEP has performed an analysis to assess the amount of time following the end of a rainfall event required for the Bronx River to recover and return to fecal coliform concentrations less than 1,000 cfu/100mL. The analyses consisted of examining the water quality model calculated the Bronx River pathogen concentrations for recreational periods (May 1st through October 31st) that were abstracted from a model simulation of the August 14-15, 2008 storm. Details on the selection of this storm are provided in Section 6.0. The time to return to 1,000 cfu/100mL was then tabulated for each location along the Bronx River. As with the other water quality runs for the Bronx River, the time to recovery analysis was based on a condition that flows from Westchester County are adjusted to be in compliance with WQS. The results of this analysis are summarized in Table 8-25 for the Bronx River. As noted, the duration of time within which pathogen concentrations are expected to be higher than the DOH considers safe for primary contact varies by location along the Bronx River. The time to recovery appears to be within the DEC desired target of 24-hours for the preferred alternative. Much of the reason for the predicted time to recovery is associated with the pathogens in the flow originating within Westchester County. Although the Westchester County flows were adjusted to be in compliance with the monthly geometric mean fecal coliform level of 200 cfu/100mL, the model included individual timesteps with the fecal coliform concentrations from Westchester County above 1,000 cfu/100mL.

Table 8-25. Time to Recovery within the Bronx River (August 14-15 2008)

Station(1)			Time to Recovery (hrs) Fecal Coliform Target (1,000 cfu/100mL) Preferred Alternative
BR-1	Fresh Water	Non-Tidal	25
BR-2			25
BR-3			26
BR-4(2)		Tidal	27
BR-5	Saline		27
BR-6			23
BR-7			19
BR-8			15
BR-9			4

Notes:
(1) Freshwater stations are not affected by the Bronx River CSOs, which are all located in the saline section of the Bronx River.
(2) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.

8.8 Recommended LTCP Elements to Meet Water Quality Goals

Water quality in Bronx River will be improved with the preferred alternative and other actions identified herein.

The actions identified in this LTCP include:

- A 2,700-ft. interceptor relief at Relief Structure 27 to reduce CSO discharges at Outfall HP-007.
- Raising a weir at Regulator 13; adding a relief pipe between Regulator 13 and the Bronx River siphon to reduce CSO discharges at Outfall HP-009.
- Implementation of floatables control for Outfall HP-011 at Regulator 5 to reduce the quantities of floatables discharged to the East River.
- Costs for the recommended Alternative 2 are: NPV $111M, Construction $110M and O&M of $53,000.
- The LTCP includes a UAA that assesses compliance with Primary Contact WQ Criteria based on projected performance of the selected CSO controls
- DEP will establish with the NYC Department of Health and Mental Hygiene (DOHMH) through public notification a wet-weather advisory during the recreational season (May 1^{st} through October 31^{st}) during which swimming and bathing would not be recommended in the Bronx River. The LTCP includes a recovery time analysis that can be used to establish the duration of the wet-weather advisory for public notification.

DEP is committed to improving water quality in this waterbody, which will be advanced by the improvements and actions identified in this LTCP. A preliminary constructability analysis has been conducted and DEP has deemed these improvements to be implementable. These identified actions have been balanced with input from the public and awareness of the cost to the citizens of NYC.

9.0 LONG-TERM CSO CONTROL PLAN IMPLEMENTATION

The evaluations performed for this Bronx River LTCP concluded that with the recommendations from previous planning work that have been implemented, the saline reach of the Bronx River meets its current water quality classification of Class I for bacteria 100 percent of the time. Analyses also indicated that additional expenditures in grey infrastructure would not result in full attainment with the Primary Contact WQ Criteria (Class SC or the recently proposed fecal coliform Class I criteria[1]). However, the cost performance and cost attainment analyses presented in Section 8.5 showed that Alternative 2 - interceptor relief at Relief Structure 27 for Outfall HP-007, raising a weir at Regulator 13, adding a relief pipe between Regulator 13 and the Bronx River siphon for Outfall HP-009, and implementation of floatables control and weir modification at Regulator 5 (Outfall HP-011) would provide a relatively high level of attainment with the Primary Contact WQ Criteria (Class SC or the recently proposed fecal coliform Class I criteria[1]) both annually and during the recreational season (May 1st through October 31st). The significantly more costly alternatives would only result in marginal improvements over that predicted for Alternative 2. As demonstrated in Sections 6.0 and 8.0, due to the influence of other wet-weather sources to the Bronx River, full attainment of Primary Contact WQ Criteria cannot be achieved through the control of the CSO discharges in the Bronx River alone, but the recommended Alternative 2 (interceptor relief at Relief Structure 27 for Outfall HP-007, raising a weir at Regulator 13, adding a relief pipe between Regulator 13 and the Bronx River siphon for Outfall HP-009, and implementation of floatables control and weir modification at Regulator 5 (Outfall HP-011)) will significantly improve water quality and achieve highest attainable use.

9.1 Adaptive Management (Phased Implementation)

Adaptive management, as defined by the EPA, is the process by which new information about the characteristics of a watershed is incorporated into a watershed management plan. The process relies on establishing a monitoring program, evaluating monitoring data and trends and making adjustments or changes to the plan. In the case of this LTCP, the DEP will continue to apply the principles of adaptive management based on its annual evaluation of monitoring data, which will be collected to optimize the operation and effectiveness once the actions identified in this LTCP are constructed.

NYC will also develop a program to further address stormwater discharges as part of the upcoming MS4 permit. This program, along with the actions identified in this LTCP, may further improve water quality in the Bronx River.

DEP will also continue to monitor water quality of the Bronx River through its ongoing monitoring programs. When evidence of dry-weather sources of pollution is found, track downs will be initiated. Such activities will be reported to the DEC on a quarterly basis as is currently required under the WWTP SPDES permit.

[1] DEC has publicly noticed a proposed rulemaking to amend 6 NYCRR Parts 701 and 703. If promulgated, the Class I standard for fecal coliform would be the same as that for current Class SB waterbodies. The proposed total and fecal coliform standards for Class I are the same as the Existing WQ Critieria for Class SC waters.

9.2 Implementation Schedule

The implementation schedule to construct the facilities associated with Alternative 2 (interceptor relief at Relief Structure 27 for Outfall HP-007, raising a weir at Regulator 13, adding a relief pipe between Regulator 13 and the Bronx River siphon for Outfall HP-009, and implementation of floatables control and weir modification at Regulator 5 for Outfall HP-011) is presented in Figure 9-1. The schedule presents the duration of time needed to perform the engineering design, advertise and bid the construction contracts and complete the construction of the actions identified in this LTCP.

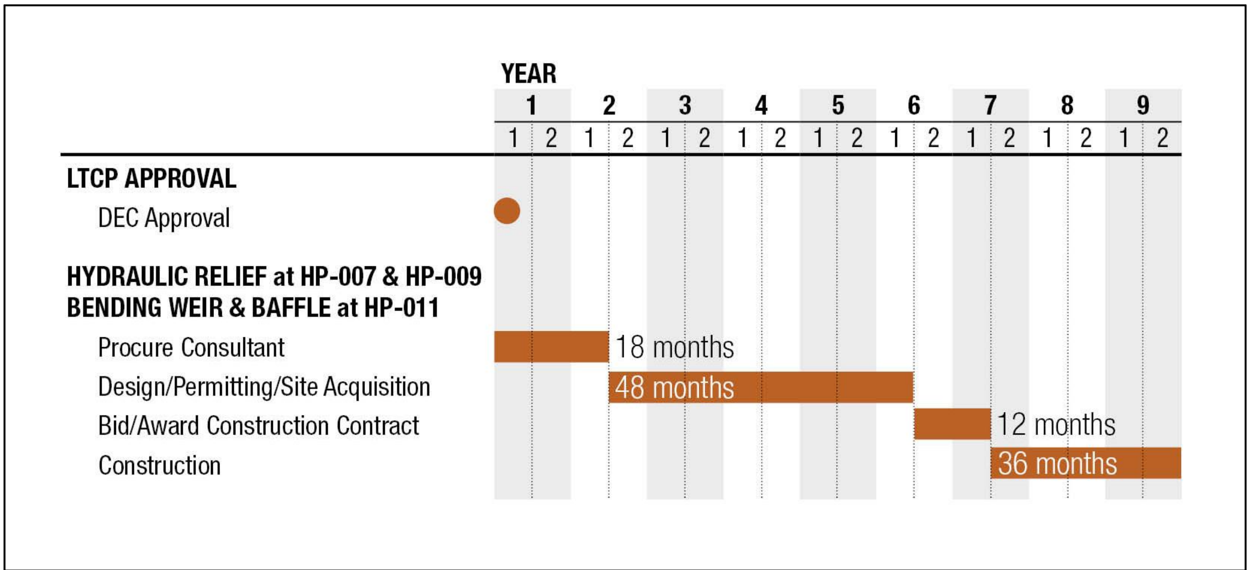


Figure 9-1. Implementation Schedule

9.3 Operational Plan/O&M

DEP is committed to effectively incorporating the Bronx River LTCP components into the Hunts Point collection and transport system as they are built-out during the implementation period. O&M of these components will be consistent with similar existing pipes and CSO regulator structures within DEP's system.

9.4 Projected Water Quality Improvements

As described in Section 8.4, Alternative 2 will result in improved water quality in the Bronx River including reduction of the human or CSO-derived bacteria as well as other CSO-related loadings both annually and during the recreational season (May 1st through October 31st). Improvements in water quality will also be realized as GI projects are built-out.

Other improvements in water quality are expected to continue as the result of implementation of NYC's MS4 program.

9.5 Post-Construction Monitoring Plan and Program Reassessment

Ongoing DEP monitoring programs will continue, including the HSM and SM Programs. Harbor Survey data collected from Stations BR-21, BR-3, BR-5 and E-14 will be used to periodically review and assess the water quality trends in the Bronx River. Depending on the findings, the data from these programs could form the basis of additional recommendations for inclusion in, as appropriate, the 2017 Citywide LTCP.

9.6 Consistency with Federal CSO Policy

The Bronx River LTCP was developed to comply with the requirements of the EPA CSO Control Policy and associated guidance documents, and the CWA. Development of the LTCP revealed that the Bronx River currently attains the Class I fecal coliform criterion but cannot support the Primary Contact WQ Criteria classification (Class SC or the recently proposed fecal coliform Class I criteria[1]) on an annual basis, even with 100% CSO control. A UAA for the Bronx River is included with this LTCP.

9.6.a Affordability and Financial Capability

EPA has recognized the importance of taking a community's financial status into consideration, and in 1997, issued "Combined Sewer Overflows: Guidance for Financial Capability Assessment and Schedule Development." This financial capability guidance contains a two-phased assessment approach. Phase I examines affordability in terms of impacts to residential households. This analysis applies the residential indicator (RI), which examines the average cost of household water pollution costs (wastewater and stormwater) relative to a benchmark of two percent of service area-wide median household income (MHI). The results of this preliminary screening analysis are assessed by placing the community in one of three categories:

- Low economic impact: average wastewater bills are less than one percent of MHI.
- Mid-range economic impact: average wastewater bills are between one percent and two percent of MHI.
- Large economic impact: average wastewater bills are greater than two percent of MHI.

The second phase develops the Permittee Financial Capability Indicators (FCI), which examine several metrics related to the financial health and capabilities of the impacted community. The indicators are compared to national benchmarks and are used to generate a score that is the average of six economic indicators, including bond rating, net debt, MHI, local unemployment, property tax burden, and property tax collection rate within a service area. Lower FCI scores imply weaker economic conditions and thus the increased likelihood that additional controls would cause substantial economic impact.

The results of the RI and the FCI are then combined in a Financial Capability Matrix to give an overall assessment of the permittee's financial capability. The result of this combined assessment can be used to establish an appropriate CSO control implementation schedule.

Importantly, EPA recognizes that the procedures set out in its guidance are not the only appropriate analyses to evaluate a community's ability to comply with CWA requirements. EPA's 2001 "Guidance: Coordinating CSO Long-term Planning with Water Quality Standards Reviews" emphasizes this by stating:

> *The 1997 Guidance "identifies the analyses States may use to support this determination [substantial and widespread impact] for water pollution control projects, including CSO LTCPs. States may also use alternative analyses and criteria to support this determination, provided they explain the basis for these alternative analyses and/or criteria* (U.S. EPA, 2001, p. 31,)".

Likewise, EPA has recognized that its RI and FCI metrics are not the sole socioeconomic basis for considering an appropriate CSO compliance schedule. EPA's 1997 guidance recognizes that there may be other important factors in determining an appropriate compliance schedule for a community, and contains the following statement that authorizes communities to submit information beyond that which is contained in the guidance:

> *It must be emphasized that the financial indicators found in this guidance might not present the most complete picture of a permittee's financial capability to fund the CSO controls. … Since flexibility is an important aspect of the CSO Policy, permittees are encouraged to submit any additional documentation that would create a more accurate and complete picture of their financial capability* (U.S. EPA, 1997, p. 7,).

Furthermore, EPA in 2012 released its "Integrated Municipal Stormwater and Wastewater Planning Approach Framework," which is supportive of a flexible approach to prioritizing projects with the greatest water quality benefits and the use of innovative approaches like GI (U.S. EPA, 2012). In November of 2014, EPA released its "Financial Capability Assessment Framework" clarifying the flexibility within their CSO guidance.

This section of this LTCP begins to explore affordability and financial capability concerns as outlined in the 1997 and 2001 guidance documents and the 2014 Framework. This section will also explore additional socioeconomic indicators that reflect affordability concerns within the NYC context. As DEP is tasked with preparing ten LTCPs for individual waterbodies and one LTCP for the East River and Open Waters, DEP expects that a complete picture of the effect of the comprehensive CSO program would be available in 2017 to coincide with the schedule for completion of all the plans. This affordability and financial capability section will be refined in each LTCP submittal as project costs are further developed and to reflect the latest available socioeconomic metrics.

9.6.a.1 Background on DEP Spending

As the largest water and wastewater utility in the nation, DEP provides over a billion gallons of drinking water daily to more than eight million NYC residents, visitors and commuters, as well as, one million upstate customers. DEP maintains over 2,000 square miles of watershed comprised of 19 reservoirs, three controlled lakes, several aqueducts, and 6,600 miles of water mains and distribution pipes. DEP also collects and treats wastewater. Averaged across the year, the system treats approximately 1.3 billion gallons of wastewater per day collected through 7,400 miles of sewers, 95 pump stations and 14 in-NYC WWTP. In wet-weather, the system can treat up to 3.5 billion gallons per day of combined storm and sanitary flow. In addition to the WWTPs, DEP has four CSO storage facilities. DEP recently launched a $2.4B GI program, of which $1.5B will be funded by DEP, and the remainder will be funded through private partnerships.

9.6.a.2 Currently Budgeted and Recent Completed Mandated Programs

As shown in Figure 9-2, from Fiscal Year (FY) 2005 through FY 2014, 59 percent of DEP's capital spending was for wastewater and water mandates. Figure 9-3 identifies associated historical wastewater and water operating expenses from FY 2003 through FY 2014, which have generally increased over time reflecting the additional operational costs associated with the NYC's investments. Many projects have been important investments that safe-guard our water supply and improve the water quality of our receiving waters in the Harbor and its estuaries. These mandates and associated programs are described below.

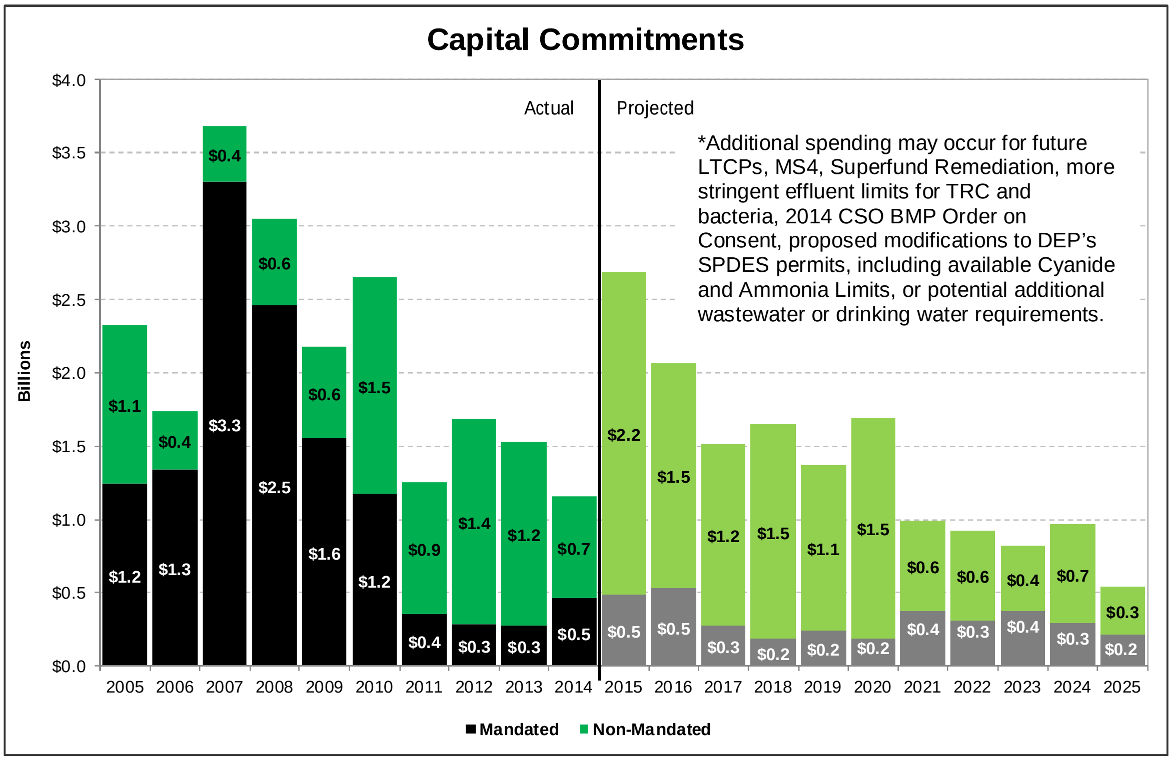


Figure 9-2. Historical and Projected Capital Commitments

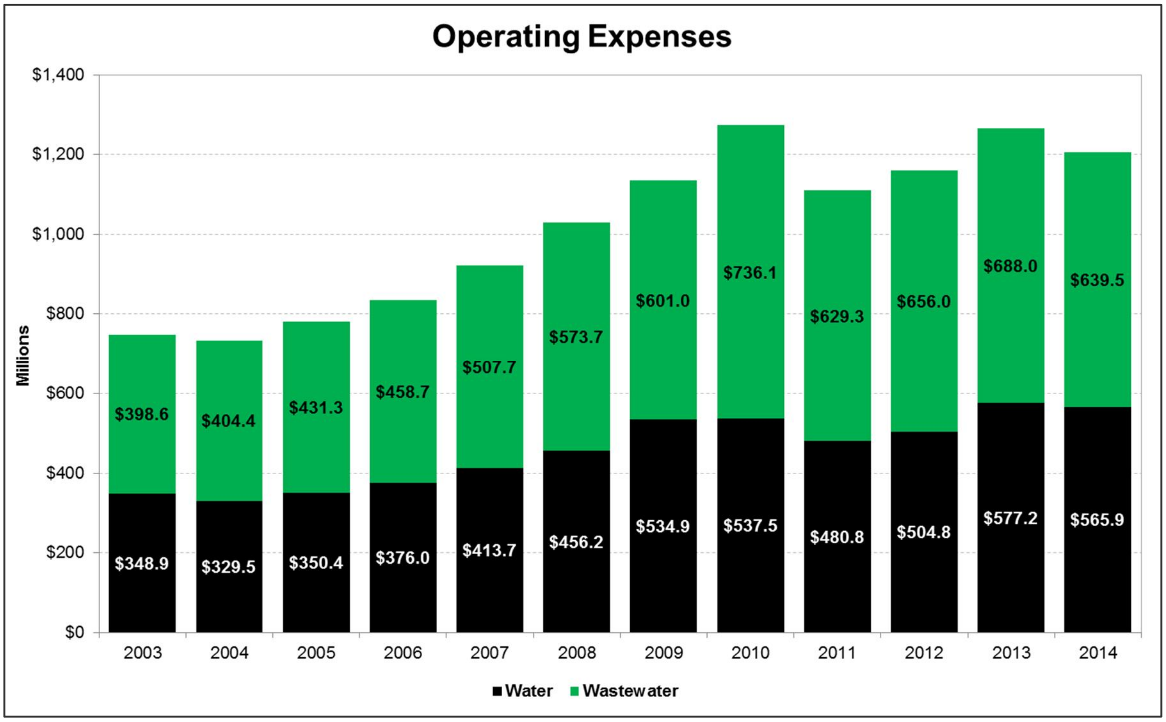


Figure 9-3. Historical Operating Expenses

Wastewater Mandated Programs

The following wastewater programs and projects have been initiated to comply with Federal and State laws and permits:

- CSO Abatement and Stormwater Management Programs

DEP has initiated a number of projects to reduce CSOs and eliminate excess infiltration and inflow of groundwater and stormwater into the wastewater system. These projects include: construction of CSO abatement facilities, optimization of the wastewater system to reduce the volume of CSO discharge, controls to prevent debris that enters the combined wastewater system from being discharged, dredging of CSO sediments that contribute to low DO and poor aesthetic conditions, and other water quality based enhancements to enable attainment of the WQS. These initiatives impact both the capital investments that must be made by DEP, as well as O&M expenses. Historical commitments and those currently in DEP's ten year capital plan for CSOs are estimated to be about $3.4B. FY 2013 annual operating costs for stormwater expenses are estimated to have been about $63M. DEP expects that additional investments in stormwater controls will be required of DEP, as well as other NYC agencies, pursuant to MS4 requirements.

