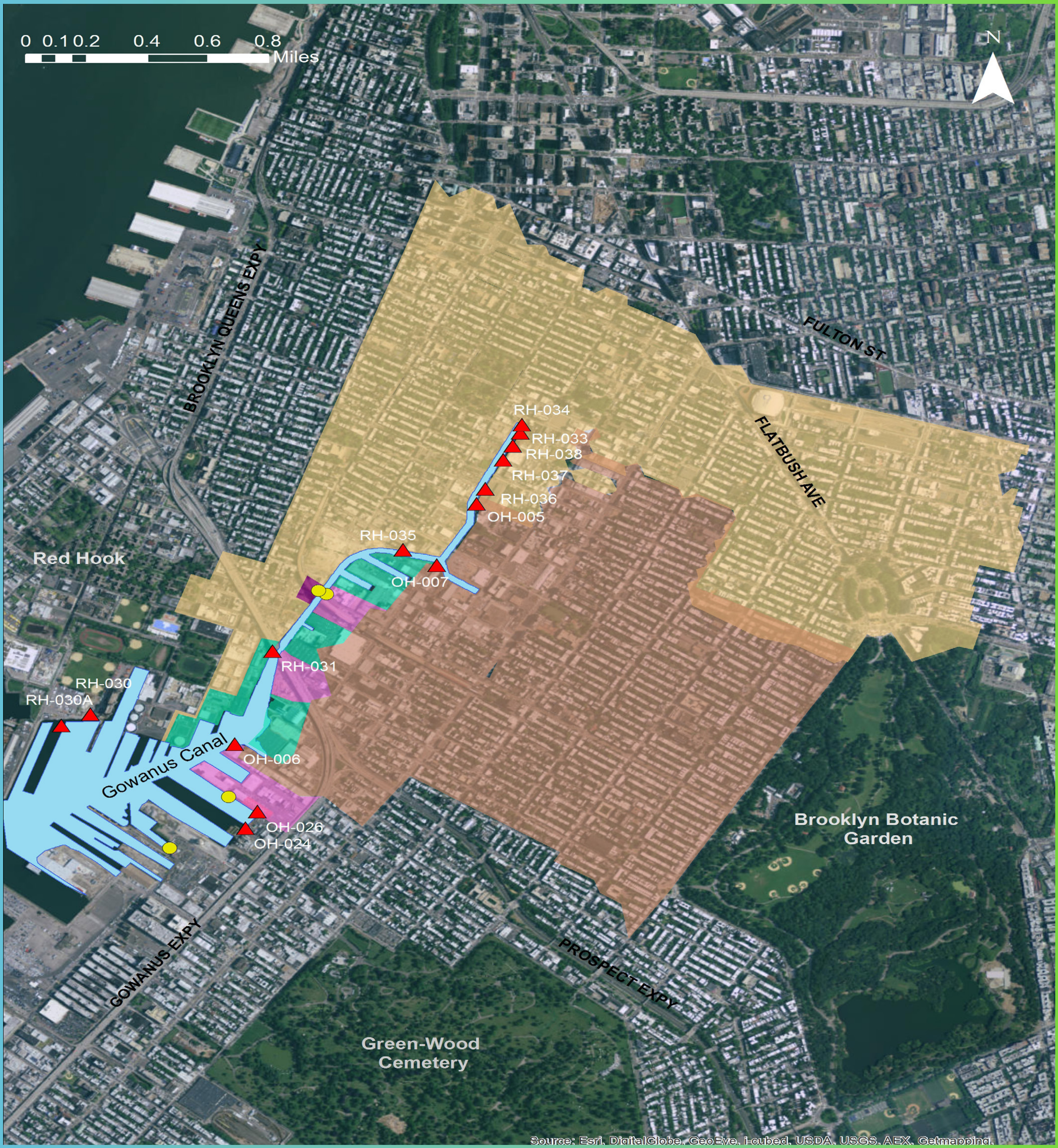
New York City Department of Environmental Protection

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

Combined Sewer Overflow Long Term Control Plan for Gowanus Canal



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Combined Sewer Overflow Long Term Control Plan for Gowanus Canal

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

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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 and WQ modeling simulations.
- Evaluations and Conclusion — Evaluations, recommendations and conclusion 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 Gowanus Canal 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 is a modification of a 2005 CSO Order on Consent (DEC Case No. CO2-20000107-8). Under the 2012 CSO Order on Consent, DEP is required to submit to DEC 11 waterbody-specific LTCPs by December 2017. The Gowanus Canal LTCP is the sixth 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 rigorous post-construction compliance monitoring (PCM).

Regulatory Requirements

The waters of NYC are subject to Federal and New York State (NYS or State) laws and regulations. Particularly relevant to this LTCP is the United States 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 Gowanus Canal Class SD above Hamilton Avenue, and Class I below Hamilton Avenue. The best usage of Class SD waters is fishing and of Class I, secondary contact recreation and fishing (6 New York Code of Rules and Regulations [NYCRR] 701.14). Figure ES-1 shows the area of the Gowanus Canal at Hamilton Avenue, below the Gowanus Expressway.

Figure ES-1. Gowanus Canal Area Map

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 Classes SD, 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 90th 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 Existing WQ Criteria (Class SD and I for the Gowanus Canal). Also assessed is the attainment of Primary Contact WQS and Potential Future Primary Contact WQ Criteria. Therefore, water quality assessments associated with current Primary Contact WQ Criteria within the Gowanus Canal considered fecal coliform and dissolved oxygen (DO) criteria exclusively (Table ES-1). As described above, the 2012 EPA RWQC recommended certain changes to the bacteria water quality criteria for primary contact. Although not currently applicable to this waterbody, the Gowanus Canal LTCP includes attainment analyses of the 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 Fish Survival (Class SD) and Boating/Fishing (Class I)	Gowanus Canal Above Hamilton Ave (Class SD)	Fecal - None; DO never < 3.0 mg/L
	Gowanus Bay Below Hamilton Ave (Class I)	Fecal Monthly GM ≤ 2,000 DO never <4.0 mg/L
Primary Contact WQ Criteria[(1)]	Saline Water	Fecal Monthly GM≤200 Daily Average DO ≥4.8 mg/L[(3)] 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 Gowanus Canal or Gowanus Bay.

(2) The Potential Future Primary Contact WQ Criteria have not yet been adopted by DEC.

(3) The daily average DO concentration may fall below 4.8 mg/L for a limited number of days.

The Gowanus Canal is also the focus of an EPA Superfund program that has a CSO mitigation component. This CSO program is being conducted under the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA" or "Superfund") through an EPA Administrative Order for Remedial Design, Index No. CERCLA 02-2014-2019, issued to NYC in advance of, and independent of, this LTCP.

Relevant here, in September 2013, the EPA issued its Record of Decision (ROD) for the Gowanus Canal Superfund Site. The ROD requires the siting, design, construction, and operation of two CSO retention tanks to control discharges of solids to the Gowanus Canal, unless other technically viable alternatives are identified.[1] The ROD preliminarily estimated that an 8 million gallon (MG) tank would be necessary at

[1] *See United States Environmental Protection Agency. Record of Decision, Gowanus Canal Superfund Site: Summary of Remedial Alternatives, page 55.*

Outfall RH-034, and a 4 MG tank at Outfall OH-007. This LTCP evaluated several alternatives including the ROD alternatives for water quality impacts.

Gowanus Canal Watershed

The Gowanus Canal watershed is highly urbanized, comprised primarily of residential areas, with some commercial, industrial, institutional and open space/outdoor recreation areas. The largest outdoor recreation area within this watershed is the Prospect Park in Brooklyn, located next to the area served by the Owls Head Wastewater Treatment Plant (WWTP). Other, smaller parks are located throughout the watershed.

The Gowanus Canal watershed comprises approximately 1,758 acres located on the northwestern shore of the Borough of Brooklyn. The majority of land immediately surrounding the shores of the Gowanus Canal is primarily industrial and commercial. The area is served by a complex collection system comprised of combined and separate storm sewers, interceptor sewers and pump stations, several CSO and stormwater outfalls, and the Flushing Tunnel. The Flushing Tunnel is the major source of flow to the Gowanus Canal, with a rated pumping capacity of 250 million gallons per day (MGD). The watershed is served by both the Red Hook and Owls Head WWTPs.

The Gowanus Canal outfalls and watershed characteristics are shown in Figures ES-2 and ES-3.

DEP activated the upgraded Gowanus Pump Station (PS) in June 20, 2014, and the refurbished Flushing Tunnel in May 3, 2014. The Flushing Tunnel introduces water from the Buttermilk Channel in the East River to the head end of the Gowanus Canal. Water is drawn at an average rate of 215 MGD to the Gowanus Canal PS. The water then flows to the mouth of the Gowanus Canal into Gowanus Bay. The introduction of the East River water has improved the water quality in the Gowanus Canal significantly. The cost of these improvements was $190M.

The Gowanus PS, located on Douglass Street at the head of the Gowanus Canal, is designed to convey sewage flow to the Columbia Street Interceptor via a force main in the Flushing Tunnel. It serves a drainage area of approximately 657 acres. The station was built in 1908 and was last upgraded in 2014. The Gowanus PS has a capacity of 30 MGD with excess flows discharged to the Gowanus Canal via CSO Outfall RH-034. During wet weather, the station receives unregulated combined sewage flow from most of its drainage area, as well as regulated combined sewage flow from the Nevins Street Pump Station.

Green Infrastructure

DEP has determined that the Gowanus Canal watershed is a target area for its Green Infrastructure (GI) Program. The Gowanus Canal has a total tributary combined sewer impervious area of 1,387 acres. DEP projects that GI penetration rates would manage 12 percent of the impervious surfaces within the Gowanus Canal 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. The model has predicted a reduction in annual overflow volume of 41 MG from this GI implementation based on the 2008 baseline rainfall condition.

2. FINDINGS

Current Water Quality Conditions

Analysis of water quality in the Gowanus Canal was based on data collected from July to September 2014, during the development of the Gowanus Canal LTCP. The sampling stations are shown in Figure ES-4. A second data collection effort that further corroborated the data collected earlier was conducted from November 2014 to June 2015.

Figure ES-5 presents fecal coliform bacteria data collected at Stations GC-1 to GC-11, and Figure ES-6 presents the enterococci data at these same stations for the sampling period of July to September 2014. The plots represent data collected from the LTCP and Harbor Survey Monitoring (HSM) programs.

Overall, the water quality data recently collected within the Gowanus Canal indicates significant improvements over those collected prior to the operation of the flushing tunnel and pump station. The fecal coliform and enterococci dry-weather GMs for the sampling period are below 200 cfu/100mL and 30 cfu/100mL, the bacteria numerical thresholds of the Primary Contact WQ Criteria and GM component of the Potential Future Primary Contact WQ Criteria, respectively.

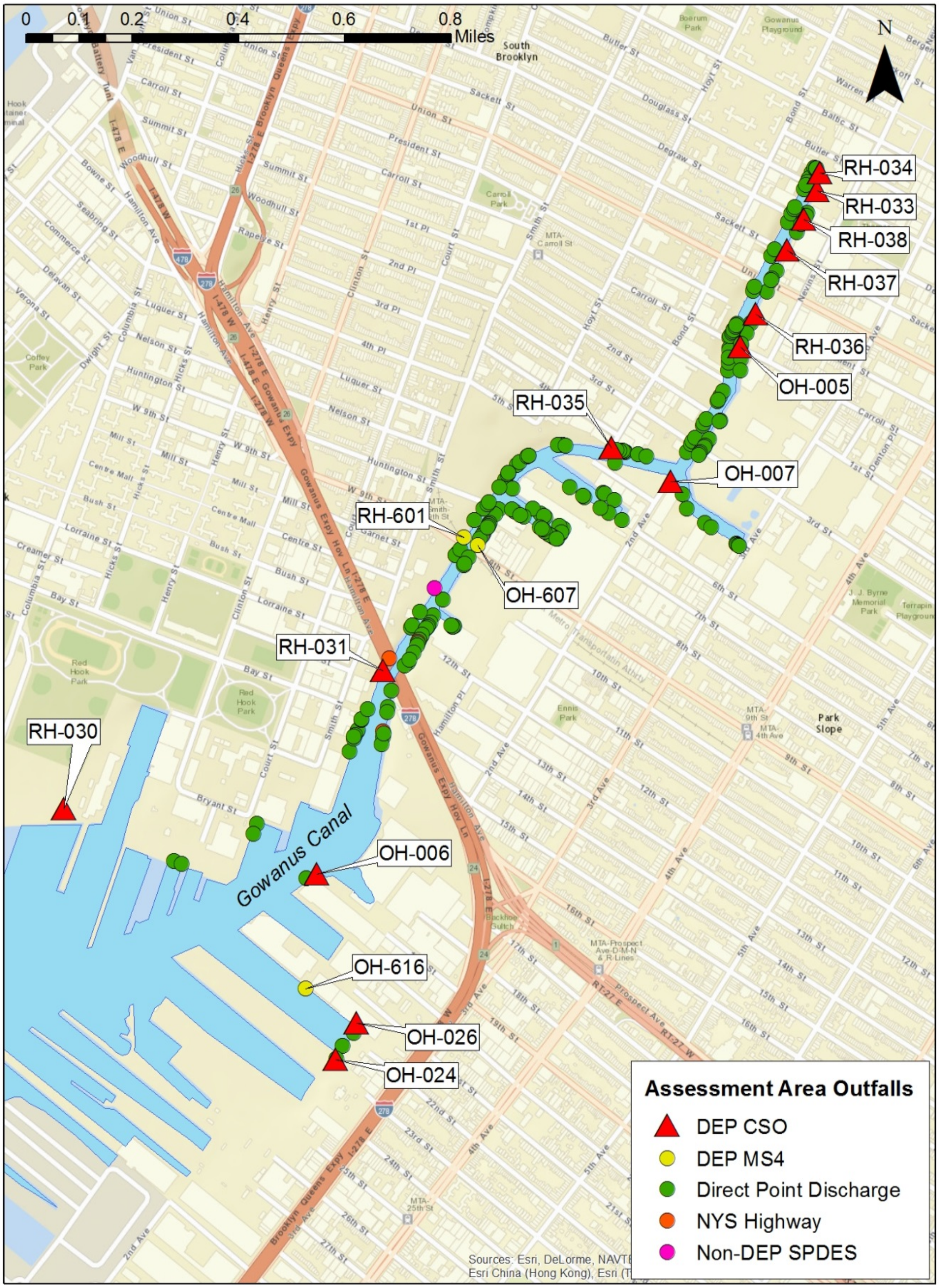

Figure ES-2. Gowanus Canal Outfalls

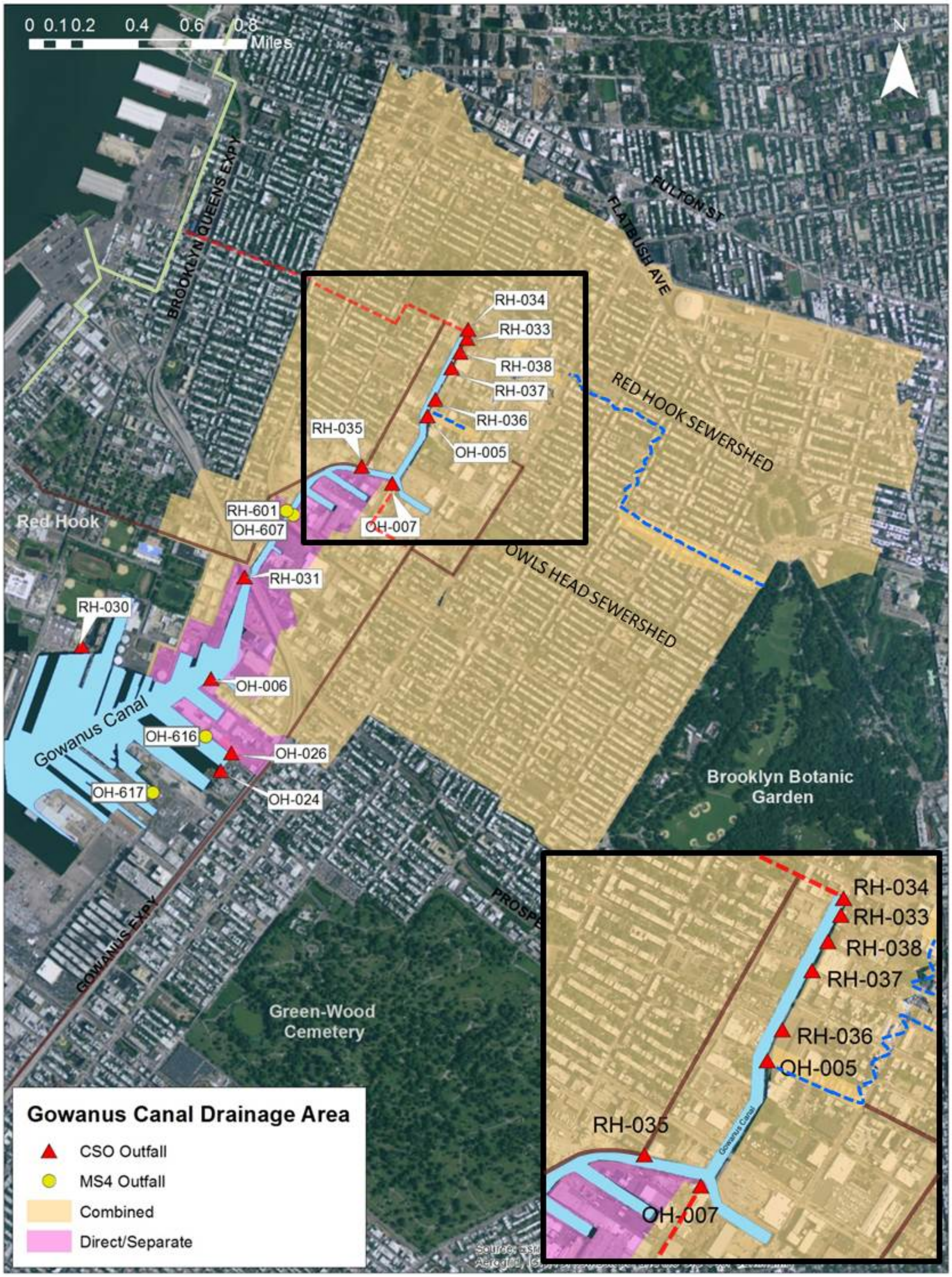

Figure ES-3. Gowanus Canal Watershed and Associated WWTP Service Areas

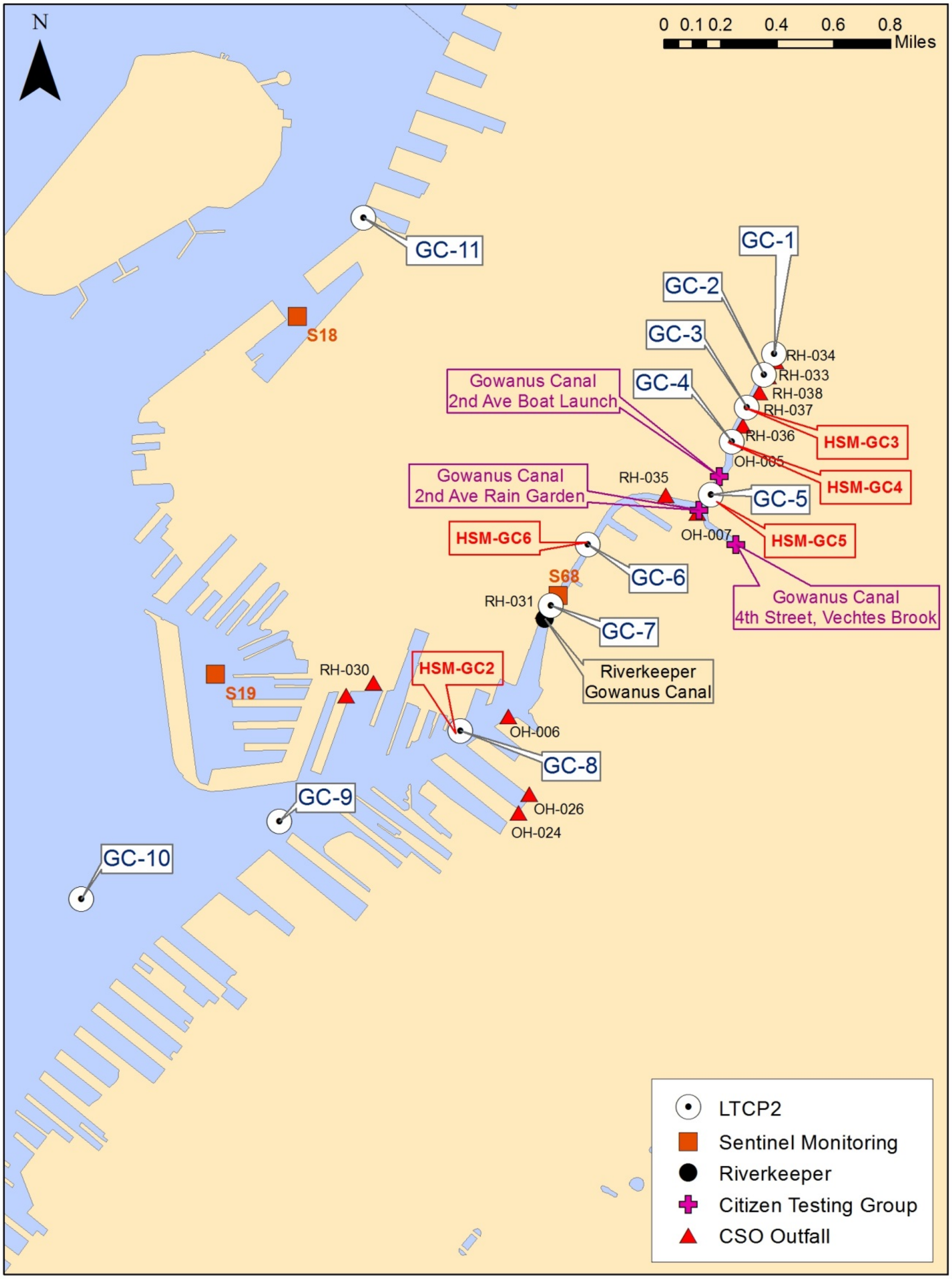

Figure ES-4. Sampling Stations of Various Sampling Programs at Gowanus Canal

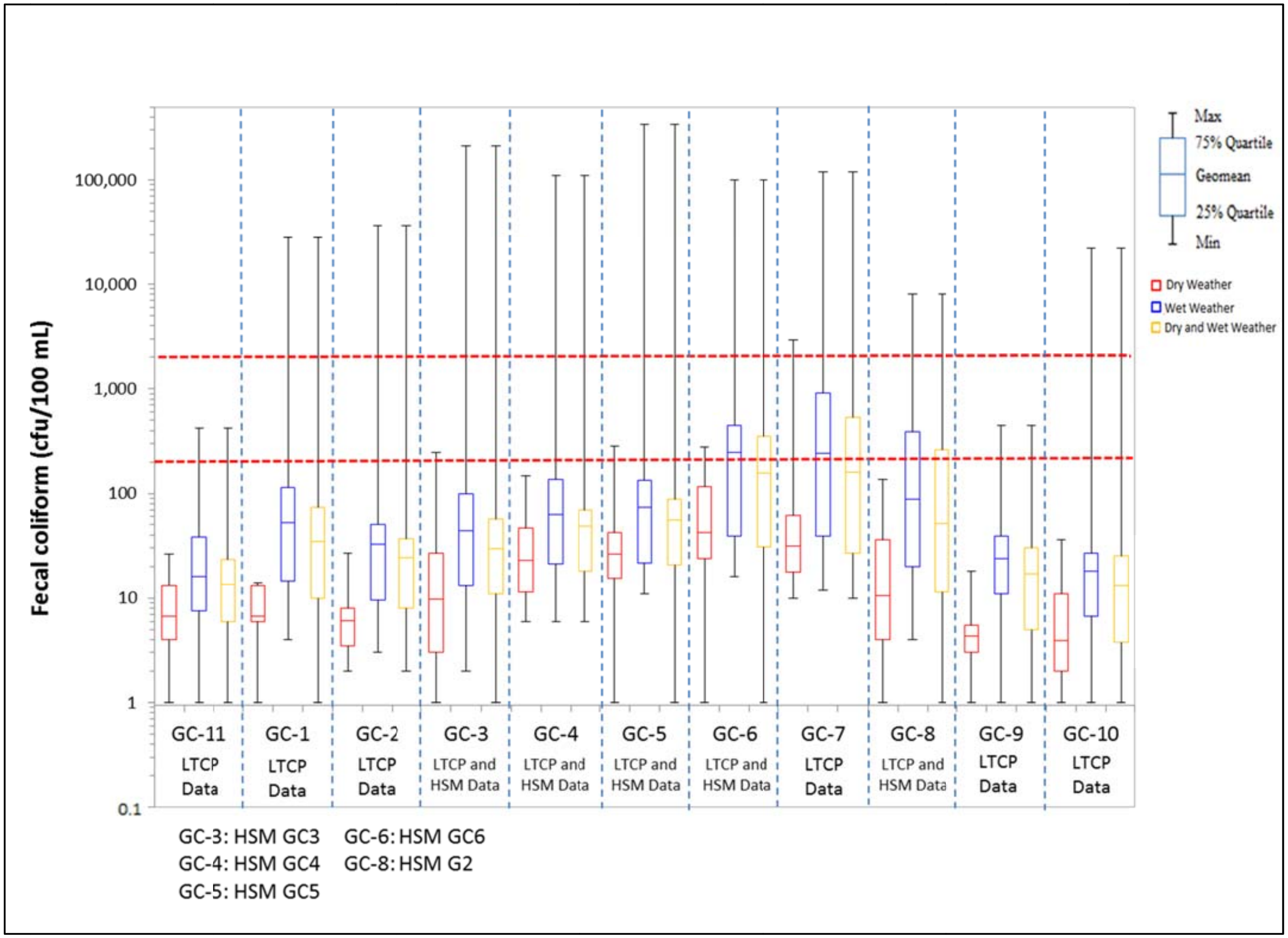

Figure ES-5. Fecal Coliform Data from LTCP and HSM - Gowanus Canal (July – September 2014)

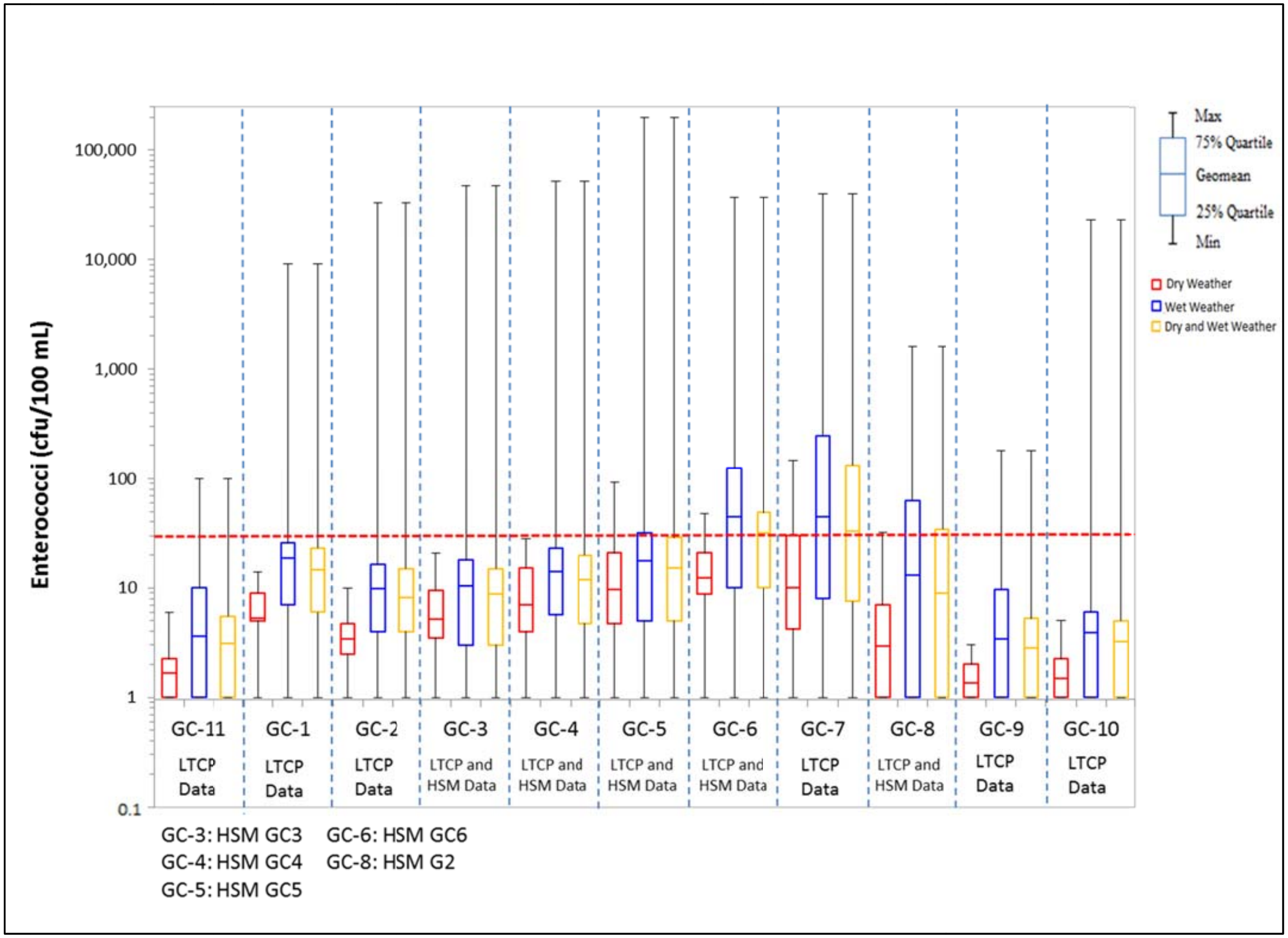

Figure ES-6. Enterococci Data from LTCP and HSM - Gowanus Canal (July – September 2014)

As shown in these graphics, dry weather fecal coliform concentrations are lower than those for wet weather conditions. Overall, the water quality reflects the significant improvements achieved by the 2008 Waterbody/Watershed Facility Plan (WWFP) recommended plan (i.e. operation of the refurbished Flushing Tunnel and upgraded Gowanus PS). As demonstrated by the sampling results and projected LTCP baseline attainment, the water quality in the Gowanus Canal has improved from the concentrations and attainment of WQS documented in prior CSO planning efforts.

Baseline Conditions, 100% CSO Control and Performance Gap

Computer models were used to assess attainment with Existing WQ Criteria (Class SD and I), Primary Contact WQ Criteria (Class SC), including the 200 cfu/100mL fecal coliform criterion and Potential Future Primary Contact WQ Criteria. The analyses focused on two primary objectives:

1. Determine the baseline levels of compliance with water quality criteria with all sources being discharged at existing levels to the waterbody. These sources would primarily be direct drainage runoff, stormwater and CSO. This analysis is presented for Existing WQ Criteria, Primary Contact WQ Criteria 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 classifications and standards criteria shown in Table ES-1.

Given the importance of the water quality modeling, the Gowanus Canal Water Quality Model (GCWQM) was updated and peer-reviewed by independent experts to confirm that the modeling was both up-to-date and accurate. The modeling was conducted using a higher resolution computational grid and hydrodynamic framework than was used in the 2008 Gowanus Canal WWFP modeling simulations. The water quality model was used to calculate ambient bacteria and DO concentrations within the waterbody for a set of baseline conditions, as described in Section 6.0.

Baseline conditions were established in accordance with the guidance provided by DEC to represent future conditions. These included the following assumptions: the design year was established as 2040; Owls Head and Red Hook WWTPs would receive combined peak flows at two times design dry weather flow (2xDDWF) or wet weather capacity of 240 and 120 MGD, respectively; grey infrastructure would include those elements recommended in the 2008 WWFP; and waterbody-specific GI application rates would be based on the best available information. In the case of the Gowanus Canal, the GI application rate was assumed to be 12 percent coverage. The water quality assessments were conducted using continuous water quality simulations – a typical year (2008 rainfall) simulation for bacteria and DO assessment to support the alternatives evaluation. For baseline conditions, Alternatives 1, 2 and 3, the LTCP analysis used the 10-year (2002 to 2011 rainfall) simulation for further analysis of bacteria criteria attainment.

Table ES-2 shows that for the 2008 baseline criteria, the Gowanus Canal meets Existing WQ Criteria for fecal coliform 100 percent of the time.

Table ES-2. Calculated 2008 Baseline Fecal Coliform Maximum Monthly GM and Attainment of Existing Criteria for the Class (I) Boating/Fishing WQ Criteria

Station	Class	Maximum Monthly Geometric Means (cfu/100mL)		% Attainment with Existing Criteria		% Attainment with Class I Criteria	
		Annual	Recreation Period	Annual GM ≤2000 #/100mL	Recreation Period GM ≤2000 #/100mL	Annual GM ≤2000 #/100mL	Recreation Period GM ≤2000 #/100mL
GC-1	SD	213	45	NA	NA	100	100
GC-2	SD	201	43	NA	NA	100	100
GC-3	SD	199	42	NA	NA	100	100
GC-4	SD	197	40	NA	NA	100	100
GC-5	SD	199	39	NA	NA	100	100
GC-6	SD	216	37	NA	NA	100	100
GC-7	SD	215	36	NA	NA	100	100
GC-8	I	181	23	100	100	100	100
GC-9	I	164	24	100	100	100	100
GC-10	I	170	31	100	100	100	100

The Primary Contact WQ Criteria for the 2008 year baseline attainment levels are shown in Table ES-3. The recreational season (May 1st through October 31st) attainment levels are met. The annual attainment levels are met at all locations with the exception of Stations GC-1, GC-2, GC-6 and GC-7 where attainment levels are 92 percent. A 92 percent attainment level means that one month out of 12 was out of attainment. However, when the baseline attainment is evaluated under the more extensive 10-year water quality simulations, as described later in this section, the baseline annual attainment of the primary contact fecal coliform criterion exceeds DEC's prescribed 95 percent attainment target for the corresponding water quality criterion.

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	Recreation Period	Annual GM ≤ 200 #/100mL	Recreation Period GM ≤ 200 #/100mL
GC-1	213	45	92	100
GC-2	201	43	92	100
GC-3	199	42	100	100
GC-4	197	40	100	100
GC-5	199	39	100	100
GC-6	216	37	92	100
GC-7	215	36	92	100
GC-8	181	23	100	100
GC-9	164	24	100	100
GC-10	170	31	100	100

The attainment levels with Primary Contact WQ Criteria under the 100% CSO control scenario are shown in Table ES-4. The projected level of attainment following 100% control of the CSO discharges is the same as that for existing baseline conditions. This indicates that little improvement in water quality attainment can be achieved with additional CSO controls.

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

Station	Maximum Monthly Geometric Means (cfu/100mL)	% Attainment
	Annual	Annual GM ≤ 200 #/100mL
GC-1	107	100
GC-2	108	100
GC-3	108	100
GC-4	105	100
GC-5	105	100
GC-6	105	100
GC-7	105	100
GC-8	80	100
GC-9	84	100
GC-10	102	100

The DO attainment levels were met for the Existing WQ Criteria as shown in Table ES-5. As shown in Table ES-6, the Primary Contact WQ Criteria for the 2008 baseline simulation are met at all locations except Stations GC-6 and GC-8 where the attainment levels are 94 percent and 87 percent, respectively.

Table ES-5. Model Calculated DO Attainment – Existing WQ Criteria (2008)

Station	Class	DO Criteria (≥ mg/L)	% Annual Attainment 2008
GC-1	SD	3	100
GC-2	SD	3	100
GC-3	SD	3	100
GC-4	SD	3	100
GC-5	SD	3	100
GC-6	SD	3	98
GC-7	SD	3	99
GC-8	I	4	95
GC-9	I	4	100
GC-10	I	4	100

Table ES-6. Model Calculated DO Attainment for Primary Contact WQ Criteria (2008)

Station	Annual Attainment Percent Attainment			
	Baseline		100% Gowanus CSO Control	
	Chronic(1)	Acute(2)	Chronic(1)	Acute(2)
GC-1	100	100	100	100
GC-2	100	100	100	100
GC-3	100	100	100	100
GC-4	100	100	100	100
GC-5	100	100	100	100
GC-6	94	98	95	99
GC-7	95	99	96	100
GC-8	87	100	89	100
GC-9	99	100	100	100
GC-10	100	100	100	100

Notes:
(1) 24-hr average DO ≥ 4.8 mg/L with allowable excursions to ≥ 3.0 mg/L for certain periods of time.
(2) Acute Criteria: DO ≥ 3.0 mg/L.

The Potential Future Primary Contact WQ Criteria attainment is shown below in Table ES-7. The table shows that the 30-day GM of 30 cfu/100mL is met at all stations, and the 110 cfu/100 mL STV criterion is met at six of the 10 stations.

Table ES-7. Calculated 2008 100% CSO Control Enterococci Maximum Monthly GM and Attainment of Potential Future Primary Contact WQ Criteria

Station	Maximum Recreational Period 30-day Enterococci (cfu/100mL)		% Attainment	
	GM	90th Percentile STV	Recreation Period GM ≤ 30 #/100mL	Recreation Period STV ≤ 110 #/100mL
GC-1	17	127	100	91
GC-2	17	132	100	91
GC-3	17	130	100	91
GC-4	17	123	100	93
GC-5	16	116	100	95
GC-6	16	100	100	100
GC-7	16	99	100	100
GC-8	11	46	100	100
GC-9	12	59	100	100
GC-10	15	104	100	100

The baseline conditions modeling shows that the Existing WQ Criteria (Class SD and Class I) are met 100 percent of the time. Similarly, the attainment levels with the Primary Contact WQ Criteria and the

Potential Future Primary Contact WQ Criteria are essentially met both annually and for the recreational season (May 1st through October 31st). WQS attainment does not meet or exceed 95 percent at four stations in which the STV component of the Potential Future WQ Criteria ranges from 91 to 93 percent and two others, at which the chronic standard of the primary contact DO criteria ranges between 84 and 97 percent.

Public Outreach

DEP's comprehensive public participation plan ensured that interested stakeholders were involved in the LTCP process. Stakeholders included both citywide and regional groups, some of whom offered comments at two public meetings. DEP will continue to solicit comments on the public's use of the waterbody, and, at the third public meeting, will present its preferred plan for the Gowanus Canal.

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; and implementation and operation and maintenance (O&M). After considering comments generated by detailed technical workshops, the retained alternatives were subjected to cost-performance and cost-attainment evaluations, where economic factors were considered, resulting in the seven retained alternatives presented in Table ES-8.

Table ES-8. Retained Alternatives

Alternative	Description
1	• 8 MG Tank at Outfall RH-034 • 4 MG Tank at Outfall OH-007
2	• 5.7MG Tank at Outfall RH-034 • 2.5 MG Tank at Outfall OH-007
3	• 3.5 MG Tank at Outfall RH-034 • 1.4 MG Tank at Outfall OH-007
4	• 3.5 MG Tank at Outfall RH-034 • Weir Modifications at Outfalls OH-006, OH-007 and OH-024
5	• Bond Lorraine Sewer Reconstruction • Weir Modifications at Outfalls OH-006, OH-007 and OH-024
6	• 8,400 LF-long, 18 ft-diameter tunnel • 15.8 MG storage
7	• 8,400 LF-long, 27 ft-diameter tunnel • 34.6 MG storage

The retained alternatives with CSO volume and bacteria load reductions are presented below in Table ES-9. The reductions range from 36 to 100 percent.