- Biological Nutrient Removal

In 2006, NYC entered into a Consent Judgment (Judgment) with the DEC, which required DEP to upgrade five WWTPs by 2017 in order to reduce nitrogen discharges and comply with draft SPDES nitrogen limits. Pursuant to a modification and amendment to the Judgment, DEP has agreed to upgrade three additional WWTPs and to install additional nitrogen controls at one of the WWTPs, which was included in the original Judgment. As in the case of CSOs and stormwater, these initiatives include capital investments made by DEP (over $1B to-date and an additional $50M in the 10-year capital plan) as well as O&M expenses (chemicals alone in FY 2014 amounted to $3.2M per year, and by FY 2017 are estimated to be about $20M per year).

- Wastewater Treatment Plant Upgrades

  The Newtown Creek WWTP has been upgraded to secondary treatment pursuant to the terms of a Consent Judgment with DEC. The total cost of the upgrade is estimated to be $5B. In 2011, DEP certified that the Newtown Creek WWTP met the effluent discharge requirements of the CWA, bringing all 14 WWTPs into compliance with the secondary treatment requirements.

Drinking Water Mandated Programs

Under the Federal Safe Drinking Water Act and the New York State Sanitary Code, water suppliers are required to either filter their surface water supplies or obtain and comply with a determination from EPA that allows them to avoid filtration. In addition, EPA has promulgated a rule known as Long Term 2 (LT2) that requires that unfiltered water supplies receive a second level of pathogen treatment (e.g., ultraviolet [UV] treatment in addition to chlorination) by April 2012. LT2 also requires water suppliers to cover or treat water from storage water reservoirs. The following DEP projects have been undertaken in response to these mandates:

- Croton Watershed - Croton Water Treatment Plant

  Historically, NYC's water has not been filtered because of its good quality and long retention times in reservoirs. However, more stringent Federal standards relating to surface water treatment have resulted in a Federal court consent decree (the Croton Water Treatment Plant Consent Decree), which mandates the construction of a full-scale water treatment facility to filter water from NYC's Croton watershed. Construction on the Croton Water Treatment Plant began in late 2004. DEP estimates that the facility will begin operating in 2015. To-date, DEP has committed roughly $3.2B in capital costs. During start-up and after commencement of operations, DEP will also incur annual expenses for labor, power, chemicals, and other costs associated with plant O&M. For FY 2015, O&M costs are estimated to be about $23M.

- Catskill/Delaware Watershed - Filtration Avoidance Determination

  Since 1993, DEP has been operating under a series of Filtration Avoidance Determinations (FADs), which allow NYC to avoid filtering surface water from the Catskill and Delaware systems. In 2007, EPA issued a new FAD (2007 FAD), which requires NYC to take certain actions over a ten year period to protect the Catskill and Delaware water supplies. In 2014, the DOH issued mid-term revisions to the 2007 FAD. Additional funding has been added to the Capital Improvement Plan (CIP) through 2017 to support these mid-term FAD revisions. DEP has committed about $1.5B to-date and anticipates that expenditures for the current FAD will amount to $200M.

- UV Disinfection Facility

  In January 2007, DEP entered into an Administrative Order on Consent (UV Order) with EPA pursuant to EPA's authority under LT2 requiring DEP to construct a UV facility by 2012. Since late 2012, water from the Catskill and Delaware watersheds has been treated at DEP's new UV disinfection facility in order to achieve Cryptosporidium inactivation. To-date, capital costs committed to the project amount to $1.6B. DEP is also now incurring annual expenses for property taxes, labor, power, and other costs related to plant O&M. For example, FY 2013 O&M costs were $20.8M including taxes.

9.6.a.3 Future System Investment

Over the next nine years, the percentage of already identified mandated project costs in the CIP is anticipated to decrease, but DEP will be funding critical but non-mandated state of good repair projects and other projects needed to maintain NYC's infrastructure to deliver clean water and treat wastewater. Moreover, DEP anticipates that there will be additional mandated investments as a result of MS4 compliance, proposed modifications to DEP's in-NYC WWTP SPDES permits, Superfund remediation, CSO LTCPs, and the 2014 CSO BMP Order on Consent. It is also possible that DEP will be required to invest in an expensive cover for Hillview Reservoir as well as other additional wastewater and drinking water mandates. Additional details for anticipated future mandated and non-mandated wastewater programs are provided below, with the exception of CSO LTCPs which are presented in Section 9.6.f.

Potential or Unbudgeted Wastewater Regulations

- MS4 Permit Compliance

  Currently, DEP's separate stormwater system is regulated through DEP's 14 WWTP-specific SPDES permits. On February 5, 2014, DEC issued a draft MS4 permit that will cover MS4 separate stormwater systems for all NYC agencies. Under the proposed MS4 permit, the permittee will be NYC.

  DEP is delegated to coordinate efforts with other NYC agencies and to develop a stormwater management program plan for NYC to facilitate compliance with the proposed permit terms as required by DEC. This plan will also develop the legal authority to implement and enforce the stormwater management program, as well as develop enforcement and tracking measures and provide adequate resources to comply with the MS4 permit. Some of the potential permit conditions identified through this plan may result in increased costs to DEP and those costs will be more clearly defined upon completion of the plan. The permit also requires NYC to conduct fiscal analysis of the capital and O&M expenditures necessary to meet the requirements of this permit, including any development, implementation and enforcement activities required, within three years of the Effective Permit date.

  The draft MS4 permit compliance costs are yet to be estimated. DEP's annual historic stormwater capital and O&M costs have averaged $131.6M. However, given the more stringent draft permit requirements, future MS4 compliance costs are anticipated to be significantly higher than DEP's current stormwater program costs. The future compliance costs will also be shared by other NYC departments that are responsible for managing stormwater. The projected cost for stormwater and CSO programs in other major urban areas such as Philadelphia and Washington DC are quite high, $2.4B and $2.6B, respectively. According to preliminary estimates completed by Washington District Department of Environment, the MS4 cost could be $7B (green build-out scenario) or as high as $10B (traditional infrastructure) to meet the TMDLs. In FY 2014, Philadelphia reported $95.4M for MS4 spending, whereas Washington DC reported $19.5M as part of these annual reports (Philadelphia, 2014; Washington DC, 2014).

MS4 compliance cost estimates for Chesapeake Bay communities provide additional data for consideration. On December 29, 2010, the EPA established the Chesapeake Bay TMDL, for nitrogen, phosphorus, and sediment. Each State has been given its quota – the pounds of nitrogen and phosphorus, and the tons of sediment it may contribute to the bay on an annual basis. To achieve these quotas and meet the WQS in the bay by 2025, each State must implement aggressive reductions incrementally across several pollution source sectors. The cost estimates vary within the bay communities. For example, the Maryland State Highway Administration estimates the cost to comply with the Chesapeake Bay TMDL at $700M for engineering and construction, and $300M for utility, right-of-way, and contingencies, whereas Fairfax County, Va., estimates its cost of compliance with the Chesapeake Bay TMDL at $845M (Civil and Structural Engineer, 2012).

There is currently limited data for estimating future NYC MS4 compliance cost. Based on estimates from other cities, stormwater retrofit costs have been estimated on the low end between $25,000 to $35,000 per impervious acre to $100,000 to $150,000 on the high end. Costs would vary on the type and level of control selected. For the purposes of developing preliminary MS4 cost estimates for NYC for this analysis, a stormwater retrofit cost of $35,000 per impervious acre was assumed, which resulted in a MS4 compliance cost of about $2B.

- Draft SPDES Permit Compliance

  In June 2013, DEC issued draft SPDES permits which, if finalized, will have a substantial impact on DEP's Total Residual Chlorine (TRC) program and set more stringent ammonia and available cyanide limits. These proposed modifications include requirements that DEP:

  - Perform a degradation study to evaluate the degradation of TRC from the chlorine contact tanks to the edge of the designated mixing zone for comparison to the water quality based effluent limit and standard. The scope of work for this study is required within six months of the effective date of the SPDES permit, and the study must be completed 18 months after the approval of the scope of work. Based upon verbal discussions with DEC, DEP believes that this study may result in the elimination of the 0.4 mg/L uptake credit previously included in the calculation of TRC limits thereby decreasing the effective TRC limits by 0.4 mg/L at every WWTP.

  - Comply with new unionized ammonia limits. These proposed limits will, at some WWTPs, potentially interfere with the chlorination process, particularly at 26th Ward and Jamaica.

  - Monitor for available cyanide and ultimately comply with a final effluent limit for available cyanide. Available cyanide can be a byproduct of the chlorination process.

  - DEC has also advised DEP that fecal coliform, the parameter that has been historically used to evaluate pathogen kills and chlorination performance/control, will be changing to enterococcus. This change will likely be incorporated in the next round of SPDES permits scheduled in the next five years. Enterococcus has been shown to be harder to kill with chlorine and may require process changes to disinfection that would eliminate the option of adding de-chlorination after the existing chlorination process.

The potential future costs for these programs have yet to be determined. Preliminary compliance costs for TRC control and ammonia control are estimated to be up to $560M and $840M, respectively.

- CSO Best Management Practices Order

  On May 8, 2014, DEC and DEP entered into an agreement for the monitoring of CSO compliance, reporting requirements for bypasses, and notification of equipment out-of-service at the WWTP during rain events. The 2014 CSO BMP Order on Consent incorporates, expands, and supersedes the 2010 CSO BMP Order by requiring DEP to install new monitoring equipment at identified key regulators and outfalls and to assess compliance with requirements to “Maximize Flow to the WWTP”. The costs for compliance for this Order have not yet been determined, but DEP expects this program to have significant capital costs as well as expense costs.

- Superfund Remediation

  There are two major Superfund sites in NYC that may affect our Long Term Control Plans and which are at various stages of investigation. The Gowanus Canal Remedial Investigation/Feasibility Study (RI/FS) is complete, and remedial design work will take place in the next three to five years. The Newtown Creek RI/FS completion is anticipated for 2018.

  DEP’s ongoing costs for these projects are estimated at about $50-60M for the next ten years, not including design or construction costs for the Gowanus Canal. EPA’s selected remedy for the Gowanus Canal requires that NYC build two combined sewage overflow retention tanks. As more fully described in Section 8, DEP has evaluated potential alternatives to the EPA selected remedy, including smaller storage tanks than the Record of Decision (ROD) recommended tanks. Potential Superfund costs for Gowanus Canal range from $507M to $829M. Similar Superfund mandated CSO controls at Newtown Creek could add costs of $1-2B.

Potential, Unbudgeted Drinking Water Regulation

- Hillview Reservoir Cover

  Long Term 2 (LT2) also mandates that water from uncovered storage facilities (including DEP’s Hillview Reservoir) be treated or that the reservoir be covered. DEP has entered into an Administrative Order with the DOH and an Administrative Order with EPA, which mandates NYC to begin work on a reservoir cover by the end of 2018. In August 2011, EPA announced that it would review LT2 and its requirement to cover uncovered finished storage reservoirs such as Hillview. DEP has spent significant funds analyzing water quality, engineering options, and other matters relating to the Hillview Reservoir. Potential costs affiliated with construction are estimated to be on the order of $1.6B.

Other: State of Good Repair Projects and Sustainability/Resiliency Initiatives

Wastewater Projects

- Climate Resiliency

  In October 2013, on the first anniversary of Hurricane Sandy, DEP released the NYC Wastewater Resiliency Plan, the nation's most detailed and comprehensive assessment of the risks that climate change poses to a wastewater collection and treatment system. The ground breaking study, initiated in 2011 and expanded after Hurricane Sandy, was based on an asset-by-asset analysis of the risks from storm surge under new flood maps at all 14 WWTPs and 58 of NYC's pumping stations, representing more than $1B in infrastructure.

  DEP estimates to spend $447M in cost-effective upgrades at these facilities to protect valuable equipment and minimize disruptions to critical services during future storms. It is estimated that investing in these protective measures today will help protect this infrastructure from over $2B in repeated flooding losses over the next 50 years. DEP is currently pursuing funding through the EPA State Revolving Fund Storm Mitigation Loan Program.

  DEP will coordinate this work with the broader coastal protection initiatives, such as engineered barriers and wetlands, described in the 2013 report, "A Stronger, More Resilient New York," and continue to implement the energy, drinking water, and drainage strategies identified in the report to mitigate the impacts of future extreme events and climate change. This includes ongoing efforts to reduce CSOs with GI as part of LTCPs and build-out of HLSS that reduce both flooding and CSOs. It also includes build-out of storm sewers in areas of Queens with limited drainage and continued investments and build-out of the Bluebelt system.

- Energy projects at WWTPs

  NYC's blueprint for sustainability, *PlaNYC 2030: A Greener, Greater New York*, set a goal of reducing NYC's greenhouse gases (GHG) emissions from 2006 levels by 30 percent by 2017. This goal was codified in 2008 under Local Law 22. In April 2015, NYC launched an update to PlaNYC called *One New York: The Plan for a Strong and Just City* (OneNYC), which calls for reducing NYC's greenhouse gas emissions by 80 percent by 2050, over 2005 levels. In order to meet the OneNYC goal, DEP is working to reduce energy consumption and GHG emissions through: reduction of fugitive methane emissions, investment in cost-effective, clean energy projects, and energy efficiency improvements.

  Fugitive methane emissions from WWTPs currently account for approximately 170,000 metric tons (MT) of carbon emissions per year and 30 percent of DEP's overall emissions. To reduce GHG emissions and to increase on-site, clean energy generation, DEP has set a target of 60 percent beneficial use of the biogas produced by 2017. Recent investments by DEP to repair leaks and upgrade emissions control equipment have already resulted in a 30 percent reduction of methane emissions since a peak in 2009. Going forward, DEP has approximately $500M allocated in its CIP to make additional system repairs to flares, digester domes, and digester gas piping, in order to maximize capture of fugitive emissions for beneficial use or flaring.

  A 12 megawatt cogeneration system is currently in design for the North River WWTP and estimated to be in operation in Spring 2019. This project will replace ten direct-drive combustion engines, which are over 25 years old and use fuel oil, with five new gas engines enhancing the

WWTP's operational flexibility, reliability, and resiliency. The cogeneration system will produce enough energy to meet the WWTP's base electrical demand and the thermal demand from the treatment process and building heat, in addition to meeting all of the WWTPs emergency power requirements. The project is taking a holistic approach and includes: (1) improvements to the solids handling process to increase biogas production and reduce treatment, transportation and disposal costs; (2) optimization of biogas usage through treatment and balancing improvements; and (3) flood proofing the facility to the latest FEMA 100-year flood elevations plus 30 inches to account for sea level rise. The cogeneration system will double the use of anaerobic digester gas produced on-site, eliminate fuel oil use, and off-set utility electricity use, which will reduce carbon emissions by over 10,000 MT per year, the equivalent of removing ~2,000 vehicles from the road. The total project cost is estimated at $212M. DEP is also initiating an investment-grade feasibility study to evaluate the installation of cogeneration at the Wards Island WWTP, NYC's second largest treatment WWTP.

To reduce energy use and increase energy efficiency, DEP has completed energy audits at all 14 in-NYC WWTPs. Close to 150 energy conservation measures (ECMs) relating to operational and equipment improvements to aeration, boilers, dewatering, digesters, HVAC, electrical, thickening and main sewage pumping systems have been identified and accepted for implementation. Energy reductions from these ECMs have the potential to reduce greenhouse gas emissions by over 160,000 MT of carbon emissions at an approximate cost of $140M. DEP is developing implementation plans for these measures.

Water Projects

- Water for the Future

  In 2011, DEP unveiled Water for the Future: a comprehensive program to permanently repair the leaks in the Delaware Aqueduct, which supplies half of New York's drinking water. Based on a 10-year investigation and more than $200M of preparatory construction work, DEP is currently designing a bypass for a section of the Delaware Aqueduct in Roseton and internal repairs for a tunnel section in Wawarsing. Since DEP must shut down the Aqueduct when it is ready to connect the bypass tunnel, DEP is working on projects that will supplement NYC's drinking water supply during the shutdown, such as developing the groundwater aquifers in Jamaica, Queens, and implementing demand reduction initiatives, such as offering a toilet replacement program. Construction of the shafts for the bypass tunnel is underway, and the project will culminate with the connection of the bypass tunnel in 2021. The cost for this project is estimated to be about $1.5B.

- Gilboa Dam

  DEP is currently investing in a major rehabilitation project at Gilboa Dam at Schoharie Reservoir. Reconstruction of the dam is the largest public works project in Schoharie County, and one of the largest in the entire Catskills. This project is estimated to cost roughly $440M.

As shown in Figure 9-4, increases in capital expenditures have resulted in increased debt. While confirmed expenditures may be on the decline over the next few years, debt service continues to be on the rise in future years, occupying a large percentage of DEP's operating budget (approximately 45 percent in FY 2015).

- Kensico Eastview Connection 2

  To ensure the resilience and provide critical redundancy of infrastructure in the NYC Water Supply system, DEP will be constructing a new tunnel between the Kensico Reservoir and the Ultraviolet Disinfection Facility. This project is included in the current capital improvement plan and has an estimated cost of about $511M.

9.6.b Background on History of DEP Water and Sewer Rates

The NYC Water Board is responsible for setting water and wastewater rates sufficient to cover the costs of operating NYC's water supply and wastewater systems (the "system"). Water supply costs include those associated with water treatment, transmission, distribution, and maintaining a state of good repair. Wastewater service costs include those associated with wastewater conveyance and treatment, as well as stormwater service, and maintaining a state of good repair. The NYC Municipal Water Finance Authority (MWFA) issues revenue bonds to finance NYC's water and wastewater capital programs, and the costs associated with debt service consume a significant portion of the system revenues.

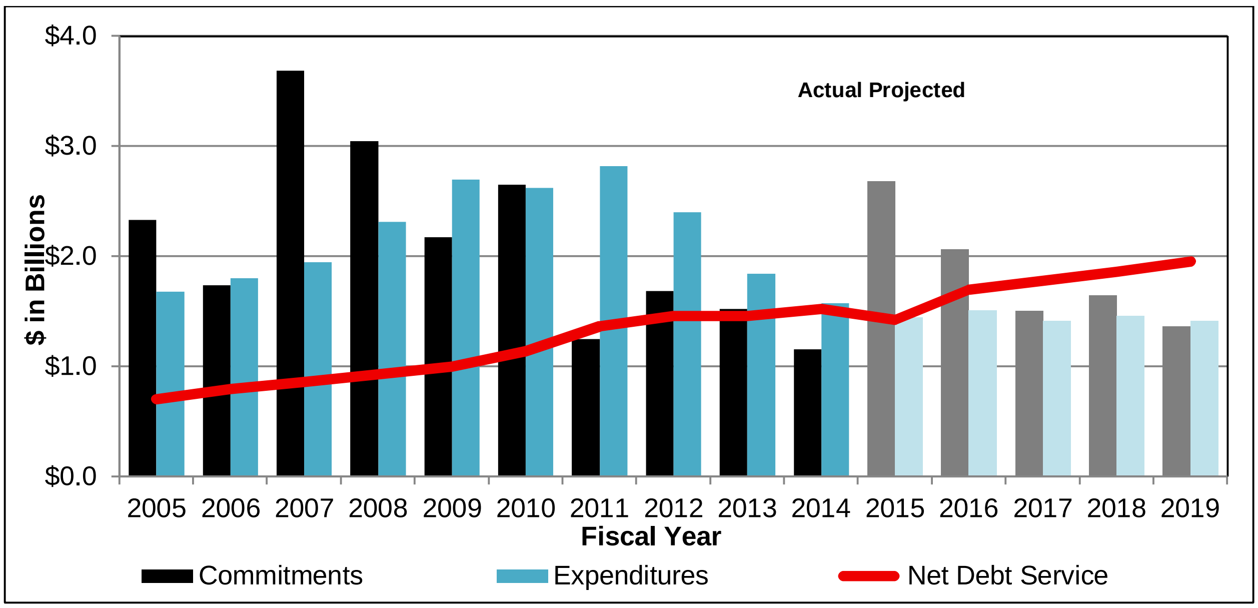


Figure 9-4. Past Costs and Debt Service

For FY 2016, most customers will be charged a uniform water rate of $0.51 per 100 gallons of water. Wastewater charges are levied at 159 percent of water charges ($0.81 per 100 gallons). There is a small percentage of properties that are billed a fixed rate. Under the Multi-family Conservation Program (MCP), some properties are billed at a fixed per-unit rate if they comply with certain conservation measures. Some nonprofit institutions are also granted exemption from water and wastewater charges on the condition that their consumption is metered and their consumption falls within specified consumption threshold levels. Select properties can also be granted exemption from wastewater charges (i.e. pay only for water services) if they can prove that they do not burden the wastewater system (e.g., they recycle wastewater for subsequent use on-site).