Table ES-9. Gowanus Canal Projected Annual CSO Volume and Bacteria Reductions for the Retained Alternatives (2008 Rainfall)

Basin-Wide Alternative	Annual CSO Volume to Gowanus Canal (MGY)	Increase in Annual CSO Volume Discharged to Other Waterbodies (MGY)	Net Change in Flow to both WWTPs (MGY)	Annual CSO Volume Reduction to Gowanus Canal (%)	Annual Fecal Coliform Reduction to Gowanus Canal (%)	Annual Enterococci Reduction to Gowanus Canal (%)	Frequency of Annual CSO Overflows to Gowanus Canal
Baseline Conditions	263	---	---	---	---	---	44
1. EPA ROD Tanks (8 MG Tank at Outfall RH-034 and 4 MG Tank at Outfall OH-007)	110	0	153	58	53	53	35
2. 5.7 MG Tank at Outfall RH-034 and 2.5 MG Tank at Outfall OH-007	133	0	130	50	45	45	35
3. 3.5 MG Tank at Outfall RH-034 and 1.4 MG Tank at Outfall OH-007	168	0	96	36	33	33	35
4. 3.5 MG Tank at Outfall RH-034 and Weir Modifications at Outfalls OH-006, OH-007 and OH-024	142	59	62	46	45	46	17
5. Bond Lorraine Sewer Reconstruction and Weir Modifications at Outfall OH-006, OH-007 and OH-024	143	117	2	46	48	49	31
6. Tunnel (75% CSO Control)	65	0	198	75	75	75	6
7. Tunnel (100% CSO Control)	0	0	263	100	100	100	0

Costs of LTCP Alternatives

The retained alternative estimated costs for Probable Bid Costs (PBC), O&M and present worth are shown below in Table ES-10. The total present worth ranges from $355M to $873M. The PBCs range from $334M to $846M.

Table ES-10. Cost of Retained Alternatives

Alternative	PBC[(2)] ($ Million)	Annual O&M Cost[(2)] ($ Million)	Total Present Worth ($ Million)
1. EPA ROD Tanks (8 MG Tank at Outfall RH-034 and 4 MG Tank at Outfall OH-007)	801[(1)]	1.9	829
2. 5.7 MG Tank at Outfall RH-034 and 2.5 MG Tank at Outfall OH-007	663	1.4	683
3. 3.5 MG Tank at Outfall RH-034 and 1.4 MG Tank at Outfall OH-007	493	0.9	507
4. 3.5 MG Tank at Outfall RH-034 and Weir Modifications at Outfalls OH-006, OH-007 and OH-024	389	0.8	401
5. Bond Lorraine Sewer Reconstruction and Weir Modifications at Outfalls OH-006, OH-007 and OH-024	334	1.4	355
6. 75% CSO Control Tunnel	680	1.0	695
7. 100% CSO Control Tunnel	846	1.8	873

Notes:
(1) EPA ROD estimate for same tanks is $77M.
(2) PBCs estimated from various methods and sources, including LTCP and Superfund. Annual O&M costs estimated from historical costs of equivalent CSO control projects implemented or previously evaluated within NYC.

3. EVALUATIONS AND CONCLUSION

DEP will implement the plan elements identified in this section upon DEC's approval of this LTCP, which also recommends the continued implementation of WWFP recommendations.

LTCP analyses for the Gowanus Canal are summarized here for the following:

1. Water Quality Modeling Results
2. Use Attainability Analysis (UAA)

3. Recommendations
4. Conclusion

Water Quality Modeling Results

The bacteria simulations used a 10-year period and the typical year (2008) was used for DO. As would be expected, 10-year simulation results vary slightly from the 2008 simulations, which were used for the evaluation of alternatives which provide an effective uniform evaluation platform for multiple CSO control alternatives. The 10-year simulation is processed to confirm the water quality impacts of the LTCP baseline scenario over a longer period. For this particular LTCP, bacteria 10-year simulations were also conducted for retained alternatives that DEP is evaluating separately, consistent with the EPA's ROD for the Gowanus Canal.

The Gowanus Canal 10-year bacteria attainment results for the baseline annual and recreational season (May 1st through October 31st) are shown in Tables ES-11 and ES-12. The tables show that water quality at all sampling stations complies with the bacteria Existing WQ Criteria and Primary Contact WQ Criteria, i.e., attainment above 95 percent. Attainment of the enterococci Potential Future Primary Contact WQ Criteria ranges from 95 to 100 percent for the 30 cfu/100mL criterion and 34 to 86 percent for the 110 cfu/100 mL STV criterion.

Table ES-11. Calculated 10-Year Bacteria Attainment
Baseline Conditions - Annual

Station	Existing WQ Criteria (Class I) (1)		Primary Contact WQ Criteria	
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
GC-1	Fecal ≤ 2,000	100	Fecal ≤ 200	98
GC-2	Fecal ≤ 2,000	100	Fecal ≤ 200	99
GC-3	Fecal ≤ 2,000	100	Fecal ≤ 200	100
GC-4	Fecal ≤ 2,000	100	Fecal ≤ 200	100
GC-5	Fecal ≤ 2,000	100	Fecal ≤ 200	100
GC-6	Fecal ≤ 2,000	100	Fecal ≤ 200	98
GC-7	Fecal ≤ 2,000	100	Fecal ≤ 200	98
GC-8	Fecal ≤ 2,000	100	Fecal ≤ 200	99
GC-9	Fecal ≤ 2,000	100	Fecal ≤ 200	100
GC-10	Fecal ≤ 2,000	100	Fecal ≤ 200	100

Notes:
(1) Not currently designated to Stations GC-1 through GC-7

Table ES-12. Calculated 10-Year Bacteria Attainment Baseline Conditions - Recreational Season (May 1st through October 31st)

Station	Existing WQ Criteria (Class I)		Primary Contact WQ Criteria		Potential Future Primary Contact WQ Criteria			
	Criterion (1) (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
GC-1	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	70
GC-2	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	73
GC-3	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	73
GC-4	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	74
GC-5	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	66
GC-6	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	95	Enterococci STV ≤ 110	34
GC-7	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	95	Enterococci STV ≤ 110	35
GC-8	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	97	Enterococci STV ≤ 110	36
GC-9	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	59
GC-10	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	100	Enterococci STV ≤ 110	86

Notes:

(1) Not currently designated to Stations GC-1 through GC-7

The 10-year simulation bacteria results show that the Gowanus Canal meets bacteria water quality criteria.

The 2008 simulation for DO is presented below in Table ES-13. It shows the DO water quality criteria are met for the Existing WQ Criteria and Primary Contact WQ Criteria, except at two water quality stations in which the chronic standard of the Primary Contact WQ Criteria ranges from 87 to 94 percent.

Table ES-13. Calculated 2008 DO Attainment Baseline Conditions - Annual

Station	Existing WQ Criteria		Primary Contact WQ Criteria			
	Criterion	Attainment (%)	Criterion(1)	Attainment (%)	Criterion(2)	Attainment (%)
GC-1	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-2	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-3	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-4	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-5	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-6	≥3.0 mg/L	100	≥4.8 mg/L	94	≥3.0 mg/L	98
GC-7	≥3.0 mg/L	100	≥4.8 mg/L	95	≥3.0 mg/L	99
GC-8	≥4.0 mg/L	100	≥4.8 mg/L	87	≥3.0 mg/L	100
GC-9	≥4.0 mg/L	100	≥4.8 mg/L	99	≥3.0 mg/L	100
GC-10	≥4.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100

Notes:
(1) Chronic standard
(2) Acute standard

In sum, the 10 year simulation shows the Gowanus Canal is meeting Existing WQ Criteria and will meet bacteria Primary Contact WQ Criteria. DO water quality criteria are met except at two water quality stations in which the chronic standard of the Primary Contact WQ Criteria ranges from 87 to 94 percent. Additional improvements would have little or no impact on projected attainment of water quality criteria.

Table ES-14 presents an overview of the findings.

Table ES-14. Classifications and Standards Applied - 10 Year Model Simulation Results

Analysis	Numerical Criteria Applied		Compliance
Existing WQ Criteria Fish Survival (Class SD) and Boating/Fishing (Class I)	Gowanus Canal Above Hamilton Ave (Class SD)	Fecal - None	Yes
		DO never < 3.0 mg/L(4)	Yes
	Gowanus Bay Below Hamilton Ave (Class I)	Fecal Monthly GM ≤ 2,000	Yes
		DO never <4.0 mg/L(4)	Yes
Primary Contact WQ Criteria(1)	Saline Water	Fecal Monthly GM ≤ 200	Yes
		Daily Average DO ≥ 4.8 mg/L(3) (4)	No(5)
		DO never < 3.0 mg/L(4)	Yes
Potential Future Primary Contact WQ Criteria(2)	Entero: rolling 30-d GM – 30 cfu/100mL Entero: STV – 110 cfu/100mL		Yes
			No

Notes:
GM = Geometric Mean; STV = 90 Percent Statistical Threshold Value
(1) This water quality standard is not currently assigned to the Gowanus Canal or Gowanus Bay.
(2) The Potential Future Primary Contact WQ Criteria have not yet been adopted by DEC.
(3) The daily average DO concentration may fall below 4.8 mg/L for a limited number of days. See Section 2 for the equation and calculation description.
(4) DO based on 2008 typical year model simulations.
(5) DO Attainment ranges from 87% to 94% at Stations GC-8 and GC-6.

DEP determined the amount of time following the end of rainfall required for the Gowanus Canal to recover and return to concentrations of less than 1,000 cfu/100mL fecal coliform using analyses from the August 14-15, 2008, 90th percentile 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 water quality station.

The results of the analysis are summarized in Table ES-15. As noted, the period of time needed for bacteria concentrations to return to levels considered by the NYS Department of Health (DOH) to be safe for primary contact varies with location. Generally, approximately 14 hours is typical for the upper reach of the Gowanus Canal, between Stations GC-1 and GC-7.

Table ES-15. Time to Recovery in Gowanus Canal (August 14-15 2008 Storm)

Class	Stations	Baseline Projected Time to Recovery (hours)
SD	GC-1 to GC-7	8 – 14
I	GC-8 to GC-10	7 – 10

UAA

The analyses contained in this LTCP demonstrate that the Gowanus Canal is projected to fully attain the bacteria Primary Contact WQ Criteria. DO levels largely comply with the primary contact standards except at Stations GC-6 and GC-8 at which attainment with the chronic standard ranges from 87 to 94 percent. As a result, a UAA is not required.

Recommendations

The LTCP presents DEP's recommendations consistent with the CWA, the CSO Control Policy, and the 2012 Order on Consent, with the goal of meeting DEC WQS. However, this LTCP additionally summarizes bacteria and DO attainment achieved by alternatives evaluated pursuant to the ROD.

LTCP Recommendations

Existing WQS are being met as a result of DEP's refurbishment of the Flushing Tunnel and upgrade of the Gowanus PS. Water quality will improve still further with the build-out of planned GI and construction of the planned high level storm sewers (HLSS), as part of the LTCP baseline. The LTCP evaluated alternatives to further reduce CSO loadings to the Gowanus Canal beyond baseline conditions and determined that additional control measures would have little or no impact on projected water quality criteria for primary contact recreation, as the Gowanus Canal meets WQS for the Primary Contact WQ Criteria and the Potential Future Primary Contact WQ Criteria, with the exception of the STV criterion of the Potential Future Primary Contact WQ Criteria (110 cfu/100mL). As discussed herein, implementation of any configuration of the Superfund remedy (two CSO tanks included as Alternatives 1, 2 or 3 referred to below) will serve to further improve water quality.

Water Quality Projections – EPA Superfund Requirements

Roughly concurrent with its analyses supporting the Gowanus Canal LTCP recommendations, DEP undertook additional analyses consistent with the ROD and as directed by the EPA's May 28, 2014 Administrative Order for Remedial Design. The latter analyses resulted in four reports that DEP will submit to the EPA. Those reports consist of the following:

1. Preliminary Remedial Design Report for CSO Facility at Red Hook Outfall RH-034.
2. Preliminary Remedial Design Report for CSO Facility at Owls Head Outfall OH-007.
3. CSO Facility Site Recommendation Report for Red Hook Outfall RH-034.
4. CSO Facility Site Recommendation Report for Owls Head Outfall OH-007.

The facilities evaluated under and described in these reports will further reduce CSO discharges to the Gowanus Canal and will further improve water quality. DEP's analyses of the alternatives proposed pursuant to the ROD are presented in the tables below and discussed fully in Section 8 of this LTCP.

Table ES-16. Performance of Storage Tank Combinations from LTCP Evaluations for Outfall RH-034

Outfall RH-034	Pre-WWFP	LTCP Baseline	ROD Proposed	Volumetric Reduction	
				74%	58%
Tank Size	-	-	8 MG	5.7 MG	3.5 MG
% Reduction	-	25%	82%	74%	58%
Remaining CSO Volume	182 MG	137 MG	33 MG	47 MG	76 MG
Annual Overflow Frequency	45	40	6	7	12

Table ES-17. Performance of Storage Tank Combinations from LTCP Evaluations for Outfall OH-007

Outfall OH-007	Pre-WWFP	LTCP Baseline	ROD Proposed	Volumetric Reduction	
				74%	58%
Tank Size	-	-	4 MG	2.5 MG	1.4 MG
% Reduction	-	16%	87%	74%	58%
Remaining CSO Volume	69 MG	58 MG	9 MG	18 MG	28 MG
Annual Overflow Frequency	48	44	5	6	13

Three alternatives from Section 8, representing alternatives with various tank sizes, are shown below. These are Alternatives 1, 2 and 3 and the corresponding tank sizes are summarized in Table ES-18. The water quality attainment with the 2008 and 10-year model simulation for bacteria and the 2008 model simulation for DO are shown below in Tables ES-19 and ES-20.

Table ES-18. LTCP Evaluated Storage Tank Sizes

Alternative	Tank Size (MG)	
	Outfall RH-034	Outfall OH-007
1. EPA ROD Tanks	8	4
2.	5.7	2.5
3.	3.5	1.4

Table ES-19. Attainment of Primary Contact WQ and Potential Future Primary Contact WQ Criteria with Alternatives 1, 2 and 3 – 2008 Model Simulation for Alternative 1 and 10 Year Model Simulations for Alternatives 2 and 3

Station	Alternatives 1, 2 and 3 Attainment with Primary Contact WQ Criteria (200 cfu/100mL fecal coliform) (%)	Attainment with Potential Future Primary Contact WQ Criteria for Enterococci					
		GM (30 cfu/100mL)			STV (110 cfu/100mL)		
		Alternative 1 (%)	Alternative 2 (%)	Alternative 3 (%)	Alternative 1[1] (%)	Alternative 2 (%)	Alternative 3 (%)
GC-1	100	≥95	≥95	≥95	87	87	86
GC-2	100	≥95	≥95	≥95	87	87	87
GC-3	100	≥95	≥95	≥95	87	87	86
GC-4	100	≥95	≥95	≥95	87	87	87
GC-5	100	≥95	≥95	≥95	90	87	84
GC-6	100	≥95	≥95	≥95	86	71	68
GC-7	100	≥95	≥95	≥95	77	71	69
GC-8	100	≥95	≥95	≥95	74	74	62
GC-9	100	≥95	≥95	≥95	76	75	72
GC-10	100	≥95	≥95	≥95	90	90	87

Notes:

(1) Alternative 1 is based on the 2008 model simulation and Alternatives 2 and 3 are based on the 10 year model simulations

Table ES-20. WQ Criteria Dissolved Oxygen Attainment with LTCP Alternatives 1, 2 and 3 – 2008 Model Simulation

Class	Stations	Criteria		Attainment		
				Alternative 1 (%)	Alternative 2 (%)	Alternative 3 (%)
SD	GC-1 to GC-7	Designated	≥ 3 mg/L	99	99	99
I	GC-8 to GC-10		≥ 4 mg/L	96	96	96
SC/SB	GC-1 to GC-7	Next Higher Classification	≥ 4.8 mg/L[(1)]	95	95	95
	GC-8 to GC-10			88	88	88
	GC-1 to GC-7		≥ 3 mg/L[(2)]	99	99	99
	GC-8 to GC-10			100	100	100

Notes:
(1) Chronic Standard.
(2) Acute Standard.

Table ES–21 compares compliance with the water quality classifications for the 2008 and 10 year model simulation for the Existing WQ Criteria, Primary Contact WQ Criteria and the Potential Primary Contact WQ Criteria achieved by Alternatives 1, 2 and 3.

Table ES-21. Alternatives 1, 2 and 3 – Compliance with Classifications and Standards - 2008 Model Simulation for Alternative 1 and 10 Year Model Simulations for Alternatives 2 and 3

Analysis	Numerical Criteria Applied		Compliance
Existing WQ Criteria Fish Survival (Class SD) and Boating/Fishing (Class I)	Gowanus Canal Above Hamilton Ave (Class SD)	Fecal - None;	Yes
		DO never < 3.0 mg/L[4]	Yes
	Gowanus Bay Below Hamilton Ave (Class I)	Fecal Monthly GM ≤ 2,000	Yes
		DO never <4.0 mg/L[4]	Yes
Primary Contact WQ Criteria[1]	Saline Water	Fecal Monthly GM ≤ 200	Yes
		Daily Average DO ≥4.8 mg/L[3] [4]	No[5]
		DO never < 3.0 mg/L[4]	Yes
Potential Future Primary Contact WQ Criteria[2]	Entero: rolling 30-d GM – 30 cfu/100mL		Yes
	Entero: STV – 110 cfu/100mL		No

Notes:

GM = Geometric Mean; STV = 90 Percent Statistical Threshold Value

(1) This water quality standard is not currently assigned to the Gowanus Canal or Gowanus Bay.
(2) The Potential Future Primary Contact WQ Criteria have not yet been adopted by DEC.
(3) The daily average DO concentration may fall below 4.8 mg/L for a limited number of days. See Section 2 for the equation and calculation description.
(4) DO based on 2008 typical year model simulations.
(5) DO Attainment is 88% at Station GC-8.

The water quality benefits achieved with Alternatives 1, 2 and 3 include reductions in CSO discharges to the Gowanus Canal. However, the 10-year water quality model runs do not show an appreciable elevation in WQS attainment. In all instances, the primary benefit will be fewer overflows to the Gowanus Canal and a greater removal of floatables.

The estimated construction and O&M costs for Alternatives 1, 2 and 3, as well as the corresponding Net Present Worth (NPW) are shown in Table ES- 22.

Table ES-22. Cost of Alternatives 1, 2 and 3

Alternative		Capital Cost ($M)	Annual O&M ($M)	NPW ($M)
1	8 MG Tank at Outfall RH-034	490	1.2	508
	4 MG Tank at Outfall OH-007	311	0.7	321
	Total	801	1.9	829
2	5.7 MG Tank at Outfall RH-034	450	0.9	462
	2.5 MG Tank at Outfall OH-007	213	0.5	221
	Total	663	1.4	683
3	3.5 MG Tank at Outfall RH-034	369	0.6	378
	1.4 MG Tank at Outfall OH-007	124	0.3	129
	Total	493	0.9	507

Conclusion

DEC and DEP have achieved dramatic improvements in water quality in the Gowanus Canal through an effective process that resulted in significant infrastructure improvements in the sewershed. These improvements were proposed in the 2008 WWFP submitted by DEP to DEC that was approved by DEC in 2009. That work included:

- Gowanus PS upgrade – increase capacity from 20 to 30 MGD and add screening facility to outfall for floatables control.
- Flushing Tunnel upgrade – three new pumps increasing average design flow to 215 MGD, and making it possible for more continuous flushing even during periods of low tide, with additional screening.
- Total project capital cost – $190M.

These WWFP projects, coupled with the planned GI build-out and the proposed HLSS, are projected to bring the Gowanus Canal into full compliance with designated WQS.

In accordance with EPA Superfund requirements to reduce TSS loadings to the Canal, DEP has evaluated a range of alternatives including various CSO storage tank sizes for Outfalls RH-034 and OH-007. Such tanks, while reducing TSS loadings, also significantly reduce the frequency of overflows from LTCP baseline conditions of over 40 per year to a maximum of approximately 12 to 13 per year. These tanks will, to a certain extent, improve the level of attainment with the potential future enterococci criteria. Schedules for construction of the two tanks would be established pursuant to the Superfund program.

As noted above, the baseline projects have led to projected full compliance with designated WQS. As a result, DEP is proposing upgrading the designated Class SD portion of the Gowanus Canal to a Class I. DEP plans to extend the period of PCM to assess the potential for even further upgrades to the waterbody classification (e.g., Class SC) as it appears, based on the monitoring to date, that water quality might support the uses associated with this classification during the recreational period. The Gowanus Canal should be considered for further upgraded WQS upon completion of the Superfund remediation work and results of water quality conditions after a longer trend of data can be analyzed from further PCM.

1.0 INTRODUCTION

This LTCP for the Gowanus Canal 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). 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 Gowanus Canal LTCP is the sixth 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 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 Gowanus Canal LTCP.

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 pollutant or 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.

As shown in Table 1-1, the Gowanus Canal remains delisted (updated September 2014) 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. 2014 DEC 303(d) Impaired Waters Listed and Delisted (with Source of Impairment)

Waterbody	Pathogens	DO/Oxygen Demand	Floatables
Gowanus Canal	Delisted Category 4b Urban/Storm/CSOs	Delisted Category 4b CSOs, Urban/Storm	Not Listed

In September 2013, the EPA issued its ROD for the Gowanus Canal Superfund Site in Brooklyn, New York. The ROD requires the siting, design, construction, and operation of two CSO retention tanks to control discharges of solids to the Gowanus Canal, unless other technically viable alternatives are identified[1]. The ROD estimated that an 8 million gallon tank would be necessary at Outfall RH-034, and a 4 million gallon tank at Outfall OH-007. In addition, in May 2014, EPA issued a Unilateral Order to NYC requiring, among other things, the completion of a siting study to identify recommended locations for the tanks; this study is being submitted at the same time as this LTCP. The final siting, design and schedules for these projects will be determined in accordance with the Superfund process.

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. The Gowanus Canal is classified as a Class SD waterbody. A Class SD waterbody is defined as "suitable for fish, shellfish, and wildlife survival. This classification may be given to those waters that, because of natural or man-made conditions, cannot meet the requirements for primary and secondary contact recreation and fish propagation." The best usage of Class SD waters is fishing (6 NYCRR 701.14). 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 SD waters be suitable for "primary contact recreation" and to adopt corresponding total and fecal coliform standards in 6 NYCRR Part 703. In developing the Gowanus Canal 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 tidal waters of greater NYC, including the Gowanus Canal. 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. Gowanus Canal 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 have entered into Orders on Consent to address CSO issues, including the 2005 CSO Order on Consent, which was issued to bring all DEP CSO-related matters into compliance with the provisions of the CWA and the New York State Environmental Conservation Law (ECL), and requires implementation of the LTCPs. The 2005 CSO Order on Consent 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

[1] See United States Environmental Protection Agency. Record of Decision, Gowanus Canal Superfund Site: Summary of Remedial Alternatives, page 55.

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 WWFP. The LTCP integrates and builds on this existing body of work.

In August 2008, DEP issued the Gowanus Canal WWFP, and an addendum in April 2009. The WWFP, which was prepared pursuant to the 2005 CSO Order on Consent, includes an analysis and presentation of operational and structure 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 Gowanus Canal WWFP on July 14, 2009.

1.3.b Coordination with DEC

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

DEP shared the Gowanus Canal 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 Gowanus Canal 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 Gowanus Canal LTCP are summarized in Section 7.0 in more detail.

2.0 WATERSHED/WATERBODY CHARACTERISTICS

This section summarizes the major characteristics of the Gowanus Canal watershed and waterbody, building upon earlier documents that present a characterization of the area including, most recently, the WWFP for the Gowanus Canal (DEP, 2008). Section 2.1 addresses watershed characteristics and Section 2.2 addresses waterbody characteristics.

2.1 Watershed Characteristics

The Gowanus Canal watershed is highly urbanized, comprised primarily of residential areas with some commercial, industrial, institutional and open space/outdoor recreation areas. The most notable outdoor recreation area within this watershed is the Prospect Park in Brooklyn, located next to the area served by the Owls Head (OH) WWTP.

This subsection contains a summary of the watershed characteristics as they relate to the land use, zoning, permitted discharges and their characteristics, and 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 Gowanus Canal watershed comprises approximately 1,758 acres located on the northwestern shore of the Brooklyn Borough. The majority of the land immediately surrounding the shores of the Gowanus Canal is primarily industrial and commercial. As described later in this section, the area is served by a complex collection system comprised of combined and separate storm sewers; interceptor sewers and pumping stations; several CSO and stormwater outfalls; and the Flushing Tunnel. The Flushing Tunnel is the major source of flow to the Gowanus Canal, with a rated pumping capacity of 215 MGD.

The watershed has undergone major changes as this part of NYC has been developed. As it developed, the condition of the waterbody and its shoreline was influenced by engineered sewer systems, filled-in wetlands and an overall “hardening” of the shorelines with bulkheads.

The urbanization of the Gowanus Canal has led to the creation of a large combined sewer system (CSS) and smaller pockets served by separate sanitary sewer systems (SSS), including its companion stormwater systems that discharge directly to the Gowanus Canal, or to a nearby CSS. Generally, the combined sewage is conveyed to the WWTPs for treatment. Combined sewage that exceeds the capacity of the CSS during wet-weather overflows through the CSO, outfalls to the Gowanus Canal. As shown in Figure 2-1 the Gowanus Canal watershed is served by both the Owls Head WWTP and Red Hook (RH) WWTP service areas.

As shown in Figure 2-2 and Table 2-1, there are numerous discharges to each section of the river. In total, 228 pipes have been documented to exist along the shoreline of the Gowanus Canal by the Shoreline Survey Unit of DEP’s Compliance Monitoring Section (CMS). Thirteen of those pipes are DEP permitted CSOs; three are DEP MS4 permitted outfalls. The remaining pipes belong to other agencies or are associated with private entities.

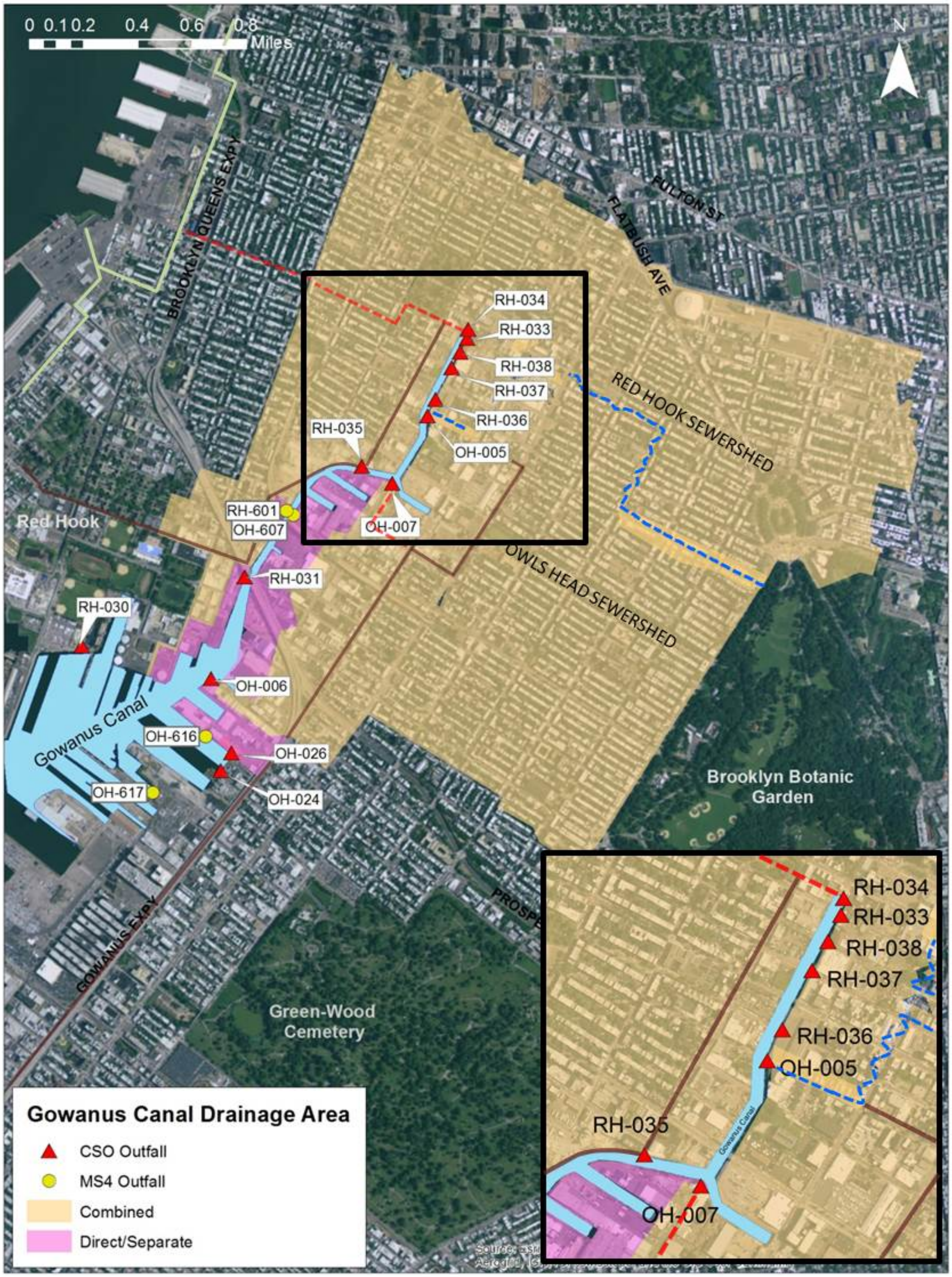

Figure 2-1. Gowanus Canal Watershed and Associated WWTP Service Areas

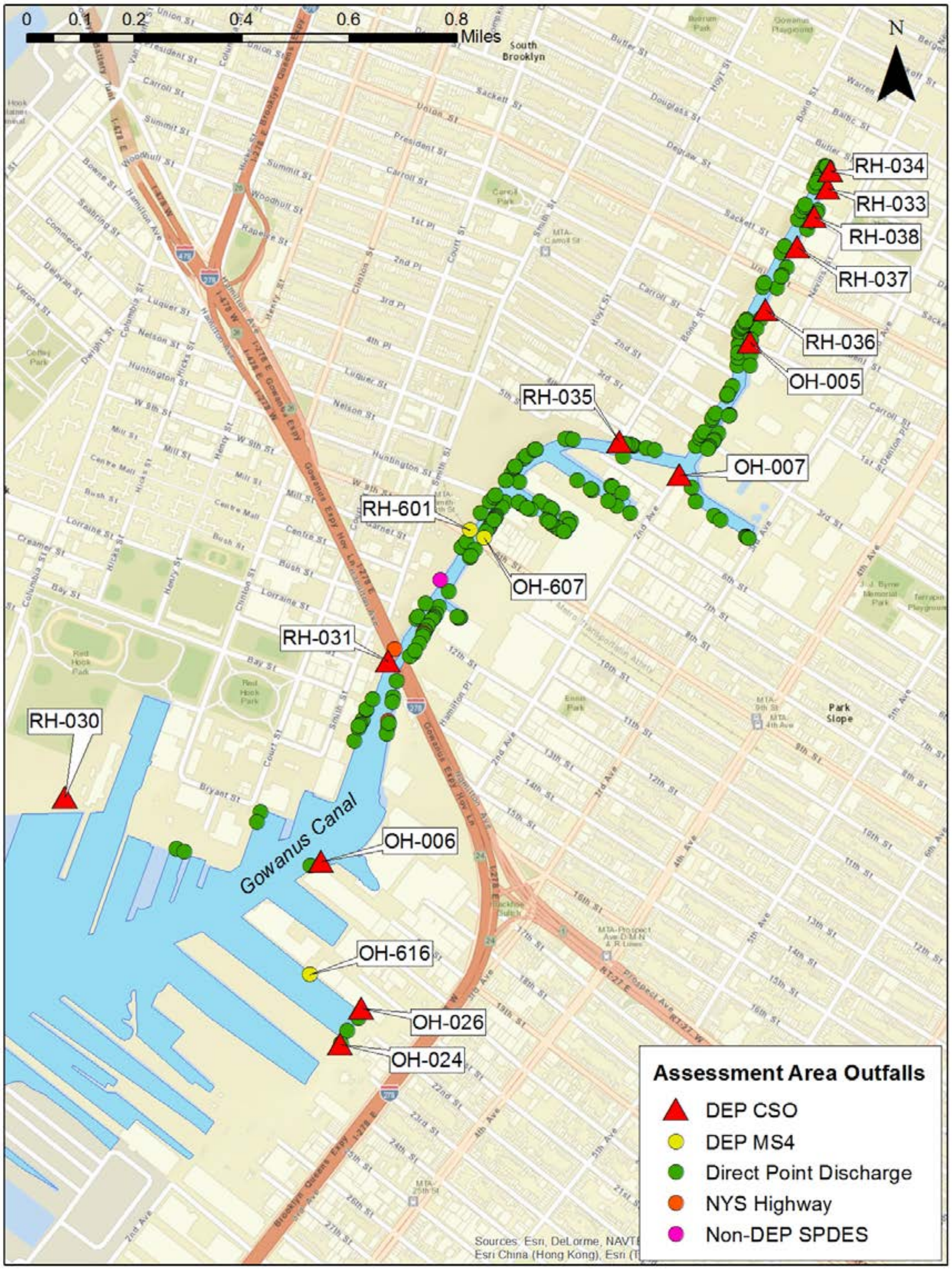

Figure 2-2. Gowanus Canal Outfalls

Table 2-1. Outfall Pipes to Gowanus Canal

Identified Ownership of Pipes	Number of Pipes
NYC DEP	DEP MS4 Permitted = 3
	DEP CSO Permitted = 13
Non-DEP SPDES	2
NYS Highway	2
NYC Department of Transportation	2
Private	177
Unknown	29
Total	228

As a residential community within NYC, the Gowanus Canal area has several large and notable aboveground transportation corridors that cross the watershed to provide access between industrial, commercial and residential areas. These access routes include the Brooklyn-Queens Expressway and parts of the NYC subway system (Figure 2-3).

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

Current land use for the watershed is shown in Figure 2-4, and generally aligns with the established zoning. Below is a discussion on current land uses, zoning, neighborhood and community characteristics, as well as NYC's planned future zoning and uses.

In general, the riparian area immediately surrounding the Gowanus Canal (including all blocks which are wholly or partially within a quarter mile of the Gowanus Canal) are dominated by warehouses, commercial and heavy industrial uses, while the rest of the watershed is mostly residential. Table 2-2 summarizes the land-use characteristics of both the Gowanus Canal watershed and riparian area. As a whole, the Gowanus Canal watershed is 50 percent residential, 13 percent industrial, 2 percent parkland and 35 percent a mix of various uses, including public facilities and institutions, commercial, and transportation related uses. Riparian areas are characterized as 20 percent residential, 30 percent industrial, 7 percent parkland, and 43 percent a mix of various uses including public facilities and institutions, commercial, and transportation related uses.

Table 2-2. Existing Land Use within the Gowanus Canal Drainage Area

Land Use Category	Percent of Area	
	Riparian Area (1/4-mile radius) (%)	Drainage Area (%)
Commercial	9	7
Industrial	30	13
Open Space and Outdoor Recreation	7	2
Mixed Use and Other	4	10
Public Facilities	2	7
Residential	20	50
Transportation and Utility	22	5
Parking Facilities	4	4
Vacant Land	2	2

Figure 2-3. Major Transportation Features of Gowanus Canal Watershed

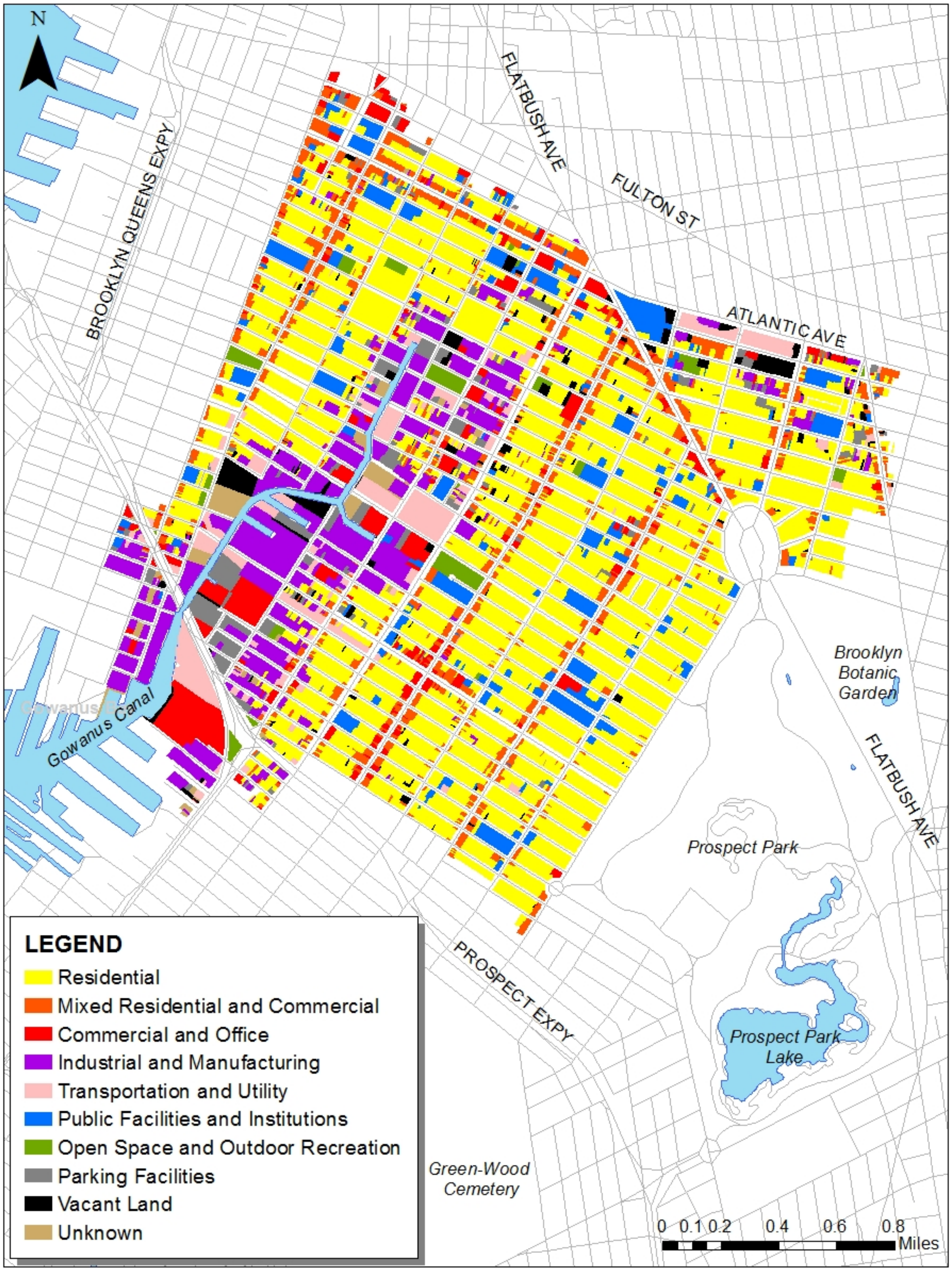

Figure 2-4. Land Use in Gowanus Canal Watershed

The riparian area is generally zoned for industrial uses along the upper reaches, with commercial, institutional and vacant land uses scattered along the waterfront in the vicinity and south of the Gowanus Expressway. Transportation uses are scattered along the watershed (Figure 2-1). Approximately, a quarter of the riparian land area (shown on Figure 2-4) surrounding the Gowanus Canal is classified as having transportation or utility uses. These transportation uses are primarily located near the mouth of the Gowanus Canal. One major transportation use is the South Brooklyn Marine Terminal, currently undergoing planning reviews, is located along the southern shoreline beyond the Gowanus Canal. Another is the Erie Basin Barge Port, which has barge slips and distribution centers located along the interior of Erie Basin. Erie Basin also features a New York City Police Department vehicle impound lot at the western end of the seawall arm, a large one-story warehouse building and associated parking area, and additional storage and commercial uses. In addition, the newly refurbished Columbia Street Esplanade, which includes a pedestrian walkway, bikeway and fishing pier, is located along the south side of the seawall. The former New York Shipyard is located to the north of Erie Basin, approximately one-quarter mile west of the lower reaches of the Gowanus Canal. Industrial, semi-industrial and warehousing uses are found along the Gowanus Canal waterfront, and generally extend from the waterfront to the first upland block from the Gowanus Canal. These uses exist on approximately 23 percent of the land within the assessment area. Common industrial uses throughout the reach include various manufacturing operations, distribution/ trucking centers, warehouses and bulk fuel/petroleum storage facilities. A cement plant is located at the intersection of Hoyt and 5th Street. Further south, along the western bank of the Gowanus Canal, fuel tanks, a scrap metal yard and a parking lot are located between 9th Street and the Gowanus Expressway. Further south and west of the Gowanus Expressway, a fuel-storage facility is located in the vicinity of Bryant and Court Streets: this facility extends from Clinton Street east to Smith Street and the Gowanus Canal. North of the fuel-storage facility, several automotive and truck repair facilities exist along the Gowanus Canal waterfront.

Situated at the intersection of Smith and 5th Streets is a six-acre parcel of NYC-owned property that was designated a “Public Place” by the NYC Board of Estimate in 1974. This parcel, which was previously occupied by a coal gasification plant, was declared an Inactive Hazardous Waste Site by the DEC due to the presence of solvents, coal tar residues, and phthalate wastes left from former industrial tenants (reference: Community Board 6 website). This parcel remains vacant pending decisions regarding remediation and lack of consensus over its future use. In general, residential uses are located upland within close proximity to the Gowanus Canal waterfront.

The Red Hook Houses, a New York City Housing Authority (NYCHA) development, is located at the westernmost extent of the assessment area, approximately three blocks north of the Gowanus Canal waterfront. Northeast of the Red Hook Houses, residential uses predominate, with scattered institutional uses and small-scale commercial uses that serve the residential populations of the area. Public and community facilities in the vicinity include the NYC Fire Department Engine Company 279, Ladder 131 facility (at the corner of Smith and Lorraine Streets), Saint Mary’s Roman Catholic Church and Convent (along Nelson Street), and the Brooklyn Psychiatric Center (at the intersection of Union and Hoyt Streets).

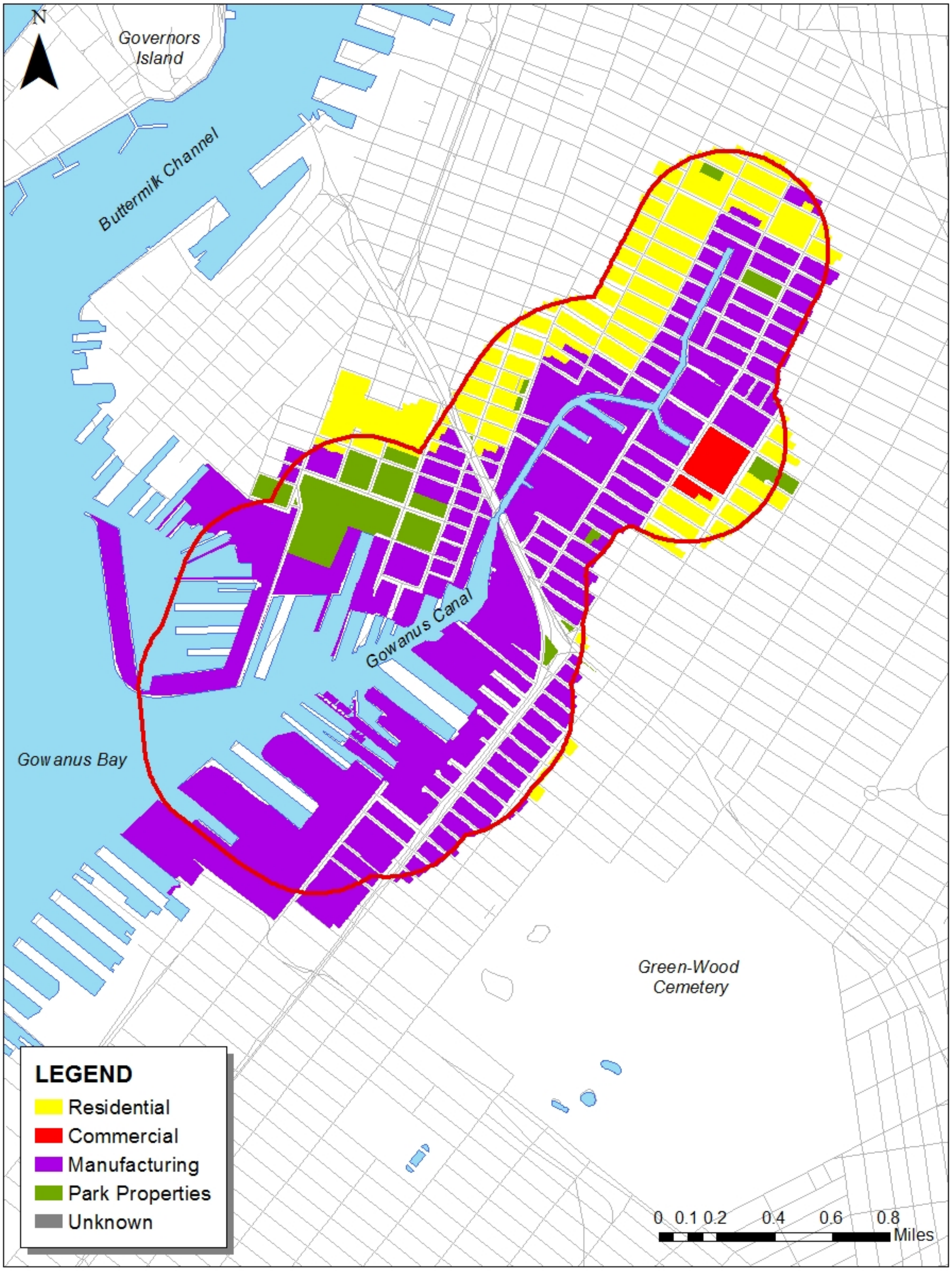

Figure 2-5. Quarter Mile Riparian Zoning in the Gowanus Canal Vicinity

Near the head of the Gowanus Canal, are the Gowanus Houses, a large NYCHA housing development that is located on Douglass Street, between Hoyt and Bond Streets. North of 1st Street, the ends of streets in the vicinity of the Gowanus Canal have undergone various improvements. These include community gardens and Green Streets, intended to convert paved, vacant areas, medians, and unused traffic islands into green spaces filled with trees, shrubs and other types of ground cover. These improvements have created small areas of open space within the assessment area. In addition, street-end improvements are currently in place along DeGraw Street, east of the Gowanus Canal. Beginning at the north end of the Gowanus Canal and proceeding southward, the eastern side of the Gowanus Canal is dominated by industrial uses, with other land uses interspersed. The Wyckoff Houses, a NYCHA housing development, is located in the vicinity of Baltic and Nevins Streets, north and east of the Gowanus Canal. The Thomas Greene Playground is located between Nevins and 3rd Avenue, east of the Gowanus Canal. Consolidated Edison of New York maintains a vehicle parking and maintenance facility between 3rd and 4th Avenues at 3rd Street, adjacent to and south of P.S. 372 - The Children's School at 219 1st Street. Further south, J.J. Byrne Park is located in the vicinity of the 4th Street Basin.

East of the Pathmark shopping center is the New York City Department of Sanitation (DSNY) Brooklyn District 6 Garage, which is located at the intersection of 2nd Avenue and 14th Street. Several large industrial and institutional operations are located south of the Gowanus Expressway and Hamilton Avenue along the Gowanus Canal waterfront.

The New York City Department of Transportation (DOT) operates an asphalt plant on the south side of the Gowanus Canal immediately west of Hamilton Avenue. Adjacent to the DOT facility is the DSNY Hamilton Avenue Marine Transfer Station, also on the south side of the Gowanus Canal. South of the DSNY facility, along Hamilton Avenue, are two large commercial uses, specifically a home-improvement retailer and a retail supermarket. To the east of 3rd Avenue, land uses are mixed residential and industrial.

Waterfront uses to the south are dominated by large-scale industrial and transportation uses.

Figure 2-5 presents a map of the established zoning within the riparian areas surrounding the Gowanus Canal. Zoning in the areas immediately surrounding the waterbody is important, not only to characterize the waterbody and the uses associated with it, but also as a consideration when developing engineering solutions as part of this LTCP, particularly siting considerations and impacts of CSO control facilities in the surrounding neighborhoods.

As shown on Figure 2-5, the riparian area, comprised of blocks wholly or partially within a quarter mile of the Gowanus Canal waterfront, is dominated by industrial zoning classifications. South of the Gowanus Expressway/Hamilton Avenue, the waterfront area (the block extending inland from the Gowanus Canal) is zoned for the heaviest industrial and manufacturing uses. This area features marine terminals, power-generating facilities, transfer stations, and an asphalt plant. North of the Gowanus Expressway, the waterfront area along the western side is mostly heavy industrial to 4th Street, while the waterfront area north of 4th Street and along the eastern side of the Gowanus Canal is virtually all zoned for moderate manufacturing uses. On the eastern side of the Gowanus Canal, just to the north of the Gowanus Expressway, there is a lighter industrial classification. On the western side, beyond the first upland block surrounding the Gowanus Canal, the zoning changes from industrial to residential. South of the Gowanus Expressway/Hamilton Avenue and east of the Gowanus Canal, the area to the east of 3rd Avenue is zoned for light industrial use that allow for limited residential development by Special Permit. On the west side of the Gowanus Canal, the heavy industrial zones adjacent to the Gowanus Canal give way to park designations, which include the Red Hook Recreational Area. Extending north from this park area to about 3rd Street are several small areas of light industrial classification that allows for certain community uses. To the west is a residential area that extends north around the head of the Gowanus Canal, just beyond the waterfront block. This residential area allows for medium-density housing—typically buildings between 3 and 12 stories. North of 3rd Street, this residential area is adjacent to the industrial-zoned waterfront block that surrounds the Gowanus Canal. Near the head of the Gowanus Canal, but just east of the waterfront block, there is a light industrial classification that generally serves as a buffer between heavier industrial uses and residential uses. South of this area, on the east side of the Gowanus Canal between 7th and 3rd Streets, there is a commercial area that serves as a transition between manufacturing and residential uses. To the south and east of these zones are residential areas that define medium-density housing districts of slightly different lot coverage and set-back requirements. The 4th Avenue corridor in the assessment area features a higher-density residential classification.

An assessment of currently proposed land uses, or significant new facilities, was conducted for the Gowanus Canal watershed area. Several significant proposed or recently completed developments were identified within the assessment area. As part of widespread revitalization and expansion efforts within the Port of New York, the NYC Economic Development Corporation (EDC) has commenced improvements within the existing South Brooklyn Marine Terminal (SBMT), located at the southernmost extent of the assessment area along the Upper New York Bay waterfront.

The Atlantic Yards project will involve the development of landscaped open space, a boutique hotel, ground-floor retail space for local businesses, office space, and over 6,400 units of affordable, middle-income and market-rate housing. The proposed project will be located at the intersection of Atlantic and Flatbush Avenues, bounded by Pacific and Dean Streets and Vanderbilt Avenue, and primarily situated over the existing Metropolitan Transit Authority (MTA)/Long Island Rail Road (LIRR) Vanderbilt rail yards. Atlantic Yards will span 22 acres and transform the current rail yards and predominantly underutilized and industrial area into 17 buildings. The $4B development will encompass 336,000 square feet of office space, up to 6.4 million square feet of residential space, an 850,000-square-foot sports and entertainment arena, 247,000 square feet of retail space, a 165,000-square-foot hotel (180 rooms) and over eight acres of publicly accessible open space. Initial construction began in 2007, and the project will be developed in phases over an estimated 10-year period. North of 3rd Street, on the eastern side of the Gowanus Canal, is a Whole Foods supermarket that was built in 2013. This approximately 1.5-acre site is located at the northwestern corner of 3rd Street at 3rd Avenue. This is an approximately 75,421-square-foot store with a 430-car parking lot. Residential developments by Lighthouse have also been proposed for areas immediately adjacent to the Gowanus Canal. Lighthouse has begun construction of an approximately 700-unit residential development along the western shore of the Gowanus Canal. In addition, other residential developments have been proposed or are in the active planning stages.

2.1.a.2 Permitted Discharges

There are several permitted stormwater and CSO discharge points along the Gowanus Canal. These are discussed in more detail in Section 2.1.c. There are no dry-weather permitted discharges associated with this waterbody. Based on data available on-line at the date of submittal of this LTCP, it was determined that a total of four state-significant industrial SPDES permit holders operate facilities located in the watershed. Table 2-3 lists these permits, their owners and location.

Table 2-3. Industrial SPDES Permits within the Gowanus Canal Watershed

Permit Number	Owner	Location
NY0201049	NYC Department of Transportation	9th Street Bridge and Gowanus Canal
NY0028606	Bayside Fuel Oil Depot Corporation	537 Smith Street
NY0110001	Hess Corporation	722 Court Street and Gowanus Canal
NY0201006	Astoria Generating Company LP	29th Street and 2nd Avenue

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 a 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 CSS performance.

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 [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 InfoWorks CS™ (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 City Planning (DCP) 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 models for the Owls Head and Red Hook WWTP sewersheds. 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 per capita dry-weather sanitary sewage flow for each year; and 2040 estimated population for the landside model subcatchment within the WWTPs service areas.

2.1.a.5 Update Landside Modeling

The Gowanus Canal watershed is represented within the overall Owls Head and Red Hook WWTPs system IW models. Several modifications to both collection systems have occurred since the models were calibrated in 2009, supporting the Gowanus Canal WWFP. Given that both models have been used for analyses associated with the annual reporting requirements of the SPDES permit, Best Management Practices (BMPs) and PCM, many of these changes have already been incorporated into the models. Other updates to the modeled representation of the collection systems that have been made since the 2009 update include:

- Outfall OH-007 tributary area pipe connectivity updated and runoff parameters validated with recent flow monitoring data.
- Outfall OH-007 diversion structures updated with recent field survey data.

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

- ***2013/2014 Additional Validation.*** Additional meters were installed to further characterize CSO discharges at Outfalls OH-007 and RH-034 for the LTCP. The meters at Outfall OH-007 were installed for 12 months as part of DEP's CSO Flow Monitoring Pilot Study, wherein both the influent sewer and overflow were monitored. For each validation event, modeled versus measured hydrographs were generated to evaluate the model's performance relative to the measured data. In addition, the overall goodness-of-fit was examined by comparing the modeled event volume, peak flow and maximum water depth of the events to the measured data in goodness-of-fit scatter plots. The validation indicates that the model closely matches measured overflow predictions at Outfall OH-007. Figure 2-6 summarizes the measured versus model-predicted overflow statistics for the monitoring period. Meters were placed at Outfall RH-034 in both the influent and overflow lines to evaluate overflows from this CSO. Due to meter data issues, only one event was available for comparison. During the April 20, 2015 storm, the meter data recorded approximately 3.7 MG of overflow. The model predicted 4.2 MG for the same storm. Although there was only one storm event to compare, a previous analysis suggests that Outfall RH-034 is reasonably calibrated. The hydrologic characteristics of the area tributary to Outfall RH-034 were calibrated during the 2012 Citywide InfoWorks Model Recalibration utilizing a meter within the Outfall RH-034 tributary area. The dry-weather flow conveyed to the Red Hook WWTP is governed by a pump station whose maximum capacity is 30 MGD. With the inflow calibrated and the flow going to the treatment plant defined, the remainder can be calculated as overflow.

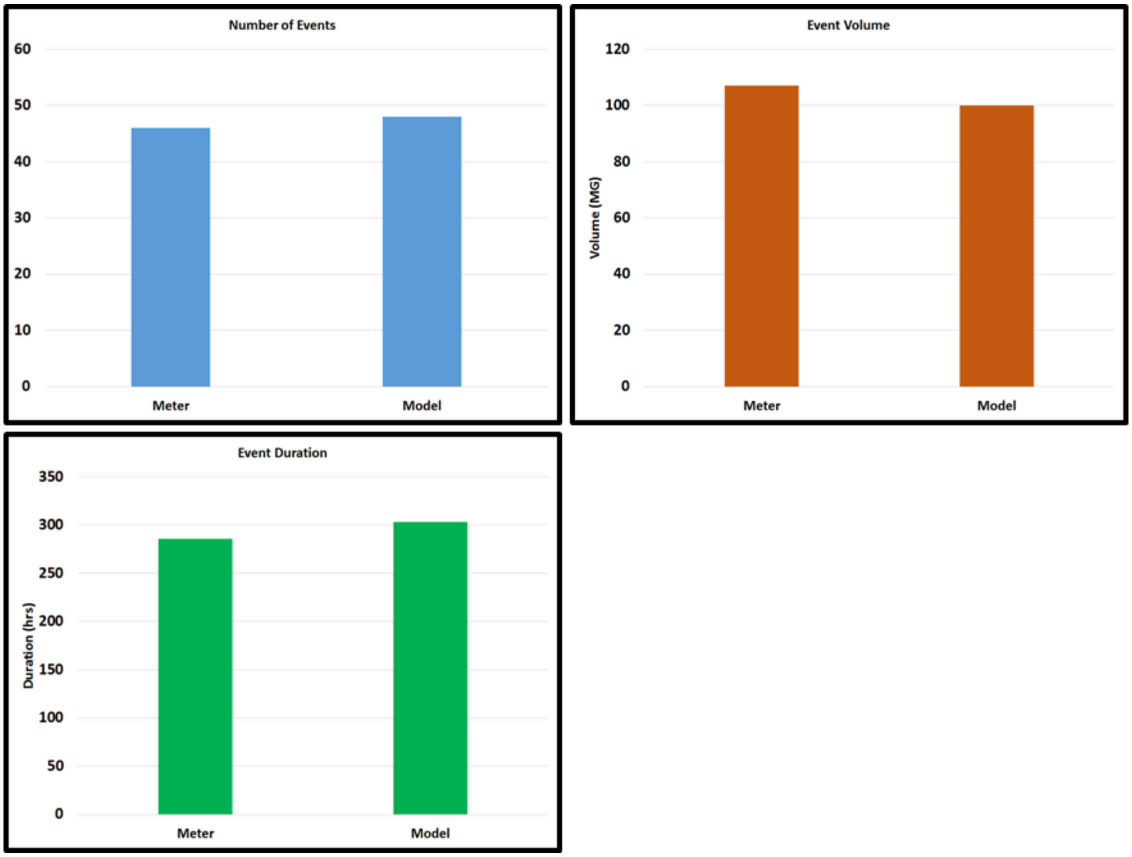

Figure 2-6. Comparison of Measured Versus Modeled Overflows at Outfall OH-007

- ***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 but 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.

- ***Tidal 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.

- ***Precipitation.*** A review of the rainfall records for model simulations was undertaken as part of this exercise, as discussed in Section 2.1.b below.

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 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. 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 results of this effort are models with better representation of the collection systems and their tributary areas. These updated models are used for the alternatives analysis as part of the Gowanus Canal LTCP. A comprehensive discussion of the recalibration efforts can be found in the IW Citywide Recalibration Report (DEP, 2012a) and Hydraulic Analysis Report (DEP, December 2012).

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 the 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 2-4. For 10-year simulations, the period of 2002-2011 is used (see Section 6).

Table 2-4. 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 Gowanus Canal watershed/sewershed is located within the Borough of Brooklyn (Brooklyn County, within NYC) political jurisdiction. The watershed is served by the Owls Head and Red Hook WWTPs and associated collection systems. The Gowanus Canal watershed and associated WWTP service areas are shown in Figure 2-1. The following sections describe the major features of the Owls Head and Red Hook WWTP tributary areas. Table 2-5 shows the areas served by the various drainage system categories.

Table 2-5. Gowanus Canal Sewershed: Acreage Per Sewer System Category

Sewer Area Description	Area (acres)
Combined	**1,612**
Separate	**42**
Direct Drainage	**146**
Total	**1,758**

It should be noted that the combined sewer drainage areas have been delineated over many years and during numerous planning studies. As such, they fairly accurately represent the area draining to the Gowanus Canal serviced by combined sewers. This is not the case for the Separate and Direct Drainage categories listed in Table 2-5. Generally the area between the CSO drainage boundary and the shoreline of the waterbody have been delineated and loosely assigned as separate if they appeared to be serviced by municipal storm sewer and as direct drainage if they drained directly in to the Gowanus Canal or were from commercial/industrial/manufacturing sites or parkland/open space located immediately adjacent to the shoreline. The allocation of areas to these categories should be considered a rough estimate at best and should be further developed through a refined analysis.

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

Owls Head WWTP Drainage Area and Sewer System

The southeastern portion of the Gowanus Canal watershed is served by the Owls Head WWTP as shown in Figure 2-1. The Owls Head sewershed includes sanitary and combined sewers. The Owls Head collection system associated with the Gowanus Canal includes:

- Two pumping stations;
- Six active combined sewer flow regulator structures; and
- Six active CSO discharge outfalls.

Table 2-6 shows the acreage by outfall/regulator/relief structure for the Owls Head WWTP Service Area within the Gowanus Canal watershed.

Table 2-6. Owls Head WWTP Service Area Within Gowanus Canal Watershed: Acreage by Outfall/Regulator/Relief Structure

Outfall	Outfall Drainage Area (acres)	Regulator/Relief Structure	Regulator Drainage Area	Regulated Drainage Area Type
OH-005	34	3rd Ave. Sewer Relief	34	Combined
OH-006	306	3rd Ave. Sewer Relief	306	Combined
OH-007	339	2nd Ave. Pump Station	339	Combined
OH-009	0	3rd Ave. Sewer Relief	0	Combined
OH-024	7	3rd Ave. Sewer Relief	7	Combined
OH-026	(1)	3rd Ave. Sewer Relief	(1)	Combined

Notes:
(1) Outfall recently reclassified to CSO in draft 2013 SPDES permit.

The 2nd Avenue and 19th Street Pump Stations operate within the Owls Head portion of the Gowanus Canal sewershed. The 2nd Avenue Pump Station, located at the northern terminus of the 2nd Avenue near the 4th Street turning basin, was built in 1990 and serves a drainage area of 373 acres. The pump station has a 1.0 MGD capacity. During dry-weather, its service area contributes an average of 0.6 MGD of sanitary flow. During wet-weather, the flow generated by the drainage area is tributary to the pump station, which conveys up to 1.0 MGD to the 3rd Avenue Sewer. Excess flow discharges to the Gowanus Canal via Outfalls OH-007 and OH-005. The 19th Street Pump Station, located near the intersection of 19th Street and 3rd Avenue, was built in 1951. With a rated capacity of 5 MGD, this pump station services separately sewered areas that generate an average of 2.5 MGD of sanitary flow. The 19th Street Pump Station conveys flow to the 3rd Avenue Interceptor Sewer.

The Owls Head WWTP is located in the Bay Ridge section of the Borough of Brooklyn, City of New York, on the southwestern tip of the Owls Head Park. The Owls Head WWTP treats wastewater from a combined sewage collection system, which serves a population of approximately 780,000 and drains stormwater flow from an area of almost 13,664 acres. The Owls Head WWTP began operating in 1952 and has been providing full secondary treatment since 1995. Treatment 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 Owls Head WWTP has a design dry-weather flow (DDWF) capacity of 120 MGD, and is designed to receive a maximum wet-weather flow of 240 MGD (2xDDWF), with 180 MGD (one and one-half times design dry-weather flow [1.5xDDWF]) receiving secondary treatment. Flows over 180 MGD receive primary treatment and disinfection.

Owls Head Non-Sewered Areas

There are no known unsewered areas in the Gowanus Canal sewershed served by the Owls Head WWTP.

Owls Head Permitted Stormwater Outfalls

There are three DEP MS4 permitted stormwater outfalls discharging to the Gowanus Canal, as shown on Figure 2-2: OH-607, OH-616 and OH-617. These outfalls are currently included in the MS4 permit. These outfalls drain stormwater runoff from small separate sewer areas around the Gowanus Canal. While runoff from these areas does not enter the combined system, the stormwater drains from the separate sewer areas to the Gowanus Canal.

There are planned ongoing HLSS works in the Gowanus Canal sewershed. These will create a separate stormwater system discharging through a stormwater outfall at Carroll Street. The planned works will be constructed in phases. Phase I is scheduled to be constructed throughout 2015 and Phase 2 is scheduled to be implemented in 2019. A portion of the new separate drainage areas to be created will also reduce CSO discharges in the Red Hook collection system.

In addition, as identified by the DEP Shoreline Survey, there are 101 other pipes that are located on the bank of the Gowanus Canal within the Owl's Head WWTP drainage area. Some of these pipes likely direct stormwater from highways and commercial/industrial sites in to the creek. For the purposes of this LTCP, these areas are considered part of the Direct Point Discharge category.

Owls Head/Gowanus Canal CSOs

Wet-weather flows in the CSS, with incidental sanitary and stormwater contributions result in overflows to the nearby waterbodies when the flows exceed the hydraulic capacity of the sewer system, or the specific capacity of the local regulator structure. The Owls Head SPDES permitted CSO outfalls to the Gowanus Canal are OH-005, OH-006, OH-007, OH-024 and OH-026. Outfall OH-007 contributes the most annual CSO volume to the Gowanus Canal from the Owls Head CSS. The locations of the Owls Head SPDES CSO outfalls tributary to the Gowanus Canal are shown in Figure 2-2.

Red Hook WWTP Drainage Area and Sewer System

The portion of the Gowanus Canal sewershed draining to the Red Hook WWTP surrounds the upper reaches of the Gowanus Canal and includes the area west of the Gowanus Canal. This drainage area is approximately 933 acres, includes two pump stations, and nine active CSOs. Table 2-7 shows the acreage by outfall/regulator/relief structure for the Red Hook WWTP Service Area within the Gowanus Canal watershed.

Table 2-7. Red Hook WWTP Service Area Within Gowanus Canal Watershed: Acreage by Outfall/Regulator/Relief Structure

Outfall	Outfall Drainage Area (acres)	Regulator/ Relief Structure	Regulator Drainage Area	Regulated Drainage Area Type
RH-030	86	CSO-2	86	Combined
RH-030A	(1)	CSO-2	(1)	Combined
RH-031	69.5	Bond Lorraine Sewer Relief	69.5	Combined
RH-033	5.1	Reg # R-25	5.1	Combined
RH-034	657	Gowanus PS	657	Combined

Table 2-7. Red Hook WWTP Service Area Within Gowanus Canal Watershed: Acreage by Outfall/Regulator/Relief Structure

Outfall	Outfall Drainage Area (acres)	Regulator/ Relief Structure	Regulator Drainage Area	Regulated Drainage Area Type
RH-035	88	CSO-3; Bond Lorraine Sewer Relief	88	Combined
RH-036	9.8	Reg # R-22	9.8	Combined
RH-037	7.4	Reg # R-23	7.4	Combined
RH-038	10	Reg # R-24	10	Combined

Notes:
(1) Outfall recently reclassified to CSO in draft 2013 SPDES permit.

The Nevins Street and Gowanus Pump Stations operate within the Red Hook portion of the Gowanus Canal sewershed. The Nevins Street Pump Station, built in 1977, and last upgraded in 1980, is located on Nevins Street between Sackett Street and Degraw Street. Serving a drainage area of about 32 acres, this pump station has a capacity of 2.2 MGD. During wet-weather, the pump station receives regulated combined sewer flow from four regulators (R-22, R-23, R-24, and R-25). The pump station conveys up to 2.2 MGD of the combined sewage via a force main to a trunk sewer feeding the Gowanus Pump Station. Excess flow is discharged to the Gowanus Canal via Outfall RH-038. The Gowanus Pump Station, located on Douglass Street at the head of the Gowanus Canal, is designed to convey flow to the Columbia Street Interceptor via a force main in the Flushing Tunnel. It serves a drainage area of about 657 acres. It was built in 1908 and was last upgraded in 2014. This pump station has a capacity of 30 MGD with excess flows discharged to the Gowanus Canal via CSO Outfall RH-034. During wet-weather, the pump station receives unregulated combined sewage flow from most of its drainage area, as well as regulated combined sewage flow from the Nevins Street Pump Station.

Red Hook Non-Sewered Areas

There are no known unsewered areas in the Gowanus Canal sewershed served by the Red Hook WWTP.

Red Hook Permitted Stormwater Outfalls

According to the MS4 permit, there is a separate storm sewer drainage area along the western shore of the Gowanus Canal contributing to stormwater Outfall RH-601. There is also an open area; a direct drainage area on the western shore near the mouth of the Gowanus Canal. In addition, as identified by the DEP Shoreline Survey, there are 111 other pipes that are located on the bank of the Gowanus Canal within the Red Hook WWTP drainage area. Some of these pipes likely direct stormwater from highways and commercial/industrial sites in to the creek. For purposes of this LTCP, these areas are considered part of the Direct Point Discharge category.

Red Hook CSOs

The Red Hook SPDES permitted CSO outfalls to the Gowanus Canal are RH-030, RH-030A, RH-031, RH-033, RH-034, RH-035, RH-036, RH-037 and RH-038. Outfall RH-034 contributes the most annual

CSO volume to the Gowanus Canal from the Red Hook CSS. The locations of the Red Hook SPDES CSO outfalls tributary to the Gowanus Canal are shown in Figure 2-2.

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 mix of the waste discharged to the system from domestic and non-domestic customers. Because the mix 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 bacteria to use in calculating loadings from various sources.

Previously collected citywide sampling data from the Inner Harbor Facility Planning Study (DEP, 1994), data for the EPA Harbor Estuary Program (HydroQual, 2005a), and data collected for other high density urban areas (DEP, 2014), was used to estimate the stormwater concentrations. The stormwater concentrations cited in Table 2-8 are based on the most recent data available.

A flow monitoring and sampling program targeting CSO contributing to the Gowanus Canal 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 waterbody.

Table 2-8. Stormwater Discharge Concentrations
Owls Head and Red Hook WWTP Service Areas

Constituent	Stormwater Concentration
$CBOD_5$ (mg/L) (1)	15
TSS (mg/L) (1)	20
Fecal Coliform Bacteria (cfu/100mL) (2,3)	120,000
Enterococci (cfu/100mL) (2,3)	50,000

Notes:
(1) HydroQual, 2005b.
(2) HydroQual Memo to DEP, 2005a.
(3) Bacterial concentrations expressed as “colony forming units” per 100mL.

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.

CSO concentrations were measured in 2014 to provide site-specific information for Outfalls RH-034, OH-007 and OH-026. The CSO overflow bacteria concentrations were characterized by direct measurements of Outfalls RH-034 (3 CSO events), OH-007 (4 CSO events) and OH-026 (4 CSO events) during various storms throughout August/September 2014. These concentrations are shown in Figures 2-7, 2-8 and 2-9, showing cumulative frequency distribution graphics. Individual sample points are shown, as well as the trend line that best fits the data distribution. For the Outfall RH-034 CSO discharges, measured fecal coliform concentrations are log-normally distributed, as is typical for this type of data, and values range from 54,600 to 2,500,000 cfu/100mL (Figure 2-7). Similarly, enterococci concentrations are also log-normally distributed and range from 40,000 to 1,700,000 cfu/100mL. For the Outfall OH-007 overflows, measured fecal coliform concentrations are log-normally distributed as well and values range from 72,700 to 6,000,000 cfu/100mL (Figure 2-8). Similarly, enterococci concentrations are also log-normally distributed and range from 70,000 to 8,000,000 cfu/100mL. In median terms, the CSO bacteria concentrations of both outfalls do not differ significantly. Lastly, for the Outfall OH-026 overflows, measured fecal coliform concentrations are again log-normally distributed, and values range from 36,300 to 3,900,000 cfu/100mL (Figure 2-9). Similarly, enterococci concentrations are also log-normally distributed and range from 32,000 to 500,000 cfu/100mL. In median terms, the CSO bacteria concentrations of Outfall OH-026 are lower than those of CSO Outfalls RH-034 and OH-007.

Flow monitoring data were collected for three CSO outfalls supporting the development of the Gowanus Canal LTCP. The Owls Head WWTP IW model calibration was supported by the peer-reviewed data gathered under the NYC CSO Pilot Monitoring Program encompassing the period of July 1, 2014 to October 15, 2014 for Outfall OH-007. Data for one wet-weather event at Outfall RH-034 that occurred on April 20, 2015 was used for verification of the prior calibration of the IW model representing the Red Hook WWTP collection system. The reason for a verification based on a single event is related to the date upon which this latter data became available. Additionally, flow monitoring data was collected at Outfall OH-026. However, such data was not included in the IW model calibration because this outfall recently had been reclassified as a CSO outfall. Corresponding updates to the IW model of the Owls Head collection system will be conducted within the scope of future CSO planning efforts.

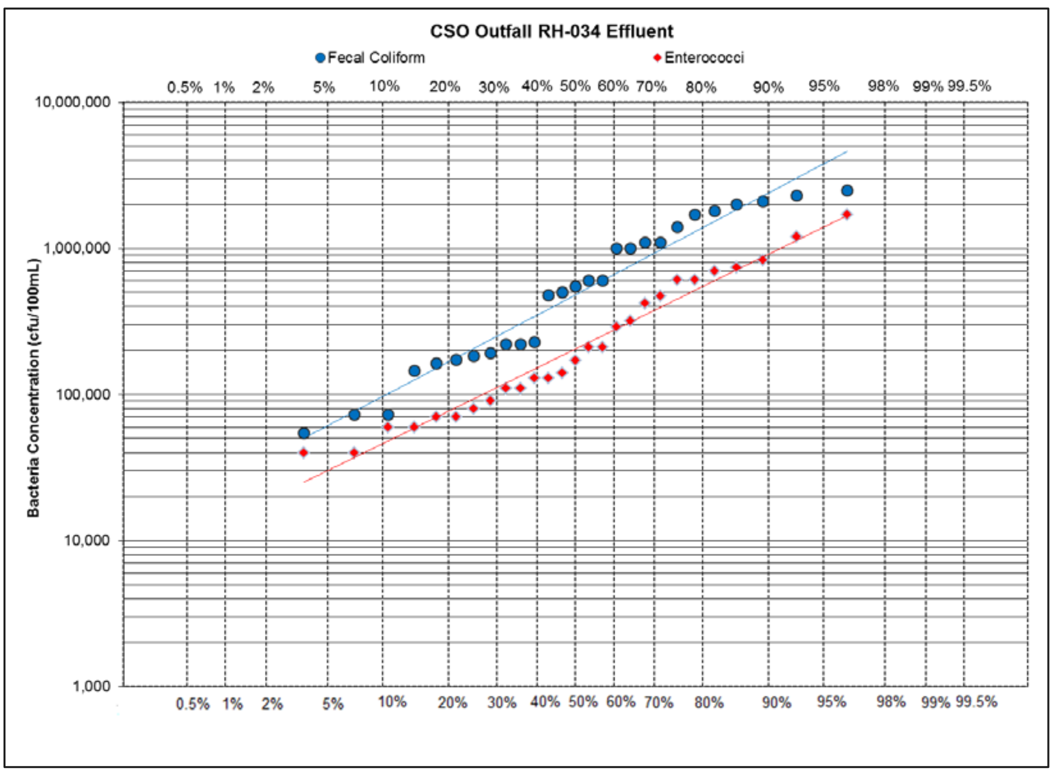

Figure 2-7. Outfall RH-034 Effluent Bacteria Concentrations

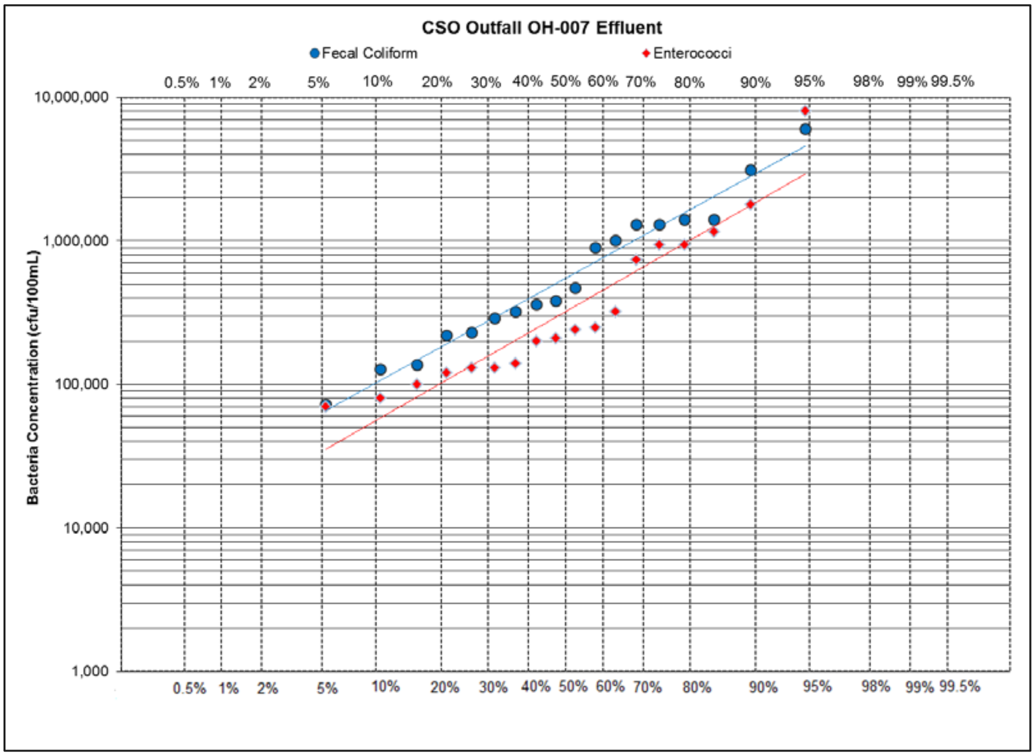

Figure 2-8. Outfall OH-007 Effluent Bacteria Concentrations

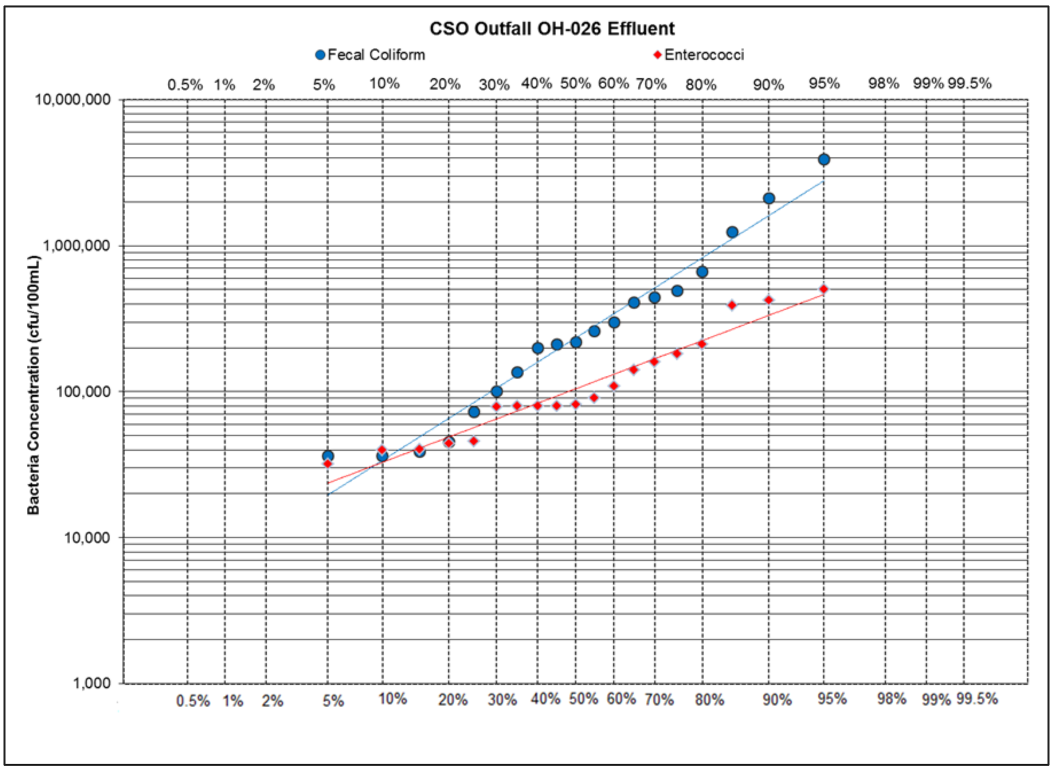

Figure 2-9. Outfall OH-026 Effluent Bacteria Concentrations

Stormwater discharge concentrations are assigned an event mean concentration (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 Gowanus Canal from the separate stormwater collection systems. Previously collected citywide sampling data from the Inner Harbor CSO Facility Planning Study (DEP, 1994), data for the EPA Harbor Estuary Program (HydroQual, 2005a), and data collected recently for other high density urban areas, was combined to develop these stormwater concentrations (DEP, 2014). The IW sewer system model (Section 2.1.a.5) is used to generate the flows from NYC storm sewer outfalls and concentrations noted in Table 2-8 are associated with the flows used to develop loadings.