There are also currently a few programs that provide support and assistance for customers in financial distress. The Safety Net Referral Program uses an existing network of NYC agency and not-for-profit programs to help customers with financial counseling, low-cost loans, and legal services. The Water Debt Assistance Program (WDAP) provides temporary water debt relief for qualified property owners who are at risk of mortgage foreclosure. While water and wastewater charges are a lien on the property served, and NYC has the authority to sell these liens to a third party, or lienholder, in a process called a lien sale, DEP offers payment plans for customers who may have difficulty paying their entire bill at one time. The agency has undertaken an aggressive communications campaign to ensure customers know about these programs and any exclusions they may be qualified to receive, such as the Senior Citizens Homeowner's Exemption and the Disabled Homeowner's Exemption. DEP also just announced the creation of a Home Water Assistance Program (HWAP) to assist low-income homeowners. In this program, DEP will partner with the NYC Human Resources Administration (HRA), which administers the Federal Home Energy Assistance Program (HEAP), to identify homeowners who would be eligible to receive a credit on their DEP bill. In FY 2016, this program will be expanded to include senior or disabled customers based on prequalified lists maintained by the Department of Finance for property tax exemptions.

Figure 9-5 shows how water and sewer rates have increased over time and how that compares with system demand and population. Despite a modest rise in population, water consumption rates have been falling since the 1990s due to metering and increases in water efficiency measures. At the same time, rates have been rising to meet the cost of service associated with DEP's capital commitments. DEP operations are funded almost entirely through rates paid by our customers with less than two percent of spending supported by Federal and State assistance over the past ten years. From FY 2002 to FY 2016, water and sewer rates have risen 182 percent. This is despite the fact that DEP has diligently tried to control operating costs. To mitigate rate increases, DEP has diligently managed operating expenses, and since 2011, the agency has had four budget cuts to be able to self-fund critical agency operating needs. Additionally, DEP has undertaken an agency-wide Operational Excellence (OpX) program to review and improve the efficiency of the agency's operations. DEP has already implemented changes through this program that will result in a financial benefit of approximately $98.2M in FY 2016.

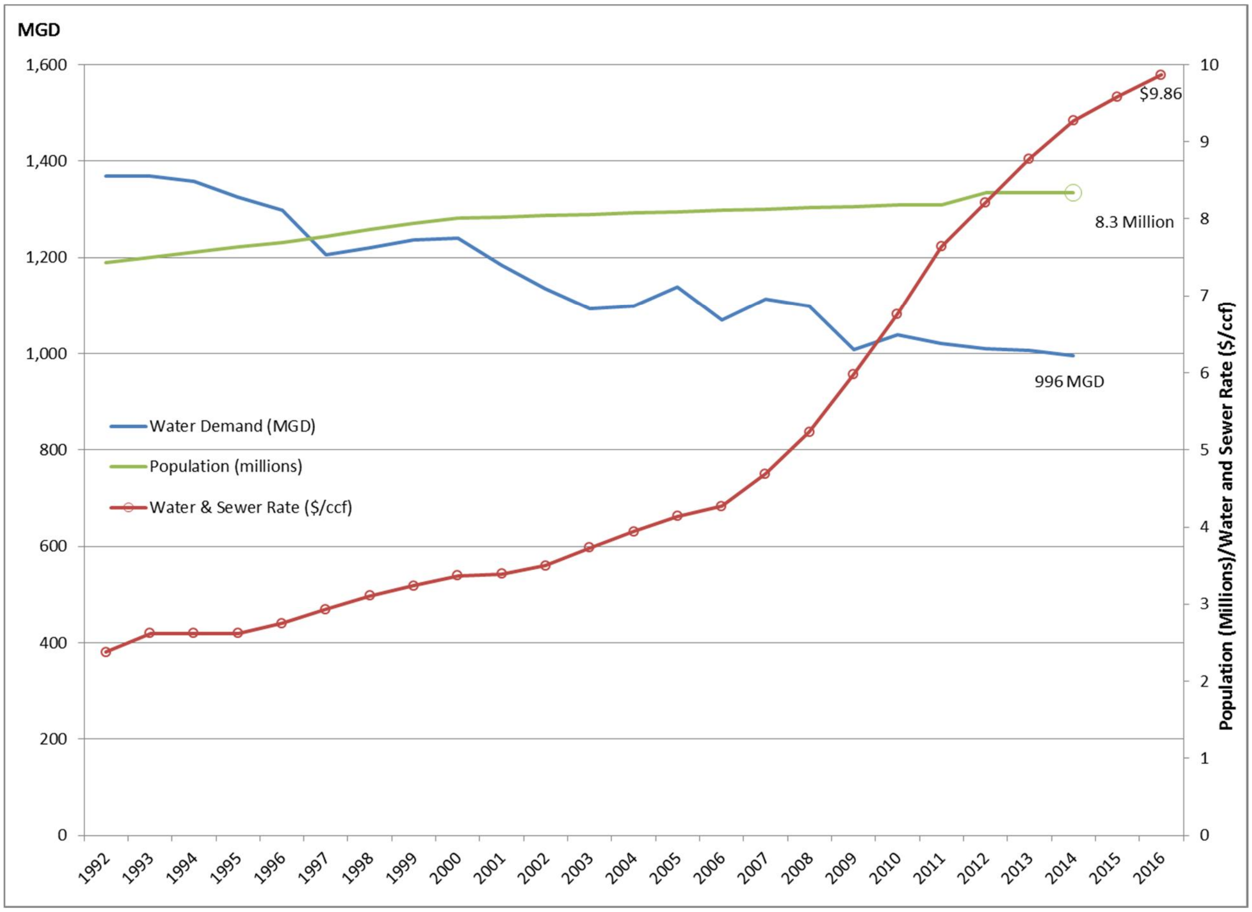


Figure 9-5. Population, Consumption Demand, and Water and Sewer Rates Over Time

9.6.c Residential Indicator

As discussed above, the first economic test as part of EPA's 1997 CSO guidance is the RI, which compares the average annual household water pollution control cost (wastewater and stormwater related charges) to the MHI of the service area. Average household wastewater cost can be estimated by approximating the residential share of wastewater treatment and dividing it by total number of households. Since the wastewater bill in NYC is a function of water consumption, average household costs are estimated based on consumption rates by household type in Table 9-1.

Table 9-1. Residential Water and Wastewater Costs compared to MHI

	Average Annual Wastewater Bill ($/year)	Wastewater RI (Wastewater Bill/MHI[1]) (%)	Total Water and Wastewater Bill ($/Year)	Water and Wastewater RI (Water and Wastewater Bill/MHI) (%)
Single-family[2]	648	**1.21**	1,056	**1.97**
Multi-family[3]	421	**0.79**	686	**1.28**
Average Household Consumption[4]	531	**0.99**	865	**1.61**
MCP	617	**1.15**	1,005	**1.87**

Notes:
(1) Latest MHI data is $52,223 based on 2013 ACS data, estimated MHI adjusted to present is $53,614.
(2) Based on 80,000 gallons/year consumption and FY 2016 Rates.
(3) Based on 52,000 gallons/year consumption and FY 2016 Rates.
(4) Based on average consumption across all metered residential units of 65,530 gallons/year and FY 2016 Rates.

As shown in Table 9-1, the RI for wastewater costs varies between 0.79 percent of MHI to 1.21 percent of MHI depending on household type. Since DEP is a water and wastewater utility and the ratepayers receive one bill for both charges, it is also appropriate to look at the total water and wastewater bill in considering the RI, which varies from 1.28 percent to 1.97 percent of MHI.

Based on this initial screen, current wastewater costs pose a low to mid-range economic impact according to the 1997 CSO guidance. However, there are several limitations to using MHI in the context of a City like New York. NYC has a large population and more than three million households. Even if a relatively small percentage of households were facing unaffordable water and wastewater bills, there would still be a significant number of households experiencing this hardship. For example, more than 685,000 households in NYC (about 22 percent of NYC's total) earn less than $20,000 per year and have estimated wastewater costs well above 2 percent of their household income. Therefore, there are several other socioeconomic indicators to consider in assessing residential affordability, as described below.

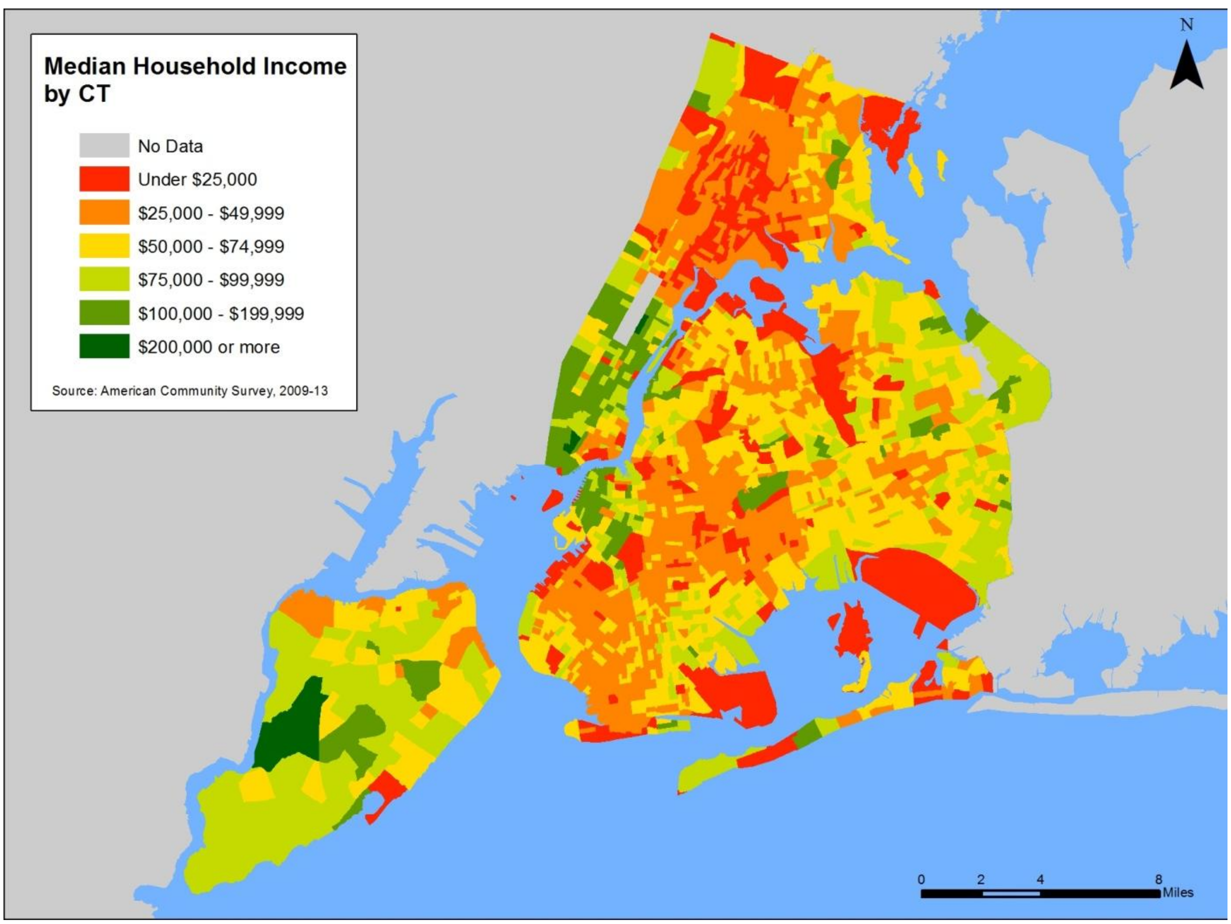
9.6.c.1 Income Levels

In 2013, the latest year for which Census data is available, the MHI in NYC was $52,223. As shown in Table 9-2, across the NYC boroughs, MHI ranged from $32,009 in the Bronx to $72,190 in Manhattan. Figure 9-6 shows that income levels also vary considerably across NYC neighborhoods, and there are several areas in NYC with high concentrations of low-income households.

Table 9-2. Median Household Income

Location	2013 (MHI)
United States	$52,250
New York City	$52,223
Bronx	$33,009
Brooklyn	$47,520
Manhattan	$72,190
Queens	$56,599
Staten Island	$69,633

Source: U.S. Census Bureau 2013 ACS 1-Year Estimates.



Source: U.S. Census Bureau 2009-2013 ACS 5-Year Estimates.

Figure 9-6. Median Household Income by Census Tract

As shown in Figure 9-7, after 2008, MHI in NYC actually decreased for several years, and it has just begun to recover to the 2008 level. At this same time, the cost of living continued to increase.

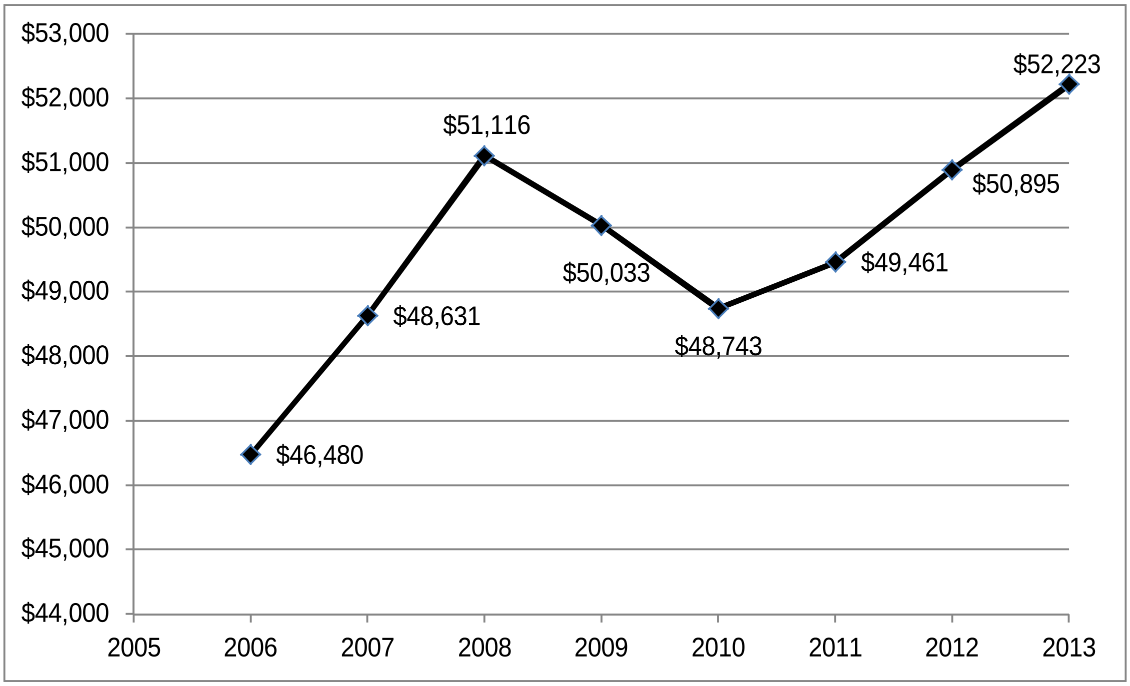


Figure 9-7. NYC Median Household Income Over Time

9.6.c.2 Income Distribution

NYC currently ranks as one of the most unequal cities in the United States (U.S.) in terms of income distribution. NYC's income distribution highlights the need to focus on metrics other than citywide MHI in order to capture the disproportionate impact on households in the lowest income brackets. It is clear that MHI does not represent "the typical household" in NYC. As shown in Figure 9-8, incomes in NYC are not clustered around the median, but rather there are greater percentages of households at both ends of the economic spectrum. Also, the percentage of the population with middle-class incomes between $20,000 and $100,000 is 7.4 percent less in NYC than in the U.S. generally.

Source: U.S. Census Bureau 2013 ACS 1-Year Estimates.

Figure 9-8. Income Distribution for NYC and U.S.

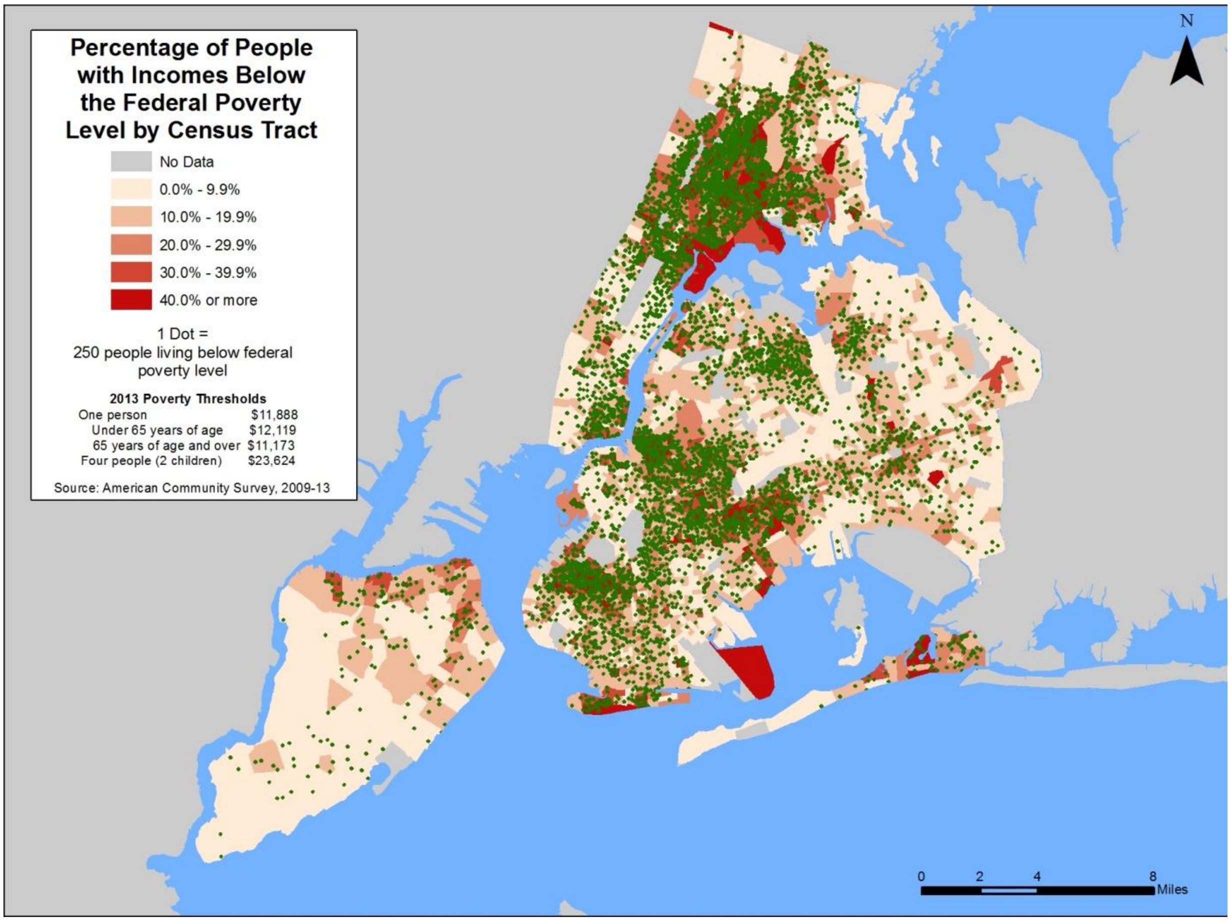
9.6.c.3 Poverty Rates

Based on the latest available Census data, 20.9 percent of NYC residents are living below the Federal poverty level (more than 1.7 million people, which is greater than the entire population of Philadelphia). This compares to a national poverty rate of 15.8 percent despite the similar MHI levels for NYC and the U.S. as a whole. As shown in Table 9-3, across the NYC boroughs, poverty rates vary from 12.8 percent in Staten Island to 30.9 percent in the Bronx.

Table 9-3. NYC Poverty Rates

Location	Percentage of Residents Living Below the Federal Poverty Level (%) (ACS 2013)
United States	15.8
New York City	20.9
Bronx	30.9
Brooklyn	23.3
Manhattan	18.9
Queens	15.3
Staten Island	12.8

Figure 9-9 shows that poverty rates also vary across neighborhoods, with several areas in NYC having a relatively high concentration of people living below the Federal poverty level. Each green dot represents 250 people living in poverty. While poverty levels are concentrated in some areas, there are pockets of poverty throughout NYC. An RI that relies on MHI alone fails to capture these other indicators of economic distress. Two cities with similar MHI could have varying levels of poverty.



Source: U.S. Census Bureau 2009-2013 ACS 5-Year Estimates.

Figure 9-9. Poverty Clusters and Rates in NYC

The New York City Center for Economic Opportunity (CEO) has argued that the official (Federal) poverty rate does not provide an accurate measure of the number of households truly living in poverty conditions (CEO, 2011). This is especially relevant in NYC, where the cost of living is among the highest in the nation. According to CEO, Federal poverty thresholds do not reflect current spending patterns, differences in the cost of living across the nation, or changes in the American standard of living (CEO, 2011). To provide a more accurate accounting of the percentage of NYC's population living in poverty, CEO developed an alternative poverty measure based on methodology developed by the National Academy of Sciences (NAS).

The NAS-based poverty threshold reflects the need for clothing, shelter, and utilities, as well as food (which is the sole basis for the official poverty threshold). The threshold is established by choosing a point in the distribution of expenditures for these items, plus a small multiplier to account for miscellaneous expenses such as personal care, household supplies, and non-work-related transportation. CEO adjusted the NAS-based threshold to account for the high cost of living in NYC.