Sampling, data analyses, and water quality modeling calibration resulted in the assignment of flows and loadings to these sources for inclusion in the calibration/validation of the water quality model for the November 2013 to October 2014 period.

The recently upgraded Flushing Tunnel significantly affects the water quality in the Gowanus Canal. The tunnel draws from the Buttermilk Channel and releases the water at the head of the Gowanus Canal. The water quality of the flow released at the head of the Gowanus Canal is provided by the Regional Model which is used extensively to simulate water-quality conditions in the New York Bay, checked against measurements.

Table 2-9. Gowanus Canal Source Loadings Characteristics

Source	Flow	Enterococci (cfu/100mL)	Fecal Coliform (cfu/100mL)	BOD-5 (mg/L)
Stormwater	IW	50,000	120,000	15
CSOs (based on Outfalls RH-034,OH-007 and OH-026)	IW	Monte Carlo	Monte Carlo	78
Direct Drainage	IW	6,000	4,000	15
Flushing Tunnel	Variable[(1)]	Regional Model	Regional Model	Variable[(2)]

Notes:
(1) Flows for the November 2014 through October 2014 model calibration/validation period represent the turn-on and ramp-up operations of the Flushing Tunnel based on operations and measurements, varying as a function of tidal conditions. Flushing Tunnel flows for projection purposes represent full design and current operations. Concentrations for the Flushing Tunnel are based on calculations developed using a Regional Water Quality Model of the entire NY Harbor complex.
(2) Harbor survey measurements were used to define monthly varying concentrations which constrain modeled particulate organic carbon (POC) and dissolved organic carbon (DOC) concentrations.

2.1.c.3 Hydraulic Analysis of Sewer System

A citywide hydraulic analysis was completed in December 2012 (an excerpt of which is included in this subsection), to provide further insight into the hydraulic capacities of key system components and system responses to various wet-weather conditions. 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 Owls Head and Red Hook WWTPs 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 two model input conditions – the recalibrated model conditions as described in the December 2012 IW Citywide Recalibration Report, and the Cost-Effective Grey (CEG) alternative defined for the service area. The CEG elements represent the CSO controls that became part of the 2012 CSO Order on Consent. For these simulations, the primary input conditions applied were as follows:

- Projected 2040 DWF conditions.
- 2008 tides and precipitation data.
- Owls Head WWTP at 2xDDWF capacity of 240 MGD and Red Hook WWTP at 2xDDWF capacity of 120 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.

The CEG conditions applicable to both service areas included the Avenue V Pump Station upgrade in the Owls Head service area and those applicable to the Red Hook service area included inflatable dams in the Regulator R-20 drainage area, upgrading of Gowanus Pump Station to 30 MGD capacity, and associated construction of a new force main to send flows directly to the interceptor.

Key observations/findings are summarized below:

- Simulation of the 2008 annual rainfall year resulted in a prediction that the Owls Head WWTP would operate at its 2xDDWF capacity for 105 hours under the no-CEG condition. When the CEG conditions were applied in the model, the annual number of hours at 2xDDWF remained about the same - at 98 hours.
- Simulation of the 2008 annual rainfall year resulted in a prediction that the Red Hook WWTP would operate at its 2xDDWF capacity for 136 hours under the no-CEG condition. When the CEG conditions were applied in the model, the annual number of hours at 2xDDWF increased to 152 hours.

- The total volume (dry- and wet-weather combined) treated annually at the Owls Head plant for the 2008 non-CEG condition was predicted to be about 38,064 MG, while the 2008 with CEG condition resulted in a prediction that 38,074 MG would be treated at the plant – an increase of 10MG.

- The total volume (dry- and wet-weather combined) treated annually at the Red Hook plant for the 2008 non-CEG condition was predicted to be about 12,976MG, while the 2008 with CEG condition resulted in a prediction that 13,096 MG would be treated at the plant – an increase of 120 MG.

- The total annual CSO volume predicted for the outfalls in the Owls Head service area were as follows:
  - 2008 non-CEG: 2,198 MG
  - 2008 with CEG: 2,196MG

- The total annual CSO volume predicted for the outfalls in the Red Hook service area were as follows:
  - 2008 non-CEG: 813 MG
  - 2008 with CEG: 758 MG

The above results indicate a slight decrease in the number of hours at the 2xDDWF operating capacity for Owls Head WWTP, while for Red Hook WWTP the above results indicate an increase in the number of hours at the 2xDDWF operating capacity.

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 models. 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 models WWFP conditions, and the second with the CEG conditions implemented. The maximum flow rates and maximum depths predicted by the models 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.

- For the single storm event simulated, the model predicted that 55.8 percent (by length) of the interceptor sewer segments in the Owls Head service area would exceed full-pipe capacity flow, while about 42.8 to 44.3 percent (by length) of the upstream combined sewers would exceed their full-pipe flow.
- For the single storm event simulated, the model predicted that about 33 percent (by length) of the interceptor sewer segments in the Red Hook service area would exceed full-pipe capacity flow, while about 45 percent (by length) of the upstream combined sewers would exceed their full-pipe flow.
- 100 percent (by length) of the interceptors in the Owls Head service area were predicted to flow at full depth or higher. Between 76.1 and 78.9 percent (by length) of the combined sewers were also predicted to flow at full depth, indicating that many of these sewers experienced backwater conditions from the downstream sewer (and interceptor) system as a result of either pipe or plant capacity limitations.
- 100 percent (by length) of the interceptors in the Red Hook service area were predicted to flow at full depth or higher under both the CEG and non-CEG scenarios and about 55 and 70 percent (by length) of the combined sewers were also predicted to flow at full depth, for the non-CEG and CEG scenarios, respectively. Many of these sewers experience some backwater conditions from the downstream sewer (and interceptor) system as a result of either pipe or plant capacity limitations.
- The length of sewers that did not reach full depth under the CEG simulations (about 21 to 24 percent) in the Owls Head service area.
- The length of sewers that did not reach full depth under the CEG simulations (about 30 percent) indicates there is some potential for in-line storage capability in the Red Hook service area.
- The results for the system condition without CEG improvements were nearly the same as the system condition that included CEG improvements in the Owls Head service area.
- The results for the system conditions without CEG improvements showed that the CEG elements will improve the system conditions to convey flows to 2xDDWF in the Red Hook service area; the number of hours at which the 2xDDWF rate was achieved increased as a result of the CEG improvements.

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 Gowanus Canal watershed. DEP conducts regular sewer inspections and cleaning as reported in the SPDES BMP Annual reports. Figure 2-10 shows the sewers inspected and cleaned throughout 2014 in the Borough of the Brooklyn.

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 Systems (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. Figure 2-10 illustrates the intercepting sewers that were inspected in the Borough of Brooklyn, encompassing the entire Gowanus Canal watershed. Throughout 2014, 5,156 feet of Owls Head WWTP intercepting sewers were inspected leading to a removal of 115 cubic yards of sediment and 5,732 feet of Red Hook WWTP intercepting sewers were inspected leading to a removal of 21 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 Gowanus Canal watershed is served by the Owls Head WWTP and Red Hook WWTP service areas.

The Red Hook WWTP was constructed in 1987 to provide secondary treatment for a design flow of 60 MGD. Current treatment includes preliminary treatment, primary settling, secondary treatment (activated sludge, step-feed aeration), and disinfection (sodium hypochlorite). Sludge is treated by gravity thickening, anaerobic digestion and dewatering by centrifuge prior to transport to a landfill for disposal. It serves an area of 3,200 acres, throughout the northwest section of Brooklyn, as well as Governor's Island.

The Owls Head WWTP was constructed in 1952. The treatment system was upgraded in 1995 and provides secondary treatment for a design flow of 120 MGD. Current treatment includes preliminary treatment, primary settling, secondary treatment (activated sludge, step-feed aeration), and disinfection (sodium hypochlorite). Sludge is treated by gravity thickening and anaerobic digestion prior to off-site transportation to a landfill for disposal. It serves an area of 13,664 acres and a population of 780,000 throughout the Borough of Brooklyn.

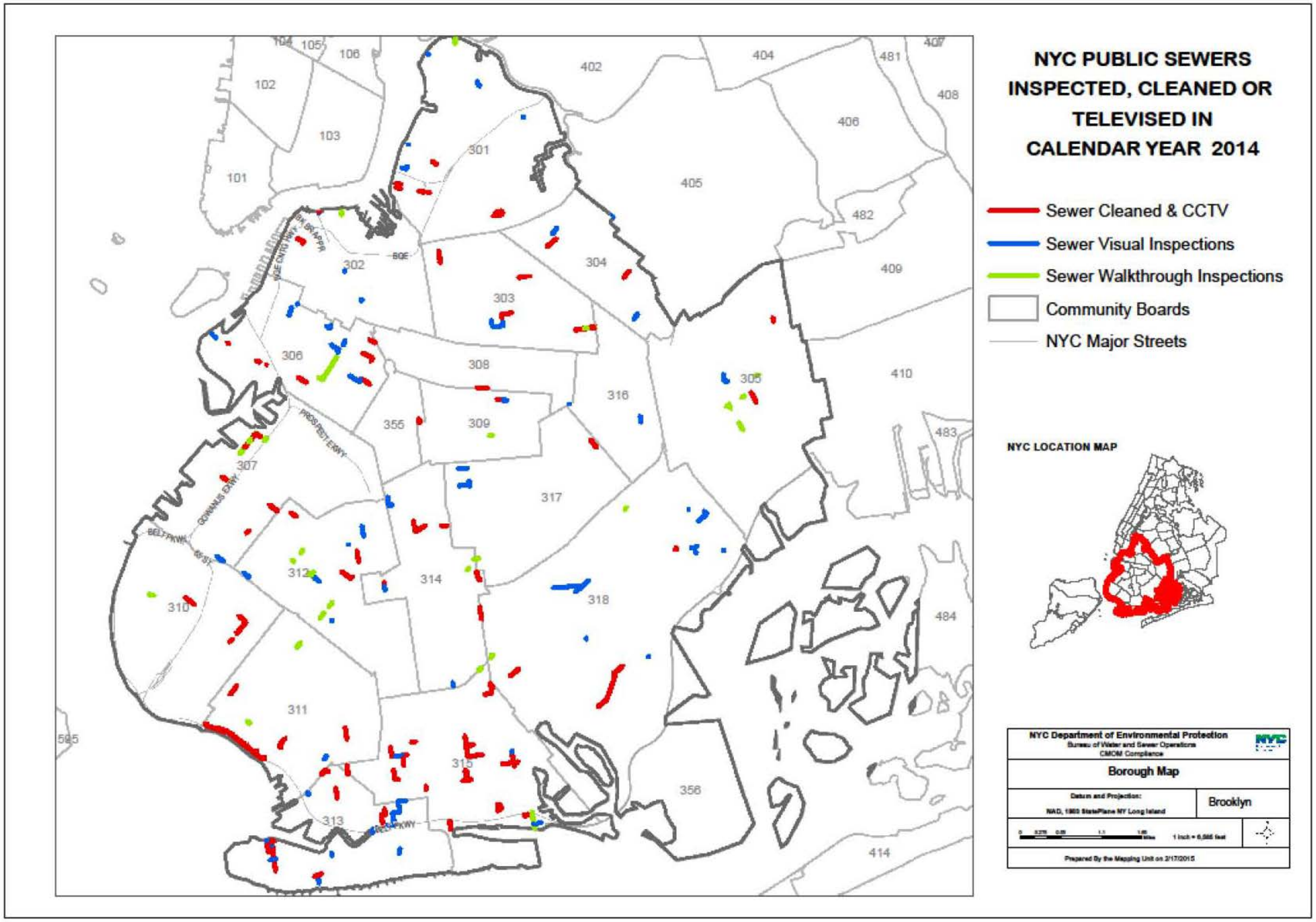

Figure 2-10. Sewers Inspected and Cleaned in Brooklyn Throughout 2014

2.2 Waterbody Characteristics

This section of the report describes the features and attributes of the Gowanus Canal. Characterizing the features of this waterbody is important for assessing the impact of wet-weather inputs and creating approaches and solutions that mitigate the impact from wet-weather discharges.

2.2.a Description of Waterbody

Gowanus is a saline waterbody located in Brooklyn, New York. The Gowanus Canal is tributary to Gowanus Bay, and the Bay is tributary to the Upper New York Bay. Water quality in the Gowanus Canal is influenced by the Flushing Tunnel continuous release of 215 MGD of East River water, as well as CSO and stormwater discharges. (See Section 4 for further description of the Flushing Tunnel.) The following section describes the present-day physical and water-quality characteristics of the Gowanus Canal, along with its existing uses.

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, the State of New York 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 Gowanus Canal as a Class SD waterbody. Numerical bacteria criteria do not apply to Class SD waters.

Numerical standards corresponding to these waterbody classifications are shown in Table 2-10. DO is the numerical criteria that DEC uses to establish whether a waterbody supports aquatic life uses. Total and fecal coliform bacteria concentrations are the numerical criteria that DEC uses to establish whether a waterbody supports recreational uses. In addition to numerical criteria, 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.

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 Beaches Environmental Assessment and Coastal Health (BEACH) Act, the criterion applies on a 30-day moving GM basis during recreational season (May 1st through October 31st). Furthermore, the Gowanus Canal waters are not considered coastal recreational waters; therefore, this criterion would not apply 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.

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

Class	Usage	Dissolved Oxygen (mg/L)	Total Coliform (cfu/100mL)	Fecal Coliform (cfu/100mL)	Enterococci (cfu/100mL)(7)
SA	Shellfishing for market purposes, primary and secondary contact recreation, 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, 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.,

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

(2) Acute standard (never less than 3.0 mg/L).
(3) Colony forming unit per 100mL 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 NYS since the 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.

The Gowanus Canal LTCP evaluates compliance with various primary contact water quality numerical limits including the Primary Contact WQ Criteria for fecal coliform. With DEC's December 3, 2014 proposed rulemaking to change Class SD fecal coliform bacteria criteria to 200 cfu/100mL, the term Class SD criteria used in this LTCP is interchangeable with the proposed Class I and Class SC numerical criteria when used in the context of bacteria water quality limits.

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 saline waters of greater NYC. The Gowanus Canal is an interstate water and is regulated by IEC as Class B-1 waters. Numerical standards for IEC-regulated waterbodies are shown in Table 2-12, while narrative standards are shown in Table 2-13.

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 State WQS, the three-tiered IEC system and the five NYS saline classifications in New York Harbor do not spatially overlap exactly.

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.

Table 2-12. IEC Numeric WQS

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. IEC Narrative Regulations

Classes	Regulation
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, color or turbidity to the extent that none of the foregoing shall be noticeable in the water or deposited along the shore or on 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.

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 is 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 a pollution event.

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 Gowanus Canal 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 Primary Contact WQ Criteria. The LTCP analyses for the Gowanus Canal were therefore based on the enterococci numerical criteria associated with EPA's RWQC Recommendation 2.

2.2.a.2 Physical Waterbody Characteristics

The Gowanus Canal is located in Brooklyn, NY. The Gowanus Canal opens into the southeast end of Gowanus Bay. Gowanus Bay opens to the Upper New York Bay, between the Erin Basin and the SBMT. The Bay and the Gowanus Canal have a navigational channel maintained by the U.S. Army Corps of Engineers (USACE) extending from the Gowanus Bay to Hamilton Avenue Bridge.

The Gowanus Canal is located at the northeastern end of Gowanus Bay. The saline tributary runs southward and its mouth opens to Gowanus Bay. The shoreline is bulkheaded or rip-rap protected throughout most of its extension and the land use immediately surrounding the Gowanus Canal is primarily industrial.

The Gowanus Canal is within the Coastal Zone Boundary as designated by the DCP.

Shoreline Physical Characterization

The shorelines of the Gowanus Canal are bulkheaded or rip-rap protected throughout most of the extension of the Gowanus Canal as shown in Figures 2-11 and 2-12.

Shoreline Slope

The Gowanus Canal shoreline is bulkheaded or rip-rap protected throughout most of its extension. There are no significant natural slopes along the shoreline.

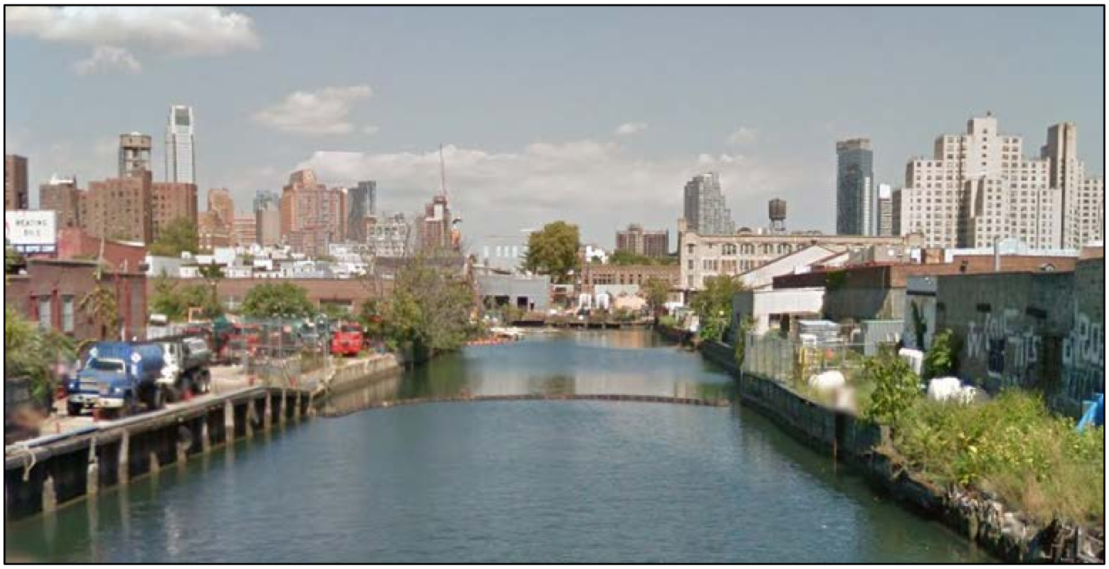

Figure 2-11. Shoreline View of Gowanus Canal (Looking North Near the Head)

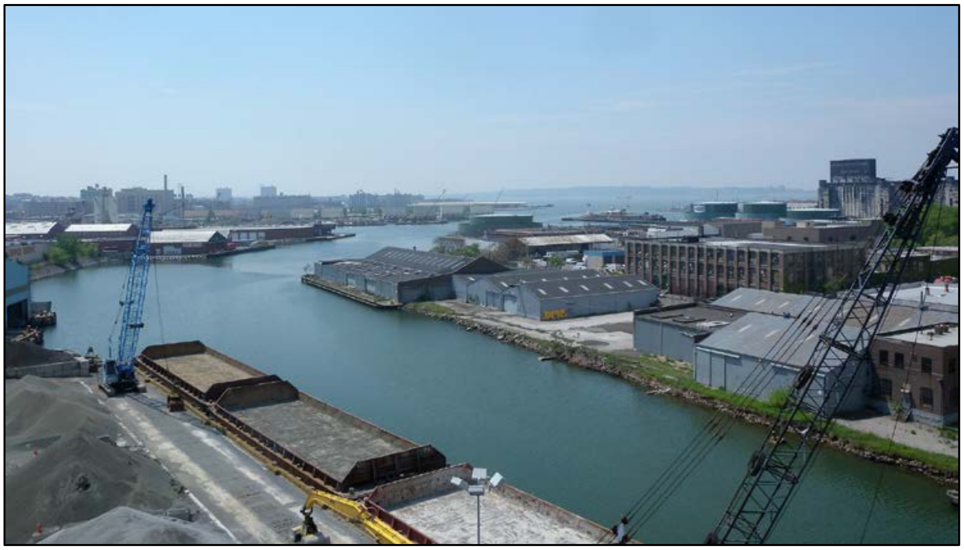

Figure 2-12. Shoreline View of Gowanus Canal (Looking South Near the Mouth)

Waterbody Sediment Surficial Geology/Substrata

According to the Feasibility Study Report Addendum prepared for EPA (CH2MHILL, 2012), the physical and chemical characteristics of the shallow sediments in the upper reach of the Gowanus Canal more closely resemble CSO solids than reference sediments from Gowanus Bay and Upper New York Bay. Shallow sediments (i.e., 0-2 foot depth interval) in the upper reach of the Gowanus Canal were deposited after the period of greatest industrial activity in the Gowanus Canal. Industrial use of the Gowanus Canal peaked in the 1930s, declined until the 1940s, stabilized at a lower level until the mid-1960s, and then declined from the mid-1960s to the present (Hunter Research, 2004). The upper reach of the Gowanus Canal was last dredged to a depth of 7 feet in 1975 (except for a small area near the Flushing Tunnel outlet that was dredged in 1999). Overall, the percentage of sand found in the surface and shallow sediments decreased in the downstream direction within the upper reach, from the head of the Gowanus Canal to 3rd Street.

USACE records indicate that the navigation channel, generally extending from Gowanus Bay to the Hamilton Avenue Bridge, was last dredged by the USACE in 1971.

Waterbody Type

The Gowanus Canal is a saline tributary. It receives flow from the Flushing Tunnel and freshwater contributions from stormwater and CSOs.

Freshwater Systems Biological Systems

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

Tidal/Estuarine Wetlands

There are no tidal/estuarine wetlands reported by the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) maps throughout the Gowanus Canal study area.

2.2.a.3 Current Public Access and Uses

In the Gowanus Canal, swimming (primary contact recreation use) is not an existing sanctioned use. Furthermore, secondary contact recreation opportunities are limited mainly due to the access restrictions imposed by the physical characteristics of the shoreline and surrounding land uses. However, there are three identified access points along the Gowanus Canal as shown in Figure 2-13.

The boat/kayak launch at the 2nd Street is highly used for recreational activities by different public groups (Figure 2-14).

Lowe’s walkway with seating (Figure 2-15) along the Gowanus Canal between 9th and 11th Streets was built voluntarily by Lowe’s in conjunction with construction of the store.

Shore public walkway along the Gowanus Canal and the 4th Street Basin between 3rd Street Bridge and 3rd Avenue Bridge, with lighting, seating and other amenities was built in conjunction with the development of Whole Foods Store 9 (Figure 2-16). The resulting total waterfront public access area is 36,080 square feet.

Figure 2-13. Access Points to the Gowanus Canal

Figure 2-14. 2nd Street Boat Launch at Gowanus Canal

Figure 2-15. Lowe's Walkway with Sitting at the Gowanus Canal

Figure 2-16. Whole Foods Walkway with Seating at the Gowanus Canal

2.2.a.4 Identification of Sensitive Areas

Federal CSO Policy requires that the LTCP 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;
- Water with primary contact recreation;
- Waters with threatened or endangered species and their habitat; and
- Additional areas determined by the Permitting Authority (i.e., DEC).

General Assessment of Sensitive Areas

An analysis of the waters of the Gowanus Canal with respect to the CSO Policy was conducted and is summarized in Table 2-15.

Table 2-15. Sensitive Areas Assessment

CSO Discharge Receiving Water Segments	Current Uses Classification of Waters Receiving CSO Discharges Compared to Sensitive Areas Classifications or Designations(1)							
	Outstanding National Resource Water (ONRW)	National Marine Sanctuaries(2)	Threatened or Endangered Species and their Habitat (3)	Primary Contact Recreation	Public Water Supply Intake	Public Water Supply Protected Area	Shellfish Bed	Additional Area Determined by Permitting Authority
Gowanus Canal	None	None	No	No(4)	None(5)	None(5)	None	Yes(6)

Notes:

(1) Classifications or Designations per CSO Policy.
(2) NOAA.
(3) Department of State - Significant Coastal Fish and Wildlife Habitats.
(4) Existing uses include fish and wildlife survival, Class SD.
(5) These waterbodies contain salt water.
(6) Targeted for regional watershed management plan by DEC (2005).

The Gowanus Canal was targeted for a regional watershed management plan by DEC in 2005. This last item in the list was derived from the policy statement that the final determination should be the prerogative of the NPDES Permitting Authority. The Natural Resources Division of DEC was consulted during development of the assessment approach, and provided additional sensitive areas for CSO abatement prioritization based on local environmental issues (Vogel, 2005). Their response listed the following: Jamaica Bay; Bird Conservation Areas; Hudson River Park; “important tributaries” such as the Bronx River in the Bronx, and Mill, Richmond, Old Place, and Main Creeks in Staten Island; the Raritan Bay shellfish harvest area; and waterbodies targeted for regional watershed management plans (the Newtown Creek and the Gowanus Canal). Designation of the Gowanus Canal as a whole does not assist in prioritizing outfalls or evaluating alternatives to address CSO discharges within the waterbody itself. Therefore, prioritization of outfalls within the waterbody and the selection and implementation of CSO control alternatives can be driven by those alternatives that most reasonably attain maximum benefit to water quality.

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 program 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 dramatically 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.

The HSM program focuses on fecal coliform bacteria, DO and Secchi disk transparency as the water quality parameters of concern. Data are presented in four sections, each delineating a geographic region within the Harbor. The Gowanus Canal is located within the Upper New York Bay (HR-Upper New York Bay) section. This area contains 12 open-water monitoring stations and eight tributary sites. Figure 2-17 shows the location of Stations GC3, GC4, GC5, GC6 and G2 of the HSM tributaries program.

Fecal coliform and enterococci are indicators of human waste and pathogenic bacteria. According to data (collected between January 2013 and June 2014), fecal coliform annual geometric means representative of all-weather conditions are above the existing, non-designated primary contact bacteria criteria at Stations GC3, GC4, GC5 and GC6, with values of 888 cfu/100mL, 1054 cfu/100mL, 714 cfu/100mL and 473 cfu/100mL, respectively. The fecal coliform annual all weather geometric mean for the same time frame is below the existing non-designated primary contact bacteria at Station G2 with a value of 75 cfu/100mL. The computed enterococci GMs are 325 cfu/100mL, 319 cfu/100mL, 192 cfu/100mL, 97 cfu/100mL and 12 cfu/100mL for Stations GC3, GC4, GC5, GC6 and G2, respectively.

DO is the oxygen in a waterbody available for aquatic life forms. Hypoxia is a water quality condition associated with low DO, and occurs when DO levels fall below 3.0 mg/L. DO measurements below 3.0 mg/L were recorded at Stations GC3, GC4 and GC5 in the Gowanus Canal during the summer period, also consistent with observations from prior summers.

Secchi disk transparency is a measure of the clarity of surface waters. Clarity is measured as a depth when the Secchi disk blends in with the water and is no longer visible. Clarity is most affected by the concentrations of suspended solids and plankton. Lack of clarity limits sunlight, which inhibits the nutrient cycle. The average summer Secchi depth for Station G2 was 4.2-ft. Secchi readings were not collected for Stations GC3, GC4, GC5 and GC6.

For the period post-Flushing Tunnel reactivation, from July 2014 to February 2015, the Harbor Survey data shows significant improvements in water quality along the Gowanus Canal. The fecal coliform annual geometric means representative of all-weather conditions are below the existing non-designated primary contact criterion with values of 148 cfu/100mL and 43 cfu/100mL at Stations GC3 and G2, respectively. The geometric means were above the criteria with values of 200 cfu/100mL, 211 cfu/100mL and 337 cfu/100mL at Stations GC4, GC5 and GC6, respectively. The computed enterococci GMs are 42 cfu/100mL, 52 cfu/100mL, 65 cfu/100mL, 62 cfu/100mL and 5 cfu/100mL for Stations GC3, GC4, GC5, GC6 and G2, respectively.

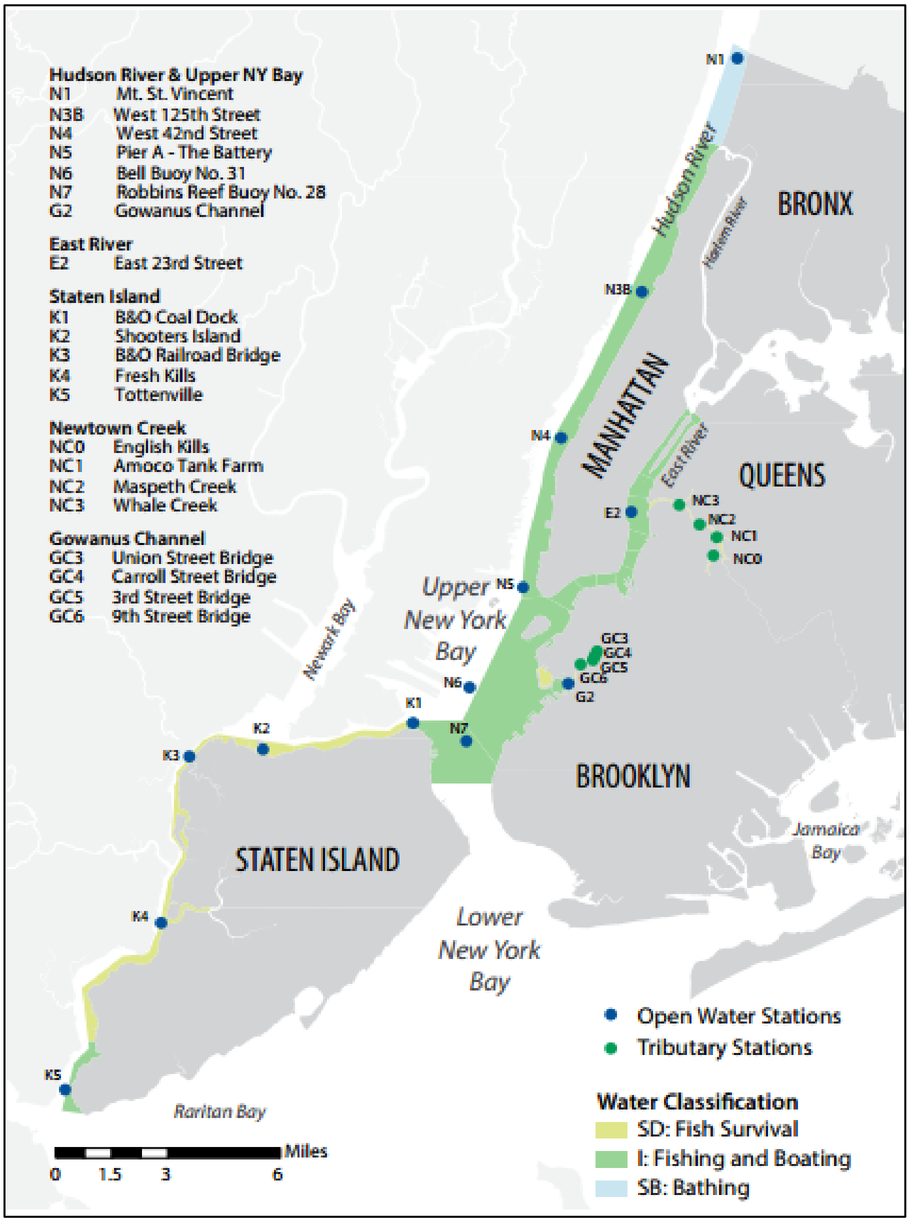

Figure 2-17. Harbor Survey HR-Upper New York Bay Region

For the period from July 2014 to February 2015, post-Flushing Tunnel reactivation, the average surface DO at Station GC3 was measured at 8.42 mg/L, while the average bottom DO was measured at 8.18 mg/L. For Station GC4, surface average DO was measured at 8.03 mg/L, while the average bottom DO was measured at 7.74 mg/L. For Station GC5, surface average DO was measured at 7.79 mg/L, while the average bottom DO was measured at 7.60 mg/L. For Station GC6, surface average DO was measured at 7.01 mg/L, while average bottom DO was measured at 6.25 mg/L. For Station G2, surface average DO was measured at 6.46 mg/L, while average bottom DO was measured at 6.00 mg/L.

During summer months, the Gowanus Canal waters met their classification requirement. No DO measurements below 3.0 mg/L were taken at Stations GC3, GC4, GC5, GC6 and G2 in the Gowanus Canal during the summer period of 2014. The average summer Secchi depth for Station G2 was 4.4-ft. Secchi disk readings were not collected for Stations GC3, GC4, GC5 and GC6.

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

Data collected within the Gowanus Canal are available from sampling conducted by DEP's HSM program from 2006 to 2015, and from intensive sampling conducted from July to September 2014 (Table 2-16), supporting the development of the LTCP. The sampling locations of both sampling programs are depicted in Figure 2-18. Figures 2-19 and 2-20 show the GM of both datasets over the concurrent sampling period (July to September 2014) along with data ranges (minimum to maximum and 25th percentile to 75th percentile) for fecal coliform and enterococci, respectively. For reference purposes, the figures also show the monthly, non-designated Primary Contact WQ Criteria GM for fecal coliform and enterococci, respectively.

Table 2-16. Number of Bacteria Samples
Collected for the Period of July – September 2014

Sampling Program	Fecal Coliform No. of samples	Enterococci No. of samples
LTCP2	598	598
Harbor Survey Monitoring	71	71
Sentinel Monitoring	1	0
Third Party Data	0	30

Samples were collected at Station GC-11 to capture the water quality parameters of the flow conveyed through the Flushing Tunnel and discharged at the head of the Gowanus Canal. The bacteria concentrations measured at Station GC-11 are shown in Figures 2-19 and 2-20.

Overall, the fecal coliform levels measured throughout the LTCP sampling program period resulted in geometric means generally uniform and below that of the non-applicable primary contact monthly GM criterion for fecal coliform (200 cfu/100mL), except at Stations GC-6 and GC-7, for wet-weather, as shown in Figure 2-19. These wet-weather excursions above the numerical criterion are explained by the CSO and stormwater impacts typical of wet-weather conditions. Similarly, wet-weather upper excursions at these locations are seen for the enterococci levels measured as well, as seen in Figure 2-20.

Available third party data collected (July through September, 2014) by Riverkeeper and Citizen Testing Group has been analyzed. The data include enterococci results for four sampling locations in the Gowanus Canal. Overall, the third party data collected from July to September was comparable to concurrent LTCP and HSM data for both wet- and dry-weather conditions. These data were included in the calibration processes described in later sections.

The LTCP and HSM sampling results also show that DO concentration in the Gowanus Canal improved significantly with the reactivation of the Flushing Tunnel. Figure 2-21 depicts the average DO measured at the LTCP and HSM sampling stations throughout the sampling period (July through September 2014). The data shows average DO above 6.0 mg/L at all stations and no single measurements below 4.0 mg/L.