In addition, the NAS-based income measure uses a more inclusive definition of resources available to households compared to the Federal measure, which is based on pre-tax income. Along with cash income after taxes, it accounts for the cash-equivalent value of nutritional assistance and housing programs (i.e. food stamps and Section 8 housing vouchers). It also recognizes that many families face the costs of commuting to work, child care, and medical out-of-pocket expenses that reduce the income available to meet other needs. This spending is accounted for as deductions from income. Taken together, these adjustments create a level of disposable income that, for some low-income households, can be greater than pre-tax cash income.

CEO's methodology shows that in NYC, poverty level incomes are actually much higher than those defined at the Federal level, which results in a higher percentage of NYC residents living in poverty than is portrayed by national measures. As an example, in 2008, CEO's poverty threshold for a two-adult, two-child household was $30,419. The Federal poverty threshold for the same type of household was $21,834. In that year, 22.0 percent of NYC residents (about 1.8 million people) were living below the CEO poverty threshold income; 18.7 percent were living below the Federal poverty threshold.

More recently, the U.S. Census Bureau developed a Supplemental Poverty Measure (SPM), reflecting the same general approach as that of CEO. The Federal SPM factors in some of the financial and other support offered to low-income households (e.g., housing subsidies, low-income home energy assistance) and also recognizes some nondiscretionary expenses that such households bear (e.g., taxes, out-of-pocket medical expenses, and geographic adjustments for differences in housing costs) (U.S. Census Bureau, 2014).

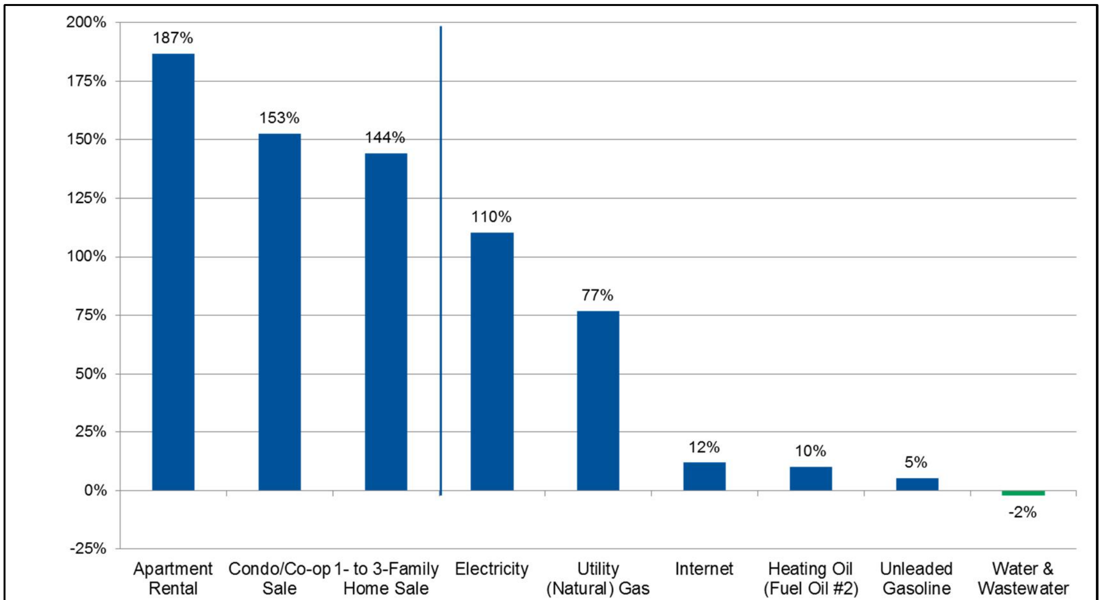
Nationwide, the SPM indicates that there are 6.39 percent more people in poverty than the official poverty threshold would indicate. The SPM also indicates that inside Metropolitan Statistical Areas the difference is 11.45 percent more people in poverty, and within "principal cities," the SPM-implied number of people in poverty is 4.27 percent higher than the official poverty measure indicates.

9.6.c.4 Unemployment Rates

In 2014 the annual average unemployment rate for NYC was 7.2 percent according to the U.S. Bureau of Labor Statistics, compared to a national average of 6.2 percent. Over the past two decades, NYC's unemployment rate has generally been significantly higher than the national average. Due to the recent recession, the national unemployment rate has increased, moving closer to that of NYC.

9.6.c.5 Cost of Living and Housing Burden

NYC residents face relatively high costs for nondiscretionary items (e.g., housing, utilities) compared to individuals living almost anywhere else in the nation as shown in Figure 9-10. While water costs are slightly less than the average for other major U.S. cities, the housing burden is substantially higher.



	Apartment Rental (average monthly rent)	Condo/Co-op Sale (median per sale)	1- to 3-Family Home Sale (median per sale)	Electricity (average per year; 6,000 kwh)	Utility (Natural) Gas (average per year)	Internet (average per year, 25-50 Mbps)	Heating Oil (Fuel Oil #2) (average per gallon)	Unleaded Gasoline (average per gallon)	Water & Wastewater (average per year; 80,000 gallons)
NYC	$3,223	$516,000	$510,000	$1,741	$1,269	$795	$3.10	$2.22	$1,025
U.S. Cities	$1,124	$204,300	$208,900	$828	$718	$711	$2.81	$2.11	$1,048

Source: Wall Street Journal and New York Times (apartment rental); The Real Estate Board of New York and National Association of Realtors (condo/co-op and 1-3 family home sale); Consolidated Edison and U.S. Bureau of Labor Statistics "BLS" (electricity); National Grid and American Gas Association (natural gas); The Open Technology Institute (internet); New York State Energy Research and Development Authority and U.S. BLS (heating oil); U.S. BLS (gasoline); NYC FY 2015 Water and Wastewater Rate Report (water & wastewater)

Figure 9-10. Comparison of Costs Between NYC and other U.S. Cities

Approximately 67 percent of all households in NYC are renter-occupied, compared to about 35 percent of households nationally. For most renter households in NYC, water and wastewater bills are included in the total rent payment. Rate increases may be passed on to the tenant in the form of a rental increase, or born by the landlord. In recent years, affordability concerns have been compounded by the fact that gross median rents have increased, while median renter income has declined as shown in Figure 9-11 (NYC Housing, 2014).

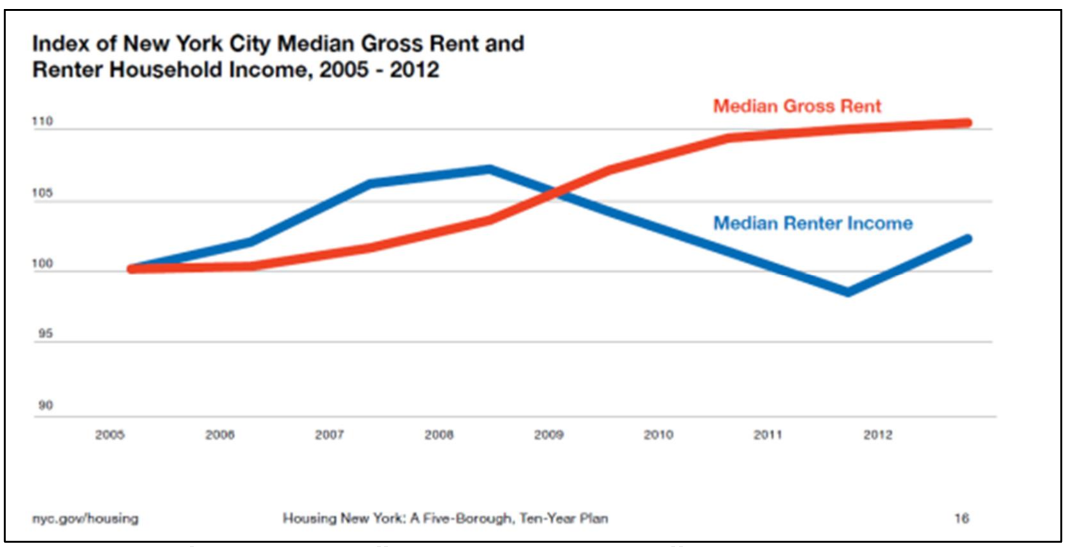


Figure 9-11. Median Gross Rent vs. Median Renter Income

Most government agencies consider housing costs of between 30 percent and 50 percent of household income to be a moderate burden in terms of affordability; costs greater than 50 percent of household income are considered a severe burden.

A review of Census data shows approximately 21 percent of NYC households (close to 645,000 households) spent between 30 percent and 50 percent of their income on housing, while about 25 percent (748,000 households) spent more than 50 percent. This compares to 20 percent of households nationally that spent between 30 percent and 50 percent of their income on housing and 16.2 percent of households nationally that spent more than 50 percent. This means that 46 percent of households in NYC versus 36.2 percent of households nationally spent more than 30 percent of their income on housing.

The NYCHA is responsible for 172,223 affordable housing units (9 percent of the total renter households in NYC). The agency is estimated to pay about $186M for water and wastewater in FY 2015. This total represents about 5.9 percent of their $3.14B operating budget. Even a small increase in rates could potentially impact the agency's ability to provide affordable housing and/or other programs.

9.6.d Financial Capability Indicators

The second phase of the 1997 CSO guidance develops the Permittee FCI, which are compared to national benchmarks and are used to generate a score that is the average of six economic indicators. Lower FCI scores imply weaker economic conditions. Table 9-4 summarizes the FCI scoring as presented in the 1997 CSO guidance.

Table 9-4. Financial Capability Indicator Scoring

Financial Capability Metric	Strong (Score = 3)	Mid-range (Score = 2)	Weak (Score = 1)
Debt indicator			
Bond rating (G.O. bonds, revenue bonds)	AAA-A (S&P) Aaa-A (Moody's)	BBB (S&P) Baa (Moody's)	BB-D (S&P) Ba-C (Moody's)
Overall net debt as percentage of full market value	Below 2%	2–5%	Above 5%
Socioeconomic indicator			
Unemployment rate	More than 1 percentage point below the national average	+/- 1 percentage point of national average	More than 1 percentage point of national average
MHI	More than 25% above adjusted national MHI	+/- 25% of adjusted national MHI	More than 25% below adjusted national MHI
Financial management indicator			
Property tax revenues as percentage of Full Market Property Value (FMPV)	Below 2%	2–4%	Above 4%
Property tax revenue collection rate	Above 98%	94–98%	Below 94%

Notes:
G.O. = general obligation

NYC's FCI score based on this test is presented in Table 9-5 and further described below.

Table 9-5. NYC Financial Capability Indicator Score

Financial Capability Metric	Actual Value	Score
Debt indicators		
Bond rating (G.O. bonds)	AA (S&P) AA (Fitch) Aa2 (Moody's)	Strong/3
Bond rating (Revenue bonds)	AAA (S&P) AA+ (Fitch) Aa1 (Moody's)	
Overall net debt as percentage of FMPV	4.5%	Mid-range/2
G.O. Debt	$41.6B	
Market value	$988.3B	
Socioeconomic indicators		
Unemployment rate (2013 annual average)	1.0 percentage point above the national average	Mid-range/2
NYC unemployment rate	7.2%	
United States unemployment rate	6.2%	
MHI as percentage of national average	99.9%	Mid-range/2
Financial management indicators		
Property tax revenues as percentage of FMPV	2.4%	Mid-range/2
Property tax revenue collection rate	98.5%	Strong/3
Permittee Indicators Score		2.3

Notes:
G.O. = general obligation

9.6.d.1 Bond Rating

The first financial benchmark is NYC's bond rating for both general obligation (G.O.) and revenue bonds. A bond rating performs the isolated function of credit risk evaluation. While many factors go into the investment decision-making process, bond ratings can significantly affect the interest that the issuer is required to pay, and thus the cost of capital projects financed with bonds. According to EPA's criteria – based on the ratings NYC has received from all three rating agencies [Moody's, Standard & Poor's (S&P), and Fitch Ratings] – NYC's financing capability is considered "strong." Specifically, NYC's G.O. bonds are rated AA by S&P and Fitch and Aa2 by Moody's; and MWFA's General Resolution revenue bonds are rated AAA by S&P, AA+ by Fitch, and Aa1 by Moody's, while MWFA's Second General Resolution revenue bonds (under which most of the Authority's recent debt has been issued) are rated AA+ by S&P, AA+ by Fitch, and Aa2 by Moody's. This results in a "strong" rating for this category.

Nonetheless, NYC's G.O. rating and MWFA's revenue bond ratings are high due to prudent fiscal management, the legal structure of the system, and the Water Board's historical ability to raise water and wastewater rates. However, mandates over the last decade have significantly increased the leverage of the system, and future bond ratings could be impacted by further increases to debt beyond what is currently forecasted.

9.6.d.2 Net Debt as a Percentage of Full Market Property Value (FMPV)

The second financial benchmark measures NYC's outstanding debt as a percentage of FMPV. Currently NYC has over $41.6B in outstanding G.O. debt, and the FMPV within NYC is $929.1B. This results in a ratio of outstanding debt to FMPV of 4.5 percent and a "mid-range" rating for this indicator. If $29.7B of MWFA revenue bonds that support the system are included, net debt as a percentage of FMPV increases to 7.7 percent, which results in a "weak" rating for this indicator. Furthermore, if NYC's $39.5B of additional debt that is related to other services and infrastructure is also included, the resulting ratio is 11.9 percent net debt as a percentage of FMPV.

9.6.d.3 Unemployment Rate

For the unemployment benchmark, the 2014 annual average unemployment rate for NYC was compared to that for the U.S. NYC's 2014 unemployment rate of 7.2 percent is 1.0 percent higher than the national average of 6.2 percent. Based on EPA guidance, NYC's unemployment benchmark would be classified as "mid-range". It is important to note that over the past two decades, NYC's unemployment rate has generally been significantly higher than the national average. Due to the recession, the national unemployment is closer to NYC's unemployment rate. Additionally, the unemployment rate measure identified in the 1997 financial guidance sets a relative comparison at a snapshot in time. It is difficult to predict whether the unemployment gap between the U.S. and NYC will once again widen further, and it may be more relevant to look at longer term historical trends of the service area.

9.6.d.4 Median Household Income (MHI)

The MHI benchmark compares the community's MHI to the national average. Using American Community Survey (ACS) 2013 single-year estimates, NYC's MHI is $52,223 and the nation's MHI is $52,250. Thus, NYC's MHI is nearly 100 percent of the national MHI, resulting in a "mid-range" rating for this indicator. However, as discussed above in this section, MHI does not provide an adequate measure of affordability or financial capability. MHI is a poor indicator of economic distress and bears little relationship to poverty or other measures of economic need. In addition, reliance on MHI alone can be a very misleading indicator of the affordability impacts in a large and diverse City such as NYC.

9.6.d.5 Tax Revenues as a Percentage of Full Market Property Value

This indicator, which EPA also refers to as the "property tax burden", attempts to measure "the funding capacity available to support debt based on the wealth of the community," as well as "the effectiveness of management in providing community services". According to the NYC Property Tax Annual report issued for FY 2014, NYC had collected $21.0B in real property taxes against an $858.1B FMPV, which amounts to 2.4 percent of FMPV. For this benchmark, NYC received a "mid-range" score. Also, this figure does not include water and wastewater revenues. Including $3.6B of FY 2014 system revenues increases the ratio to 2.7percent of FMPV.

However, this indicator (including or excluding water and wastewater revenues) is misleading because NYC obtains a relatively low percentage of its tax revenues from property taxes. In 2007, property taxes accounted for less than 41 percent of NYC's total non-exported taxes, meaning that taxes other than property taxes (e.g., income taxes, sales taxes) account for nearly 60 percent of the locally borne NYC tax burden.

9.6.d.6 Property Tax Collection Rate

The property tax collection rate is a measure of “the efficiency of the tax collection system and the acceptability of tax levels to residents”. The FY 2014 NYC Property Tax Annual report indicates NYC’s total property tax levy was $21.3B, of which 98.5 percent was collected, resulting in a “strong” rating for this indicator.

It should be noted, however, that the processes used to collect water and wastewater charges and the enforcement tools available to water and wastewater agencies differ from those used to collect and enforce real property taxes. The DOF, for example, can sell real property tax liens on all types of non-exempt properties to third parties, who can then take action against the delinquent property owners. DEP, in contrast, can sell liens on multi-family residential and commercial buildings whose owners have been delinquent on water bills for more than one year, but it cannot sell liens on single-family homes. The real property tax collection rate thus may not accurately reflect the local agency’s ability to collect the revenues used to support water supply and wastewater capital spending.

9.6.e Future Household Costs

For illustration purposes, Figure 9-12 shows the average estimated household cost for wastewater services compared to household income, versus the percentage of households in various income brackets for the years 2016 and 2022. As shown, 48 percent of households are estimated to pay more than one percent of their income on wastewater service in 2016. Roughly 27 percent of households are estimated to pay two percent or more of their income on wastewater service alone in 2016. Estimating modest future rate and income increases (based on costs in the CIP and historic Consumer Price Index data, respectively), up to 36 percent of households could be paying more than two percent of their income on wastewater services by 2022. These projections are preliminary and do not include additional future wastewater spending associated with the programs outlined in Section 9.6.a.3 - Future System Investment. When accounting for these additional costs, it is likely that an even greater percentage of households could be paying well above two percent of their income on wastewater services in the future.

DEP, like many utilities in the nation, provides both water and wastewater service, and its rate payers see one bill. Currently the average combined water and sewer bill is around 1.6 percent of MHI, but 22 percent of households are estimated to be currently paying more than 4.5 percent of their income, and that could increase to about 28 percent of households in future years as shown in Figure 9-13. Again, this estimate does not include additional spending for the additional water and wastewater programs outlined in Section 9.6.a.3 - Future System Investment.

9.6.f Potential Impacts of CSO LTCPs to Future Household Costs

As previously discussed, DEP is facing significant future wastewater spending commitments associated with several regulatory compliance programs. This section presents the potential range of CSO LTCP implementation costs for NYC and describes the potential resulting impacts to future household costs for wastewater service. The information in this section reflects a simplified household impact analysis that will be refined in future LTCP waterbody submittals. All referenced WWFP costs presented in this section have been escalated to June 2014 dollars using the Engineering News-Record City Cost Index (ENRCCI) for New York for comparison purposes.

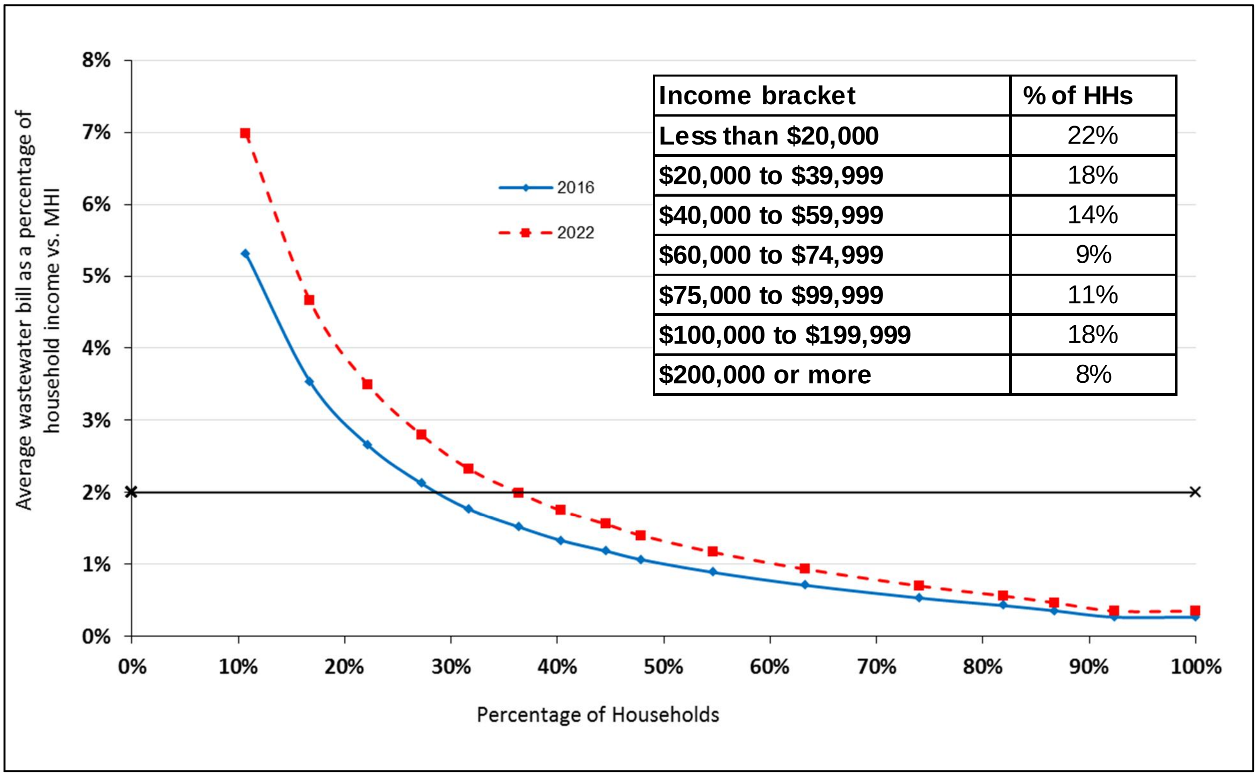


Figure 9-12. Estimated Average Wastewater Household Cost Compared to Household Income (FY 2016 and FY 2022)

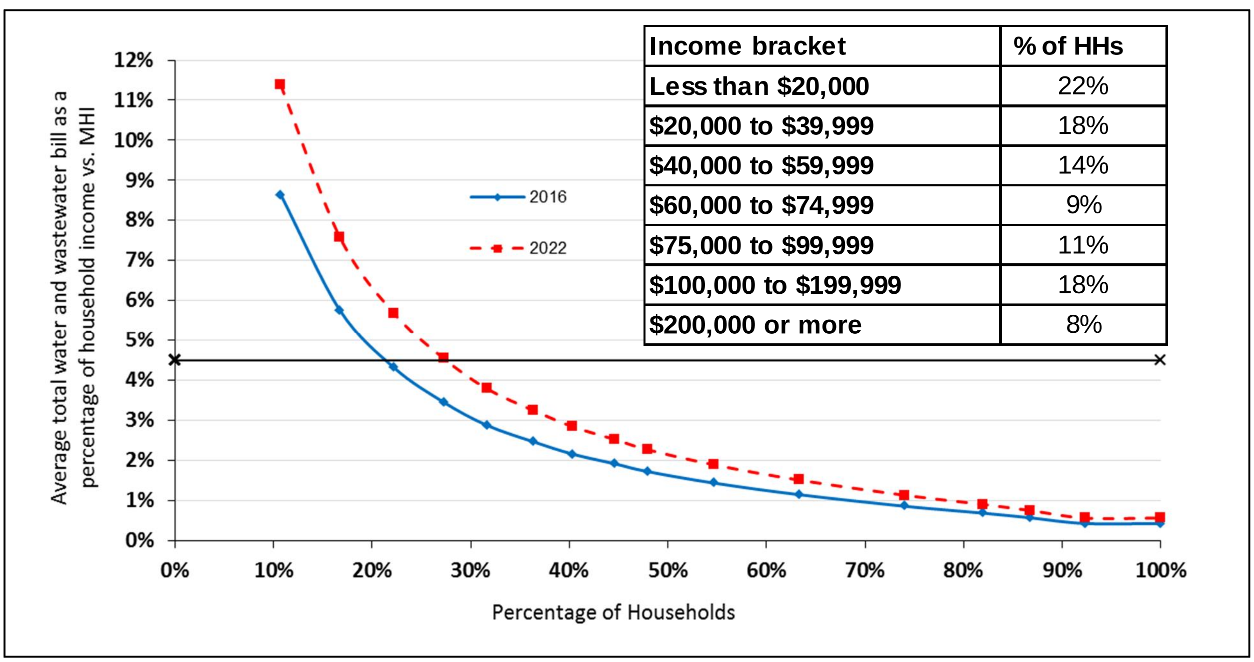


Figure 9-13. Estimated Average Total Water and Wastewater Cost as a Percentage of Household Income (FY 2016 and FY 2022)

9.6.f.1 Estimated Costs for Waterbody CSO Preferred Alternative

As discussed in Section 8.8, the preferred LTCP alternative for the Bronx River is Alternative 2 - interceptor relief at Relief Structure 27 for Outfall HP-007, raising a weir at Regulator 13, adding a relief pipe between Regulator 13 and the Bronx River siphon for Outfall HP-009, and implementation of floatables control and weir modification at Regulator 5 (Outfall HP-011). This alternative will reduce the CSO frequency and volume at Outfalls HP-007 and HP-009, with resultant reductions in bacteria and other loadings associated with CSOs, and will control floatables discharged at Outfall HP-011. Existing floatables control facilities at Outfalls HP-004, HP-007 and HP-009 will continue to operate to control the discharge of floatables in the remaining CSO volume at those outfalls. DEP will conduct PCM to determine bacteria reduction and DO benefits from the preferred LTCP alternative. The preferred LTCP alternative also includes management of 14 percent of the combined sewer impervious area by implementing GI in the Bronx River watershed by 2030. To-date, approximately $47M has been committed to grey CSO control infrastructure in the Bronx River system.

The total present worth cost for the grey component of the LTCP alternative, which reflects the Probable Bid Cost and O&M costs over the projected useful life of the project, is approximately $111M.

9.6.f.2 Overall Estimated Citywide CSO Program Costs

DEP's LTCP planning process was initiated in 2012 and will extend until the end of 2017 per the 2012 CSO Order on Consent schedule. Overall anticipated CSO program costs for NYC will not be known until all of the LTCPs have been developed and approved. Capital costs for the LTCP preferred alternatives that have been identified to-date are presented in Table 9-6a. Also, GI is a major component of the 2012 CSO Order on Consent. The overall GI program cost is estimated at $2.4B, of which $1.5B will be spent by DEP. The GI program costs are in addition to the grey CSO program costs and are therefore presented as a separate line item.

As illustrated in Tables 9-6a and 9-6b, from FY02-FY14, DEP has committed about $2.068 billion to CSO control. While the LTCP process is not complete, DEP has budgeted additional funding towards CSO in the current capital improvement plan. Approximately $2.27 billion has been budgeted toward CSO investments, which could be some combination of grey, green, and treatment options from FY 15- FY25.

Projected disinfection costs as well as 25%, 50%, and 100% CSO control alternatives (developed as part of a previous WWFP effort) are provided in Table 9-6b for waterbodies where a LTCP has not yet been completed to identify a possible range of future CSO program costs. The actual LTCP preferred alternatives for these waterbodies could be a mix of treatment and storage options.

Based on the information contained in Tables 9-6a and 9-6b, overall future CSO program capital costs could range from $2.6B to $74.7B when considering costs for the LTCP preferred alternatives plus the range of costs presented for the other waterbodies.

9.6.f.3 Potential Impacts to Future Household Costs

To estimate the impact of the possible range of future CSO control capital costs to ratepayers, the annual household cost impact of the future citywide CSO control costs was calculated for the CSO spending scenarios. The cost estimates presented will evolve over the next few years as the LTCPs are completed for the ten waterbodies. The cost estimates will be updated as the LTCPs are completed. Also, it is important to note that the current analysis does not include rate impacts of future O&M and other incremental costs, which would contribute to additional increases to the rate.

Table 9-6a. Committed Costs and LTCP Preferred Alternative Costs[(1)]

Waterbody / Watershed	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs			LTCP Preferred Alternative	LTCP Preferred Alternative Cost
		Committed FY 2002-FY 2014	Committed in FY 2015-FY 2025 CIP	Total Existing Committed		
Alley Creek and Little Neck Bay	CSO Abatement Facilities and East River CSO	$139,131,521	$13,000,000	$152,131,521	Alternative 4 - Disinfection in Existing CSO Retention Facility	$7,600,000
Westchester Creek	Hunts Point WWTP Headworks	$7,800,000	$0	$7,800,000	Green Infrastructure Implementation and Post-Construction Compliance Monitoring	$0
Hutchinson River	Hunts Point WPCP Headworks	$3,000,000	$108,000,000	$111,000,000	Alternative 12 - 50 MGD Seasonal Disinfection in New Outfall HP-024	$90,000,000
Flushing Creek	Flushing Bay Corona Avenue Vortex Facility, Flushing Bay CSO Retention, Flushing Bay CSO Storage	$357,015,599	$75,195,000	$432,210,599	Alternative 3 - TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection	$6,890,000
Bronx River	Installation of Floatable Control Facilities, Hunts Point Headworks	$46,866,831	$0	$46,866,831	Alternative 2 - Combination of former Alts. 7-1 and 9-1	$110,100,000
Gowanus Canal	Gowanus Flushing Tunnel Reactivation, Gowanus PS Upgrade	$176,165,050	$308,954,000	$485,119,050	Current Baseline Plus Green Infrastructure, Proposed HLSS, and Future Superfund Commitments	Included in Superfund Costs[(2)]
Green Infrastructure Program	*Miscellaneous Projects Associated with Citywide Green Infrastructure Program*	$173,462,000	$940,074,000	$1,113,536,000	Full Implementation of Green Infrastructure Program	$1,500,000,000
TOTAL		*$903,441,001*	*$1,445,223,000*	*$2,348,664,001*		*$1,714,590,000*

Notes:

(1) All costs reported in this table reflect estimated capital costs only (i.e. probable bid cost). Projected O&M costs are not included in this analysis.

(2) The DEP Superfund tank costs for Gowanus Canal are not shown here as LTCP costs but are included with the future mandated programs in Tables 9.7 and 9.8. Potential Superfund costs for Gowanus Canal range from $507M to $829M.

Table 9-6b. Committed Costs and Range of Future CSO Program Costs for Waterbodies without Completed LTCP[1]

Waterbody / Watershed	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs			Range of Potential Future CSO Program Costs			
					Treatment / Disinfection Cost[2]	Storage Alternatives		
		Committed FY 2002-FY 2014	Committed in FY 2015-FY 2025 CIP	Total Existing Committed		25% CSO Control Cost[3]	50% CSO Control Cost[3]	100% CSO Control Cost[3]
Coney Island Creek	Avenue V Pumping Station, Force Main Upgrade	$196,885,560	$0	$196,885,560	$53,955,000	$59,646,395	$119,292,789	$1,163,462,575
Jamaica Bay	Improvements of Flow Capacity to Fresh Creek-26th Ward Drainage Area, Hendrix Creek Canal Dredging, Shellbank Destratification, Spring Creek AWCP Upgrade	$161,378,669	$21,010,000	$182,388,669	$0	$180,881,883	$367,416,325	$4,142,534,281
Flushing Bay[4]	See Flushing Creek in Table 9-6a	$0	$0	$0	$333,431,000	$222,270,368	$791,802,838	$4,787,918,645
Newtown Creek	English Kills Aeration, Newtown Creek Water Quality Facility, Newtown Creek Headworks	$159,639,614	$90,404,000	$250,043,614	$537,766,000	$566,569,452	$1,586,394,467	$3,421,512,923
East River and Open Waters	Bowery Bay Headworks, Inner Harbor In-Harbor Storage Facilities, Reconstruction of the Port Richmond East Interceptor Throttling Facility, Outer Harbor CSO Regulator Improvements, Hutchinson River CSO	$153,145,476	$19,094,000	$172,239,476	$0	$534,921,268	$7,016,829,726	$59,488,594,159
Bergen and Thurston Basins[5]	Pumping Station and Force Main Warnerville	$41,876,325	$0	$41,876,325	NA	NA	NA	NA

Table 9-6b. Committed Costs and Range of Future CSO Program Costs for Waterbodies without Completed LTCP[1]

Waterbody / Watershed	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs			Range of Potential Future CSO Program Costs			
					Treatment / Disinfection Cost[2]	Storage Alternatives		
		Committed FY 2002-FY 2014	Committed in FY 2015-FY 2025 CIP	Total Existing Committed		25% CSO Control Cost[3]	50% CSO Control Cost[3]	100% CSO Control Cost[3]
Paerdegat Basin	Retention Tanks, Paerdegat Basin Water Quality Facility	$397,046,298	$ (2,643,000)[6]	$394,403,298	NA	NA	NA	NA
TOTAL		*$1,109,971,941*	*$127,865,000*	*$1,237,836,941*	*$925,152,000*	*$1,564,289,366*	*$9,881,736,146*	*$73,004,022,583*

Notes:

(1) All costs reported in this table reflect estimated capital costs only (i.e. probable bid cost). Projected O&M costs are not included in this analysis.
(2) Values reflect current estimated disinfection costs projected by DEP; costs will be refined in future LTCP submittals.
(3) 25%, 50%, and 100% CSO costs are estimated using knee-of-the-curve / cost vs. CSO control plots from WWFPs as needed and do not subtract historic and currently committed costs, which are presented separately. All costs taken from the WWFPs have been escalated to June 2014 dollars for comparison purposes using the ENRCCI for New York.
(4) Committed costs for Flushing Bay are captured in the committed costs reported for Flushing Creek; see Table 9-6a.
(5) Bergen and Thurston Basins and Paerdegat Basin are not part of the current LTCP effort; thus, no LTCP detail is provided for them.
(6) Negative value for Paerdegat Basin reflects a de-registration of committed funds.

A 4.75 percent interest rate was used to determine the estimated annual interest cost associated with the capital costs, and the annual debt service was divided by the FY 2016 Revenue Plan value to determine the resulting percent rate increase. This also assumes bonds are structured for a level debt service amortization over 32 years. Note that interest rates on debt could be significantly higher in the future. As Table 9-7 shows, the LTCP preferred alternatives plus disinfection for the remaining waterbodies would result in a two percent rate increase, the LTCP preferred alternatives plus 25% CSO control scenario would result in a three percent rate increase, the LTCP preferred alternatives plus 50% CSO control scenario would result in a double-digit rate increase of 17 percent, and the LTCP preferred alternatives plus 100% CSO control scenario would result in a substantial 125 percent rate increase. These rate increases translate into additional annual household costs of up to $1,318. Both the 50 percent and 100% CSO control scenarios represent a substantial increase in annual household costs, which only reflects possible future CSO control program costs. The cost of the additional future mandated and non-mandated programs discussed in Section 9.6.a.3 - Future System Investment, would further increase the annual burden to ratepayers. For illustrative purposes, estimates for future spending on TRC, Ammonia, MS4, Superfund and Hillview Cover have been assumed in Table 9-7 and Table 9-8, and these are subject to change.

Table 9-8 shows the potential range of future spending and its impact on household cost compared to MHI. While these estimates are preliminary, it should be noted (as discussed in detail earlier in this section) that comparing household cost to MHI alone does not tell the full story since a large percentage of households below the median could be paying a larger percentage of their income on these costs.

9.6.g Benefits of Program Investments

DEP has been in the midst of an unprecedented period of investment to improve water quality in New York Harbor. Projects worth $9.9B have been completed or are under way since 2002 alone, including projects for nutrient removal, CSO abatement, marshland restoration in Jamaica Bay, and hundreds of other projects. In-NYC investments are improving water quality in the Harbor and restoring a world-class estuary while creating new public recreational opportunities and inviting people to return to NYC's 578 miles of waterfront. A description of citywide water quality benefits resulting from previous and ongoing programs is provided below, followed by the anticipated benefits of water quality improvements to the Bronx River resulting from implementation of the preferred alternative.

Table 9-7. CSO Control Program Household Cost Impact

Capital Spending Scenario	Projected Capital Cost ($M)(1)	Additional O&M and other Incremental Costs(2)	Annual Debt Service ($M)(3)	% Rate Increase from FY 2016 Rates	Additional Annual Household Cost	
					Single-family Home	Multi-family Unit
Current CIP	$17,312	*TBD*	$1,063	30	$312	$203
Future Potential Mandated Program Costs for MS4, TRC, Ammonia, Superfund, and Hillview Cover(4)	$6,500	*TBD*	$399	11	$117	$76
LTCP Preferred Alternatives + 100% CSO Control(5)	$73,146	*TBD*	$4,492	125	$1,318	$856
LTCP Preferred Alternatives + 50% CSO Control(5)	$10,023	*TBD*	$616	17	$181	$117
LTCP Preferred Alternatives + 25% CSO Control(5)	$1,706	*TBD*	$105	3	$31	$20
LTCP Preferred Alternatives + Disinfection(5)	$1,067	*TBD*	$66	2	$19	$12
Citywide LTCP CSO Control Alternatives(6)	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*

Notes:

TBD – To be determined

(1) CSO Capital costs have been reduced to reflect currently committed costs for CSO control projects (see Tables 9-6a and 9-6b).
(2) This analysis does not include rate impacts of future O&M and other incremental costs, which would contribute to additional increases to the rate.
(3) Assumes bonds are structured for a level debt service amortization over 32 years at a 4.75% interest rate.
(4) DEP will face additional future wastewater mandated program costs. While these costs have not been finalized and actual costs could be very different due to compliance uncertainties (particularly with respect to MS4), the following estimated costs for select programs are included to represent potential future annual household cost on top of costs for the CSO control program: MS4 Permit Compliance - $2.0B, TRC - $560M, Ammonia $840M, Superfund Remediation - $1.5B, and $1.6B for Hillview Cover.
(5) Reflects LTCP Preferred Alternatives (see Table 9-6a) plus the identified level of control or treatment for the remaining waterbodies (see Table 9-6b).
(6) Projected capital cost for the citywide preferred LTCP CSO control alternatives is not currently available. This information will be included in the citywide LTCP following completion of the individual waterbody LTCPs.

Table 9-8. Total Estimated Cumulative Future Household Costs/MHI[1]

Capital Spending Scenario	Total Projected Annual Household Cost[2]		Total Water and Wastewater Household Cost / MHI[3]		Total Wastewater Household Cost / MHI[3]	
	Single-family Home	Multi-family Unit	Single-family Home (%)	Multi-family Unit (%)	Single-family Home (%)	Multi-family Unit (%)
FY 2016 Rates	$1,056	$686	2.0	1.3	1.2	0.79
Current CIP	$1,368	$889	2.2	1.5	1.4	0.89
Other Future Potential Mandated Program Costs for MS4, TRC, Ammonia, Superfund, and Hillview Cover[4]	$1,485	$965	2.4	1.6	1.5	0.97
CIP+Other+LTCP Preferred Alternatives+100% CSO Control[5]	$2,803	$1,821	4.6	3.0	2.8	1.83
CIP+Other+LTCP Preferred Alternatives+50% CSO Control[5]	$1,666	$1,082	2.7	1.8	1.7	1.09
CIP+Other+LTCP Preferred Alternatives+25% CSO Control[5]	$1,516	$985	2.5	1.6	1.5	0.99
CIP+Other+LTCP Preferred Alternatives+Disinfection[5]	$1,504	$977	2.5	1.6	1.5	0.98
CIP+Other+Citywide LTCP CSO Control Alternatives	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*

Notes:

(1) Future costs reported in this table reflect capital costs only and do not include projected O&M costs.
(2) Projected household costs are estimated from rate increases presented in Table 9-7.
(3) Future costs were compared to assumed 2025 MHI projection ($61,142), which was estimated using Census and Consumer Price Index data.
(4) Reflects estimated costs for additional future wastewater mandated program costs. These costs have not been finalized and actual costs could be very different due to compliance uncertainties (particularly with respect to MS4).
(5) Reflects LTCP Preferred Alternatives (see Table 9-6a) plus the identified level of control or treatment for the remaining waterbodies (see Table 9-6b), current CIP, and other future potential mandated program costs.

9.6.g.1 Citywide Water Quality Benefits from Previous and Ongoing Programs and Anticipated Bronx River Water Quality Benefits

Water quality benefits have been documented in the Harbor and its tributaries from the almost $10B investment that NYC has already made in grey and GI since 2002. Approximately 95 percent of the Harbor is available for boating and kayaking and 14 of NYC's beaches provide access to swimmable waters in the Bronx, Brooklyn, Queens and Staten Island.

Of the $10B already invested, almost 20 percent has been dedicated to controlling CSOs and stormwater. That investment has resulted in NYC capturing and treating over 70 percent of the combined stormwater and wastewater that otherwise would be directly discharged to our waterways during periods of heavy rain or runoff. Projects that have already been completed include: GI projects in 26^{th} Ward, Hutchinson River and Newtown Creek watersheds; area-wide GI contracts; Avenue V Pump Station and Force Main; and the Bronx River Floatables Control. Several other major projects are in active construction or design. The water quality improvements already achieved have allowed greater access of the waterways and shorelines for recreation as well as enhanced environmental habitat and aesthetic conditions in many of NYC's neighborhoods.

More work is needed, and DEP has committed to working with DEC to further reduce CSOs and make other infrastructure improvements to gain additional water quality improvements. The 2012 CSO Order on Consent between DEP and DEC outlines a combined grey and green approach to reduce CSOs. This LTCP for the Bronx River is just one of the detailed plans that DEP is preparing by the year 2017 to evaluate and identify additional control measures for reducing CSO and improving water quality in the Harbor. DEP is also committed to extensive water quality monitoring throughout the Harbor which will allow better assessment of the effectiveness of the controls implemented.

As noted above, a major component of the 2012 CSO Order on Consent that DEP and DEC developed is GI stormwater control measures. DEP is targeting a 10 percent application rate for implementing GI in combined sewer areas citywide. The GI will take multiple forms including green or blue roofs, bioinfiltration systems, right-of-way bioswales, rain barrels, and porous pavement. These measures provide benefits beyond the associated water quality improvements. Depending on the measure installed, they can recharge groundwater, provide localized flood attenuation, provide sources of water for non-potable use such as watering lawns or gardens, reduce heat island effects on streets and sidewalks, improve air quality, enhance aesthetic quality, and provide recreational opportunities. These are all benefits that contribute to the overall quality of life for residents of NYC.

A detailed discussion of anticipated water quality improvements to the Bronx River is included in Section 8.0, and a UAA is included in Appendix C.

9.6.h Conclusions

As part of the LTCP process, DEP will continue to develop and refine the affordability and financial capability assessments for each individual waterbody as it works toward an expanded analysis for the citywide LTCP. In addition to what is outlined in the Federal CSO guidance on financial capability, DEP has presented in this section a number of additional socioeconomic factors for consideration in the context of affordability and assessing potential impacts to our ratepayers. Furthermore, it is important to include a fuller range of future spending obligations and DEP has sought to present an initial picture of that here. Ultimately the environmental, social, and financial benefits of all water-related obligations should be considered when priorities for spending are developed and implementation of mandates are scheduled, so that resources can be focused where the community will get the most environmental benefit.