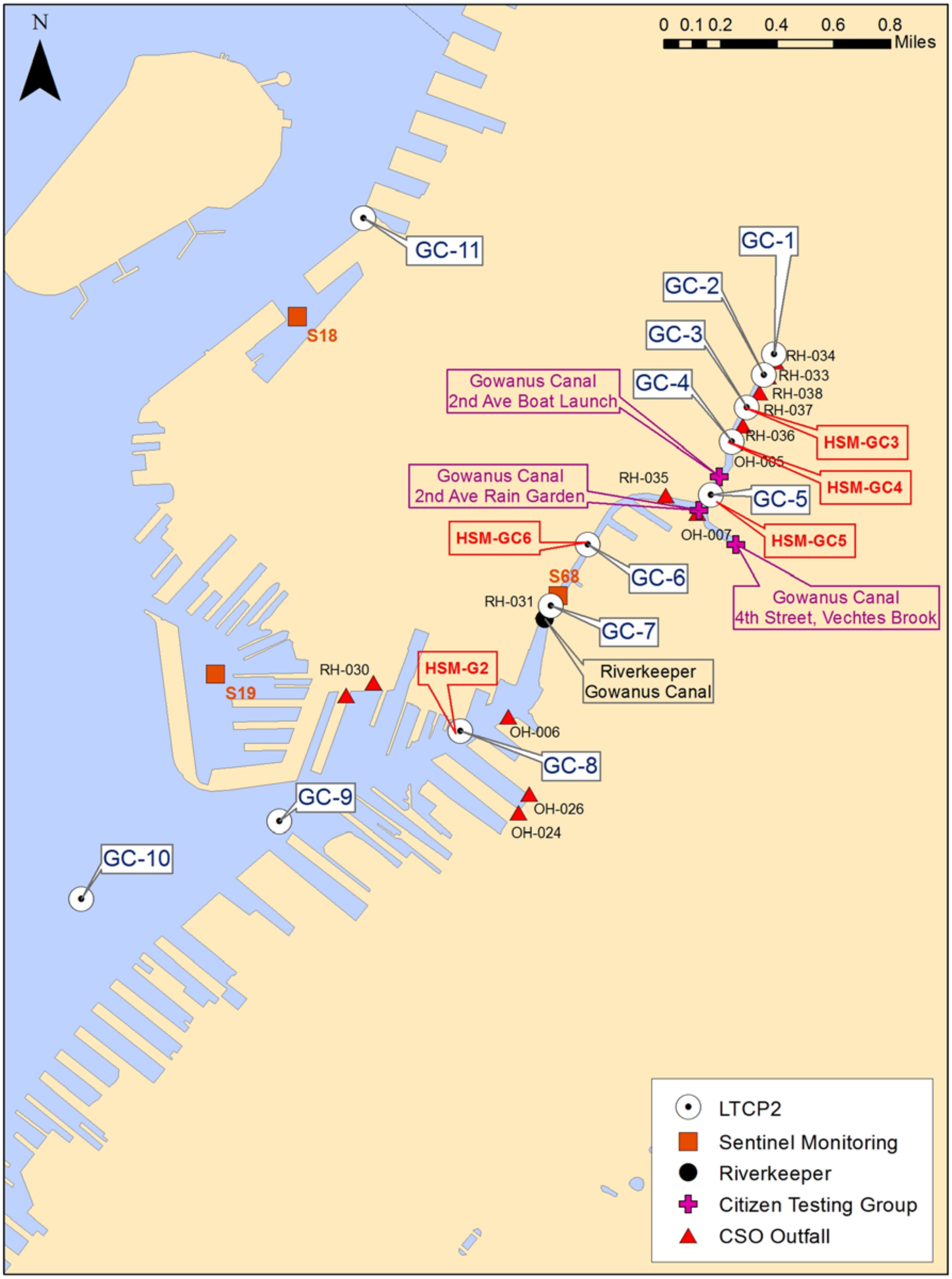

Figure 2-18. Sampling Stations of Various Sampling Programs at Gowanus Canal

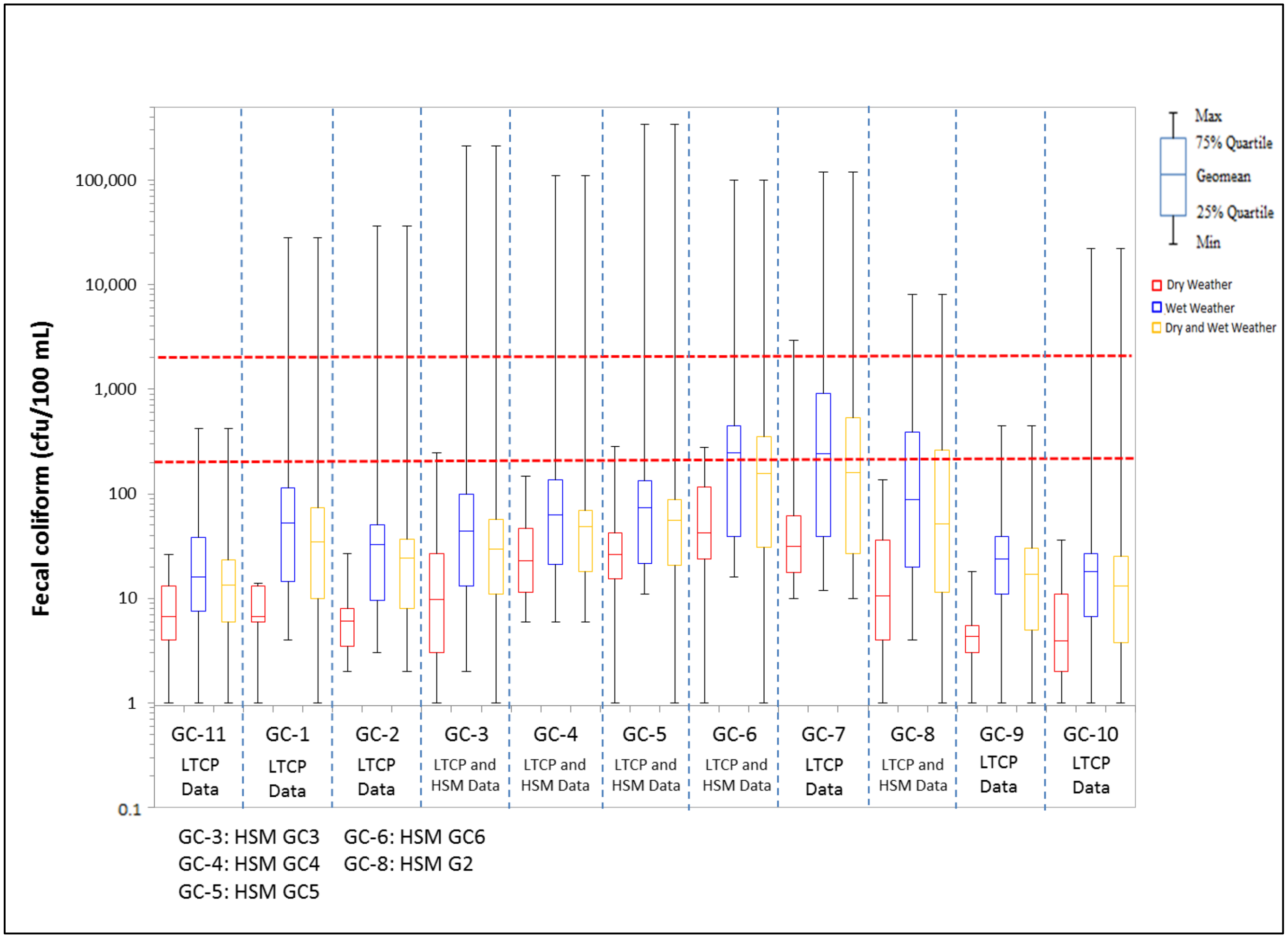

Figure 2-19. Fecal Coliform Data from LTCP and HSM - Gowanus Canal (July – September 2014)

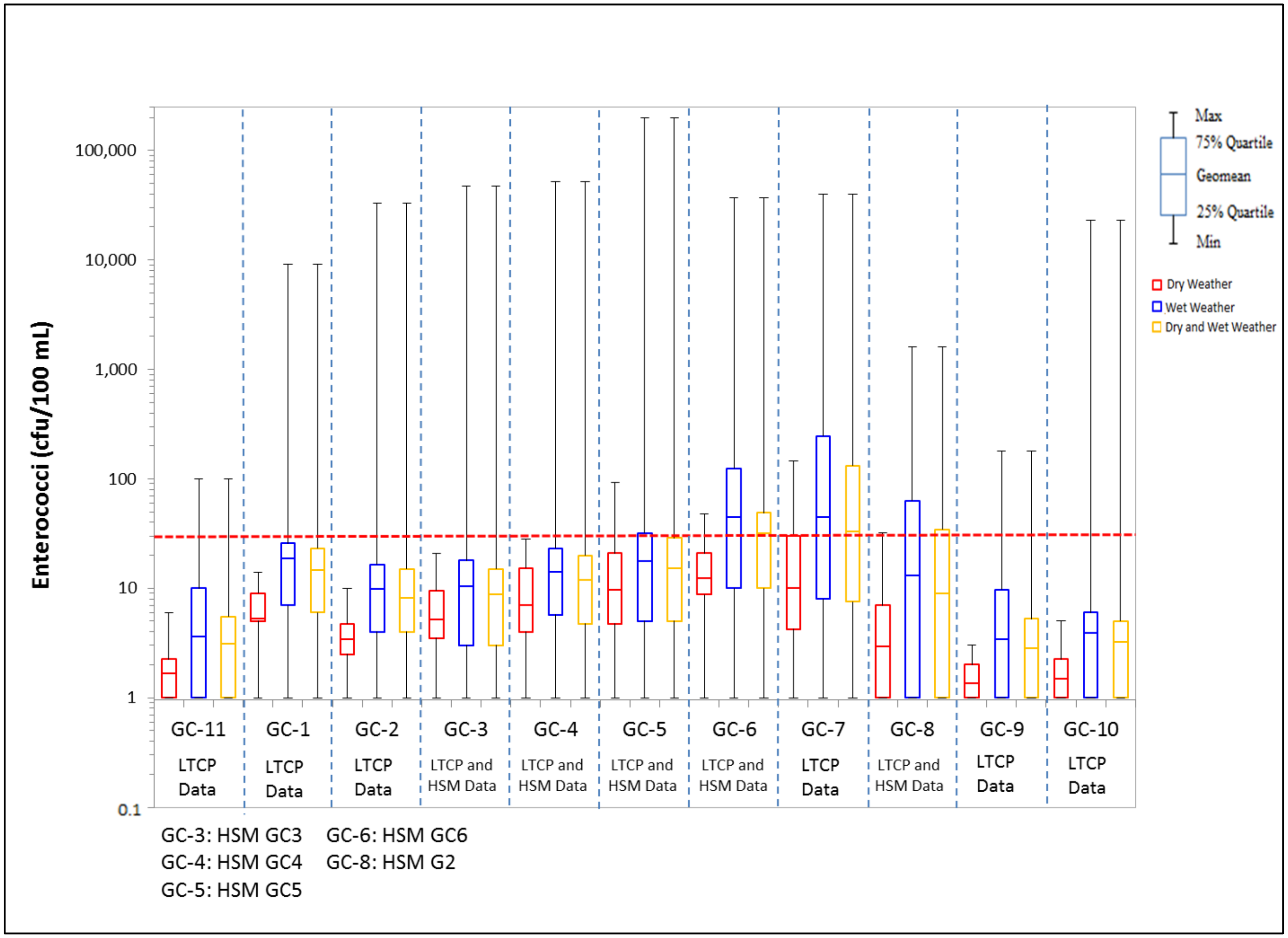

Figure 2-20. Enterococci Data from LTCP and HSM - Gowanus Canal (July – September 2014)

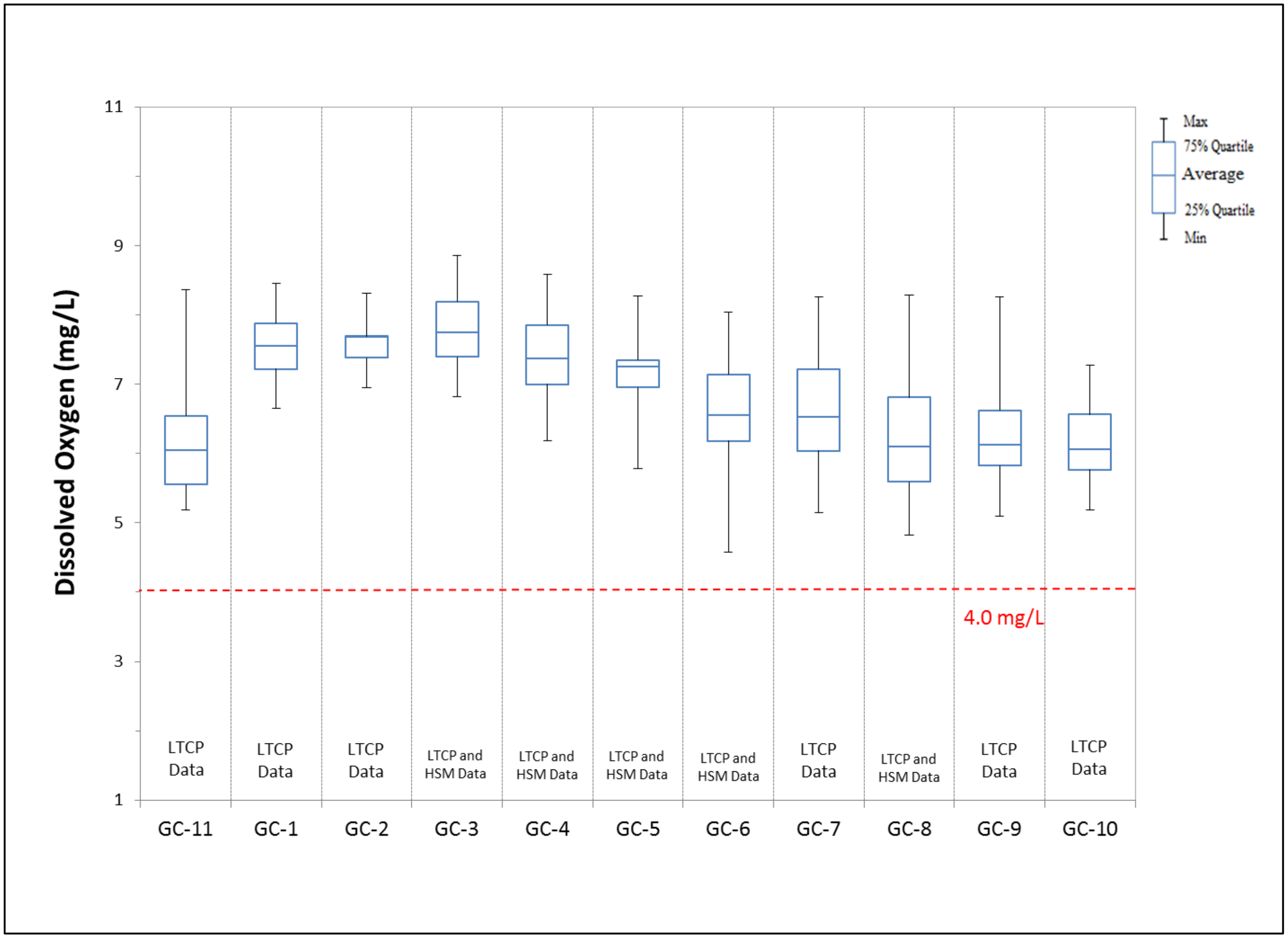

Figure 2-21. DO Data from LTCP and HSM - Gowanus Canal (July-September 2014)

2.2.a.7 Water Quality Modeling

In addition to the collection, compilation, and analysis of measurements described in Section 2.2.a.6, water quality modeling was also used to characterize and assess the Gowanus Canal water quality. A model computational grid was developed for the LTCP to represent the Gowanus Canal at a higher resolution than had been used for modeling supporting previous waterway planning. The model computational grid, shown in Figures 2-22 and 2-23, was used for LTCP hydrodynamic, pathogens, and dissolved oxygen modeling. The calibration and validation of these water quality models using measurements collected and compiled from November 1, 2013 to October 31, 2014 is described in the Gowanus Canal LTCP Sewer System and Water Quality Modeling Report (DEP, 2015). The measurements used for model calibration and validation include LTCP, DEP Harbor Survey, Citizen Testing Group and Riverkeeper data, with wet-weather volumetric loading information from validated InfoWorks models. Once calibrated and validated, the water quality models were used to aid in the assessment of water quality benefits associated with LTCP CSO control alternatives as will be presented in Sections 6 and 8.

The Gowanus Canal water quality models were peer reviewed by a panel of internationally renowned modeling experts convened by NYC. The peer review panel met seven times over the course of model development, calibration/validation, and application, providing continual feedback and guidance. A written report being prepared by the peer review panel, expected to be available in July 2015, will document the modeling peer review process and conclusions. The peer review experts are listed below:

- Alan Blumberg -Stevens Institute of Technology; Hydrodynamics
- Steven Chapra - Tufts University; Water Quality and Contaminant Fate and Transport
- Joseph Gailani - USACE Engineer Research and Development Center; Sediment Transport

Figure 2-22. Computational Grid for Gowanus Canal Water Quality Modeling, Full View

Figure 2-23. Computational Grid for Gowanus Canal Water Quality Modeling, Zoomed-In View

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 CSO Policy, and were developed by 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.

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

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;
- 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 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 Biological Nutrient Removal (BNR) processes, if required.

As required by the 2014 CSO BMP Order on Consent, DEP resubmitted all WWOPs, including the Owls Head WWTP WWOP and Red Hook WWTP WWOP, to DEC in December 2014. DEC has not yet responded to those submittals.

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 regulators and pump stations reveal that there were dry-weather flows to the Gowanus Canal due to a pump station bypass in 2014. The event took place at the Red Hook-Gowanus PS bypass on February 9, 2013, due to failure of a generator that overheated.

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 NYSDOH 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. According to the 2014 BMP Annual Report, DEP has proposed HLSS in the Gowanus area of Brooklyn. The project is proposed in two (2) phases. The area covered by this project currently consists of combined storm and sanitary sewers that are directed to the Red Hook and Owl's Head WWTP areas, and drain to the Gowanus Canal during periods of overflow. Phase I of the HLSS Corridor consists of: the entire length of Denton Place between 1st Street and Carroll Street; Carroll Street from the Gowanus Canal to 4th Avenue; 3rd Avenue between Carroll Street and Douglass Street; and President, Union, Sackett and Degraw Streets between 3rd Avenue and 4th Avenue in Brooklyn.,. Phase II of the HLSS Corridor continues northward including Douglas Street, Butler Street, Baltic Street, St. Mark's Place, Bergen Street, Dean Street, Pacific Avenue, Atlantic Avenue and State Street, generally between 3rd Avenue and 4th Avenue in Brooklyn. The new storm sewer will discharge to the Gowanus Canal at Carroll Street. Phase I is currently in final design.

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 the Gowanus Canal.

3.14 Characterization and Monitoring

Previous studies have characterized and described the Red Hook WWTP collection system, Owls Head WWTP collection system, and the water quality for the Gowanus Canal (see Chapters 3 and 4 of the Gowanus Canal WWFP, 2008). Additional data were collected 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

Water quality issues in the Gowanus Canal were identified as early as the late 19^{th} Century, when construction of a flushing tunnel and pumping station were first conceived to improve circulation through the waterbody. CSO facility planning became a priority around 1978, when New York City's City-Wide 208 Water Quality Study identified it as requiring additional study. Subsequently, the NYC was awarded a revised 201 Facilities Plan grant for the Gowanus Pump Station that included a water quality study of the Gowanus Canal and Bay, a pump station and force main study, and public participation. Among other recommendations, the 1983 Facilities Plan report identified upgrading the Gowanus Pump Station, rehabilitating the Bond Lorraine Sewer, rehabilitating and reactivating the Gowanus Canal Flushing Tunnel, and installing a force main to convey sewage to the Columbia Street Interceptor. These recommendations remained through the 1993 Inner Harbor CSO Facility Plan, which focused on quantifying and assessing the impacts of CSO discharges to the Gowanus Canal, among other waterbodies, as well as the 2008 WWFP. The recommendations are thus considered part of the WWFP improvements included in the baseline described in this section.

4.1.a Completed Projects

The 2012 CSO Order on Consent capital projects to improve water quality in the Gowanus Canal was constructed under contract CSO-GCER:

1. Rehabilitation of the Gowanus Canal Flushing Tunnel System to eliminate shutdowns during low tide and improve maintenance operations with the installation of a new pumping system with redundant, interchangeable pumps.

2. Gowanus Pumping Station reconstruction to improve operational reliability and to redirect flow directly to the Columbia Street Interceptor via a new force main to be constructed within the Flushing Tunnel.

Each of these is discussed in detail below. Both projects were certified as completed by the DEP on February 27, 2015 at a total cost of $160.3M.

The Gowanus Canal Flushing Tunnel Modernization

The Gowanus Canal Flushing Tunnel was originally constructed in 1911 to convey water in either direction between the Gowanus Canal and Buttermilk Channel. The original flushing system consisted of a 400 horsepower (hp) motor and a 7-foot-diameter propeller that could pump 325 MGD through the approximately 6,070-foot-long, 12-foot-diameter brick tunnel. The system failed in the 1960s and remained out-of-service until 1999, when it was rehabilitated and returned to service as recommended in the Inner Harbor CSO Facility Plan. However, once reactivated, this system was determined to be deficient. The actual capacity of the system, as installed, averaged only about half the design flow, and was inoperable at low tide. Further, the physical assets were problematic for numerous operations and maintenance considerations, including accelerated corrosion, custom-made equipment, inadequate redundancy, and the need to deploy SCUBA crews or dewatering for basic maintenance.

To address these issues, the Gowanus Canal Flushing Tunnel pumping system was modernized to reduce downtime and to improve overall operation (see Figure 4-1). The system features three submersible, vertical, axial-flow pumps installed in parallel within the existing motor pit (which became the wet well), with two additional pumps stored on-site as spares that can be changed in without dewatering or system shutdowns. The design capacity of each pump is 69,500 gym (100 MGD) at a head of 20 feet when operated at full speed (500 rpm), discharging through a 54-inch-diameter concrete tube opening to a common discharge chamber. The Flushing Tunnel itself was also rehabilitated by minimizing the occlusion in its cross-section cause by the Columbia Street Interceptor, and the tie-in of the existing 36-inch Gowanus Pump Station force main that lies within the tunnel.

Gowanus Pump Station Reconstruction

Combined sanitary and wastewater flow from a 650-acre tributary area enters the Gowanus Pump Station via three large sewers from Butler Street. Hydraulic analyses of these influent conduits show that the maximum wet-weather flow rate that can be delivered to the pump station is about 650 MGD. During wet-weather, flows exceeding the pumping capacity of the station bypass via Outfall RH-034 to the head end of the Gowanus Canal. The Gowanus Pump Station previously discharged to the nearby Bond Lorraine Sewer via the Butler Street force main, but the force main was redirected to the Columbia Street Interceptor to bypass the hydraulically limited sewer that discharges CSO to the Gowanus Canal. The new force main runs approximately one mile within the 12-foot diameter Gowanus Canal Flushing Tunnel. The new force main was sized to provide an optimum balance between combined sewer conveyance needs and Flushing Tunnel capacity.

The increased sewer system capacity that this new force main provides allows for the expansion of the firm capacity of the Gowanus Pump Station from 20.2 MGD to 30 MGD. The gain in capacity was accomplished through the installation of four 140-hp submersible wastewater pumps, each with a rating point of 6,950 gym at 55 feet total dynamic head, providing 30 MGD combined flow capacity at this rating point. Up to three pumps are in service at any given time, with a fourth providing redundancy and allowing for pump servicing without reducing operating capacity.

In addition, CSO screening facilities were upgraded to provide floatables control of overflows to the Gowanus Canal, including a horizontally raked bar screen above the existing dry-weather influent channel to the pumping station, capable of screening a CSO flow rate of up to 200 MGD (more than the 5-minute peak CSO flow of 172 MGD calculated during the design rainfall year). Only the portion of the flow in excess of 200 MGD is unscreened for larger events. Floatables already captured in such storms are retained rather than discharged.

Figure 4-2 shows a rendering of the Rehabilitated Gowanus Pump Station located at the head end of the Gowanus Canal.

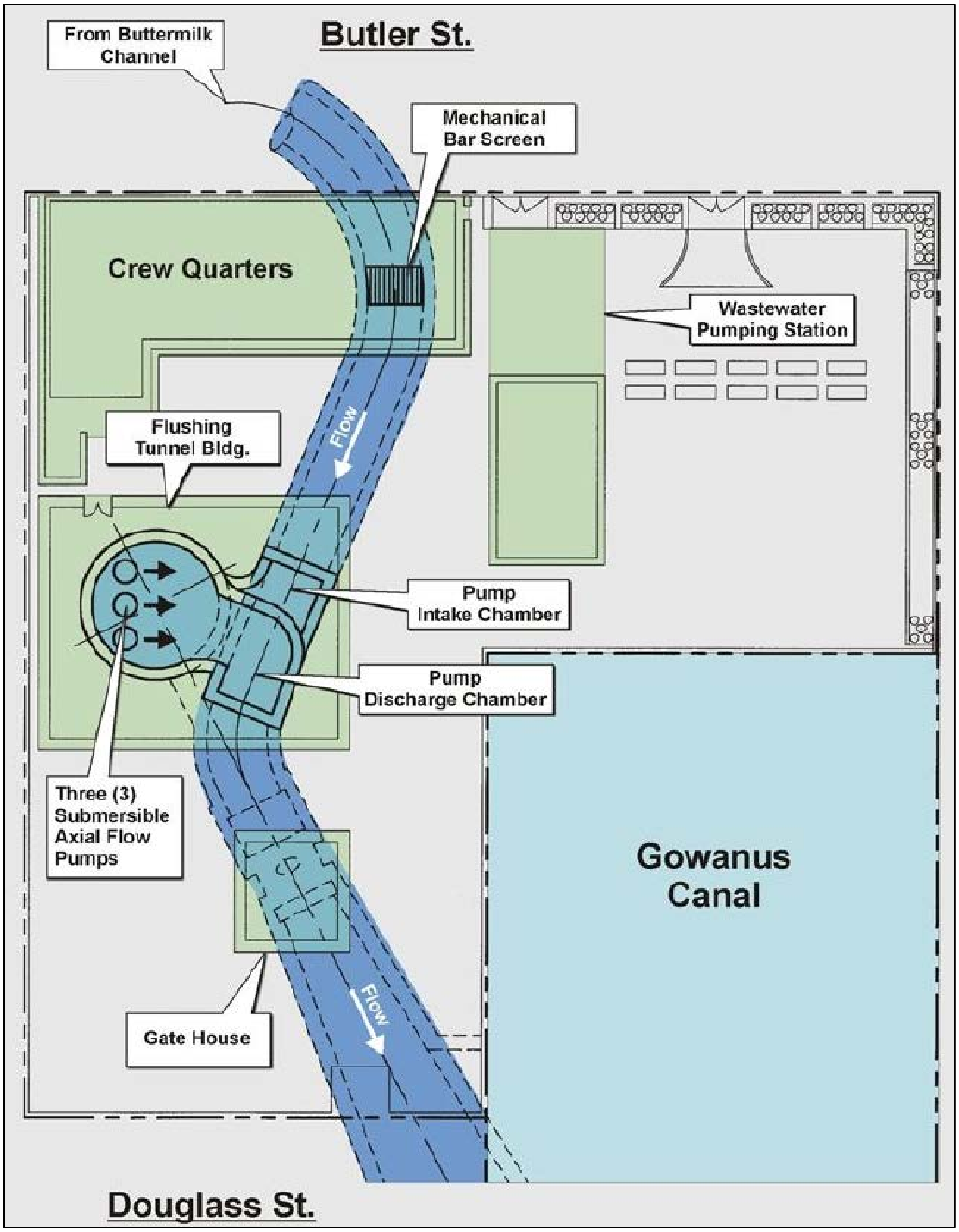

Figure 4-1. Flushing Tunnel Rehabilitation

Figure 4-2. Rehabilitated Gowanus Pump Station at the Head End of Gowanus Canal

4.1.b Ongoing Projects

There are no ongoing grey infrastructure projects in the Gowanus Canal planning area.

4.1.c Planned Projects

In September 2013, the EPA issued its ROD for the Gowanus Canal Superfund Site in Brooklyn, New York. The ROD requires the siting, design, construction, and operation of two CSO retention tanks to control discharges of solids to the Gowanus Canal, unless other technically viable alternatives are identified[1]. The ROD estimated that an 8 million gallon tank would be necessary at Outfall RH-034, and a 4 million gallon tank at Outfall OH-007. In addition, in May 2014, EPA issued a Unilateral Order to NYC requiring, among other things, the completion of a siting study to identify recommended locations for the tanks; this study is being submitted at the same time as this LTCP. The final siting, design and schedules for these projects will be determined in accordance with the Superfund process.

[1] *See United States Environmental Protection Agency. Record of Decision, Gowanus Canal Superfund Site: Summary of Remedial Alternatives, page 55.*

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

The CSO Consent Order included a dredging project to be executed under Contract CSO-DRDG/DRG. Environmental dredging was to be performed in approximately 825 feet of the head end of the Gowanus Canal to a final water depth of 3.0 feet below mean lower low water (MLLW). The estimated cost of this project is $13.1M. DEP has placed the design under CSO-DRDG/DRG on hold pending reconciliation of that project with the sediment-related requirements of the USEPA's ROD.

4.3 Post-Construction Monitoring

The PCM Program is integral to optimization of the Gowanus Canal 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 Gowanus Canal and the actions identified in this LTCP with the ultimate goal of fully attaining compliance with current WQS. The data collection monitoring consists of three basic components:

1. Evaluation of the inflows and loads entering the Gowanus Canal;
2. Receiving-water data collection in the Gowanus Canal using DEP HSM locations; and
3. Modeling of the collection system and receiving waters to characterize water quality using the existing IW model and the Gowanus Water Pathogen Model (GC-PATH), respectively.

The details provided herein are limited to the Gowanus Canal 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 Gowanus Canal 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 program in the Gowanus Canal commenced in 2013, with all stations being sampled a minimum of twice per month from May through September, and 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 NYC has used these parameters for decades to identify historical and spatial trends in water quality throughout New York Harbor. DO 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 analyses is an essential component of the PCM. For the Gowanus Canal, the most representative long-term rainfall data record is available from the National Weather Service's JFK gauges (Owls Head and Red Hook). 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 analyses 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/GC-PATH 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 analyses 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 discharge to the CSS.[1] In 2010, the New York City Department of Environmental Protection (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 this 1.5 percent goal is not met, DEP must certify that $187M has been encumbered for the purpose of GI and submit a contingency plan to the DEC by June 20, 2016. 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, used 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, 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

[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.

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 in 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 EDC, Department of Parks and Recreation (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.

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 Right-of-Way (ROW) GI practices. Users can also view a map of the target areas to learn whether GI is coming to their neighborhood.

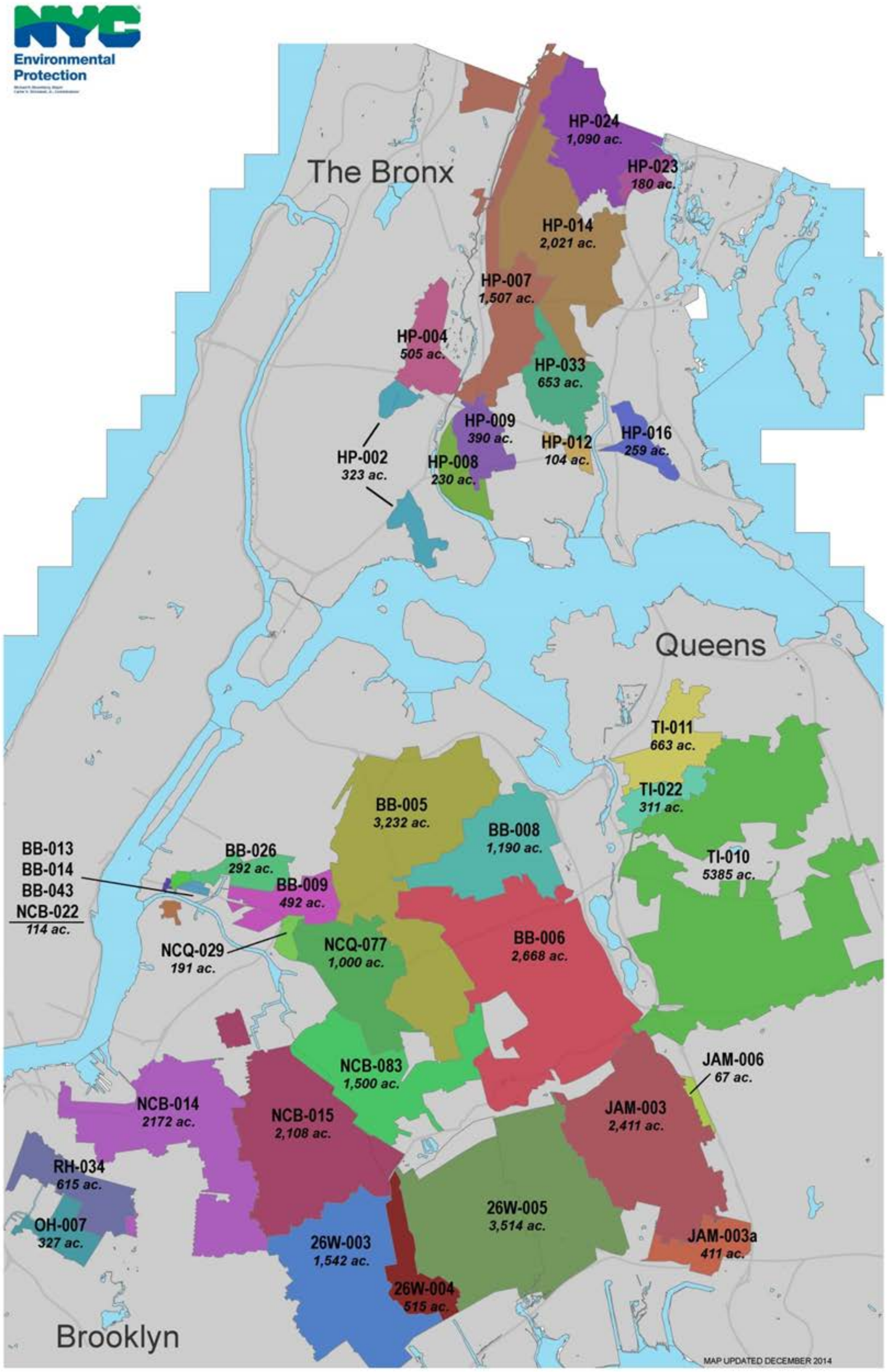

Figure 5-1. Target CSO Tributary Areas for Green Infrastructure Implementation

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 Long Term Control Plan (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, the 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 resubmitted 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 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 Department of Buildings (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, total organic carbon (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 Gowanus Canal 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., 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 Gowanus Canal as well as costs.

Green Infrastructure Baseline Penetration Rate – The Gowanus Canal

Based on the above criteria, the Gowanus Canal'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 1,387 acres. DEP projects that GI penetration rates would manage 12 percent of the impervious surfaces within the Gowanus Canal 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 2012-2030. 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 Gowanus Canal that will be accounted for as the Green Infrastructure Program progresses toward the 2030 goal. The current Area-wide contracts in the Gowanus Canal CSO TDA are in RH-034 and OH-007. 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 Gowanus Canal

6.0 BASELINE CONDITIONS AND PERFORMANCE GAP

This Section compares the existing baseline water quality to the 100% of CSO control condition. Modeling simulations are used to predict water quality for the baseline and 100% CSO control conditions. A comparison of the two simulations is then done to determine the gap between the baseline and 100% CSO Control. A Key to development of the Gowanus Canal LTCP is the assessment of water quality using applicable WQSs within the waterbody. Water quality was assessed using the GC-PATH and the Gowanus Canal Sediment Transport and Eutrophication Model (GC-STEM), verified with both Harbor Survey and the synoptic water quality data collected in 2014. The models simulated ambient bacteria concentrations within the Gowanus Canal and Gowanus Bay for a set of baseline conditions, as described in this section, to assess future conditions. The IW sewer system model was used to provide flows and loads from intermittent wet-weather sources as input to the GC-PATH and GC-STEM models.

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 calculated baseline bacteria and DO levels and both the Existing WQ Criteria and Potential Future Primary Contact WQ Criteria. As detailed below, a one-year (using average 2008 rainfall) simulation was performed for bacteria and DO. This simulation served as a basis for evaluating the control alternatives presented in Section 8.

This section of the LTCP describes the baseline conditions, loading volumes calculated with the IW model, bacteria and DO loadings, and the resulting bacteria and DO concentrations calculated by the GC-PATH and GC-STEM water quality models. It further describes the gap between calculated baseline DO and bacteria concentrations and both the existing and potential future WQSs. The section 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. Baseline conditions are used to compare and contrast the effectiveness of CSO controls and to predict whether water quality goals would be attained if 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:

- The design dry-weather sanitary flow and load was based on CY 2040 projections.
- The Red Hook and Owls Head WWTPs can accept and treat peak flows at 2xDDWF during wet-weather events.
- Cost-effective Grey Infrastructure CSO controls included in the 2012 CSO Order on Consent for the Red Hook and Owls Head sewersheds are operating. For Red Hook this includes: the Gowanus Canal Pump Station upgrade; the Gowanus Canal Flushing Tunnel improvements and

demonstration bending weir at RH-2 (Outfall RH-028). For Owls Head, this includes the Avenue V Pump Station upgrade.

- HLSS for flood mitigation.
- GI application rate of 10 percent ROW and 2 percent GI through on-site detention in the Red Hook and Owls Head-Gowanus Canal drainage areas implemented.
- Completion of Superfund dredging within the Gowanus Canal to the depths noted in the EPA Region 2 Feasibility Study (FS) and Proposed Remedial Action Plan (PRAP) documents for the Gowanus Canal: *Feasibility Study Report for the Gowanus Canal Site Brooklyn, NY, December 2011 Appendix A, Non-Aqueous-Phase Liquid (NAPL) Technical Evaluation* and *Superfund Proposed Plan Gowanus Canal Superfund Site Kings County, NY December 2012*.

Mathematical modeling tools were used to calculate the CSO volume and loadings of pathogen indicator organisms and nutrients and their impacts on water quality. The performance gap is assessed by comparing the baseline pathogen and DO concentrations, within the Gowanus Canal, as calculated by the water quality model to the WQS. In addition, complete removal of CSO was evaluated. Further analyses were conducted for CSO control alternatives as presented in Section 8. The mathematical modeling tools include the IW model and several models for water quality. The current IW model and the water quality models are described in the *Gowanus Canal LTCP Sewer System and Water Quality Modeling Report (DEP, 2015).*

The IW model was used to develop stormwater flows, conveyance system flows, and CSO volumes within the Gowanus Canal for a defined set of future or baseline conditions. For the Gowanus Canal LTCP, the baseline conditions were developed in a manner consistent with the earlier WWFP. However, based on more recent data, as well as the public comments received on various 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 loadings, catchment areas and new or upgraded physical components of the system. In addition, an IW model recalibration report was issued in 2012 (*InfoWorks Citywide Recalibration Report, June 2012a*) that used improved impervious surface satellite data. Specific to the Gowanus Canal, the IW model was calibrated to represent 2013/2014 conditions as described in the *Gowanus Canal LTCP Sewer System and Water Quality Modeling Report (DEP, 2015).* The new 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. The baseline modeling conditions primarily related to dry-weather flow (DWF) rates, wet-weather capacity for the Red Hook and Owls Head WWTPs, sewer conditions, precipitation conditions and tidal boundary conditions are as follows:

- **Rainfall/Tides:** The 2008 year rainfall and tides were used in the model, in addition to evaluating a 10-year period (2002-2011).
- **Dry-Weather Flows**: The 2040 projected dry-weather flow rates at the Red Hook and Owls Head WWTPs are 28 and 85 MGD, respectively.

- **Wet-Weather Capacity**: The rated wet-weather capacity at the Red Hook and Owls Head WWTPs (2xDDWF) are 120 and 240 MGD, respectively.

- **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.

- **Upstream Source Loadings:** The Gowanus Canal receives continuous flows from Buttermilk Channel via the Gowanus Canal Flushing Tunnel. During 2014, Flushing Tunnel flows for modeling were estimated based on start-up and other preliminary operational conditions and 2014 tidal conditions. For the baseline, Flushing Tunnel flows were modeled based on design operations and performance and baseline tidal conditions. In 2014, the intake of the Flushing Tunnel in Buttermilk Channel was sampled for bacteria and organic carbon. Year 2014 concentration measurements were used for developing 2014 loadings, as well as validating baseline loadings to the Gowanus Canal from the Flushing Tunnel.

To properly represent future baseline water quality conditions in the Gowanus Canal, it was first necessary to update the NYC Gowanus Canal water quality models. Water quality modeling was conducted using a higher resolution computational grid and hydrodynamic model than was used for the Gowanus Canal WWFP modeling. Further, the water quality models were upgraded to include the same modern eutrophication and DO kinetics now used in the models for other NYC LTCP waterways. In addition, the Gowanus Canal water quality models include sediment transport calculations for particulate organic carbon and suspended sediment within the eutrophication framework. LTCP water quality modeling work for the Gowanus Canal was in progress for more than one year, allowing for twelve month calibrations/validations of the hydrodynamic, pathogens, and dissolved oxygen models for contemporary conditions, including the Flushing Tunnel activation and various levels of Flushing Tunnel operation. The calibrations/validations were based on model and data comparisons using continuous measurements from moored instruments and discrete measurements conducted during wet- and dry-conditions, including the days immediately following wet-weather. Further, all of the Gowanus Canal water quality modeling was peer reviewed by an internationally renowned panel that met on seven occasions during the course of model selection, development, calibration/validation and application. The updates to the IW model and the water quality models are described in the Gowanus Canal LTCP Sewer System and Water Quality Modeling Report (DEP, 2015). The peer review panel is preparing a report summarizing their review findings, which is expected to be ready in July 2015. The future baseline conditions simulated with the updated models are discussed in the remainder of this document section.

6.1.a Hydrological Conditions

For this LTCP, the precipitation characteristics from JFK 2008 NOAA gauges 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 tidal boundary conditions at the CSO outfalls that discharge to the tidally influenced the Gowanus Canal and Gowanus Bay.

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 analyses of water demand and wastewater flow projections. A detailed GIS analysis was performed to apportion total population among the 14 WWTP drainage areas. For this analysis, Transportation Analysis Zones (TAZs) were overlaid with WWTP drainage areas. Population projections for 2010-2040 were derived from population projections developed by the 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 BMP Findings and Optimization

A list of BMPs, along with a brief summary of each and its respective relationship to the EPA NMCs, were reported in Section 3.0, as they pertain to the Gowanus Canal 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 development of the baseline conditions, specifically in setting up and using the IW models to simulate CSO discharges and in establishing non-CSO discharges that impact water quality in the Gowanus Canal:

- Sentinel Monitoring: In accordance with BMPs #1 and #5, DEP collects quarterly samples of bacteria water quality at three locations in the Gowanus Canal vicinity (near LTCP2 Stations GC-7, GC-9 and GC-11; Figure 2-18) in dry-weather to assess whether dry-weather sewage overflows occur, or whether illicit connections to storm sewers exist. While no evidence of large illicit sanitary sewer connections was observed based on these data, these measurements show non-zero bacteria concentrations during dry-weather, likely due to sources outside of the Gowanus Canal and, potentially, small distributed sources within the Gowanus Canal. It is not known whether the sources are human or non-human. Dry-weather measurements collected for the LTCP and by NYC HSM Program are in agreement with the sentinel monitoring results. Although a small number of dry-weather sources of bacterial internal to the Gowanus Canal were included in the water quality model calibration exercises to accurately simulate the observed ambient bacteria concentrations, these sources were excluded from the baseline conditions to reflect future corrected conditions within the Gowanus Canal. Background dry-weather sources outside the Gowanus Canal model boundaries were maintained in the baseline 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 Red Hook and Owls Head WWTPs treat 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.

- WWOPs: The Red Hook and Owls Head 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

Cost-effective grey infrastructure for the Gowanus Canal watershed included in the 2012 CSO Order on Consent has been represented in the IW and water quality models. For the Red Hook sewershed, the grey infrastructure includes the Gowanus Canal Pump Station upgrade, the Gowanus Canal Flushing Tunnel improvements, the demonstration bending weir at RH-2 (Outfall RH-028), and HLSS. Flushing Tunnel improvements were in progress for the period of model calibration so that variable performance flows were used for model calibration analyses. Modeled baseline conditions include Flushing Tunnel design performance flows.

The cost-effective grey infrastructure for the Owls Head sewershed includes the completed Avenue V Pump Station upgrade and both in progress and near future HLSS projects. The HLSS projects planned for construction within the next 10 years were included in the model baseline. These projects are known as the SEK20065 and SEK20067 projects.

The GI plan for the Gowanus Canal is also included in baseline modeling. The citywide total application rate of 10 percent of combined sewer impervious drainage areas was applied to the baseline model on a citywide basis. The Red Hook-Gowanus Canal area individual baseline watershed GI application rate for baseline modeling was defined as 10 percent ROW and 2 percent GI through on-site detention. The Owls Head-Gowanus Canal area individual baseline watershed GI application rate for baseline modeling was defined as 10 percent ROW and 2 percent GI through on-site detention.

6.1.e Non-CSO Discharges

Non-CSO discharges to the Gowanus Canal for modeling are considered in terms of both the Red Hook and Owls Head WWTP drainage areas as shown on Figure 2-1. The Red Hook WWTP drainage area for the Gowanus Canal includes both stormwater and direct drainage. According to the latest SPDES permit (Red Hook WWTP SPDES permit issued November 1, 2010), there is a small separately sewered drainage area along the western shore of the Gowanus Canal contributing to stormwater Outfall RH-601. There is also a 13.7-acre direct drainage area on the western shore near the mouth of the Gowanus Canal which drains to the Gowanus Canal. The Owls Head WWTP drainage area for the Gowanus Canal includes three MS4-permitted stormwater outfalls: OH-607, OH-616 and OH-617. These MS4 outfalls are currently included in the WWTP's SPDES permit. These outfalls drain stormwater runoff from small, separate sewer areas around the Gowanus Canal. While runoff from these areas does not enter the CSS, the stormwater drains from the separate sewer areas to the Gowanus Canal and the stormwater is included in modeling. It is further noted that the direct drainage areas for the Gowanus Canal are inclusive of highway drains and other local pipes not associated with the NYC's MS4 system.

There is planned and ongoing HLSS work in the Gowanus Canal sewershed that is relevant to baseline modeling. Once completed, the HLSS projects will create a separate stormwater discharge to the Gowanus Canal through a stormwater outfall at Carroll Street. The planned work will be constructed in phases. Phase I is scheduled to be constructed throughout 2015, and Phase 2 is scheduled to be implemented in 2019. A portion of the new, separate drainage areas to be created will also reduce CSO discharges in the Red Hook collection system.

Discharge volumes from stormwater and direct drainage for the baseline conditions were estimated in concert with CSO discharge volumes using the IW model. It is noted that the IW model represents CSO structures in combined sewered areas with greater detail than it represents separately sewered, direct drainage and highway drainage areas. Accordingly, the volumes provided for separately sewered, direct drainage and highway drainage areas should be considered rough estimates. Stormwater, direct drainage and highway areas roughly included in the IW models are combined to represent the area between the boundary of the CSO drainage system and the waterfront. Like volumes, the loadings from these areas could not be estimated with the same level of accuracy as CSO loads. Calculated volume and loading contributions from individual fractions of the non-CSO areas will require future refinement.

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

As discussed in Section 2, the Red Hook and Owls Head WWTP drainage areas to the Gowanus Canal include multiple CSO outfalls. The IW model was used to develop CSO discharge volumes for the baseline conditions. The IW model incorporates the implementation of the grey infrastructure and GI improvements described in Section 6.1.d. Using these overflow volumes, loadings from the CSOs were generated using measured enterococci, fecal coliform and BOD concentrations and provided input to the receiving water quality models, GC-PATH and GC-STEM. GC-PATH and GC-STEM were calibrated using 2013/2014 monitoring data collected during preparation of this LTCP, as well as HSM measurements for the same period. The calibration assessment consisted of comparing the time series and cumulative frequency distributions of 2013/2014 collected concentration data against the time series and cumulative frequency distribution output from the model for coincident dry- and wet-weather periods.

In addition to CSO loadings, loadings from other sources, such as storm sewer discharges, highway drains, and direct drainage may impact water quality in the Gowanus Canal, but to a lesser degree, based on the rough modeling estimates. These are summarized in Table 6-2. The concentrations assigned to various sources to the Gowanus Canal are summarized in Table 6-1. Concentrations in Table 6-1 represent typical stormwater, direct drainage and sanitary sewage for the Gowanus Canal drainage area and are based on data collected from the Gowanus Canal area.

For the modeling baseline simulations, concentrations presented in Table 6-1 were used to develop mass loadings based on the volumes presented in Table 6-2. For the CSOs, bacteria loading concentrations were developed based on a Monte Carlo analysis of LTCP measurements collected at four locations within the Gowanus Canal sewer system (Section 2.0). Time-varying concentrations associated with the Flushing Tunnel were determined using results of the regional Harbor models, as well as measurements collected for the LTCP and by HSM in Buttermilk Channel and the Lower East River. The concentrations in Table 6-1 used for baseline modeling were verified during the calibrations of the GC-PATH and GC-STEM models.

Table 6-1. Source Concentrations from Sources to Gowanus Canal

Source	Enterococci (cfu/100mL)	Fecal Coliform (cfu/100mL)	BOD_5 (mg/L)
Flushing Tunnel (1)	Regional Model	Regional Model	Variable(4)
CSOs (1)	Monte Carlo	Monte Carlo	78
Urban Stormwater (2,1)	50,000	120,000	15
Highway Runoff (3,1)	8,000	20,000	15
Direct Drainage (3,1)	6,000	4,000	15

Notes:
(1) Gowanus Canal 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.
(4) Harbor Survey measurements were used to define monthly varying BOD concentrations which constrain modeled Particulate Organic Carbon (POC) and Dissolved Organic Carbon (DOC) concentrations.

Typical baseline volumes of CSO, stormwater and direct drainage to the Gowanus Canal are summarized in Table 6-2 for the 2008 year, along with mass loadings. Table 6-2 also shows the loading delivered to the Gowanus Canal from Buttermilk Channel in the East River through the Flushing Tunnel under baseline modeling conditions. Table 6-3 includes outfall-specific information for baseline volumes of CSO.

Table 6-2. 2008 Baseline Loading Summary

Totals by Source by Waterbody		Volume	Enterococci	Fecal Coliform	BOD
Waterbody	**Source**	**Total Discharge (MG/yr)**	**Total Org (10^12/yr)**	**Total Org (10^12/yr)**	**Total (lbs/yr)**
Gowanus Canal and Bay	Flushing Tunnel	80,448	85	308	863,376
	CSO	659	7106	13,605	402,807
	Stormwater	26	49	118	3274
	Direct Drainage	220	50	33	27746
	Highway Runoff	16	5	12	2016
Total		**81,369**	**7,295**	**14,077**	**1,299,219**

Notes:
The above summary does not consider bacteria and nutrients entering the Gowanus Canal through tidal exchange between Gowanus Bay and Upper New York Bay.

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

CSO Outfall	Waterbody	Volume	Annual Overflow Events
		Total Discharge (MG/yr)	Total (No./yr)
OH-003	Upper New York Bay	370.6	47
OH-004	Upper New York Bay	5.9	15
OH-005	Gowanus Canal	0.5	1
OH-006	Gowanus Canal	15.6	32
OH-007	Gowanus Canal	57.6	44
OH-023	Gowanus Bay	0.9	12
OH-024	Gowanus Canal	26.4	35
RH-030	Gowanus Bay	16.2	15
RH-031	Gowanus Canal	16.7	15
RH-033	Gowanus Canal	0.3	7
RH-034	Gowanus Canal	136.8	40
RH-035	Gowanus Canal	5.4	14
RH-036	Gowanus Canal	1.8	17
RH-037	Gowanus Canal	0.4	9
RH-038	Gowanus Canal	0.6	7

6.3 Performance Gap

Concentrations of bacteria and DO in the Gowanus Canal are controlled by a number of factors, including the volumes of all sources of bacteria and nutrients into the Gowanus Canal, and the concentrations of those bacteria and nutrients, by the Flushing Tunnel entering near the head of the Gowanus Canal, and by exchange with Gowanus Bay and Upper New York Bay. Because portions of the flow and loads discharged into this waterbody are the result of runoff from rainfall events, the frequency, duration and amounts of rainfall influence the Gowanus Canal's water quality. In addition, the Flushing Tunnel produces a reduced residence time in the Gowanus Canal, especially near the head of the Gowanus Canal, which improves water quality.

The GC-PATH and GC-STEM models were 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 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 (Upstream of Hamilton Ave – Class SD, Downstream of Hamilton Ave – Class I);
- Primary Contact WQ Criteria; and

- Potential Future Primary Contact Recreational WQ Criteria (EPA RWQC, 2012).

Analyses are developed to 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 focuses on ten locations spaced somewhat evenly across the entire length of the Gowanus Canal and Gowanus Bay. 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 geometric mean (GM) of 30 cfu/100mL, and the STV of 110 cfu/100mL for enterococci.

Table 6-4. Classifications and Standards Applied

Analysis	Numerical Criteria Applied	
Existing WQ Criteria Fish Survival (Class SD) and Boating/Fishing (Class I)	Gowanus Canal Above Hamilton Ave (Class SD)	Fecal - None; DO never < 3.0 mg/L
	Gowanus Bay Below Hamilton Ave (Class I)	Fecal Monthly GM ≤ 2,000 DO never < 4.0 mg/L
Primary Contact WQ Criteria(1)	Saline Water	Fecal Monthly GM ≤ 200 Daily Average DO ≥ 4.8 mg/L(3) 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 Gowanus Canal or Gowanus Bay.
(2) The Potential Future Primary Contact WQ Criteria have not yet been adopted by DEC.
(3) The daily average DO concentration may fall below 4.8 mg/L for a limited number of days. See Section 2 for the equation and calculation description.

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

Assessing the performance gap required calculating the Gowanus Canal fecal coliform concentrations under baseline conditions, comparing them to the current (existing) water quality criteria, determining if they exceed the criteria, and then establishing whether the gap could be closed through reductions to CSO overflows. The assessment was extended to determine whether water quality met the standards for Class I Boating/Fishing WQ Criteria throughout the Gowanus Canal. Upstream of Hamilton Avenue, the Gowanus Canal is not assigned Class I. The portion of the Gowanus Canal that is downstream of

Hamilton Avenue is assigned that Class. A one-year simulation of bacteria water quality was performed for the 2008 baseline loading conditions. The results of the 2008 baseline simulation 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 recreation period. The results are presented for each sampling location in the Gowanus Canal.

Table 6-5. Calculated 2008 Baseline Fecal Coliform Maximum Monthly GM and Attainment of Existing Criteria and the Class (I) Boating/Fishing WQ Criteria

Station	Class	Maximum Monthly Geometric Means (cfu/100mL)		% Attainment with Existing Criteria		% Attainment with Class I Criteria	
		Annual	Recreation Period	Annual GM ≤2,000 #/100mL	Recreation Period GM ≤2,000 #/100mL	Annual GM ≤2,000 #/100mL	Recreation Period GM ≤2,000 #/100mL
GC-1	SD	213	45	NA	NA	100	100
GC-2	SD	201	43	NA	NA	100	100
GC-3	SD	199	42	NA	NA	100	100
GC-4	SD	197	40	NA	NA	100	100
GC-5	SD	199	39	NA	NA	100	100
GC-6	SD	216	37	NA	NA	100	100
GC-7	SD	215	36	NA	NA	100	100
GC-8	I	181	23	100	100	100	100
GC-9	I	164	24	100	100	100	100
GC-10	I	170	31	100	100	100	100

This table 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 2,000 cfu/100mL. Table 6-5 shows that the Existing Criteria and the Class I Criteria (monthly GM of 2,000 cfu/100mL) for boating/fishing are met at all sampling locations in the Gowanus Canal and Bay and, as such, there is no gap between the baseline conditions and the calculated bacteria concentrations for the Class I Criteria.

Water quality model simulation DO attainment results are presented in Table 6-6 for year 2008 conditions. Water quality model calculations indicate DO standard attainment equal to or greater than the DEC desired attainment of 95 percent for 2008 baseline conditions.

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

Station	Class	DO Criteria (≥ mg/L)	% Annual Attainment 2008
GC-1	SD	3	100
GC-2	SD	3	100
GC-3	SD	3	100
GC-4	SD	3	100

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

Station	Class	DO Criteria (≥ mg/L)	% Annual Attainment 2008
GC-5	SD	3	100
GC-6	SD	3	98
GC-7	SD	3	99
GC-8	I	4	95
GC-9	I	4	100
GC-10	I	4	100

6.3.b CSO Volumes and Loadings that Would Be Needed to Support Primary Contact Uses

DEC has introduced a proposed rule to require Class SD and I waterways to meet the Primary Contact WQ Criteria for bacteria. The Primary Contact WQ Criteria for fecal coliform is a monthly GM less than or equal to 200 cfu/100mL. Table 6-7 presents the maximum monthly geometric means for fecal coliform during annual and recreation periods at each sampling station location. The table also contains the percent attainment of the Primary Contact WQ Criteria for the same periods.

Table 6-7. Calculated 2008 Baseline Fecal Coliform Maximum Monthly GM and Attainment of Primary Contact WQ Criteria

Station	Maximum Monthly Geometric Means (cfu/100mL)			% Attainment		
	Annual	11 Months	Recreation Period	Annual GM ≤200 #/100mL	11 Month GM ≤200 #/100mL	Recreation Period GM ≤200 #/100mL
GC-1	213	171	45	92	100	100
GC-2	201	163	43	92	100	100
GC-3	199	162	42	100	100	100
GC-4	197	159	40	100	100	100
GC-5	199	162	39	100	100	100
GC-6	216	184	37	92	100	100
GC-7	215	182	36	92	100	100
GC-8	181	159	23	100	100	100
GC-9	164	139	24	100	100	100
GC-10	170	133	31	100	100	100

Table 6-7 shows that full annual attainment of the Primary Contact WQ Criteria was not calculated for baseline conditions; however, modeling results presented in Table 6-7 show full attainment of Primary Contact WQ Criteria has been calculated for 2008 baseline conditions for eleven months of the year, including the recreation season. The cause of the calculated annual non-attainment is the model calculated maximum monthly geometric means as shown in Table 6-7 right at or slightly above the standard for several stations for one month, the month of February. The calculated maximum monthly geometric means for the eleven remaining months also shown in Table 6-7 attain the standard. To address the calculated annual non-attainment, a gap analysis was performed to determine the effect of 100% CSO controls during all months of the 2008 baseline conditions. Gap analysis results shown in Table 6-8 demonstrate that 100% CSO controls would fully attain the Primary Contact WQ Criteria, achieving geometric means well below the Primary Contact WQ Criteria for all months.

Table 6-8. Calculated 2008 100% CSO Controls Fecal Coliform Maximum Monthly GM and Attainment of Primary Contact WQ Criteria

Station	Maximum Monthly Geometric Means (cfu/100mL)	% Attainment
	Annual	Annual GM ≤200 #/100mL
GC-1	107	100
GC-2	108	100
GC-3	108	100
GC-4	105	100
GC-5	105	100
GC-6	105	100
GC-7	105	100
GC-8	80	100
GC-9	84	100
GC-10	102	100

The calculated attainment results for the Primary Contact WQ DO Criteria are presented in Table 6-9 for the 2008 baseline conditions. Greater than 98 percent attainment is calculated for the acute portion of the Primary Contact WQ DO Criteria. For the chronic portion of the Primary Contact WQ DO Criteria, the calculated attainment is greater than 95 percent for eight out of ten stations, with two stations having calculated attainment of 94 percent and 87 percent, respectively. A gap analysis was performed to determine the effect of 100% CSO controls on attainment of the chronic portion of the Primary Contact WQ DO Criteria. Gap analysis results are presented in Table 6-9. Calculations indicate that 100% CSO controls would result in greater than 99 percent attainment for the acute portion of the Primary Contact WQ DO Criteria as compared to 98 percent attainment for baseline conditions. This gap analysis shows a small improvement in DO concentrations with 100% removal of the Gowanus Canal CSOs. Calculations indicate that 100% CSO controls would result in greater than 95 percent attainment for the chronic portion of the Primary Contact WQ DO Criteria at nine stations as compared to eight stations for baseline conditions. Calculations indicate that attainment for the chronic portion of the Primary Contact WQ DO Criteria at the worst station with 100% CSO controls would be 89 percent as compared to 87 percent for baseline conditions. This would still be lower than the DEC desired goal of 95 percent attainment, even though all the CSOs are removed. The station, GC-8, located at the interface of the Gowanus Canal and the Bay is subject to changing geometry and complex circulation patterns which may explain the relatively lower attainment results.

Table 6-9. Model Calculated DO Attainment for Primary Contact WQ Criteria (2008)

Station	Annual Attainment Percent Attainment			
	Baseline		100% Gowanus CSO Control	
	Chronic(1)	Acute(2)	Chronic(1)	Acute(2)
GC-1	100	100	100	100
GC-2	100	100	100	100
GC-3	100	100	100	100
GC-4	100	100	100	100
GC-5	100	100	100	100
GC-6	94	98	95	99
GC-7	95	99	96	100
GC-8	87	100	89	100
GC-9	99	100	100	100
GC-10	100	100	100	100

Notes:
(1) 24-hr average DO ≥ 4.8 mg/L with allowable excursions to ≥ 3.0 mg/L for certain periods of time.
(2) Acute Criteria: DO ≥ 3.0 mg/L.

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 RWQC for protecting human health in all coastal and non-coastal waters designated for primary contact recreational 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 Water Quality 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 Gowanus Canal and Bay. That analysis consisted of first assessing the baseline conditions for enterococci. The results of the analyses for baseline conditions are presented in Table 6-10 for the maximum 30-day GM and attainment of the rolling 30-day GM criterion and maximum 30-day 90th percentile concentrations and attainment of the STV. All results are for the attainment of the potential future recreational water quality criterion during the May 1st through October 31st recreational period defined by the DEC.

Table 6-10. Calculated 2008 Baseline Enterococci Maximum Monthly GM and Attainment of Potential Future Recreational WQ Criteria

Station	Maximum Recreational Period 30-day Enterococci (cfu/100mL)		% Attainment	
	GM	90th Percentile STV	Recreation Period GM ≤ 30 #/100mL	Recreation Period STV ≤ 110 #/100mL
GC-1	24	690	100	59
GC-2	23	460	100	65
GC-3	22	496	100	65
GC-4	22	454	100	65
GC-5	23	635	100	61
GC-6	30	1,358	100	22
GC-7	29	1,562	100	30
GC-8	25	653	100	27
GC-9	20	250	100	63
GC-10	17	150	100	90

Calculated attainment of the 30-day rolling GM enterococci concentration of 30 cfu/100mL standard is 100 percent at all stations for baseline conditions. It is noted that, for several stations, the calculations are at compliance. Calculated attainment of the 90th percentile STV at 10 stations, for 2008 baseline conditions, ranges from 90 percent attainment at the Bay boundary (GC-10), to 22 percent at the lowest attainment station (GC-6). Water quality modeling analyses were conducted to assess attainment of the 30-day rolling GM and 90th percentile STV with 100% removal of the CSO enterococci loadings.

Water quality modeling analyses conducted to assess attainment of the enterococci criteria with complete removal of the CSO enterococci loadings, as provided in Table 6-11, show that 100% CSO controls would result in full attainment of the 30-day rolling GM enterococci criterion and greater than 91 percent attainment of the 90th percentile STV enterococci criterion. This high level of improved STV attainment with 100% CSO controls calculated for the Gowanus Canal, as compared to other waterways. Other waterways being addressed by NYC LTCP's do not show this high degree of improvement in calculated STV attainment with 100% CSO controls. Since STV attainment is driven by 90th percentile concentrations in the Gowanus Canal, the calculated improvements in STV attainment suggest that in the Gowanus Canal, the 90th percentile enterococci concentrations are produced by CSOs and therefore can be altered with CSO controls. The reasons specific to the Gowanus Canal why CSO's produce the 90th percentile in the Gowanus Canal enterococci concentrations can be explained by the small magnitude of stormwater entering the Gowanus Canal and the large volume of water with low enterococci concentrations introduced to the Gowanus Canal by the Flushing Tunnel.

Table 6-11. Calculated 2008 100% CSO Control Enterococci Maximum Monthly GM and Attainment of Potential Future Recreational WQ Criteria

Station	Maximum Recreational Period 30-day Enterococci (cfu/100mL)		% Attainment	
	GM	90th Percentile STV	Recreation Period GM ≤ 30 #/100mL	Recreation Period STV ≤ 110 #/100mL
GC-1	17	127	100	91
GC-2	17	132	100	91
GC-3	17	130	100	91
GC-4	17	123	100	93
GC-5	16	116	100	95
GC-6	16	100	100	100
GC-7	16	99	100	100
GC-8	11	46	100	100
GC-9	12	59	100	100
GC-10	15	104	100	100

6.3.g Component Analysis

A loading source component analysis was conducted for the 2008 baseline condition using JFK Airport rainfall data to better understand how each source type contributes to bacteria concentrations in the Gowanus Canal. The source types include: the Buttermilk Channel, entering via the Flushing Tunnel; stormwater and direct drainage; CSOs; and Gowanus Bay. The analysis was completed using the GC-PATH model, and included the calculation of fecal coliform and enterococci bacteria GMs, both 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 concentrations were evaluated on a recreational season (May 1st through October 31st) basis.

Table 6-12 summarizes the fecal coliform component analysis for the maximum winter month. While the Gowanus Canal is a Class SD waterbody (which has no fecal coliform criterion), modeling calculations indicate that the waters of the Gowanus Canal fully meet the Class I Existing WQ fecal coliform Criteria, and are slightly above and below the Primary Contact WQ fecal coliform Criteria during the month with the highest fecal coliform monthly GM. From Stations GC-1 through GC-7, the Buttermilk Channel dominates the monthly fecal coliform GM. This switches to Gowanus Bay having the largest contribution to the monthly GM at Stations GC-8 through GC-10. The highest contribution to the monthly GM made by CSOs is 54 cfu/100mL at Stations GC-6 and GC-7. The highest monthly fecal coliform GM is also calculated at GC-6 at 216 cfu/100mL, which is just above the Primary Contact WQ Criteria of 200 cfu/100mL.

Table 6-12 also summarizes the enterococci component analysis. The rolling 30-day enterococci GM 30 cfu/100mL is not exceeded during baseline conditions. The maximum rolling 30-day enterococci GM calculated by the model is 30 cfu/100mL at Station GC-6. The maximum calculated GM contribution at any location from CSOs is 14 cfu/100mL. This is because CSOs discharge infrequently relative to other bacteria sources.

Table 6-12. Fecal and Enterococci GM Source Components

Source	Station	Fecal Coliform Contribution (cfu/100mL)	Enterococcus Contribution (cfu/100mL)
		Annual Worst Month February Monthly GM	Max 30-Day Rolling GM during the Recreational Period
Buttermilk Channel	GC-1	171	17
Stormwater and Direct Drainage	GC-1	0	0
CSO	GC-1	42	7
Gowanus Bay	GC-1	1	0
Total	GC-1	213	24
Buttermilk Channel	GC-2	171	17
Stormwater and Direct Drainage	GC-2	0	0
CSO	GC-2	28	7
Gowanus Bay	GC-2	1	0
Total	GC-2	201	23
Buttermilk Channel	GC-3	171	17
Stormwater and Direct Drainage	GC-3	0	0
CSO	GC-3	28	5
Gowanus Bay	GC-3	1	0
Total	GC-3	199	22
Buttermilk Channel	GC-4	168	17
Stormwater and Direct Drainage	GC-4	0	0
CSO	GC-4	28	5
Gowanus Bay	GC-4	1	0
Total	GC-4	197	22
Buttermilk Channel	GC-5	165	16
Stormwater and Direct Drainage	GC-5	0	0
CSO	GC-5	32	7
Gowanus Bay	GC-5	1	0
Total	GC-5	199	23
Buttermilk Channel	GC-6	139	12
Stormwater and Direct Drainage	GC-6	9	3
CSO	GC-6	54	14
Gowanus Bay	GC-6	13	0
Total	GC-6	216	30
Buttermilk Channel	GC-7	134	12
Stormwater and Direct Drainage	GC-7	9	3
CSO	GC-7	54	14
Gowanus Bay	GC-7	17	1
Total	GC-7	215	29

Table 6-12. Fecal and Enterococci GM Source Components

Source	Station	Fecal Coliform Contribution (cfu/100mL)	Enterococcus Contribution (cfu/100mL)
		Annual Worst Month February Monthly GM	Max 30-Day Rolling GM during the Recreational Period
Buttermilk Channel	GC-8	46	4
Stormwater and Direct Drainage	GC-8	5	2
CSO	GC-8	46	14
Gowanus Bay	GC-8	84	6
Total	GC-8	**181**	**25**
Buttermilk Channel	GC-9	15	1
Stormwater and Direct Drainage	GC-9	3	1
CSO	GC-9	20	8
Gowanus Bay	GC-9	126	11
Total	GC-9	**164**	**20**
Buttermilk Channel	GC-10	1	0
Stormwater and Direct Drainage	GC-10	0	0
CSO	GC-10	8	2
Gowanus Bay	GC-10	160	15
Total	GC-10	**170**	**17**

Table 6-12 indicates that CSO discharges influence the 30-day GM bacteria concentrations throughout the Gowanus Canal, but not at a level that exceeds even the Primary Contact WQ Criteria during baseline conditions.

6.3.e Time to Recovery

The analyses provided above examines the long-term impacts of wet-weather sources, as is required by existing and future primary contact bacteria 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 New York State Department of Health (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 waterways 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 Gowanus Canal to recover and return to concentrations of less than 1,000 cfu/100mL.

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 (May 1st through October 31st) 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 that there was sufficient time before the next rainfall event started to allow fecal coliform concentrations in the Gowanus Canal associated with the August 15, 2008 JFK rainfall event adequate time to reach and remain at or below the fecal coliform target concentration. It would not be possible to calculate time of recovery for a given storm if a second storm started before the impact of the first storm attenuated.

Table 6-13 presents the time to recovery for the baseline condition and the Gowanus Canal 100% CSO control scenario. Under the baseline conditions, Stations GC-6 and GC-7 have the longest time to recovery of 14 hours. The longest time to recovery occurs in the middle of the Gowanus Canal because the upper end of the Gowanus Canal is flushed out by the Flushing Tunnel and the lower end of the Gowanus Canal is flushed out due to tidal exchange more rapidly than in the middle of the Gowanus Canal. DEC has indicated that it is desirable to have a time to recovery of less than 24 hours. Times to recovery in the Gowanus Canal are below 14 hours.

When the Gowanus Canal CSO loading is removed, the time to recovery for all stations is below 10 hours. Time to recovery is 0 hours at GC-6, GC-8 and GC-9 because, during the design storm at those locations, the fecal coliform concentrations do not exceed 1,000 cfu/100mL after precipitation ends. It is noted that while the time to recovery is reported as 10 hours at GC-7 with 100% CSO control, calculated fecal coliform concentrations are at or above 1,000 cfu/100mL only for hours 9 and 10 after the storm. Decreases in the time to recovery within the Gowanus Canal due to the removal of CSO loadings are from 0 to 14 hours, depending on location. The time to recovery is significantly less than the DEC's 24-hour target, irrespective of CSO discharges.

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; ….

Table 6-13. Time to Recovery

Station	Time to Recovery (hours)	
	Fecal Threshold (1,000 cfu/100mL)	
	Baseline	100% CSO Control
GC-1	9	9
GC-2	8	8
GC-3	9	9
GC-4	9	9
GC-5	10	10
GC-6	14	0
GC-7	14	10
GC-8	10	0
GC-9	7	0
GC-10	9	9

7.0 PUBLIC PARTICIPATION AND AGENCY COORDINATION

The DEP is committed to implementing a proactive and robust public participation program to inform the public of the development of the watershed-specific and citywide LTCPs. Public outreach and public participation are important aspects of plans 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 signed by DEC and DEP on March 8, 2012.

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 as a result of public comments received 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 Gowanus Canal LTCP by reaching out to the Brooklyn Community Board 6, 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 (Gowanus Dredgers, Community Advisory Group, New Yorkers for Parks, New York Environment Report, Gowanus Canal Community Development Corporation, Riverkeeper, Gowanus Canal Conservancy); interest groups (University College London, Columbia University, St. Lydia's Church, Fifth Avenue Committee, Louis Berger, National Grid, HWA, Steven Winter Association, NYCC); NYC governmental entities (Brooklyn Borough Office and Council members, NYC Department of Parks and Recreation, NYC Department of City Planning) and State assembly and senate members.

7.2 Summaries of Stakeholder Meetings

DEP has held public meetings and several stakeholder group meetings to aid in the development and execution of the LTCP. The objective of the public meetings and a summary of the discussion are presented below:

Public Meetings

- Public Meeting #1: Gowanus Canal LTCP Kickoff Meeting (November 19, 2014)

  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 Gowanus Canal waterbody. The two-hour event, held at Public School 32, 317 Hoyt Street in Brooklyn, served to provide overview information about DEP's LTCP Program, present information on the Gowanus Canal watershed characteristics and status of waterbody improvement projects, obtain public information on waterbody uses in the Gowanus Canal, and describe additional opportunities for public input and outreach. The presentation can be found at http://www.nyc.gov/dep/ltcp. Approximately 55 stakeholders from 32 different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event, and two reporters from local newspapers.

The Gowanus Canal LTCP Kickoff Public Meeting was the first opportunity for public participation in the development of this LTCP. 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 the Gowanus Canal;
- Modeling baseline assumptions utilized during LTCP development;
- Rainfall amounts and other assumptions utilized during LTCP development;
- Water quality data collection;
- Existing Gowanus Canal 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: Gowanus Canal LTCP Alternatives Review Meeting (May 14, 2015)

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

DEP hosted the second of three public meetings for the water quality planning process for long term control of CSOs in the Gowanus Canal waterbody. The two-hour event was held at Public School 32, 317 Hoyt Street in Brooklyn. DEP presented information on the LTCP process, the Gowanus Canal 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 35 stakeholders from 20 different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event and one representative from the local media.

In 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 the Gowanus Canal;

- Green infrastructure and grey infrastructure potential alternatives;
- Opportunity to review and comment on the draft Gowanus Canal 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

  The purpose of this meeting will be to 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

- Public Meeting at Wyckoff Gardens Community Center (September 17, 2014)

  DEP held a meeting to present information on tank siting in connection with the EPA September 2013 ROD for the Gowanus Canal Superfund Site.

- Meeting with Riverkeeper and Bronx Alliance (November 18, 2014)

  DEP held a meeting with Riverkeeper on November 18, 2014. During this meeting, DEP staff presented sampling data obtained during the LTCP2 Gowanus Canal sampling programs, as well as data from Harbor Survey and Sentinel monitoring.

- Expo Gowanus (May 28, 2015)

  DEP attended a community event featuring design, stewardship and investigation projects and ideas that enhance the health of the Gowanus Canal and the watershed.

Public Comments Received

No public comments were received following the Gowanus Canal Public Kickoff and Alternatives Review Meetings.

7.3 Coordination with Highest Attainable Use

DEC has established WQS for all navigable waters within its jurisdiction. The Gowanus Canal is classified Class SD in its upper section, and Class I in its lower section. A Class SD waterbody is defined in 6 NYCRR 701.13 as "suitable for fish, shellfish, and wildlife survival" and Class I is defined as "suitable for fish propagation and survival". The best usage of Class SD waters is fishing; for Class I, "secondary contact recreation and fishing" (6 NYCRR 701.14. Class SD does not currently have assigned numerical bacteria criteria. 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 Gowanus Canal LTCP concluded that the standards for the Primary Contact WQ criteria for bacteria will be fully attained. A variance for DO levels would be still be required. However, consideration of upgrading the Gowanus Canal to Class SC should await completion of the construction associated with Superfund remedial measures as well as post-construction compliance monitoring.

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 the Gowanus Canal LTCP public participation activities.

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. 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.

Table 7-1. Summary of Gowanus Canal 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: November 19, 2014 • Meeting #2: May 14, 2015 • Meeting #3: TBD

Table 7-1. Summary of Gowanus Canal LTCP Public Participation Activities Performed

Category	Mechanisms Utilized	Dates (if applicable) and Comments
	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 • Gowanus Canal LTCP webpage launched November 20, 2014 and frequently updated
	Social Media	• TBD
	Media Outreach	• Published advertisements in newspapers, Caribbean Life, Corier Life, and The Brooklyn Paper
	FAQs	• LTCP FAQs developed and disseminated beginning June 2014 via website, meetings and email
Communication Tools	Print Materials	• LTCP FAQs: November 19, 2014 • LTCP Goal Statement: June 26, 2012 • LTCP Public Participation Plan: June 26, 2012 • Gowanus Canal Summary: November 19, 2014 • LTCP Program Brochure: November 19, 2014 • Glossary of Modeling Terms: February 28, 2013 • Meeting advertisements, agendas and presentations • PDFs of poster board displays from meetings • Meeting summaries and responses to 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

A dedicated Gowanus Canal LTCP webpage was created on November 20, 2014, and includes:

- Gowanus Canal public participation and education materials
  - Gowanus Canal Summary Paper
  - LTCP Public Participation Plan
- Gowanus Canal LTCP Meeting Announcements
- Gowanus Canal Kickoff Meeting Documents – November 19, 2014
  - Advertisement
  - Meeting Presentation
  - Meeting Summary and Response to Comments
- Gowanus Canal Meeting #2 Meeting Documents – May 14, 2015
  - Meeting Advertisement
  - Meeting Presentation
  - Meeting Summaries and Responses to Comments

8.0 EVALUATION OF ALTERNATIVES

This section 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 Gowanus Canal.

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).

To evaluate attainment with WQS that would be achieved by the various CSO control alternatives evaluated in this section, the bacteria and DO water quality criteria presented in Section 6.0, Table 6-3 were applied. The Gowanus Canal is the focus of an EPA program conducted under CERCLA (or "Superfund") in connection with the Gowanus Canal Superfund Site through an EPA Administrative Order for Remedial Design, Index No. CERCLA 02-2014-2019, issued to NYC in advance, and independent of this LTCP, but with has a CSO-related mitigation component. Where that effort intersects with, and has an impact on, the evaluation of the CSO controls discussed below, it has been noted throughout this section.

8.1 Considerations for LTCP Alternatives under the Federal CSO Policy

This LTCP addresses the water quality objectives of the CWA, the EPA CSO Control Policy, and the NYS ECL. This LTCP also builds upon the conclusions presented in DEP's August 2008 Gowanus Canal 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 is required.. A UAA is the mechanism to determine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State. If deemed necessary,, the UAA assesses compliance with the next higher classification that the State would consider in adjusting WQS. For the reasons detailed in Section 8.6, a UAA was deemed unnecessary for this LTCP.

The remainder of Section 8.1 discusses the development and evaluation of CSO control measures and watershed-wide alternatives to comply with applicable WQS and with the CSO Control Policy. The evaluation factors considered for each alternative are described below followed by an overview of the evaluation process.

8.1.a Performance

Section 6.0 presented evaluations of baseline LTCP conditions, and concluded that no performance gaps exist because of attainment of existing designated WQS (Classes SD and I) projected for baseline conditions, (i.e., 2040 CY design dry-weather flow and load projections; 2xDDWF at Owls Head and Red Hook WWTPs; implementation of WWFP recommended cost-effective grey; GI implementation rate of 12 percent; and completion of Superfund dredging to the depths specified in the *Feasibility Study Report for the Gowanus Canal Site Brooklyn, NY, December 2011)*. The analyses presented in Section 6.0 show that the Gowanus Canal currently attains the recreational season (May 1st through October 31st) fecal coliform component of the Primary Contact WQ Criteria (200 cfu/100mL). Annual attainment of the fecal coliform criterion of the Primary Contact WQ Criteria is achieved approximately 92 percent of the time based on the typical year (2008) rainfall, based WWFP control alone, even without any additional CSO controls. In addition, baseline enterococci concentrations are projected to meet the Potential Future Primary Contact GM component of the WQ Criteria even without further CSO controls. However, performance gaps exist between baseline projected water quality and the STV criterion of the Potential Future Primary Contact WQ Criteria (2012 EPA RWQC).

The analyses in Section 6.0 showed that the waterbody also attains the applicable DO criteria (Classes SD and I) without additional CSO controls. Thus, through implementation of the projects recommended in the August 2008 WWFP and other CSO planning documents, including the Flushing Tunnel and Gowanus PS upgrades, water quality in the Gowanus Canal has steadily improved to the point where the waterbody is in full compliance with current WQS, and also largely attains the Section 101(a)(2) goals, as projected by the 10-year model runs presented later in this section. Moreover, current water quality of the Gowanus Canal substantially meets the fishable/swimmable goals of the CWA.

As a result of the substantial investments made through the WWFP projects, the Gowanus Canal meets both existing WQS the Potential Future Primary Contact GM. Nevertheless, this section reviews alternatives that could improve water quality still further. A major focus of the development and evaluation of control alternatives for LTCPs is the ability to achieve bacteria load reduction and to attain applicable water quality criteria using a two-step process. First, based upon watershed (IW) model runs for typical year (2008) rainfall, the level of CSO control of each alternative was established, including the reduction of CSO volume, fecal coliform and enterococci loading. The second step used the previously estimated levels of CSO control to project levels of attainment in the receiving waters. This step used the Gowanus Canal 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 - up to 100% CSO control - including investments that would be made by DEP through green and grey infrastructure. Intermediate levels of CSO volume control - approximately 50% and 75% - were also evaluated. The intermediate levels of CSO control analyzed in this LTCP were selected based on the CSO controls evaluated under the Superfund framework, as well as by other controls conceptualized under the LTCP framework. Performance of each control alternative was 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 environmentally sensitive areas, and to enhance water quality in those areas. As described in

Section 2.0, no environmentally sensitive areas exist within the Gowanus Canal, so this criteria is not applicable to this LTCP.

8.1.c Cost

For the purpose of this LTCP, three sources/methods of estimating the construction costs of CSO control alternatives were used to determine their PBC, namely:

- Preliminary estimation based on historical construction costs of equivalent projects.
- Costs estimated used in the Superfund evaluations.
- Typical LTCP methodology 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 purposes of this LTCP, all costs are reported in 2015 dollars.