9.7 Compliance with Water Quality Goals

As noted above, the Bronx River is currently attaining the Class I bacteria criterion. The assessment of the waterbody indicates that the Bronx River cannot support Primary Contact WQ Criteria (Class SC or the recently proposed fecal coliform Class I criteria), nor is it suitable for such uses. A UAA for the Bronx River is included with this LTCP.

10. REFERENCES

City of Philadelphia, 2014. FY 2014 Combined Sewer and Stormwater Management Program Annual Reports.

Civil and Structural Engineer. 2012. Update: Chesapeake Bay TMDL. http://cenews.com/article/8949/update-chesapeake-bay-tmdl.

HydroQual Environmental Engineers & Scientists, P.C. 2005a. NY/NJ Harbor Estuary Program Model Applications of Stormwater Sampling Results, Memorandum to C. Villari, NYCDEP from C. Dujardin and W. Leo. May 4, 2005.

National Stormwater Database. http://www.bmpdatabase.org/nsqd.html

New York City, NY. 2010. Rules of the City of New York Governing House/Site Connections to the Sewer *System.* www.nyc.gov/html/gbee/.../dep_rule_title15_ch.31.pdf.

New York City Center for Economic Opportunity. 2011. Policy Affects Poverty: The CEO Poverty Measure, 2005-2009. March 2011.

New York City Department of Environmental Protection. Long Term Control Plan Quarterly Progress Reports. http://www.nyc.gov/ html/dep/html/cso_long_term_control_plan/index.shtml.

New York City Department of Environmental Protection. New York City Harbor Water Quality Annual Report. http://www.nyc.gov/html/dep/html/harborwater/harborwater_ quality_survey.shtml.

New York City Department of Environmental Protection. NYC Green Infrastructure Program. http://www.nyc.gov/html/dep/html/stormwater/using_green_infra_to_manage_stormwater.shtml.

New York City Department of Environmental Protection. 1994. Inner Harbor CSO Facility Planning Project. Facilities Planning Report: prepared for NYCDEP by Hazen and Sawyer, P.C. and HydroQual Environmental Engineers and Scientists, P.C.

New York City Department of Environmental Protection. 2004. DRAFT: The Bronx River Waterbody/Watershed Facility Plan. March 2004.

New York City Department of Environmental Protection. 2005. Combined Sewer Overflow (CSO) Order on Consent (DEC Case No. CO2-20000107-8).

New York City Department of Environmental Protection. 2007. The City of New York PlaNYC 2030: A Greener, Greater New York Report. http://www.nyc.gov/html/planyc/downloads/pdf/publications/full _report_2007.pdf.

New York City Department of Environmental Protection. 2010. Hunts Point Wastewater Treatment Plant Wet Weather Operating Plan. August 2010.

New York City Department of Environmental Protection. 2010a. Bronx River Waterbody/Watershed Facility Plan Report. July 2010. http://www.hydroqual.com/projects/ltcp/wbws/bronx_river.htm.

New York City Department of Environmental Protection. 2010b. NYC Green Infrastructure Plan, A Sustainable Strategy for Clean Waterways. September 2010.

New York City Department of Environmental Protection, 2011. Water for the Future. http://www.nyc.gov/html/waterforthefuture/index.shtml.

New York City Department of Environmental Protection. 2012. Combined Sewer Overflow (CSO) Order on Consent (DEC Case No. CO2-20110512-25). March 8 2012. http://www.dec.ny.gov/docs/water_pdf/csosum2012.pdf.

New York City Department of Environmental Protection. 2012 Long Term Control Plan (LTCP) Program. http://www.nyc.gov/dep/ltcp.

New York City Department of Environmental Protection. 2012. Green Infrastructure Annual Report. http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_plan.shtml.

New York City Department of Environmental Protection. 2012a. InfoWorks Citywide Model Recalibration Report. June 2012.

New York City Department of Environmental Protection. 2012b. Citywide Hydraulic Analysis Report. December 2012.

New York City Department of Environmental Protection. 2012c. The State of the Harbor 2012.

New York City Department of Environmental Protection. 2012d. NYC Green Infrastructure Plan: 2012 Green Infrastructure Pilot Monitoring Report. http://www.nyc.gov/html/dep/pdf/green_infrastructure/2012_green_infrastructure_pilot_monitoring_report.pdf.

New York City Department of Environmental Protection in consultation with the New York City Department of Buildings. 2012e. Guidelines for the Design and Construction of Stormwater Management Systems. http://www.nyc.gov/html/dep/pdf/green_infrastructure/stormwater_guidelines_2012_final.pdf.

New York City Department of Environmental Protection. 2013. NYC Green Infrastructure. Video located at: https://www.youtube.com/watch?v=zrhw2cMTpJs.

New York City Department of Environmental Protection. 2013. Green Infrastructure Annual Report. http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_plan.shtml.

New York City Department of Environmental Protection. 2013. Climate Change and Population Growth Effects on New York City Sewer and Wastewater Systems. Prepared by Halcrow/Hazen and Sawyer under contract EE-GCC for the New York City Department of Environmental Protection. March 2013.

New York City Department of Environmental Protection. 2014a. Post-Construction Compliance Monitoring Green Infrastructure Neighborhood Demonstration Areas. August 2014, Resubmitted January 2015.

New York City Department of Environmental Protection. 2014b. Combined Sewer Overflow Best Management Practices: Annual Report 2013. April 2014.

New York City Department of Environmental Protection. 2014. Post-Construction Compliance Monitoring and CSO Retention Facility Overflow Summary for Calendar Year 2013. June 2014.

New York City Department of Environmental Protection. 2014. Combined Sewer Overflow (CSO) Long Term Control Plan (LTCP) for the Westchester Creek. June 2014.

New York City Department of Environmental Protection. 2015. Bronx River LTCP Sewer System and Water Quality Modeling Report.

New York City Department of Environmental Protection. 2015. One New York: The Plan for a Strong and Just City (OneNYC). http://www1.nyc.gov/html/onenyc/index.html.

New York City Department of Parks and Recreation. http://www.nycgovparks.org/.

New York City Housing. 2014. Housing New York: A Five-Borough, Ten-Year Plan.

New York State, 2008. New York City Plumbing Code. June 2008. https://law.resource.org/pub/us/code/ibr/nyc.plumbing.2008.pdf.

New York State Department of Environmental Conservation. 6 NYCRR 701.13. http://www.dec.ny.gov/regs/4592.html.

New York State Department of Environmental Conservation. Wet Weather Operating Practices for POTWs with Combined Sewers. http://www.dec.ny.gov/chemical/48980.html.

New York State Department of Environmental Conservation. 1975. Freshwater Wetland Maps.

New York State Department of Environmental Conservation. 2010. 2010 CSO BMP Order on Consent.

New York State Department of Environmental Conservation. 2010. State Pollution Discharge Elimination System Discharge Permit (SPDES): NY0026191. November 2010 http://www.dec.ny.gov/docs/permits_ej_operations_pdf/huntsptspdes.pdf.

New York State Department of Environmental Conservation. 2012. 2012 Section 303(d) List of Impaired Waters Requiring a TMDL/Other Strategy. Revised February 2013. http://www.dec.ny.gov/docs/water_pdf/303dlistfinal12.pdf.

New York State Department of Environmental Conservation. 2014. 2014 CSO BMP Order on Consent. April 25, 2014. http://www.dec.ny.gov/docs/water_pdf/csobmp2014.pdf.

New York State Department of Environmental Conservation. 2015. Stormwater Management Design Manual. January 2015.

New York City Department of Finance, 2014. NYC Property Tax Annual Report. http://www.nyc.gov/html/taxcomm/html/report/report.shtml.

New York State Department of Health. 2000. New York State Sanitary Code, Section 6-2.15-Bathing Beach Design Standards.

Susag, Russell H. 1968. Journal (Water Pollution Control Federation) Vol. 40, No. 11, Research Supplement to: 40, 11, Part II (Nov., 1968), pp. R434-R444, Published by: Water Environment Federation. Article Stable URL: http://www.jstor.org/stable/25036172

U.S. Congress. 1972. Clean Water Act. http://cfpub.epa.gov/npdes/cwa.cfm?program_id=45.

U.S. Congress. 1974. Safe Drinking Water Act. Amended 1996. http://water.epa.gov/ lawsregs/ rulesregs/ sdwa/.

U.S. Census Bureau. 2012. https://www.census.gov/content/dam/Census/library/publications/2014/demo/p60-251.pdf.

U.S. Census Bureau. 2008-2012. American Community Survey 5-Year Estimates.

U.S. Census Bureau. 2013. American Community Survey 2013 1-Year Estimates.

U.S. Environmental Protection Agency. 1994a. Combined Sewer Overflow (CSO) Control Policy. EPA 830-B-94-001. April 1994.

U.S Environmental Protection Agency. 1995. Combined Sewer Overflows: Guidance for Nine Minimum Controls. 1995. http://www.epa.gov/npdes/pubs/owm0030.pdf**.**

U.S. Environmental Protection Agency. 1995a. Combined Sewer Overflows - Guidance for Long-Term Control Plan. EPA 832-B-95-002. September 1995.

U.S. Environmental Protection Agency. 1995b. Combined Sewer Overflows **-** Guidance for Permit Writers. EPA 832-B-95-008. September 1995.

U.S Environmental Protection Agency. 1997. Combined Sewer Overflows-Guidance for Financial Capability Assessment and Schedule Development. February 1997. http://www.epa.gov/ npdes/ pubs/ csofc.pdf.

U.S. Environmental Protection Agency. 2000. Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000.

U.S. Environmental Protection Agency. 2001. Guidance: Coordinating CSO Long-Term Planning With Water Quality Standards Reviews. EPA-833-R-01-002, July 31, 2001.

U.S. Environmental Protection Agency. 2007. Administrative order on consent (UV Order). January 2007.

U.S. Environmental Protection Agency, 2007. Filtration Avoidance Determinations. http://www.epa.gov/region02/water/nycshed/filtad.htm.

U.S Environmental Protection Agency. 2012. Integrated Municipal Stormwater and Wastewater Planning Approach Framework. June 5, 2012. http://www.wefnet.org/CleanWaterActIPF/Integrated%20Planning%20%20Framework%20(06.05.12).pdf.

U.S Environmental Protection Agency. 2012. 2012 Recreational Water Quality Criteria. http://water.epa.gov/scitech/swguidance/standards/criteria/health/recreation/upload/factsheet2012.pdf.

U.S Environmental Protection Agency. 2014. Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control. March 2014.

U.S. Environmental Protection Agency, 2014. Financial Capability Assessment Framework. http://www.epa.gov.

Washington D.C., District Department of the Environment. 2014. 2013 DC MS4 Annual Report.

11.0 GLOSSARY

1.5xDDWF:	One and One-half Times Design Dry Weather Flow
2xDDWF:	Two Times Design Dry Weather Flow
AACE:	Association for the Advancement of Cost Engineering
ACS:	American Community Survey
AWPCP:	Auxiliary Water Pollution Control Plant
BB:	Bowery Bay
BEACH:	Beaches Environmental Assessment and Coastal Health
BEPA	Bureau of Environmental Planning and Analysis
BGY:	Billon Gallons Per Year
BMP:	Best Management Practice
BNR:	Biological Nutrient Removal
BOD:	Biochemical Oxygen Demand
BODR:	Basis of Design Report
BWSO:	Bureau of Water and Sewer Operations
CAC:	Citizens Advisory Committee
$CBOD_5$:	Carbonaceous Biochemical Oxygen Demand
CEO:	New York City Center for Economic Opportunity
CERCLA:	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR:	Code of Federal Regulation
CFS:	Cubic Feet Per Second
CFU:	Colony-Forming Unit
CIP:	Capital Improvement Plan
CMMS:	Computerized Maintenance and Management Systems
CMS:	Compliance Monitoring System

CPK:	Central Park
CSO:	Combined Sewer Overflow
CSS:	Combined Sewer System
CWA:	Clean Water Act
DCIA:	Directly Connected Impervious Areas
DCP:	New York City Department of City Planning
DDC:	New York City Department of Design and Construction
DDWF:	Design Dry Weather Flow
DEC:	New York State Department of Environmental Conservation
DEP:	New York City Department of Environmental Protection
DO:	Dissolved Oxygen
DOB:	New York City Department of Buildings
DOE:	New York City Department of Education
DOF:	New York City Department of Finance
DOH:	New York State Department of Health
DOHMH:	New York City Department of Health and Mental Hygiene
DOT:	New York City Department of Transportation
DPR:	New York City Department of Parks and Recreation
DSNY:	New York City Department of Sanitation
DW:	Dry Weather
DWF:	Dry Weather Flow
E. Coli:	Escherichia Coli.
EBP:	Environmental Benefit Project
ECL:	New York State Environmental Conservation Law
ECM:	Energy Conservation Measure
EDC:	New York City Economic Development Corporation

EMC:	Event Mean Concentration
ENRCCI:	Engineering News-Record City Cost Index
EPA:	United States Environmental Protection Agency
ERTM:	East River Tributaries Model
ET:	Evapotranspiration
EWR:	Newark Liberty International Airport
FAD:	Filtration Avoidance Determination
FAQ:	Frequently Asked Question
FC:	Fecal Coliform
FCI:	Financial Capability Indicators
FMPV:	Full Market Property Value
FOIA:	Freedom of Information Act
FSAP:	Field Sampling Analysis Program
FT:	Abbreviation for “Feet”
FY:	Fiscal Year
GHG:	Greenhouse Gases
GI:	Green Infrastructure
GIS:	Geographical Information System
GM:	Geometric Mean
G.O.:	General Obligation
GRTA:	NYC Green Roof Tax Abatement
HEAP:	Home Energy Assistance Program
HGL:	Hydraulic Grade Line
HLSS:	High Level Storm Sewers or can referenced as High Level Sewer Separation
HP:	Hunts Point
HRA:	New York City Human Resources Administration

HRC:	High Rate Clarification
HSM:	Harbor Survey Monitoring Program
HVAC:	Heating, Ventilation and Air Conditioning
HWAP:	Home Water Assistance Program
IEC:	Interstate Environmental Commission
I/I:	Inflow and Infiltration
in.:	Abbreviation for "Inches".
in/hr:	Inches per hour
IW:	InfoWorks CS™
JFK:	John F. Kennedy International Airport
KOTC:	Knee-of-the-Curve
lbs/day:	pounds per day
Lf:	Linear Feet
LGA:	LaGuardia Airport
LIRR:	Long Island Rail Road
LT2:	Long Term 2
LTCP:	Long Term Control Plan
MCP:	Multifamily Conservation Program
mg/L:	milligrams per liter
MG:	Million Gallons
MGD:	Million Gallons Per Day
MGY:	Million Gallons Per Year
MHI:	Median Household Income
MLLW:	Mean Lower Low Water
MOU:	Memorandum of Understanding
MPN:	Most probable number

MS4:	Municipal separate storm sewer systems
MSS:	Marine Sciences Section
MT:	Metric Ton
MTA:	Metropolitan Transit Authority – New York City
MWFA:	New York City Municipal Water Finance Authority
NAS:	National Academy of Sciences
NEIWPCC:	New England Interstate Water Pollution Control Commission
NMC:	Nine Minimum Control
NOAA:	National Oceanic and Atmospheric Administration
NPDES:	National Pollutant Discharge Elimination System
NPW:	Net Present Worth
NRDC:	Natural Resources Defense Council
NWI:	National Wetlands Inventory
NYC:	New York City
NYCHA:	New York City Housing Authority
NYCRR:	New York State Code of Rules and Regulations
NYMTC:	New York Metropolitan Transportation Council
NYS:	New York State
NYSDOH:	New York State Department of Health
NYSDOS:	New York State Department of State
NYSDOT:	New York State Department of Transportation
O&M:	Operation and Maintenance
OGI:	Office of Green Infrastructure
OLTPS:	Mayor’s Office of Long Term Planning and Sustainability
OMB:	Office of Management and Budget
OneNYC:	One New York: The Plan for a Strong and Just City

ONRW:	Outstanding National Resource Waters
OpX:	Operational Excellence
PBC:	Probable Bid Cost
PCM:	Post-Construction Compliance Monitoring
POTW:	Publicly Owned Treatment Plant
ppt:	Parts per thousand
PS:	Pump Station or Pumping Station
Q:	Symbol for Flow (designation when used in equations)
RI:	Residential Indicator
RI/FS:	Remedial Investigation/Feasibility Study
ROD:	Record of Decision
ROW:	Right-of-Way
ROWB:	Right-of-Way Bioswales
ROWRG:	Right-of-Way Rain Gardens
RTB:	Retention Treatment Basin
RTC:	Real-Time Control
RWQC:	Recreational Water Quality Criteria
S&P:	Standard and Poor
SCA:	NYC School Construction Authority
SCADA:	Supervisory Control and Data Acquisition
SGS:	Stormwater Greenstreets
SIU:	Significant Industrial User
SM:	Sentinel Monitoring
SPDES:	State Pollutant Discharge Elimination System
SPM:	Supplemental Poverty Measure
STV:	Statistical Threshold Value

SWIM:	Stormwater Infrastructure Matters Coalition
SWMM:	Stormwater Management Model
SYNOP:	Surface Synoptic Observations
TAZ:	Transportation Analysis Zone
TBD:	To Be Determined
TDA:	Tributary Drainage Areas
TI:	Tallman Island
TMDL:	Total Maximum Daily Load
TOC:	Total Organic Carbon
TPL:	Trust for Public Land
TRC:	Total Residual Chlorine
TSS:	Total Suspended Solids
UAA:	Use Attainability Analysis
UER-WLIS:	Upper East River – Western Long Island Sound
U.S.:	United States
USA:	Use and Standards Attainment
USACE:	United States Army Corps of Engineers
USEPA:	United States Environmental Protection Agency
USFWS:	United States Fish and Wildlife Service
USGS:	United States Geological Survey
UV:	Ultraviolet Light
WC:	Westchester Creek
WC SWMM:	Westchester County Storm Water Management Model
WDAP:	Water Debt Assistance Program
WERF:	Water Environment Research Foundation
WQ:	Water Quality

WQS:	Water Quality Standards
WWFP:	Waterbody/Watershed Facility Plan
WWOP:	Wet Weather Operating Plan
WWTP:	Wastewater Treatment Plant

Appendix A: Supplemental Tables

Annual CSO, Non-CSO,
Local Source Baseline Volumes (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Discharge (MG/Yr)**
Bronx River	HP-004	28	8.5
Bronx River	HP-007	27	31.7
Bronx River	HP-008	26	1.1
Bronx River	HP-009	13	412.5
Bronx River	HP-010	25	0.0
		Total CSO	**453.8**

InfoWorks Non-CSO Outfalls – Freshwater Section			
Waterbody	**Outfall**	**Regulator**	**Total Discharge, (MG/Yr)**
Bronx River	HP-041	NA	72.1
Bronx River	HP-084	NA	13.3
Bronx River	HP-085	NA	27.1
Bronx River	HP-086	NA	13.0
Bronx River	HP-097	NA	18.8
Bronx River	HP-505	NA	36.7
Bronx River	HP-606	NA	72.2
Bronx River	HP-610	NA	27.4
Bronx River	HP-614	NA	6.6
Bronx River	HP-637	NA	71.8
Bronx River	HP-943	NA	19.6
		Total Non-CSO - Fresh	**378.8**

InfoWorks Non-CSO Outfalls – Saline Section			
Waterbody	**Outfall**	**Regulator**	**Total Discharge, (MG/Yr)**
Bronx River	HP-109	NA	38.6
Bronx River	HP-106	NA	42.5
Bronx River	HP-105	NA	3.9
Bronx River	HP-630	NA	84.8
Bronx River	HP-082	NA	14.6
Bronx River	HP-081	NA	9.4
		Total Non-CSO - Saline	**193.7**

Local Sources – Freshwater Section			
Waterbody	**Outfall**	**Regulator**	**Total Discharge (MG/Yr)**
Bronx River	Bronx River		17,638.2
Bronx River	Cope Lake		401.5
		Total Dry Weather	**18,039.7**

Totals by Waterbody			
Waterbody	**Outfall**	**Regulator**	**Total Discharge (MG/Yr)**
Bronx River			19,066.0

Totals by Source			
Waterbody	**Outfall**	**Regulator**	**Total Discharge (MG/Yr)**
CSO			453.8
Non-CSO Fresh			378.8
Non-CSO Saline			193.7
Local Sources-Baseflows			18,039.7

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Discharge (MG/Yr)**
Bronx River	CSO	2	453.8
	Non-CSO Fresh	2	378.8
	Non-CSO Saline	1	193.7
	Local Sources	95	18,039.7
		Total	**19,066.0**

Annual CSO, Non-CSO,
Local Sources Enterococci Loads (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River	HP-004	28	2.2
Bronx River	HP-007	27	11.9
Bronx River	HP-008	26	2.2
Bronn River	HP-009	13	356.9
Bronx River	HP-010	25	0.0
		Total CSO	**373.2**

InfoWorks Non-CSO Outfalls – Freshwater Section			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River	HP-041	NA	1.7
Bronx River	HP-084	NA	0.3
Bronx River	HP-085	NA	0.6
Bronx River	HP-086	NA	0.3
Bronx River	HP-097	NA	0.4
Bronx River	HP-505	NA	0.9
Bronx River	HP-606	NA	2.5
Bronx River	HP-610	NA	0.6
Bronx River	HP-614	NA	0.2
Bronx River	HP-637	NA	2.5
Bronx River	HP-943	NA	0.5
		Total Non-CSO - Fresh	**10.5**

InfoWorks Non-CSO Outfalls – Saline Section			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River	HP-109	NA	0.9
Bronx River	HP-106	NA	1.0
Bronx River	HP-105	NA	0.1
Bronx River	HP-630	NA	1.9
Bronx River	HP-082	NA	0.3
Bronx River	HP-081	NA	0.2
		Total Non-CSO - Saline	**4.4**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River	Bronx River		314.4
Bronx River	Cope Lake	NA	0.2
		Total Dry Weather	**314.6**

Totals by Waterbody			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River			702.7

Totals by Source			
Source	**Outfall**	**Regulator**	**Total Org.x10^{13}**
CSO			373.2
Non-CSO Fresh			10.5
Non-CSO Saline			4.4
Local Sources			314.6

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Org.x10^{13}**
Bronx River	CSO	53	373.2
	Non-CSO Fresh	1	10.5
	Non-CSO Saline	<1	4.4
	Local Sources	45	314.6
		Total	**702.7**

Annual CSO, Non-CSO,
Local Sources Fecal Coliform Loads (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River	HP-004	28	7.2
Bronx River	HP-007	27	19.6
Bronx River	HP-008	26	0.6
Bronx River	HP-009	13	1,586.3
Bronx river	HP-010	25	0.0
		Total CSO	**1,613.7**

InfoWorks Non-CSO Outfalls – Freshwater Section			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River	HP-041	NA	1.1
Bronx River	HP-084	NA	0.2
Bronx River	HP-085	NA	0.4
Bronx River	HP-086	NA	0.2
Bronx River	HP-097	NA	0.3
Bronx River	HP-505	NA	0.6
Bronx River	HP-606	NA	2.5
Bronx River	HP-610	NA	0.4
Bronx River	HP-614	NA	0.5
Bronx River	HP-637	NA	2.5
Bronx River	HP-943	NA	0.3
		Total Non-CSO Fresh	**9.0**

InfoWorks Non-CSO Outfalls – Saline Section			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River	HP-109	NA	0.6
Bronx River	HP-106	NA	0.6
Bronx River	HP-105	NA	0.1
Bronx River	HP-630	NA	1.3
Bronx River	HP-082	NA	0.2
Bronx River	HP-081	NA	0.1
		Total Non-CSO Saline	**2.9**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River	Bronx River	NA	688.1
Bronx River	Cope Lake	NA	0.8
		Total Dry Weather	**688.9**

Totals by Waterbody			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Bronx River			2,314.5

Totals by Source			
Source	**Outfall**	**Regulator**	**Total Org.x10^{13}**
CSO			1,613.7
Non-CSO Fresh			9.0
Non-CSO Saline			2.9
Local Sources			688.9

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Org.x10^{13}**
Bronx River	CSO	70	1,613.7
	Non-CSO Fresh	<1	9.0
	Non-CSO Saline	<1	2.9
	Local Sources	30	688.9
		Total	**2,314.5**

Annual CSO, Stormwater, Direct Drainage,
Local Sources BOD_5 Loads (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Bronx River	HP-004	28	1,418
Bronx River	HP-007	27	6,555
Bronx River	HP-008	26	142
Bronx River	HP-009	13	106,131
Bronx river	HP-010	25	0
		Total CSO	**114,246**

InfoWorks Non-CSO Outfalls – Freshwater Section			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Bronx River	HP-041	NA	9,021
Bronx River	HP-084	NA	1,669
Bronx River	HP-085	NA	3,391
Bronx River	HP-086	NA	1,631
Bronx River	HP-097	NA	2,357
Bronx River	HP-505	NA	4,594
Bronx River	HP-606	NA	9,038
Bronx River	HP-610	NA	3,426
Bronx River	HP-614	NA	825
Bronx River	HP-637	NA	8,983
Bronx River	HP-943	NA	2,451
		Total Non-CSO Fresh	**47,385**

InfoWorks Non-CSO Outfalls – Saline Section			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Bronx River	HP-109	NA	4,827
Bronx River	HP-106	NA	5,311
Bronx River	HP-105	NA	490
Bronx River	HP-630	NA	10,604
Bronx River	HP-082	NA	1,821
Bronx River	HP-081	NA	1,178
		Total Non-CSO Saline	**24,230**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Bronx River	Bronx River	NA	147,103
Bronx River	Cope Lake	NA	50,228
		Total Dry Weather	**197,331**

Totals by Waterbody			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Bronx River			383,192

Totals by Source			
Source	**Outfall**	**Regulator**	**Total Lbs**
CSO			114,246
Stormwater			47,385
Direct Runoff			24,230
Local Sources			197,331

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Lbs**
Bronx River	CSO	30	114,246
	Non-CSO Fresh	12	47,385
	Non-CSO Saline	6	24,230
	Local Sources	52	197,331
		Total	**383,192**

Appendix B: Long Term Control Plan (LTCP) Bronx River Meeting #1 – Summary of Meeting and Public Comments Received

On February 12, 2015, DEP hosted a Public Meeting to initiate the water quality planning process for long term control of combined sewer overflows in the Bronx River waterbody. The two-and-a-half-hour event, held at the Casita Maria Center for Arts & Education at 290 Simpson St., 6th Floor, Bronx, NY, 10459, served to provide overview information about DEP's Long Term Control Plan (LTCP) Program, present information on the Bronx River watershed characteristics and status of waterbody improvement projects, obtain public information on waterbody uses in Bronx River, and describe additional opportunities for public input and outreach. The presentation can be found at http://www.nyc.gov/dep/ltcp. Approximately 78 stakeholders from 36 different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event, and three media representatives.

The Bronx River LTCP Kickoff Public Meeting was an opportunity for public participation in the LTCP. As part of DEP's LTCP Public Participation Plan, Bronx River Long Term Control Planning process will be posted on DEP's website, shown above. The public will have more opportunities to provide feedback and participate in the development of Bronx River waterbody-specific LTCP. Specific questions asked during the public kickoff meeting are summarized below with DEP's responses to each.

- What is a CSO?
    - *CSO stands for "combined sewer overflow". New York City, like many older urban communities, is largely serviced by a combined sewer system where stormwater that falls on roofs, streets and sidewalks, and wastewater from homes and businesses are both carried through a single sewer line to treatment plants. On some rainy days, when the sewer system is at full capacity, a diluted mixture of rain water and sewage can be released into local waterways. This is called a combined sewer overflow (CSO).*
- Does snow melt cause CSOs or does it only happen in warm weather?
    - *It is not necessarily a warm weather activity; CSOs occur during large storm events and is not typically caused by snow melt. Sometimes if it warms very quickly, snow melt could cause a CSO.*
- How does the dry and wet sampling data compare?
    - *As the data slides show, water quality is better in dry weather.*
- You mentioned there is something going on upstream causing poor water quality upstream of BR1; but it is not unknown what is going on, right?
    - *Correct, there are known illicit discharges in Westchester County and they are under Consent Order mandate to address those.*
- How many samples were collected?
    - *12 dry and 34 wet weather samples were collected at each of the 9 sampling locations.*

- What is a green roof?
    - *Green roofs are installed on rooftops and consist of a vegetated layer on top of engineered soil and a drainage layer. DEP builds green roofs to collect rainwater before it goes into sewer system and contributes to combined sewer overflows.*
- What are permeable pavers?
    - *Permeable pavers are installed in sidewalks, walkways, or parking lots. The pavers have void spaces that allow rainwater to "infiltrate" into stones and soils below. DEP constructs permeable pavers to collect rainwater before it goes to the sewer system and contributes to combined sewer overflows.*
- Are you still doing the rain barrel program and can you explain what they do?
    - *Yes, the program is still active. For more information visit www.nyc.gov/dep. Rain barrels collect rainwater from rooftops and store it for non-potable uses such as watering lawns and gardens. By harvesting rainwater for these purposes, homeowners are able to save money on their water bills.*
- How many trees have been planted in Bloomberg's million tree program?
    - *The MillionTreesNYC program is different from the NYC Green Infrastructure Program. DEP's understanding is that the program is very close to meeting its 2015 goal. For more information on the MillionTreesNYC program or to request a tree in front of your house, call 311 or visit MillionTreesNYC.org.*
- How was the 10% Green Infrastructure goal determined?
    - *In 2010 DEP released the NYC Green Infrastructure Plan which set the goal to manage 1" of stormwater runoff from 10% of the impervious area of the combined sewer areas of New York City. Each watershed then has its own unique green infrastructure target, which when added together equals the 10% goal by 2030.*
- Are their special structural needs for green roofs?
    - *It depends on the property, but yes, the building must have adequate structural capacity to accommodate a green roof. A Professional Structural Engineer should determine the structural capacity of a building before a property owner decides to construct a green roof.*
- What is a roof farm?
    - *A rooftop farm is similar to a green roof but has deeper soils and edible or agricultural plants. Examples include the 1-acre rooftop farm at the Brooklyn Navy Yard.*
- What is the difference in a soil bed?
    - *There are two standard types of green roof systems. An extensive green roof is 4" or less and an intensive green have 4" or more. Rooftop farms are considered intensive green roofs and can have a soil depth up to 12".*

- Who maintains bioswales?
    - *DEP maintains all of the bioswales its funds. Maintenance responsibilities include a variety of activities from removing litter to caring for the plants. DEP has individual maintenance agreements for green infrastructure that is located on public property such as public housing or public schools,*
- Has the predictive modeling been adjusted to account for the added GI and explain the impact?
    - *The green infrastructure target for the Bronx River watershed is to manage 1" of stormwater runoff from 14% of the impervious area of the combined sewer areas. Current modeling projects a 10% CSO reduction in the Bronx River watershed once this green infrastructure target is reached. Green infrastructure collects stormwater runoff from impervious surfaces such as streets, sidewalks and rooftops in order to reduce the runoff that contributes to CSOs.*
- What are you doing about stormwater?
    - *There is a separate MS4 Permit that is coming in March/April that will address SW impacts.*
- Do you have a date set of the 2nd public meeting?
    - *There is no firm data but it will likely be in April.*
- Why is stormwater combined with sanitary sewer flows? Why not separate?
    - *Sewer separation helps if flooding is the concern but doesn't necessarily make sense to reduce CSOs because of the increased stormwater runoff that overflows, more frequently to the waterbody which may have a negative impact on water quality.*
- What is dissolved oxygen improvement?
    - *Aeration, like the bubblers you see in the parks.*
- What other waterbody would flow be relocated to?
    - *CSO flows would directly discharge into the East River rather than flowing through the Bronx River into the East River.*
- Today we heard from you; what are you getting from us?
    - *We are collecting your questions and live feedback plus soliciting emailed and other future feedback.*
- How will the new water quality standards impact the LTCPs?
    - *All LTCPs have included evaluations against the new standards.*

- When is the LTCP Report available for public review?
    - *The Bronx River LTCP will be submitted to DEC on June 30, 2015. It will be posted on the DEP website and is available for public comment then.*
- Will DEC have input on the LTCP Report?
    - *Yes, they will provide comments once the LTCP is submitted. DEP and DEC also have regular meetings throughout the development of the LTCP where input and guidance is provided on the analyses and development of the LTCP.*
- You may need to dumb-down the presentation to reach the broader audience.
    - *Yes, we are trying to strike a balance of broad stroke concepts and details behind it all.*

Long Term Control Plan (LTCP) Bronx River Meeting # 2 – Summary of Meeting and Public Comments Received

On May 7, 2015, DEP hosted the second of three public meetings for the water quality planning process for long term control of combined sewer overflows in the Bronx River waterbody. The two-hour event was held at the Casita Maria Center for Arts & Education at 290 Simpson St., 6th Floor, Bronx, NY, 10459. DEP presented information on the LTCP process, Bronx River watershed characteristics, and the status of engineering alternatives evaluations, and provided opportunities for public input. The presentation can be found at http://www.nyc.gov/dep/ltcp. Approximately 40 stakeholders from 10 different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event and a reporter from local Bronx paper.

The Bronx River LTCP Meeting #2 was an opportunity for public participation in the LTCP. As part of DEP's LTCP Public Participation Plan, Bronx River Long Term Control Planning process will be posted on DEP's website, shown above. The public will have more opportunities to provide feedback and participate in the development of Bronx River waterbody-specific LTCP. Specific questions asked during the public meeting #2 are summarized below with DEP's responses to each.

- Which is a higher standard, Class B or Class C?
    - *DEP stated that the standards shown are the current standards, but could not confirm which the higher standard was.*
- When was the manmade dam installed?
    - *DEP did not know the exact date, but mentioned that it affects the flow of the Bronx River. DEP added that they did not install the dam.*
- Is the East River improving in water quality?
    - *DEP stated recent Harbor Survey results indicated that water quality in the East River and other open waters is improving.*
- How often are the floatable controls cleaned?
    - *DEP did not have that information at the meeting but will check. Stakeholders then mentioned that sometimes big tree branches block the Bronx River.*
- How did DEP come up with 10% reduction for Green Infrastructure?
    - *DEP GI staff explained that the planning and analysis was conducted for the NYC Green Infrastructure Plan. The citywide goal is to manage 1-inch of stormwater runoff from 10% of the impervious areas of the combined sewer areas by 2030.*
- What level of disinfection will DEP disinfect at HP-007?
    - *DEP explained that they are still conducting constructability review on the various the types of disinfection that could be used at HP-007. Public mentioned that they asked the question because nearby there are oyster beds and they were concerned that the chlorine used in disinfection could affect the oyster beds. DEP explained that the amount of chlorine would be small, similar to the levels used to treat drinking water.*

- When will chlorine pilot study on wet weather flow be finished?
    - *DEP responded that the pilot study will not be complete for about 2 years.*
- What is the difference between outfall conduit disinfection and RTB contact tank disinfection?
    - *DEP explained a major factor is cost and added that a RTB presents a siting issue while conduit disinfection would be more intrusive. DEP explained that a major issue in selecting a route for an outfall conduit disinfection alternative is the outfall's distance to the treatment plant.*
- How do you balance short-term vs. long-term water quality goals when selecting an alternative?
    - *DEP mentioned that they plan on trying to fix the current issue of improving the water body and also short term with GI, disinfection facilities, etc.*
- How can the community have more input for the types of GI used around the community?
    - *DEP explained that community input on GI has primarily been project specific. For instance, a DEP partnership to add green infrastructure to schools provides opportunities for students and teachers to give input on the project. For more information on green infrastructure programming, community members can contact their local community board or visit www.nyc.gov/greeninfrastructure. DEP further explained that there will be a public kick-off meeting in the summer of 2015 to discuss the expansion of green infrastructure implementation in the Bronx River Watershed.*
- How is DEP funded?
    - *DEP explained that it is funded through the water and sewer charges collected from property owners. In addition, capital projects are financed through the sale of state bonds.*
- Does the City have a Water Conservation Program?
    - *DEP mentioned that they have a comprehensive demand management and water conservation program which is working towards a 5% or 50 MGD goal for reductions in current demand. The water conservation program includes multiple initiatives ranging from retrofitting and replacing water fixtures at municipal facilities, NYCHA and Colleges; replacing fixtures in residential buildings; creating voluntary conservation programs in non-residential sectors and provide cost sharing; and adopting Water Shortage Rules, and emergency rates. DEP mentioned that for the first time since the 1960s, the yearly city water demand has decreased and concurrently as the population has increased the water use has decreased. Currently, there is not an active campaign but it is presented in multiple forums city-wide.*

Bronx River Alliance Comments on DEP's Long Term Control Plan for the Bronx River

March 3, 2015

The strong turnout at the kickoff meeting on February 12 clearly demonstrated that the Bronx community cares about the river and depends on it for recreation. Residents want to be able to safely swim, fish, kayak, canoe, and enjoy the entire river, as well as use it year-round as an outdoor classroom for education.

To increase opportunities for public participation at the next meeting, DEP should allow more time for questions and provide clear instructions on how to submit meaningful input in a timely manner. That includes defining the type of input needed and setting a deadline for consideration of this input. Ensuring that the information being presented is in a format that the public can understand is the first step in engaging them in a meaningful dialog about the issue.

To achieve meaningful water quality improvements, NYC needs to control CSOs in the Bronx portion of the river and seek ways of getting upstream issues addressed. A coordinated approach should include an analysis of inputs and actions to address sources of pollution in NYC and Westchester County. It will take more than eliminating CSO discharges to meet Clean Water Act goals for Bronx River. DEP needs to insure that all water quality programs are implemented in a coordinated fashion, to maximize resources and achieve the greatest outcomes. This requires coordination among units of government responsible for CSO abatement, stormwater management via the MS4 permit, Long Term Control Plan, and green infrastructure.

A river safe for primary contact (i.e., fishable and swimmable) is our long term goal for the Bronx River, to protect the health of the community that depends on this river for recreation, education and enjoyment. DEP should consider alternatives that make the river safe for primary contact throughout the entire year and as soon as possible after a rain event.

The draft plan should include feasibility studies and impacts for alternatives presented, to ensure that these options are viable. It would be helpful to provide information for the public to assess alternatives in a citywide context, in terms of resource allocation. How will DEP determine how much to prioritize alternatives on each water body and how will rate payers share the cost of these improvements?

The Bronx River has enjoyed steady improvements and has an active constituency of users, making water quality a priority for this waterbody.

Bronx River Alliance • One Bronx River Parkway • Bronx • NY 10462 T 718.430.4665 F 718.430.4658 • www.bronxriver.org

From: Nandan Hara Shetty [mailto:nhs2123@columbia.edu]
Sent: Friday, May 29, 2015 5:52 PM
To: LTCP
Subject: Bronx River CSO LTCP

To DEP,

The Bronx River CSO LTCP has a tremendous amount of money considered for GREY infrastructure. All of the alternatives (p33 on the most recent DEP presentation) number in the tens and hundreds of millions of dollars. It is safe to say that all of the green infrastructure built and planned in the Bronx River sewershed is at best a tiny fraction. While it's true that DEP is trying it's best to ramp up bioswale construction, in comparison to grey infrastructure, green infrastructure is extremely limited. For example, zero green roofs are being considered in the sewershed. There are so many green infrastructure options that are not even considered. It is not acceptable to say that green infrastructure can only reduce CSOs by 10%, and that we need grey infrastructure for the rest, as seems to be suggested on page 21. The Bronx community has been an early advocate of green infrastructure from the very beginning, and would rather that tens of millions be spent on green infrastructure than grey infrastructure.

Thanks,
Nandan Shetty

From: Carolyn McLaughlin [mailto:carolynmclaughlin111@gmail.com]
Sent: Saturday, June 20, 2015 8:29 PM
To: LTCP
Cc: Maggie Greenfield
Subject: Bronx River Long Term Control Plan Comments

DEP

Thank you for the opportunity to comment on the Long Term Control Plan for the Bronx River.
I attended the last presentation at Casita Maria that was made on the options you were considering. My concern after that meeting was that I was not convinced that potential benefits from expanding green infrastructure were being maximized. I do understand that the problem is so large that green infrastructure improvements will not resolve it but they should be pushed to the maximum.
If you do have to treat the discharge with chlorine, it should be removed or neutralized before water is discharged into the river. So much work has gone into improving the water quality for fish, we don't want to lose these gains.

Thank you.
Carolyn McLaughlin

Appendix C: Bronx River Use Attainability Analysis

EXECUTIVE SUMMARY

The DEP has performed a UAA for the Bronx River in accordance with the 2012 CSO Order on Consent. The Bronx River begins in Westchester County, NY, flows through the Borough of the Bronx, and empties into the Upper East River (Figure 1). The Bronx River watershed is located throughout central Bronx. The waters of the Bronx River are saline throughout three miles upstream of the confluence with the Upper East River within the Bronx County and receive freshwater input in Westchester County, NY, and from CSO and stormwater discharges within NYC. The inter-jurisdictional character of the Bronx River waters, the various sources of loadings from both NYC and Westchester County, as well as their impacts on the WQ conditions of the freshwater and saline portions of the Bronx River, make this a complex waterbody with specific intricacies that were analyzed within the LTCP framework and which support this UAA.

According to Title 6 NYCRR, Chapter X, Part 935, the Bronx River saltwater front is at East Tremont Avenue in NYC. All of NYC's five CSOs discharge to the saline portion of the Bronx River. Therefore, this UAA refers exclusively to the saline portion of the Bronx River, which is within the jurisdiction of NYC.

Detailed analyses performed during the Bronx River LTCP concluded that the proposed Primary Contact WQ Criteria (Class SC) in this waterbody would not be attained for both the annual fecal coliform and DO criteria with implementation of the preferred alternative. These analyses also suggested that the Class SC fecal coliform and DO criteria will not be attained even with the implementation of 100% CSO control. However, the preferred alternative results in meeting the recreational season (May 1st through October 31st) attainment target of 95 percent and above for the Class SC fecal coliform criteria at all saline stations, with exception of the upstream Station BR-5, where attainment is 87 percent. Enterococci criteria do not apply to tributaries such as the Bronx River under the Beaches Environmental Assessment and Coastal Health (BEACH) act of 2000. Each applicable criterion is discussed below:

Fecal Coliform

Detailed analyses performed during the Bronx River LTCP concluded that the designated Class I secondary contact recreational uses in the Bronx River are in full attainment (100 percent) for the fecal coliform criterion. However, based on this technical assessment, it was found that for the 10 year simulation for the preferred alternative the Bronx River would approach (ranging from 83 to 96 percent across five saline stations), but not be able to attain, Primary Contact Bacteria WQ Criteria (Class SC) 100 percent of the time throughout the saline portion on an annual basis. Even with 100% CSO control, the annual attainment with Primary Contact Bacteria WQ Criteria would only be 83 to 96 percent. However, as noted before, Class SC fecal coliform criterion is attained during the recreational season (May 1st through October 31st) at all saline stations with one exception.