For the alternatives evaluated, annual O&M costs were used to calculate the total or 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. The O&M costs for all alternatives were derived from historical costs of operating equivalent facilities and equipment within NYC, or were developed within the Superfund framework. In some instances, as costs are further refined through the Superfund framework, the O&M costs may differ from those reported herein based on different estimation methods.

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 “knee-of-the-curve” (KOTC), 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:

- Effectiveness for controlling CSO
- Reliability
- Implementability

The effectiveness of CSO control measures was assessed based on their ability to reduce CSO frequency, volume, and loadings. 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 the implementability of a given control measure or basin-wide alternative, 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 were evaluated under the 2040 design year sanitary flows (dry-weather flow), 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.

Breaking construction into segments allowed adjustment of the design of future phases based on monitoring the performance of already-constructed phases. Lessons learned during operation of the current infrastructure can be incorporated into the design of future infrastructure. However, phased construction also exposes the local community to a longer construction period. Where applicable, the LTCP discusses constructability, potentially required additional infrastructure and land acquisition, as well as adaptive management strategies.

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.

Finally, all LTCPs include provisions for PCM, as appropriate, to monitor the effectiveness of the implemented control measures.

8.1.f Long Term Phased Implementation

According to the CSO Control Policy, implementation steps 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.

8.1.g Other Environmental Considerations

When construction is required, impacts on the environment and surrounding neighborhood will be minimized as much as possible. 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 impact 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 to the public throughout the development of this LTCP. 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 public's health and safety are a priority of the Plan. DEP's 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. DEP also has considered, and planned other projects to enhance community well-being, such as projects targeting flood mitigation.

8.1.i Methodology for Ranking Alternatives

The multi-step evaluation process that DEP employed in developing this alternatives analysis included the following:

1. Evaluating benchmarking scenarios, including baseline and 100% CSO control, to establish the full range of controls within the Gowanus Canal watershed. The results of this step were described in Section 6.0.
2. Developing a list of promising control measures for further evaluation based, in part, on a prioritized list of CSO outfalls.
3. Conducting a series of "brainstorming" workshops to review and further advance the most promising control measures and to solicit additional options to explore.
4. Estimating both costs and performance of the most promising control measures to establish a listing of retained measures for inclusion in basin-wide alternatives.
5. Establishing the preferred alternative from the steps above.

Unique to the Gowanus Canal LTCP, there were also a number of coordination meetings with EPA concerning the Gowanus Canal Superfund program. During these meetings, these two independent legal mandates (CWA and Superfund) were discussed with respect to their possible overlap of purpose and/or points of coordination. The range of CSO control measures that were considered for this and other LTCPs fall under the categories of Source Control, System Optimization, CSO Relocation, Water Quality/Ecological Enhancement, Treatment, and Storage, with the following constituents:

Source Control
- Additional GI Infrastructure
- HLSS

System Optimization
- Fixed Weir Modifications
- Parallel Interceptor Sewer
- Inflatable Dams, Bending Weirs and Control Gates
- PS Expansion

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

Water Quality/Ecological Enhancement

- Floatables Control
- Dredging
- DO Improvement
- Flushing Tunnel

Treatment

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

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 loads removal performance of each measure typically corresponds with the level of cost and complexity.

The vast majority of the control measures shown above were screened-out early in the evaluation process upon the results of the performance gap from Section 6.0, analysis of the collection system and compatibility with the available sites. Unique to this LTCP, the EPA Superfund evaluations also informed the evaluation process. For example, the Superfund evaluations focused primarily on storage tanks due to their ability to reduce TSS loadings to the Gowanus Canal, a priority for the CSO-related portion of the Superfund ROD for this site. Thus, to provide consistency in both sets of evaluations, storage tanks were evaluated here as well.

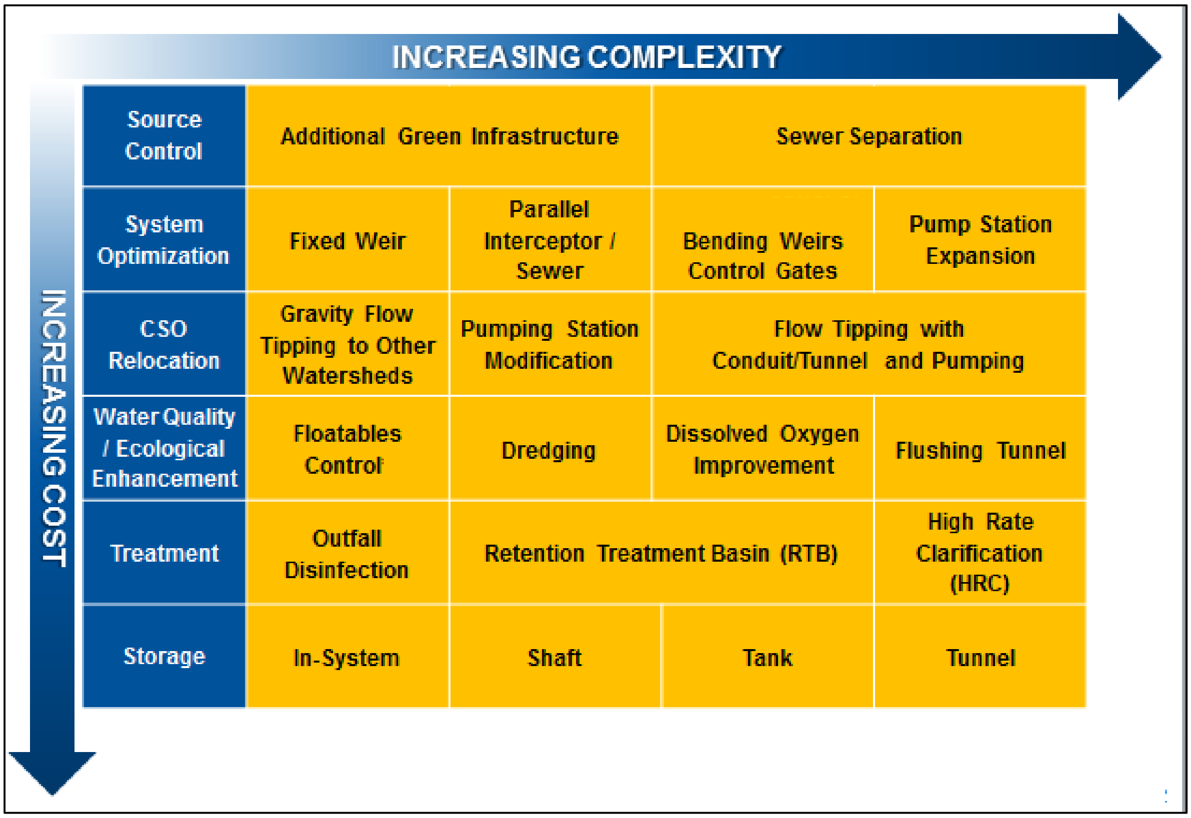


Figure 8-1. Matrix of CSO Control Measures for the Gowanus Canal

Alternatives to tanks were also evaluated, including those in the System Optimization category (directing flow to other watersheds through flow tipping, weir modification and parallel or increased sewer capacity of the Bond Lorraine Sewer), as were deep tunnels in the Storage Category to provide higher levels of volumetric control (75 and 100% CSO Control).

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

The performance gap for the typical year (2008) water quality model simulation of baseline conditions described in Section 6.0 is quite small with respect to the annual minimum attainment of the 200 cfu/100mL fecal coliform criterion, a key component of the Primary Contact WQ Criteria. Using the 2008 typical year computer run, projected attainment for this criterion is 92 percent; it is 100 percent for the recreational season (May 1st through October 31st). As described later in this section, when the full 10-year simulation is run, seasonal attainment of the 200 cfu/100mL criterion exceeds 95 percent, which is the target level of attainment for this analysis as established by the DEC. Thus, based on this latter, more representative analysis, there is no performance gap with Existing WQ Criteria or Primary Contact WQ GM Criteria. Under either typical year or 10-year model runs, a performance gap exists between baseline conditions and the STV 110 cfu/100mL enterococci criterion of the Potential Future Primary Contact WQ Criteria.

In summary, the evaluation of control measures for the Gowanus Canal LTCP focused on improving attainment of the Potential Future Primary Contact WQ Criteria, and to determine whether additional water quality benefits would be derived from implementing the Superfund CSO control measures.

With the above context, control measures that advanced beyond initial screening were evaluated against three of the key considerations described in Section 8.1: (1) benefits, as expressed by levels of CSO control and WQS attainment; (2) costs; and (3) challenges, such as siting, construction, and operations. Using this methodology, the control measures that were deemed most viable for the Gowanus Canal 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.

The evaluations of control measures and basin-wide alternatives focused on Outfalls RH-034 and OH-007, the two largest contributing CSOs in the Gowanus Canal watershed. However, alternatives also were considered for other, smaller overflows in conjunction with the two tunnel alternatives.

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 that were 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, and includes 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 2008 WWFP, were described in Section 4.0. These include refurbishment of the Gowanus Canal Flushing Tunnel system, construction of a new force main to the Columbia Street interceptor, and the reconstruction of the Gowanus PS.

8.2.a.1 High Level Sewer Separation

HLSS is a form of partial separation that separates stormwater from streets or other public rights-of-way from combined sewers, while leaving roof leaders or other building connections unaltered. In NYC, this is typically accomplished by constructing a new shallow stormwater system and directing flow from street inlets and catch basins to the new storm sewers and reducing CSO volumes. 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 reduces the amount of CSO being discharged to receiving waters, but results in increased separate stormwater discharges to receiving waters.

HLSS was considered in the 2008 WWFP, but was not recommended at that time. However, DEP does plan to implement a HLSS project in the watershed to address localized flooding, scoped outside the LTCP process. As noted, although HLSS was not recommended in prior CSO planning efforts, it has been included in the baseline conditions described in Section 6.0, as its multi-phased implementation is scheduled to commence in the near-term. Figure 8-2 shows the affected area.

As described earlier, the HLSS is planned to be implemented in two phases. Details of the projects were provided in Sections 2.0 and 6.0.

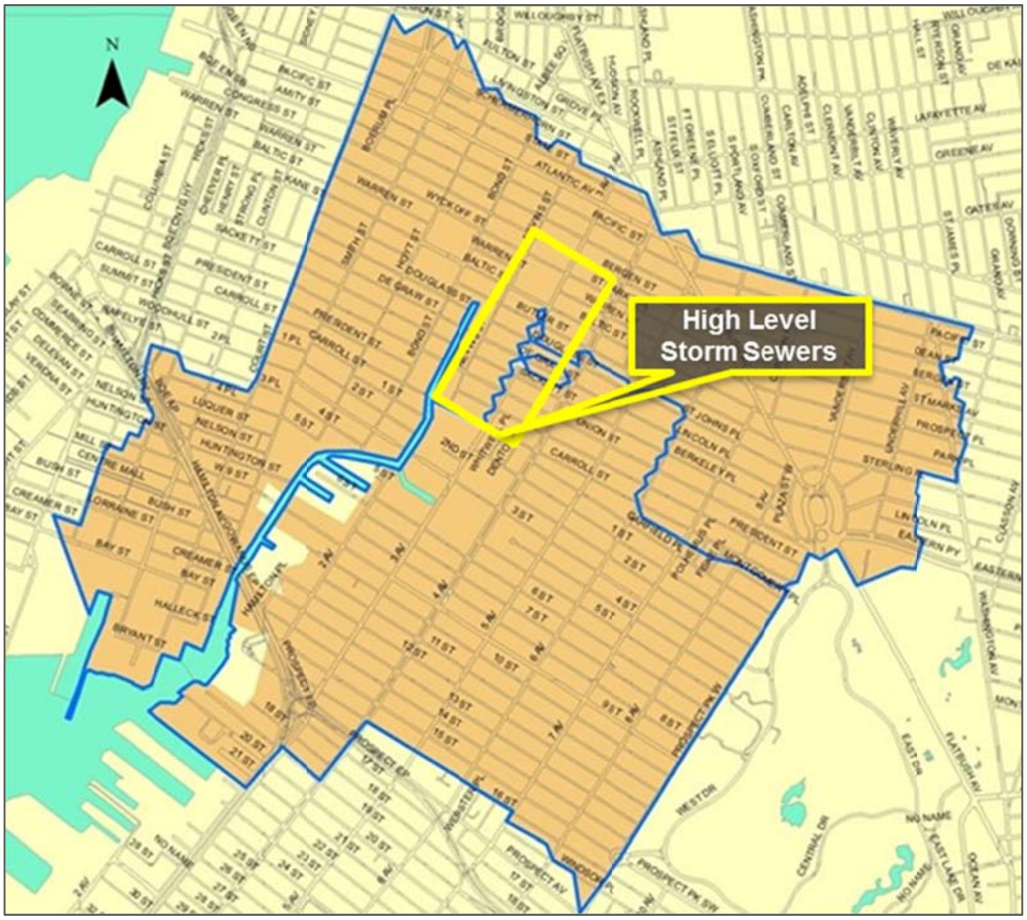


Figure 8-2. Proposed Gowanus Canal HLSS

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.

As part of the control measure review process described in Section 8.1, two system optimization measures made it past the initial screening process and were subsequently developed and evaluated for the Gowanus Canal:

- Reconstruction of the Bond Lorraine Sewer targeting CSO reduction at Outfall RH-034
- Regulator modifications targeting CSO reduction at Outfalls OH-006, OH-007 and OH-024

Each is described as follows:

Reconstruction of the Bond Lorraine Sewer

The Bond Lorraine Sewer, shown in Figure 8-3, is a 72-inch-diameter sewer that runs from the Gowanus PS southward along Bond Street on the western side of the Gowanus Canal to Lorraine Street. The Bond Lorraine Sewer originates at Bond and Douglas Streets and terminates at the beginning of the Red Hook Interceptor Sewer on Columbia Street. It is approximately 2.5 miles in length and accepts gravity flow from its tributary drainage area. The Bond Lorraine Sewer has two relief points that can discharge into the Gowanus Canal via Outfalls RH-035 and RH-031. Prior to the recent reconstruction, the Gowanus PS discharged its flow into the Bond Lorraine Sewer.

Figure 8-3. Bond Lorraine Sewer

A general chronology of the Bond Lorraine Sewer over the last hundred-plus years follows:

- 1890s – Bond Lorraine Sewer Constructed (72-inch diameter).
- 1947 – Gowanus PS (22 MGD) constructed to reduce dry-weather overflows at Outfall RH-034 into the Gowanus Canal.
- 1970s – Bond Lorraine Sewer control structures raised to eliminate dry-weather overflows into the Gowanus Canal.
- 1980s – Gowanus PS Upgrade including construction of a high density polyethylene (HDPE) force main within the Flushing Tunnel to reduce overflows from the Bond Lorraine Sewer into the Gowanus Canal.
- 1990s – Gowanus PS flow routed to Bond Lorraine Sewer because force main within Flushing Tunnel failed.
- Current – Reconstruction of the Gowanus PS increased capacity and replaced original HDPE force main with a concrete encased ductile iron force main within the Flushing Tunnel removing the pumped flow from Bond Lorraine Sewer.

With respect to this LTCP, the reconstruction and enlarging of the Bond Lorraine Sewer was evaluated as a means of reducing CSO loadings to the Gowanus Canal from Outfall RH-034 and potentially eliminating the need for a CSO storage tank at this outfall as was recommended by the EPA ROD. Specifically, this control measure consists of replacing the existing Bond Lorraine Sewer with an enlarged 6-ft-by-8-ft box sewer for improved conveyance capacity. Two alternative concepts were considered: Alternative 1 evaluated a new pump station to be constructed in the vicinity of Outfall RH-034 near the existing Gowanus PS to convey up to 20 MGD of CSO flow to the enlarged Bond Lorraine Sewer. Alternative 2 would redirect approximately 200 acres of tributary area away from the Gowanus PS and divert it directly by gravity to the enlarged Bond Lorraine Sewer, thus eliminating the need for a new pump station. The layout of both alternatives is shown in Figure 8-4. The enlarged Bond Lorraine Sewer is a common element to both alternatives.

Weir elevations at Outfalls RH-035 and RH-031 would also be raised to prevent increased CSO discharges into the Gowanus Canal. Alternative 1 includes a 0.75-ft increase at the Outfall RH-035 weir and a 0.65-ft increase at the Outfall RH-031 weir. Other existing weir elevations need not be modified.

The benefits, costs and challenges associated with enlarging the Bond Lorraine Sewer are as follows:

<u>Benefits:</u>

The primary benefit for both alternatives involves CSO loading reductions into the Gowanus Canal from Outfall RH-034. Alternative 1 achieves a 47% CSO volume reduction at RH-034 as a result of the higher pump capacity realized by the new dedicated pump station. However, the corresponding CSO discharges into Gowanus Bay and Buttermilk Channel increase by 16 MGY and 48 MGY, respectively. This is due to the conveyance capacity of the Red Hook Interceptor not being able to convey the additional CSO flows from the Bond Lorraine Sewer. However, the increased discharges into Gowanus Bay and Buttermilk Channel are unlikely to have significant water quality impacts on these waterbodies, as the incremental volumes are small in comparison to the available assimilation capacity. The overflow reduction at Outfall RH-034 obtained by Alternative 2 was 59 percent, with flows conveyed by gravity instead of pumping. Similarly, the corresponding CSO discharges into Gowanus Bay and Buttermilk Channel increase by 16 MGY and 49 MGY, respectively.

Figure 8-4. Alternatives Layout for Bond Lorraine Sewer

Both alternatives will also likely alleviate flooding in this area. An additional benefit is it eliminates the need to site a structure on a highly contaminated manufacturing gas plant (MGP) site with extensive remediation of the site required before construction can begin.

Both alternatives will reduce CSO volumes by removing stormwater from the combined sewer system. It is not simply a redirection of CSO flow.

Costs:

The Probable Bid Cost for the Bond Lorraine Sewer options are $313M for Alternative 1 and $334M for Alternative 2.

Challenges:

The Bond Lorraine Sewer poses significant challenges. Principal among them are complex construction issues associated with removing the existing 72-inch-diameter Bond Lorraine Sewer and replacing it with an enlarged 6-ft-by-8-ft box structure. Construction would require very conservative methods including:

- Extensive soil borings and test pits
- Sheeting
- Dewatering

- Pile supports
- Underpinning of structures, where needed
- Every structure within a 300-ft radius of the construction route will need to be inspected and continuously monitored
- Relocation of all subsurface and surface utilities
- Temporary bypass pumping (24/7) of sewage to facilitate new sewer construction
- Likelihood that some buildings will need to be condemned and demolished.

Alternative 1 would require a site to construct a new pump station in the vicinity of Outfall RH-034, whereas Alternative 2 would require additional sewer construction to direct up to 200 acres of drainage directly to the Bond Lorraine Sewer by gravity. Under both alternatives, the enlarged Bond Lorraine Sewer remains surcharged along its entire length, in conflict with the drainage plan criteria for new sewer construction. Because of the conveyance limitations of the beginning section of the Red Hook interceptor, both alternatives will redistribute CSO volume from the Gowanus Canal to downstream portions of Gowanus Bay and Buttermilk Channel. Finally, hydraulics in the new Bond Lorraine Sewer would not be improved because the elevations at the beginning and end locations are fixed by the other existing sewer connections. Low sewer slopes and the potential for grit accumulation will limit the conveyance capacity of the new Bond Lorraine Sewer. However, reconstruction of the portion of the Bond Lorraine Sewer, which runs through the Citizens MGP site, is expected to be rebuilt under the remediation activities at that site.

While there are many challenges associated with enlarging the Bond Lorraine Sewer, Alternative 1 will be further evaluated within this LTCP because it offers an alternative to tank construction for Outfall RH-034. While a new pump station would be involved, Alternative 1 provides less constructability concerns than does Alternative 2's gravity approach, in which rerouting up to 200 acres of drainage area would require the construction of up to 2,000 feet of sewer and the minimum pipe cover requirements would not be met.

Weir Modifications at Outfalls OH-006, OH-007 and OH-024

DEP also evaluated a control measure that would relocate the affected CSO discharges along the collection system that run generally parallel to the Gowanus Canal, essentially, "flow tipping" to outfalls outside of the watershed. This control measure would modify weirs at three regulators that discharge to Outfalls OH-006, OH-007 and OH-024 as a means of reducing CSO discharges to the Gowanus Canal. This measure would be employed in lieu of a storage tank at Outfall OH-007. The weir modification concept is illustrated in Figures 8-5 and 8-6 for Outfall OH-007.

As shown, the existing regulator structures and weirs would be enlarged to increase the wet weather flow conveyed by the 3rd Avenue combined sewer, thus reducing CSO discharges to the Gowanus Canal.

The benefits, costs and challenges associated with weir modifications at Outfalls OH-006, OH-007 and OH-024 are as follows:

<u>Benefits</u>

The primary benefit of this measure is that it avoids the construction of a storage tank, shaft or tunnel by relocating CSO discharges outside of the watershed. Further, all construction would be in public rights-of-way, thus avoiding the need to site a control measure on private property or public property that could provide other, more valuable uses to the community. Finally, unlike any of the other off-line storage measures, the annual additional O&M requirements of the weir modifications would be minimal. Also, the weir modifications would result in a hydraulically neutral solution, i.e., the water elevations at and upstream of the improvement should not change or rise under the 5-year design storm. This would allow DEP to maintain the same level of service.

Cost

The estimated NPW for this control measure is $22M.

Challenges

The most pressing challenge for this and any system optimization measure that involves a significant weir adjustment is to prevent upstream hydraulic impacts. Other challenges include the temporary traffic disruption that would occur during construction and the periodic inconveniences to the public during routine O&M functions due to its location beneath an active public street.

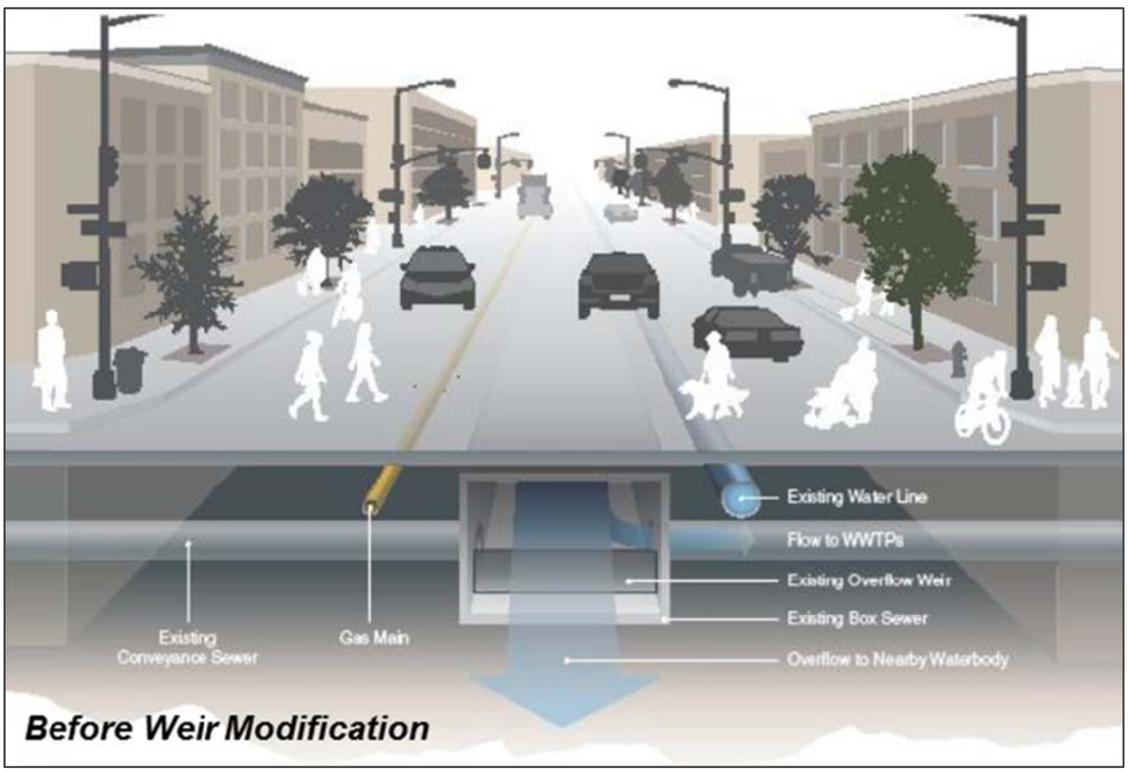


Figure 8-5. Current Weir Schematic at Outfall OH-007

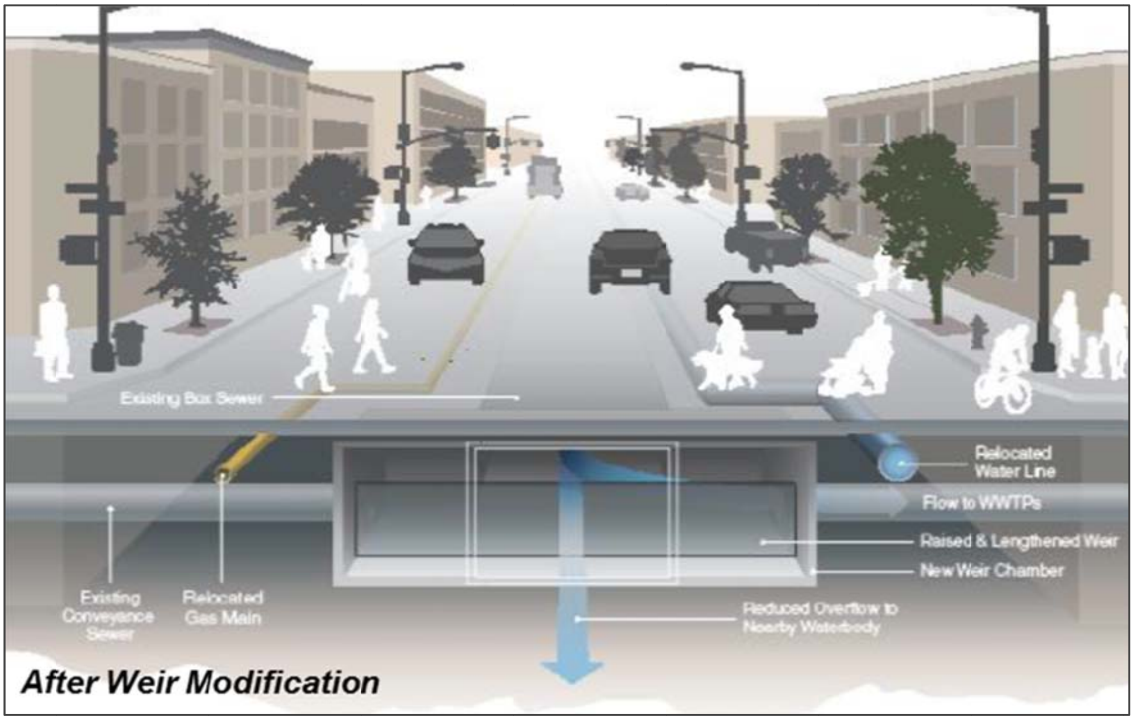


Figure 8-6. Proposed Weir Modification at Outfall OH-007

Sewer Enhancement/Optimization Findings

Both of the system optimization measures described above were found to be worthy of the next level of evaluation for possible inclusion in basin-wide alternatives.

8.2.a.3 Retention/Treatment Alternatives

A number of the control measures considered for the Gowanus Canal fall under this dual category of treatment and retention. The term “retention” is also referred to as “storage”. 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 RTBs, disinfection, in either CSO outfalls or RTBs, and other, more advanced, treatment processes such as HRC.

EPA’s Superfund ROD focused on tank storage, which for consistency was incorporated into the LTCP evaluations. However, tunnels were evaluated as well for their ability to provide a high level of volumetric control, up to and including 100% CSO control as upper boundary water quality endpoint.

While DEP initially considered some treatment control measures, most notably RTBs, these were eliminated early in the screening process in favor of tank and tunnel storage. Disinfection was also screened out early in the evaluation process due to the high level of the projected attainment of bacterial WQS.

Additional in-line storage was also screened-out from further consideration because the existing combined sewer system has little available in-line storage capacity as demonstrated by the results of the weir modification evaluations.

The storage and treatment control measures that advanced beyond the initial screening steps described in Section 8.1 were:

- Tank storage at Outfalls RH-034 and OH-007, consistent with the DEP Superfund evaluations
- Tunnel storage for all CSO outfalls along the Gowanus Canal

Each is described below.

Retention Alternative - Tank Storage at Outfalls RH-034 and OH-007

Storage tanks were evaluated for Outfalls RH-034 and OH-007. The evaluation included an 8 MG tank for Outfall RH-034 and a 4 MG tank for Outfall OH-007, as preliminarily estimated in the ROD, and which are referred to herein as the "EPA ROD Tanks" or Alternative 1. Other combinations of tank sizes were also evaluated, as summarized in Table 8-1.

Table 8-1. LTCP Evaluated Storage Tank Sizes

Alternative	Outfall Tank Size (MG)	
	Outfall RH-034	Outfall OH-007
1. EPA ROD Tanks	8	4
2.	5.7	2.5
3.	3.5	1.4

The other tank size options included 5.7 MG and 3.5 MG tanks at Outfall RH-034, coupled with 2.5 MG and 1.4 MG tanks at Outfall OH-007. These are referred to as Alternatives 2 and 3, respectively. As discussed below, these tank sizes were evaluated in this LTCP because they represent the sizes estimated necessary to meet the preliminary estimates of TSS reductions set forth in the ROD. The reduction range set forth in the ROD is 58-74%. Alternative 2 represents tank sizes that would achieve a 74% reduction, while Alternative 3 represents tank sizes that would achieve a 58% reduction.

The LTCP evaluations led to a determination that a combination of smaller tanks would provide a similar level of CSO control when implemented in conjunction with the reductions in CSO discharges realized from the reconstruction of the Gowanus PS and other measures included in the baseline conditions described in Section 6.0. The results of the LTCP evaluation of the tank options is summarized in Tables 8-2 and 8-3.

Table 8-2. Performance of Storage Tank Combinations from LTCP Evaluations for Outfall RH-034

Outfall RH-034	Pre-WWFP	LTCP Baseline	ROD Proposed	Volumetric Reduction	
				74%	58%
Tank Size	-	-	8 MG	5.7 MG	3.5 MG
% Reduction	-	25%	82%	74%	58%
Remaining CSO Volume	182 MG	137 MG	33 MG	47 MG	76 MG
Annual Overflow Frequency	45	40	6	7	12

Table 8-3. Performance of Storage Tank Combinations from LTCP Evaluations for Outfall OH-007

Outfall OH-007	Pre-WWFP	LTCP Baseline	ROD Proposed	Volumetric Reduction	
				74%	58%
Tank Size	-	-	4 MG	2.5 MG	1.4 MG
% Reduction	-	16%	87%	74%	58%
Remaining CSO Volume	69 MG	58 MG	9 MG	18 MG	28 MG
Annual Overflow Frequency	48	44	5	6	13

Both of the smaller tank combinations (Alternatives 2 and 3) meet or exceed the ROD TSS targeted reduction for each outfall.

CSO overflow frequency is also included in the table. All three tank options significantly reduce the frequency of overflows from LTCP baseline conditions of over 40 per year to a maximum of between 12 and 13 per year with the smallest tanks.

DEP considered other options that are consistent with the ROD findings, one including a single 3.5 MG tank at Outfall RH-034 coupled with a system optimization measure, and the other using only system optimization measures and containing no tanks. These two options are discussed following this discussion of tanks.

Following an extensive siting evaluation conducted as part of the Superfund work, two sites each for both the Outfall RH-034 and Outfall OH-007 tanks were identified, designated Sites RH-3, RH-4, OH-4 and OH-5, respectively, as shown on Figures 8-7 through 8-10. The details of the siting evaluation can be found in the Superfund submittals referenced in Section 8.8. All of the sites would accommodate the largest tanks associated with the ROD: 8 MG for the two Outfall RH-034 sites and 4 MG for the two Outfall OH-007 sites. As shown, RH-3 is closer to the actual RH-034 Outfall than is Site RH-4. Similarly, Outfall OH-007 Site OH-4 is also closer to the actual OH-007 outfall than is Site OH-5.