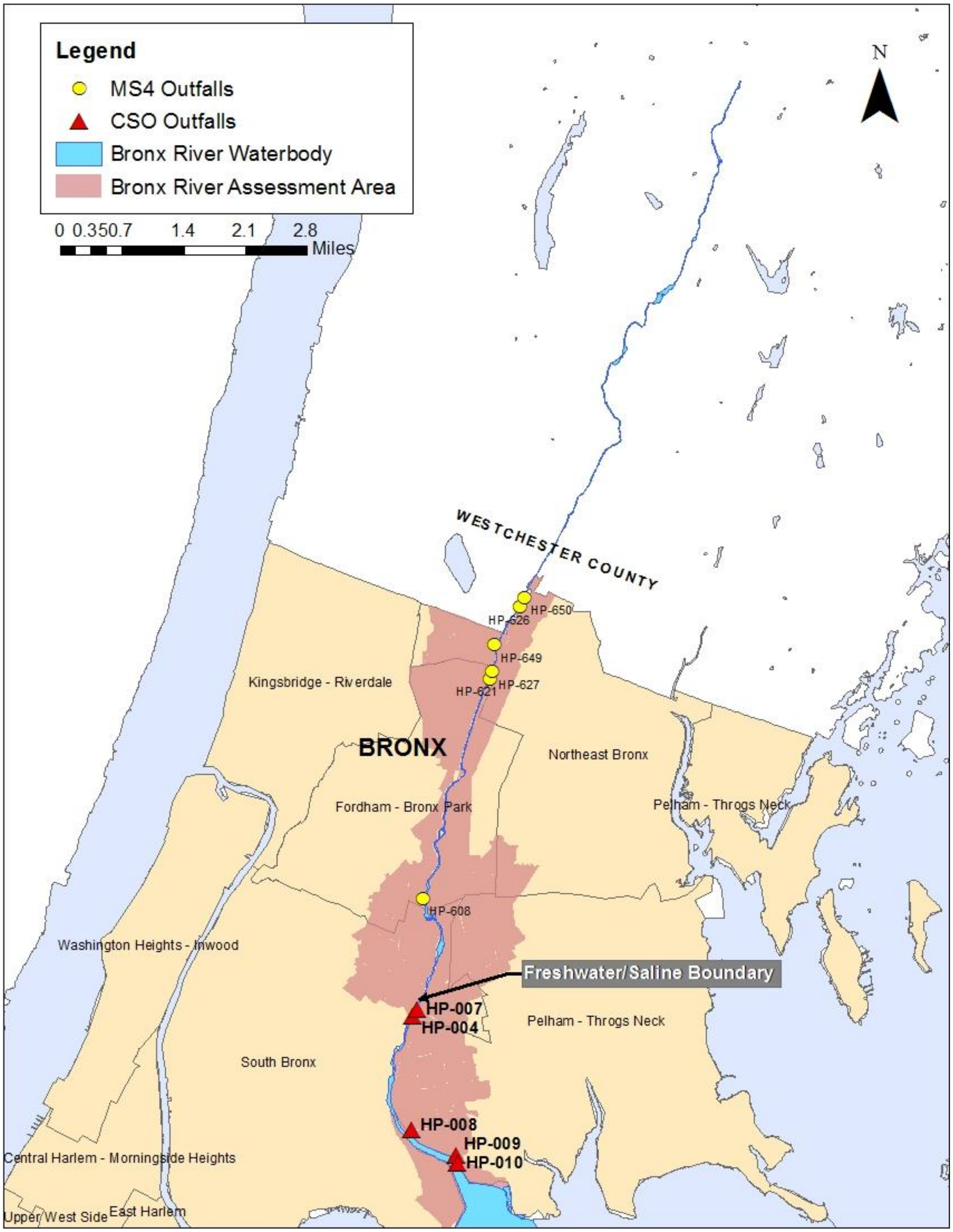


Figure 1. Overview of the Bronx River

Dissolved Oxygen

Based on the technical assessment, the waterbody is projected to attain the existing Class I DO criteria at least 95 percent of the time for the entire water column on an annual basis. The waterbody is not projected to attain the Class SC DO criteria on an annual basis. Attainment of the Class SC DO criteria is computed to be in the range of 92 to 94 percent at four of the five stations evaluated in the saline reach of the Bronx River (and 100 percent at the fifth station (BR-05)). These levels are similar to the levels projected for 100 percent CSO reduction.

Bronx River is a unique and valuable resource to the adjacent communities, as well as to all NYC residents. In 2012, the lower eight miles of the Bronx River was designated a National Water Trail by the National Park Service in recognition of how far we have come in reclaiming the Bronx River as a recreational asset. The Bronx River provides recreational opportunities with five kayak and canoe launch sites in the saline portion (Figure 2), and additional boat access points and portages in the freshwater section. Besides its recreational value, it provides ecological habitat for many fish and wildlife species. A wide variety of wetland habitat resides in the Bronx River watershed, including salt marshes in Soundview Park, riverine wetlands in the Bronx River Forest, and the depressional wetlands in the Bronx Zoo. Accordingly, DEP is proposing a preferred plan with additional investments of $111M that will result in water quality improvements in the Bronx River.

Based on the detailed analyses provided above, DO conditions are not met for the existing standard under the existing classification, or under the alternatives that are being considered. DO levels appear to be related to non-CSO related conditions in the Bronx River. However, based on the predicted water quality improvements with the proposed project, it is anticipated that the Bronx River should be upgraded to SC classification (with a wet-weather advisory) during the recreational season (May 1st through October 31st), although a variance for DO levels would be still be required. However, it should be noted that although the water quality might be suitable for primary contact swimming during recreational season (May 1st through October 31st) with an advisory period, other factors, such as adjacent land use and safety, must be taken into account, inasmuch as there are no DOHMH certified bathing beaches anywhere within the waterbody.

INTRODUCTION

Regulatory Considerations

DEC has designated the saline Bronx River as a Class I waterbody. The best usages of Class I waters are *"secondary contact recreation and fishing. These waters shall be suitable for secondary contact and fishing"* (6 NYCRR 701.11). In December 2014, DEC proposed a rule that would require Class I waterbodies to meet the Primary Contact Bacteria WQ Criteria ("Proposed Rule"). As of the date of this LTCP's submission, DEC has not issued a final rule.

Federal policy recognizes that the uses designated for a waterbody may not be attainable, and the UAA has been established as the mechanism to modify the WQS in such a case. Here, the Bronx River meets the existing designated use classification for bacteria, but does not for DO, and also would not meet the Primary Contact Bacteria WQ Criteria. Furthermore, even the complete elimination of CSO discharges will not result in attainment of the Primary Contact WQ Criteria.

This UAA identifies the attainable and existing uses of the Bronx River and compares them to those designated by DEC in order to provide data to establish appropriate WQ targets for this waterway. An examination of several factors related to the physical condition of the waterbody and the actual and possible uses suggests that full attainment with bacteria criteria associated with existing Class I standards is projected, and at least 95 percent attainment with the corresponding DO criteria is projected. However, it is projected that the waterbody would not fully attain Primary Contact Bacteria WQ Criteria, particularly in the colder winter months and even 100 percent CSO reduction would not fully attain the Primary Contact Bacteria WQ Criteria. Under Federal regulations (40 CFR 131.10), six factors may be considered in conducting a UAA:

1. Naturally occurring pollutant concentrations prevent the attainment of the use; or
2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original conditions or to operate such modification in a way that would result in the attainment of the use; or
5. Physical conditions related to the natural features of the waterbody, such as the lack of proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by Sections 301(b) and 306 of the CWA would result in substantial and widespread economic and social impact.

Identification of Existing Uses

The waterfront area surrounding the saline portion of the Bronx River is predominantly altered on the eastern and western banks, including the shoreline along Soundview Park on the eastern shore, near the mouth of the Bronx River. The formal and informal River access points along the Bronx River supporting secondary contact recreation activities (e.g., canoe/kayak launch sites) are shown in Figure 2 for the saline portion of the Bronx River.

The Bronx River is not suitable for bathing; as such, no DOHMH certified bathing beaches exist anywhere within the waterbody. (Despite that fact, instances of body immersion by wading or bathing have been reported.) Because parkland partially surrounds the waterbody, opportunities exist for fishing and canoeing/kayaking. However, due to limited access, altered shorelines (bulkheads and rip-rap), and marine industrial uses, the bulk of the waterbody is not conducive to primary contact uses. Figure 3a shows an example of the Bronx River shoreline at Westchester Avenue. Figures 3b and 3c show canoe/kayak launch facilities at Starlight Park and Soundview Park, respectively, and Figure 3d shows kayakers in the Bronx River adjacent to Cement Park.

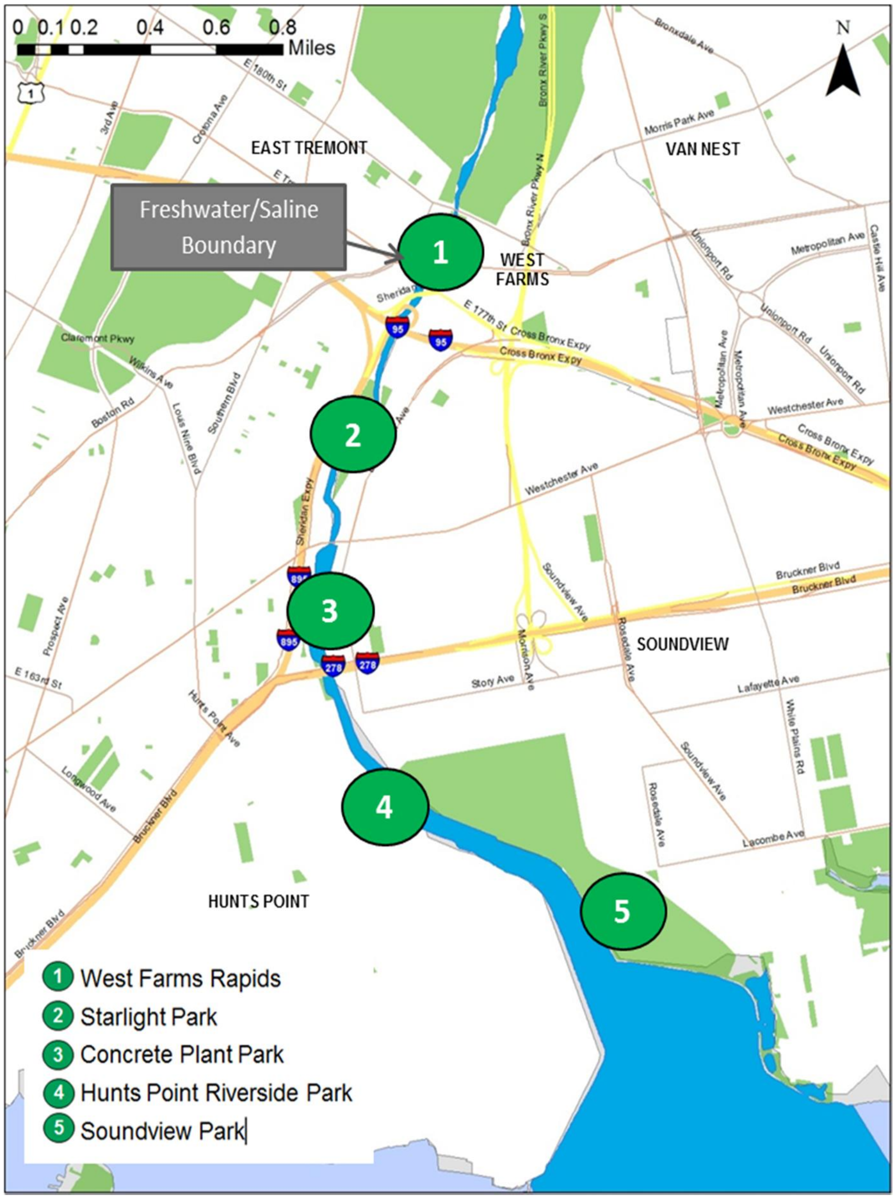


Figure 2. Bronx River Access Areas – Saline River

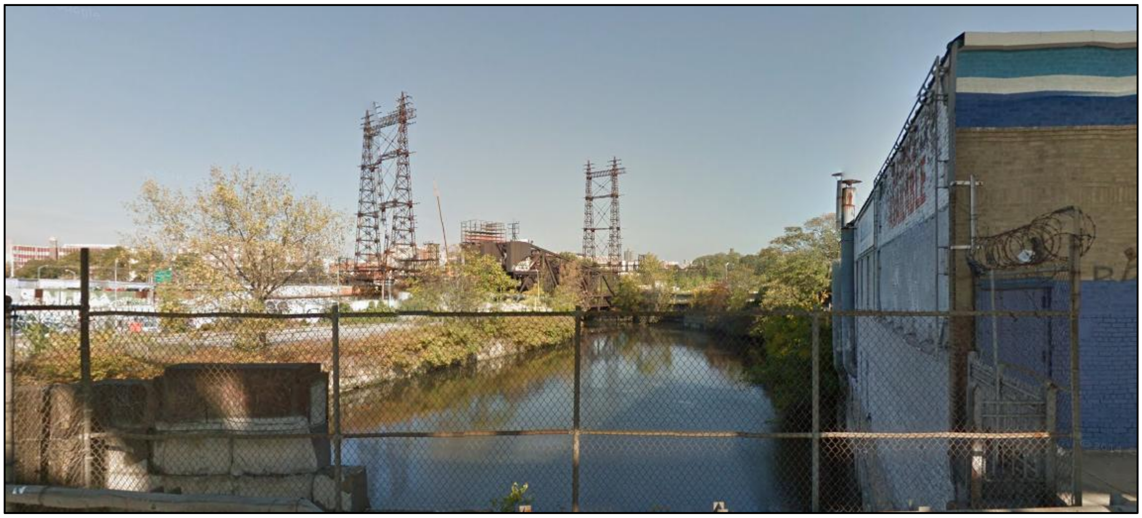


Figure 3a. Bronx River Shoreline (Westchester Avenue)

Figure 3b. Bronx River Kayak Launch at Starlight Park

Figure 3c. Kayak Launch – Soundview Park

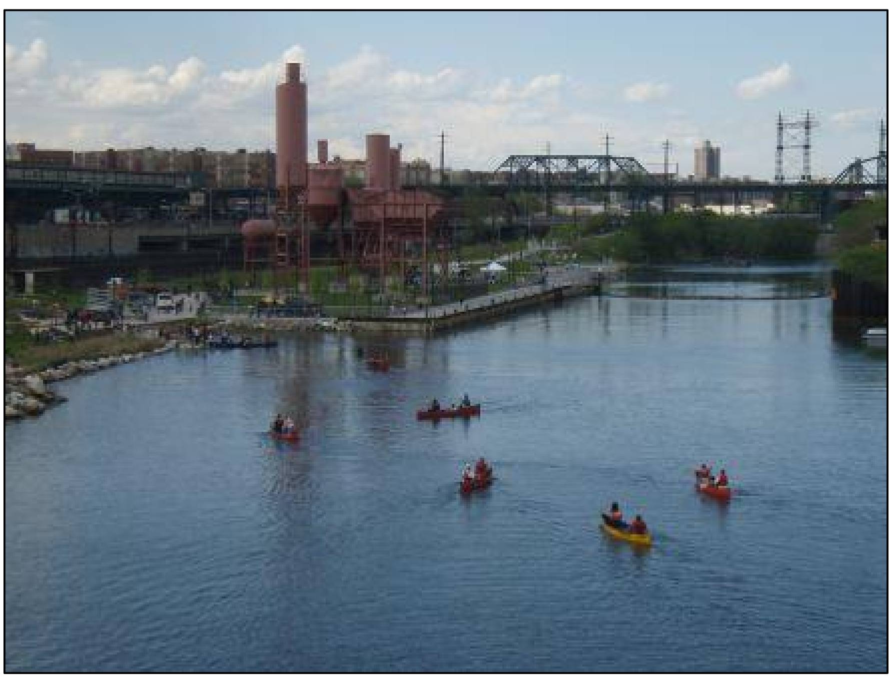


Figure 3d. Kayaking Near Cement Park

ATTAINMENT OF DESIGNATED USES

The Bronx River is a Class I waterbody, suitable for secondary contact recreation and aquatic life propagation and survival. As noted previously, the Bronx River is used frequently for secondary contact recreation, and although there is evidence of limited full body immersion, primary contact is not an existing or permitted use. As part of this LTCP, an analysis was performed to assess the level of attainment were DEC to finalize the Proposed Rule and modify the bacteria criteria to be consistent with Primary Contact WQ Criteria (Class SC).

Water quality modeling and observed data indicate that the existing Class I (secondary contact) bacteria criterion is being achieved. With respect to the Primary Contact WQ Criteria, the annual attainment of the fecal coliform numeric criterion throughout the entirety of the saline Bronx River is not possible 100 percent of the time due to Bronx River CSOs and other sources, namely, direct drainage, urban stormwater, and the East River. However, analyses indicate that the waterbody under the preferred alternative would attain the Primary Contact Bacteria WQ Criteria for Fecal Coliform (monthly mean) numeric criteria during the recreational season (May 1st through October 31st) except at upstream Station BR-5, where attainment is 87 percent.

An analysis was also conducted during the development of the LTCP water quality model to predict the recovery time in the Bronx River following a rain event. As primary contact uses could be attained in the Bronx River during the recreational season (May 1st through October 31st) a high percent of the time, DEP used the primary contact fecal coliform recreation warning level of 1,000 cfu/100mL from the DOH guidelines in this analysis. The result of the analysis is summarized in Section 8 of the Bronx River LTCP report. As noted, the duration within which fecal coliform bacteria concentrations are expected to be higher than DOH considers safe for primary contact varies along the Bronx River, ranging from 27 hours at the upper saline/freshwater boundary (BR-5), to four hours at the mouth of the Bronx River (BR-9). Generally, a value of around 24 hours or less appears to be reasonable for the saline Bronx River.

DEP has been using model projections in various waterbodies and near beaches to assist with advisories that are typically issued twice a day. The recovery time is essentially the timeline that the waterbody will not support primary contact and is intended to advise the water users of the potential health risk associated with this use during this time period.

CONCLUSIONS

The Bronx River attains the existing Class I WQS for bacteria and DO. The Bronx River cannot fully achieve the Primary Contact Bacteria WQ Criteria based on fecal coliform on an annual basis. However, the analyses show that Primary Contact Bacteria WQ Criteria can be attained throughout the recreational season (May 1st through October 31st) a high percentage of the time, although bacteria levels will be elevated during and after rain events. There are no permitted swimming locations on the Bronx River; thus, the non-attainment of swimmable standard during and after rainfall or during the non-recreational season (November 1st through April 30th) would not impact such uses. Non-attainment of Primary Contact WQ Criteria is attributable to the following UAA factors:

Fecal Coliform:

- Human caused conditions (direct drainage and urban runoff) create high bacteria levels that prevent the attainment of the use and that cannot be fully remedied for large storms (UAA factor #3).

Dissolved Oxygen

- Human caused conditions (wastewater treatment plant nitrogen discharges to East River) create a level of eutrophication in the Upper East River that prevents the attainment of the use and that cannot be fully remedied (UAA factor #3).

- Physical conditions related to the natural features of the waterbody, such as the lack of proper substrate, cover, flow, depth, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses (UAA factor #5).

It should be emphasized that the Bronx River watershed, although surrounded by commercial and industrial uses in some areas, does provide shoreline access points for recreation, which attract the public to take advantage of the recreational uses of the waterway.

RECOMMENDATIONS

The Bronx River attains the current Class I criterion for bacteria. However, as noted above, recent and on-going improvements to recreational access to and along the Bronx River have reflected an increase in the public awareness of the River as a recreational resource. This awareness was demonstrated in the attendance and input received through the public participation process, where the desire for continued improvement in water quality was expressed clearly. DEP has responded with a preferred alternative for the waterbody that reflects a significant capital investment in CSO control. Accordingly, adopting Primary Contact Bacteria WQ Criteria in the Bronx River is possible on a limited basis. To protect such uses, DEP would implement wet-weather advisories during the recreational season (May 1st through October 31st) while advancing the waterbody towards the numerical limits established, or as under consideration by DEC, including Primary Contact Bacteria WQ Criteria. With anticipated reductions in CSO overflows resulting from grey and green infrastructure, the Bronx River could be protective of limited primary contact should it occur, as long as it did not occur during or following rainfall events. DO conditions are not met for the existing standard under the existing classification, or under the alternatives that are being considered. DO levels appear to be related to non-CSO related conditions in the Bronx River. However, based on the predicted water quality improvements with the proposed project, it is anticipated that the Bronx River should be upgraded to SC classification (with a wet-weather advisory) during the recreational season (May 1st through October 31st), although a variance for DO levels would be still be required.