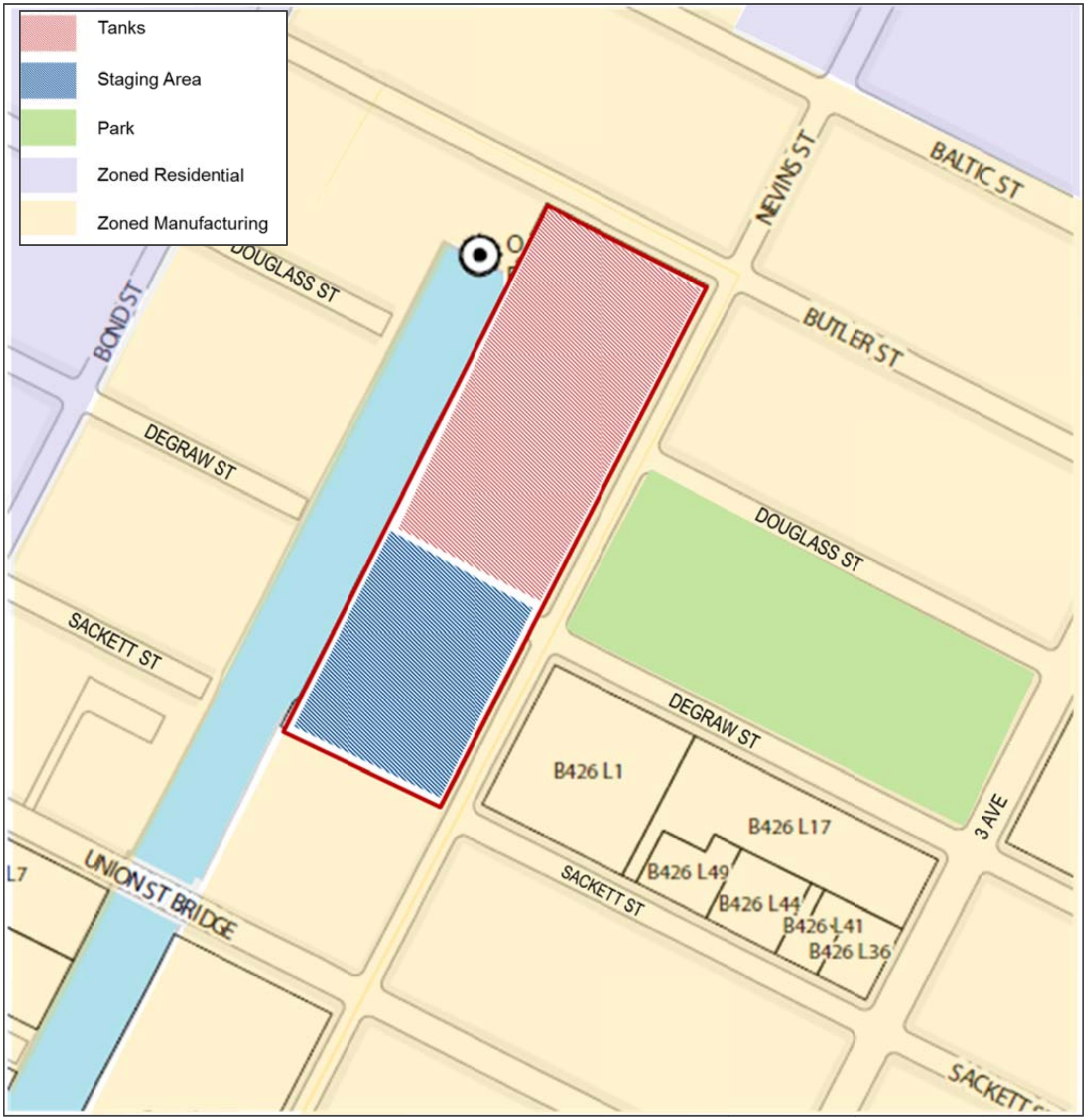


Figure 8-7. Outfall RH-034 Site RH-3

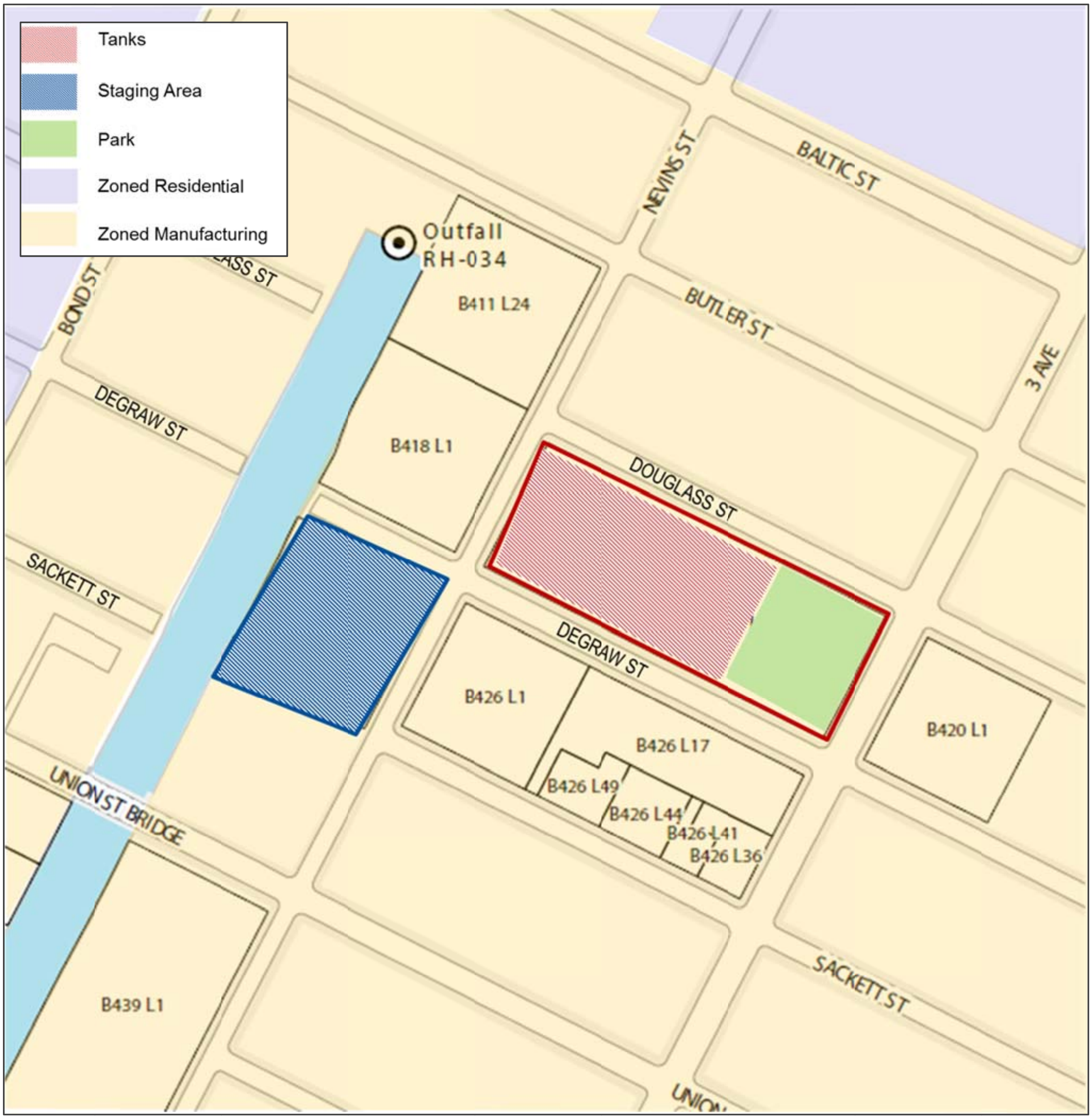


Figure 8-8. Outfall RH-034 Site RH-4

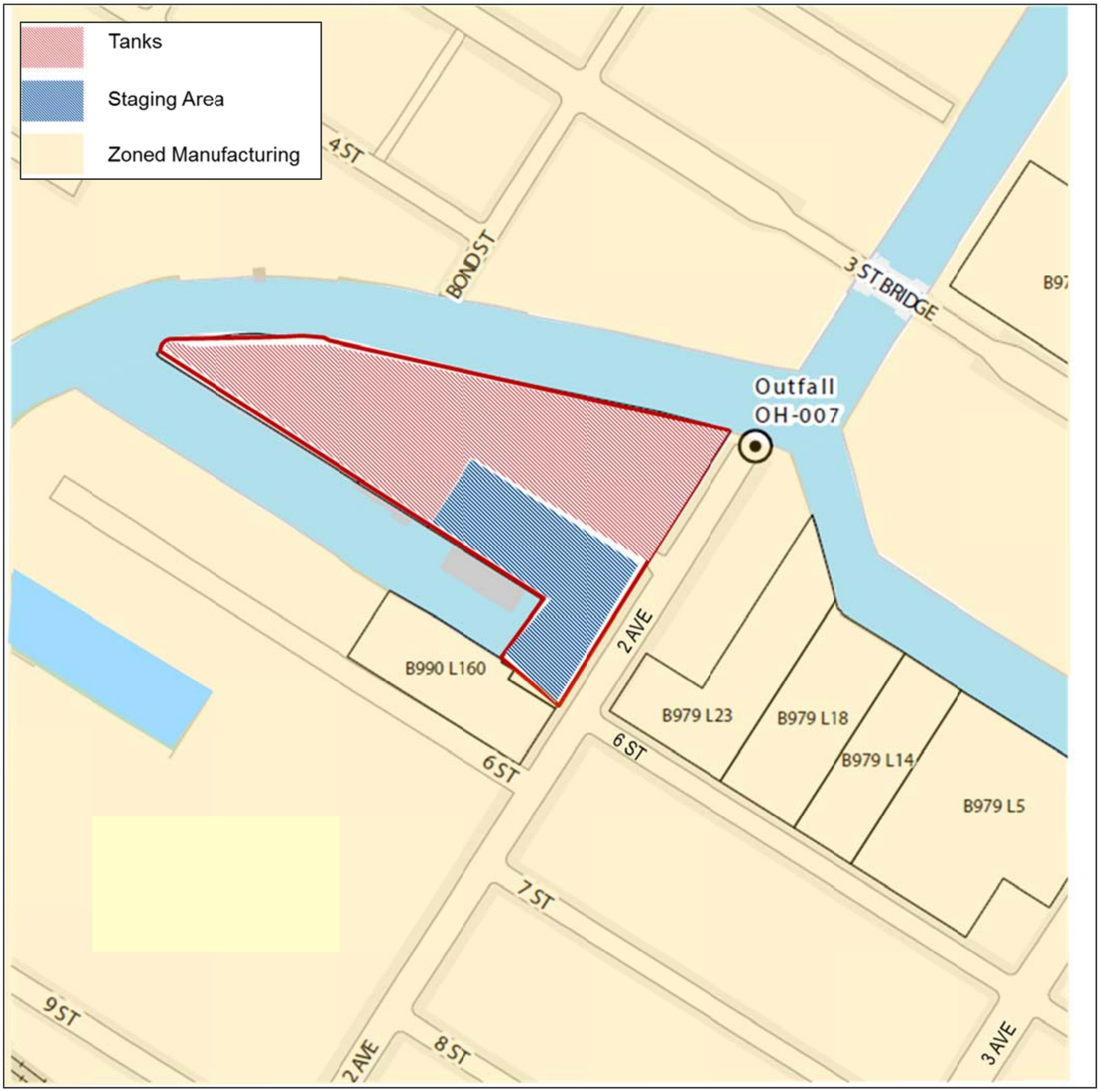


Figure 8-9. Outfall OH-007 Site OH-4

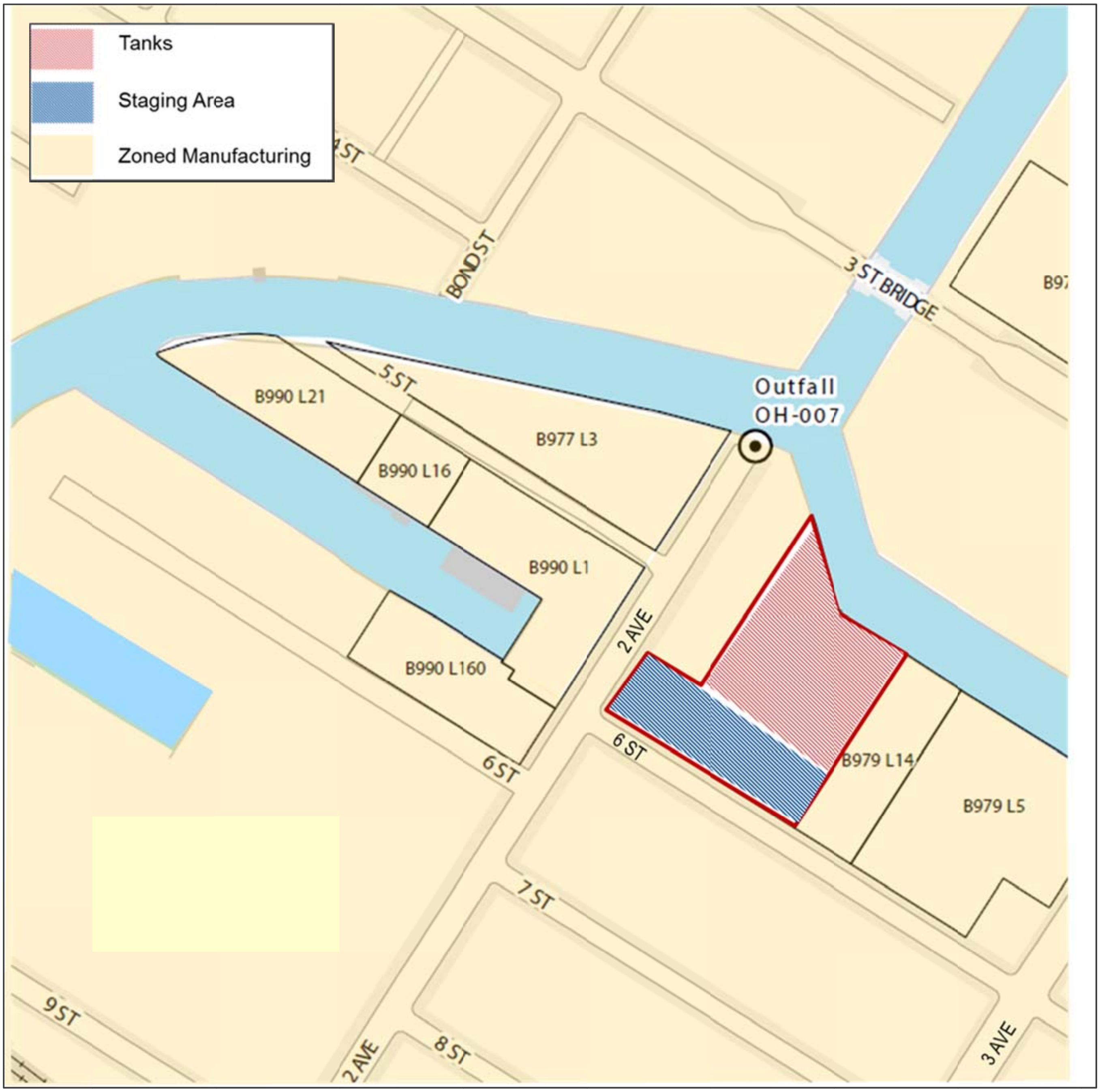


Figure 8-10. Outfall OH-007 Site OH-5

The benefits, costs and challenges associated with tank storage at Outfalls RH-034 and OH-007 are as follows:

Benefits

The primary benefit of this control measure is that it employs a technology that DEP is familiar with during both construction and operations. In essence, it is proven technology both locally and nationwide for CSO volumetric control. The tanks sizes presented also meet the ROD TSS reduction targets and will provide floatables control.

Cost

The estimated NPW for these storage tank options was $829M for the largest EPA ROD Tanks; $683M for the mid-size Alternative 2 tanks (5.7 MG and 2.5 MG); and $507M for the smaller Alternative 3 tanks (3.5 MG and1.4 MG). Details of these estimates are presented in Section 8.4.

Challenges

The most critical challenge to implementing storage tanks or any major CSO control facility is siting, followed by constructability. Even with the smaller tanks, major excavation and soil contamination mitigation is required, excavation sheeting and dewatering, and truck traffic during construction. There are also operational challenges, even with current DEP experience, with such facilities as each new tank requires significant pre- and post-storm O&M functions. Other challenges are aboveground support facilities, odor control and grit removal. All activities would require close coordination with planned clean-up efforts within the Superfund framework. Additionally, one of the two possible RH-034 sites is located within parkland which raises community impacts and presents park alienation challenges.

Retention Alternative – Variants to Tank Storage at Outfalls RH-034 and OH-007

As noted above, there were two variants to what were referred to as Alternatives 1, 2 and 3, all three of which included a tank at both Outfalls RH-034 and OH-007. The first variant, referred to as Alternative 4, would retain the smaller 3.5 MG tank at Outfall RH-034 but replace the Outfall OH-007 tank with the weir modifications, described above, at Outfalls OH-006, OH-007 and OH-024. The second variant, referred to as Alternative 5, includes no tanks. Alternative 5 includes a combination of both system optimization measures: reconstruction of the Bond Lorraine Sewer for Outfall RH-034 and the weir modifications that were described above at Outfalls OH-006, OH-007 and OH-024.

The benefits, costs and challenges associated with these two variants to the two tank options are as follows:

Benefits

With respect to Alternative 4, the primary benefit is that it employs a technology that DEP is familiar with during both construction and operations. In essence, it is proven technology both locally and nationwide for CSO volumetric control.

With respect to Alternative 5, the primary benefit is that no tanks are included, thus eliminating the major siting process involved with such projects. Further, the additional O&M cost to DEP of the no-tank option would be eliminated over those involving two or even a single tank.

Cost

The estimated NPW for these two control measure options was $401M for the single tank at RH-034 Alternative 4 and $355M for the no-tank Alternative 5. The weir modifications would represent a small fraction of the NPW in both instances, at approximately $22M. Details of the estimates are presented in Section 8.4.

Challenges

With respect to Alternative 4, the most critical challenge to implementing storage tanks or any major CSO control facility is siting followed by constructability. Even with the smaller, single tank under this option, major excavation and site remediation at Outfall RH-034 is required with mitigation of subsurface conditions, excavation sheeting and dewatering, and truck traffic during construction. There are also operational challenges even with current DEP experience with such facilities, as each new tank requires significant pre- and post-storm O&M functions. Other challenges are aboveground support facilities, odor control and grit removal. All activities would require close coordination with planned clean-up efforts within the Superfund framework.

With respect to Alternative 5, there are significant challenges as previously noted under the individual discussion of the Bond Lorraine Sewer and weir modifications.

Retention Alternative Tunnel Storage for all CSO Outfalls

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 such facilities.

The deep tunnel that was evaluated for the Gowanus Canal watershed would begin at Outfall RH-034 and terminate near the mouth of the Gowanus Canal in the vicinity of Outfall OH-024. The tunnel would be 8,400 feet long and have a 27-ft diameter for 100% volumetric control; an 18-ft diameter tunnel of the same length would provide 75% control. Both the mining shaft and dewatering pump station would be located at the downstream end of the tunnel. The layout of the tunnels is shown on Figure 8-11, following the route of the Gowanus Canal, and shows the intermediate shafts to collect flows from eight CSO outfalls along the route. Table 8-4 contains a summary of the key features of the two tunnel configurations, Alternatives 6 and 7, for the smaller and larger volume tunnel, respectively.

Table 8-4. Deep Tunnel Characteristics

Tunnel Options	Level of Service (CSO Volumetric Capture)	
	75%	100%
Tunnel Volume (MG)	15.8	34.6
Tunnel Length (lf)	8,400	8,400
Tunnel Diameter (ft)	18	27
NPW ($ Millions)	695	873

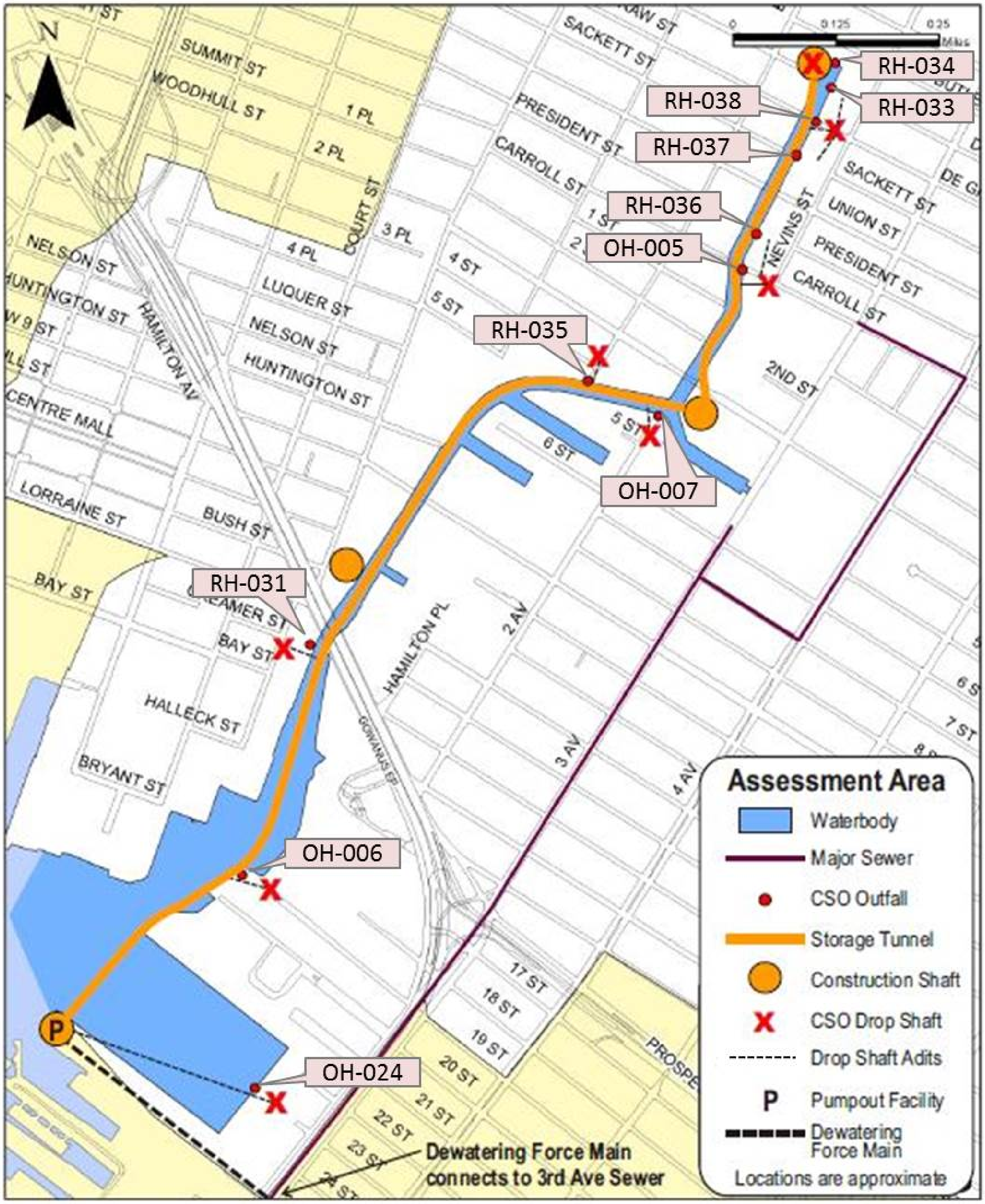


Figure 8-11. Route of Tunnels for 75% and 100% CSO Control

The 8,400-ft-long tunnel should be considered as a placeholder, particularly for the 75% control concept, where the length could possibly be reduced by focusing on the two largest outfalls, Outfalls RH-034 and OH-007.

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

Benefits

The primary benefit of the tunnel storage is the reduction of annual overflow volume with minimal permanent aboveground land requirements, unlike with other types of CSO controls. Also, as with the system optimization alternatives, the storage tunnel would preclude the need for chemical treatment and associated equipment.

Cost

The estimated NPW for this control measure is $695M for the 75% control tunnel and $873M for the 100% 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 for deep, confined spaces. Also, DEP has no operating experience with tunnels in its wastewater system. Other challenges include: 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 warrant the next level of evaluation for inclusion in basin-wide alternatives.

Storage Dewatering

Each of the control measures described above involving storage requires dewatering of the retained CSO volumes after wet weather events occur. The capacity of the required dewatering system is shown in Table 8-5 for each of the storage measures, based on a two-day dewatering period.

Table 8-5. Dewatering System Capacity of Retention Alternatives Based on Two-Day Tank Dewatering

Alternative	Storage Volume (MG)	PS Capacity (MGD)
1	8 (Outfall RH-034)	4
	4 (Outfall OH-007)	2.0
2	5.7 (Outfall RH-034)	2.9
	2.5 (Outfall OH-007)	1.3
3	3.5 (Outfall RH-034)	1.8
	1.4 (Outfall OH-007)	0.7
4	3.5 (Outfall RH-034)	1.8
6	15.8	7.9
7	34.6	17.4

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 12 percent of the impervious surfaces within the Gowanus Canal watershed. 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 in addition to those implemented under previous facility plans and those included in the baseline conditions. Because DEP is currently working on the implementation of GI area-wide contracts in the Gowanus Canal watershed, additional GI beyond the baseline is not recommended 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 are identified.

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 Gowanus Canal LTCP.

8.2.d Retained Alternatives

Based on the results of the preceding evaluations, a limited number of control measures were deemed suitable for inclusion in the development of basin-wide alternatives for the Gowanus Canal. These are shown in Table 8-6, together with the reason for excluding those control measures that were screened from further consideration.

Table 8-6. Summary of Next Level of Control Measure Screening

Control Measure	Category	Retained for Further Analysis?	Remarks
HLSS	Source Control	NO	Already planned for the watershed under flood mitigation efforts outside the LTCP framework.
Sewer Enhancements (Weir Modifications and Bond Lorraine Sewer Reconstruction)	System Optimization	YES	Not as stand-alone measures; included as part of basin-wide alternatives.
In-line Storage	Storage	NO	No available capacity.
Storage (Tanks)	Storage	YES	Included consistent with Superfund program.
Off-line Storage (Tunnels)	Storage	YES	For 75% and 100% control.

Table 8-6. Summary of Next Level of Control Measure Screening

Control Measure	Category	Retained for Further Analysis?	Remarks
Floatables Control	Floatables Control	YES	Not as a stand-alone measure; included as part of weir modifications and inherent with all storage measures.
Additional GI Build-out	Source Control	NO	Planned 12% 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 two in the Sewer Optimization category and two in the Storage Category.

The retained alternatives are presented in Table 8-7.

Table 8-7. Retained Alternatives

Alternative	Description
1	• 8 MG Tank at Outfall RH-034 • 4 MG Tank at Outfall OH-007
2	• 5.7MG Tank at Outfall RH-034 • 2.5 MG Tank at Outfall OH-007
3	• 3.5 MG Tank at Outfall RH-034 • 1.4 MG Tank at Outfall OH-007
4	• 3.5 MG Tank at Outfall RH-034 • Weir Modifications at Outfalls OH-006, OH-007 and OH-024
5	• Bond Lorraine Sewer Reconstruction • Weir Modifications at Outfalls OH-006, OH-007 and OH-024
6	• 8,400 LF-long, 18 ft-diameter tunnel • 15.8 MG storage
7	• 8,400 LF-long, 27 ft-diameter tunnel • 34.6 MG storage

These retained alternatives for the Gowanus Canal were then analyzed on the basis of their cost-effectiveness in reducing CSO discharges 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 8-7 were analyzed using both the Gowanus Canal (IW) and receiving water/waterbody or water quality models. Evaluations of levels of CSO control for each alternative are presented below. In all cases, the 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 reflect the fact that the grey infrastructure projects from the WWFP have been implemented, along with the 12 percent GI penetration and the HLSS project mentioned earlier in Section 8-2.

8.3.a CSO Volume and Bacteria Loading Reductions of Retained Alternatives

Table 8-8 summarizes the projected annual CSO volume and bacteria reductions for the retained alternatives. These data are plotted on Figure 8-12.

The bacteria loading reductions shown in Table 8-8 approximate the CSO volume reductions within a few percent. Both reductions are not exactly equal because both bacteria concentrations and percent reductions vary simultaneously for each wet weather event. This leads to the same loadings being computed for any given outfall at any given point in time during a CSO event, but to small variations when computing cumulative loadings. However, differences between volumetric reduction and bacteria loading reductions are small in any case.

8.3.b Water Quality Impacts

The Gowanus Canal is a Class I and Class SD waterbody. The water quality impact analysis is presented in Section 6.0, and is supported by the following: the 2008 baseline and 10-year East River Tributaries Model (ERTM) runs; as well as historic and recent water quality monitoring data; and baseline conditions modeling. The analysis reveals that all locations along the waterbody will be in attainment with the Class I (2,000 cfu/100mL) and primary contact fecal coliform criteria (200 cfu/100mL) under baseline conditions. As explained in the gap analysis presented in Section 6.3, bacteria loadings from other sources (particularly the tidal exchange with the Gowanus Bay, direct drainage and other urban wet weather discharges to the Gowanus Canal), influence the enterococci concentrations to the extent that even the removal or control of 100% of the CSO discharges would not result in full attainment of the Potential Future Primary Contact WQ Criteria STV component. The relationship between levels of CSO control through implementation of the retained alternatives, including 100% CSO control, and predicted levels of WQS attainment, are discussed in greater detail in Section 8.5. These analyses are based primarily on 2008 typical year water quality model runs.

Table 8-8. Gowanus Canal Projected Annual CSO Volume and Bacteria Reductions for the Retained Alternatives (2008 Rainfall)

Alternative	Annual CSO Volume to Gowanus Canal (MGY)	Increase in Annual CSO Volume Discharged to Other Waterbodies (MGY)	Net Change in Flow to both WWTPs (MGY)	Annual CSO Volume Reduction to Gowanus Canal (%)	Annual Fecal Coliform Reduction to Gowanus Canal (%)	Annual Enterococci Reduction to Gowanus Canal (%)	Frequency of Annual CSO Overflows to Gowanus Canal
Baseline Conditions	263	---	---	---	---	---	44
1. EPA ROD Tanks (8 MG Tank at Outfall RH-034 and 4 MG Tank at Outfall OH-007)	110	0	153	58	53	53	35
2. 5.7 MG Tank at Outfall RH-034 and 2.5 MG Tank at Outfall OH-007	133	0	130	50	44	44	35
3. 3.5 MG Tank at Outfall RH-034 and 1.4 MG Tank at Outfall OH-007	168	0	96	36	33	33	35
4. 3.5 MG Tank at Outfall RH-034 and Weir Modifications at Outfalls OH-006, OH-007 and OH-024	142	59	62	46	45	46	17
5. Bond Lorraine Sewer Reconstruction and Weir Modifications at Outfalls OH-006, OH-007 and OH-024	143	117	2	46	48	49	31
6. Tunnel (75% CSO Control)	65	0	198	75	75	75	6
7. Tunnel (100% CSO Control)	0	0	263	100	100	100	0

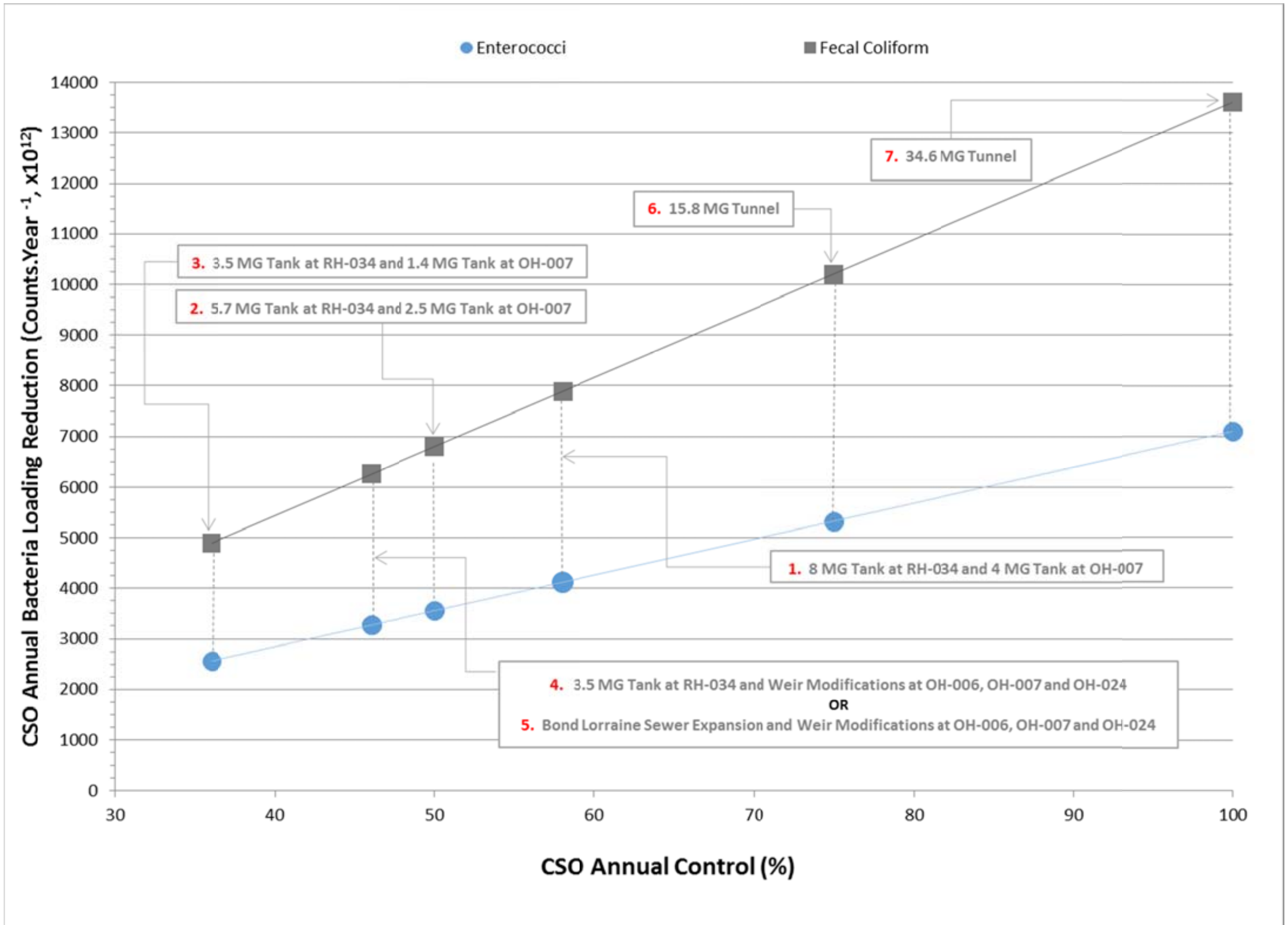


Figure 8-12. CSO Annual Control vs. Annual CSO Bacteria Loading Reduction (2008 Rainfall)

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 or control measure under consideration, its annual O&M requirements, and, unique to this LTCP, cost data made available from the DEP Superfund analysis. The capital costs were developed as PBCs following various methodologies, 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. O&M costs were derived from similar projects evaluated within NYC. All costs are reported in 2015 dollars.

8.4.a Alternative 1 – EPA ROD Tanks (8-MG Tank at Outfall RH-034 and 4-MG Tank at Outfall OH-007)

Costs for Alternative 1 include all of the construction, facilities and support systems required to build an 8 MG tank at Outfall RH-034 and a 4 MG tank at Outfall OH-007. These tanks are described in the Superfund References 1 and 2 listed in Section 8.8. As shown in Table 8-9, the total cost for Alternative 1, expressed as NPW, is estimated to be $829M.

Table 8-9. Costs For Alternative 1 – EPA ROD Tanks (8 MG Tank at Outfall RH-034 and 4 MG Tank at Outfall OH-007)

Item	8 MG Tank at Outfall RH-034	4 MG Tank at Outfall OH-007	2015 Cost ($ Million)
Capital Costs	490	311	801(1)
Annual O&M	1.2	0.7	1.9
Total Present Worth	508	321	829

Notes:
(1) EPA estimate for same tanks is $77M.

8.4.b Alternative 2 - (5.7-MG Tank at Outfall RH-034 and 2.5-MG Tank at Outfall OH-007)

Costs for Alternative 2 include all of the construction, facilities and support systems required to build a 5.7 MG Tank at Outfall RH-034 and a 2.5 MG Tank at Outfall OH-007. As shown in Table 8-10, the total cost for Alternative 2 is estimated to be $683M.

Table 8-10. Preliminary Costs for Alternative 2 (5.7 MG Tank at Outfall RH-034 and 2.5 MG Tank at Outfall OH-007)

Item	5.7 MG Tank at RH-034	2.5 MG Tank at OH-007	2015 Cost ($ Million)
Capital Costs	450	213	663
Annual O&M	0.9	0.5	1.4
Total Present Worth	462	221	683

8.4.c Alternative 3 (3.5 MG Tank at Outfall RH-034 and 1.4 MG Tank at Outfall OH-007)

Costs for Alternative 3 include all of the construction, facilities and support systems required to build a 3.5 MG Tank at Outfall RH-034 and a 1.4 MG Tank at Outfall OH-007. As shown in Table 8-11, the total cost for Alternative 3 is estimated to be $507M.

Table 8-11. Preliminary Costs for Alternative 3
(3.5 MG Tank at Outfall RH-034 and 1.4 MG Tank at Outfall OH-007)

Item	3.5 MG Tank at RH-034	1.4 MG Tank at OH-007	2015 Cost ($ Million)
Capital Costs	369	124	493
Annual O&M	0.6	0.3	0.9
Total Present Worth	379	129	507

8.4.d Alternative 4 (3.5-MG Tank at Outfall RH-034 and Weir Modifications at Outfalls OH-006, OH-007 and OH-024)

Costs for Alternative 4 include all of the construction, facilities and support systems required to construct a 3.5 MG Tank at Outfall RH-034 and Weir Modifications at regulators discharging to Outfalls OH-006, OH-007 and OH-024. As shown in Table 8-12, the total cost for Alternative 4 is estimated to be $401M.

Table 8-12. Preliminary Costs for Alternative 4
(3.5 MG Tank at RH-034 and Weir Modifications at Outfalls OH-006, 007 and OH-024)

Item	3.5 MG Tank at RH-034	Weir Modifications at Outfalls OH-006, 007 and OH-024	2015 Cost ($ Million)
Capital Costs	369	20	389
Annual O&M	0.6	0.2	0.8
Total Present Worth	379	22	401

8.4.e Alternative 5 (Bond Lorraine Sewer Reconstruction and Weir Modifications at Outfalls OH-006, OH-007 and OH-024)

Costs for Alternative 5 include all of the construction, facilities and support systems required to implement an expansion of the Bond Lorraine Sewer and Weir Modifications at Outfalls OH-006, OH-007 and OH-024. As shown in Table 8-13, the total cost for Alternative 5 is $355M.

Table 8-13. Preliminary Costs for Alternative 5
(Reconstruction of Bond Lorraine Sewer and Weir Modifications at Outfalls OH-006, OH-007 and OH-024)

Item	Reconstruction of Bond Lorraine Sewer	Weir Modifications at Outfalls OH-006, OH-007 and OH-024	2015 Cost ($ Million)
Capital Costs	314	20	334
Annual O&M	1.2	0.2	1.4
Total Present Worth	333	22	355

8.4.f Alternatives 6 and 7 (75% and 100% CSO Control Tunnels)

Cost estimates for 75% control and 100% control tunnels, Alternatives 6 and 7, are summarized in Table 8-14. The estimated total NPW ranges from $695M to $873M 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.

Table 8-14. Costs for Alternatives 6 and 7 (75% and 100% Control Tunnels)

Tunnel Control Level	75% Tunnel (Alternative 6)	100% Tunnel (Alternative 7)
2015 PBC ($ Million)	680	846
Annual O&M Cost ($ Million)	1.0	1.8
Total Present Worth ($ Million)	695	873

The cost estimates of the retained basin-wide alternatives are summarized below in Table 8-15 and are then used in the development of the cost-performance and cost-attainment plots presented in Section 8.5.

Table 8-15. Summary of Retained Alternatives Costs

Alternative	PBC[(2)] ($ Million)	Annual O&M Cost[(2)] ($ Million)	Total Present Worth ($ Million)
1. EPA ROD Tanks (8 MG Tank at Outfall RH-034 and 4 MG Tank at Outfall OH-007)	801[1)]	1.9	829
2. 5.7 MG Tank at Outfall RH-034 and 2.5 MG Tank at Outfall OH-007	663	1.4	683
3. 3.5 MG Tank at Outfall RH-034 and 1.4 MG Tank at Outfall OH-007	493	0.9	507
4. 3.5 MG Tank at RH-034 and Weir Modifications at Outfalls OH-006, OH-007 and OH-024	389	0.8	401
5. Bond Lorraine Sewer Reconstruction and Weir Modifications at Outfalls OH-006, OH-007 and OH-024	334	1.4	355
6. 75% CSO Control Tunnel	680	1.0	695
7. 100% CSO Control Tunnel	846	1.8	873

Notes:
(1) EPA estimate for same tanks is $77M.
(2) PBCs estimated from various methods and sources, including LTCP and Superfund. Annual O&M costs estimated from historical costs of equivalent CSO control projects implemented or previously evaluated within NYC.

8.5 Cost-Attainment Curves for Retained Alternatives

The final step of the analysis is to evaluate the cost-effectiveness of the retained, basin-wide alternatives based on their NPW and projected impact in 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. Both the cost-performance and subsequent cost-attainment analyses focused on bacteria loadings and bacteria water quality criteria. A 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 for the typical year rainfall (2008).

The goal of the LTCP is to reduce CSO bacteria loadings to the waterbody to the extent such loadings are responsible for non-attainment of applicable WQS. Although the substantial improvements introduced by implementation of the 2008 WWFP resulted in the Gowanus Canal achieving full compliance with existing designated and primary contact bacteria WQS, an assessment of the CSO volumetric and bacteria loading reductions associated with the retained alternatives was conducted. Figure 8-13 shows the volumetric reductions achieved by each alternative, and bacteria reduction plots are presented in Figures 8-14 and 8-15. These latter curves plot the cost of the retained alternatives against their associated projected annual CSO enterococci and fecal coliform loading reductions, respectively. The primary vertical axis shows the percent of 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.

8.5.b Cost-Attainment Curves

This section evaluates the relationship of the costs of the retained alternatives to their expected level of attainment of the bacteria criteria associated with the Existing WQ Criteria (Class I), Primary Contact WQ Contact Criteria, and Potential Future Primary Contact WQ Criteria, as modeled using the water quality model with 2008 rainfall.

The cost-performance plot shown in Figure 8-13 indicates that Alternatives 2, 5, 6, and 7 represent incremental gains in marginal performance, i.e., an increase in CSO reduction for a given additional expenditure. The retained alternatives that do not show incremental gains in volumetric performance (shown in red in the Figure 8-13) include Alternatives 1, 3 and 4.

In addition to the current Class I WQS, the cost-attainment analysis considered other standards and bacteria criteria, including Primary Contact WQ Criteria and Potential Future Primary Contact WQ Criteria. Again, under the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, enterococci criteria do not apply to tributaries, such as the Gowanus Canal. The Primary Contact WQ Criteria evaluations thus only considered the fecal coliform criterion, specifically the monthly GM of 200 cfu/100mL both on an annual and recreational season (May 1st through October 31st) basis. Class SD does not have assigned numerical bacteria criteria and attainment of the Class I Existing WQ Criteria for fecal coliform is met 100 percent of the time at all stations. Thus, the Gowanus Canal is in compliance with designated bacteria criteria.

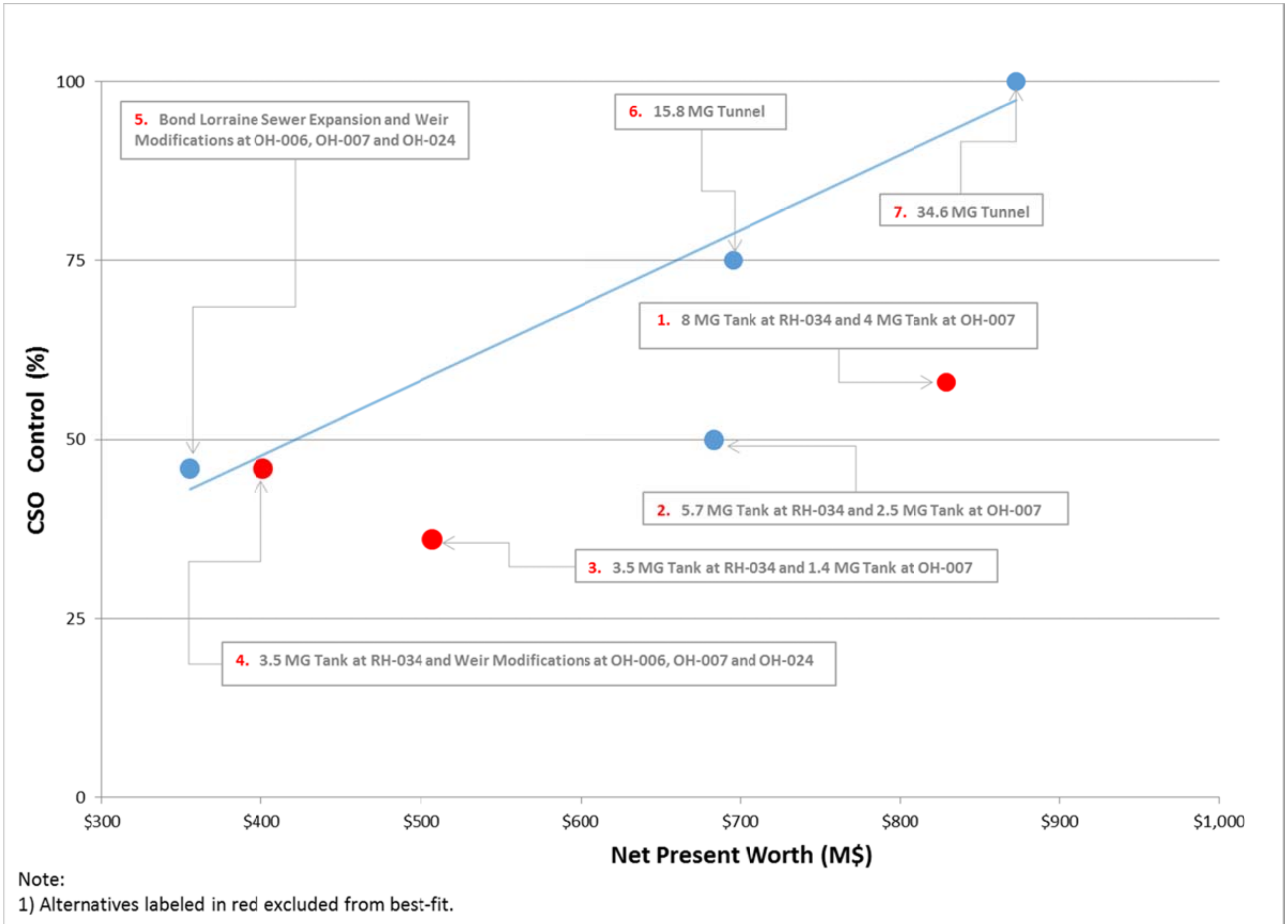
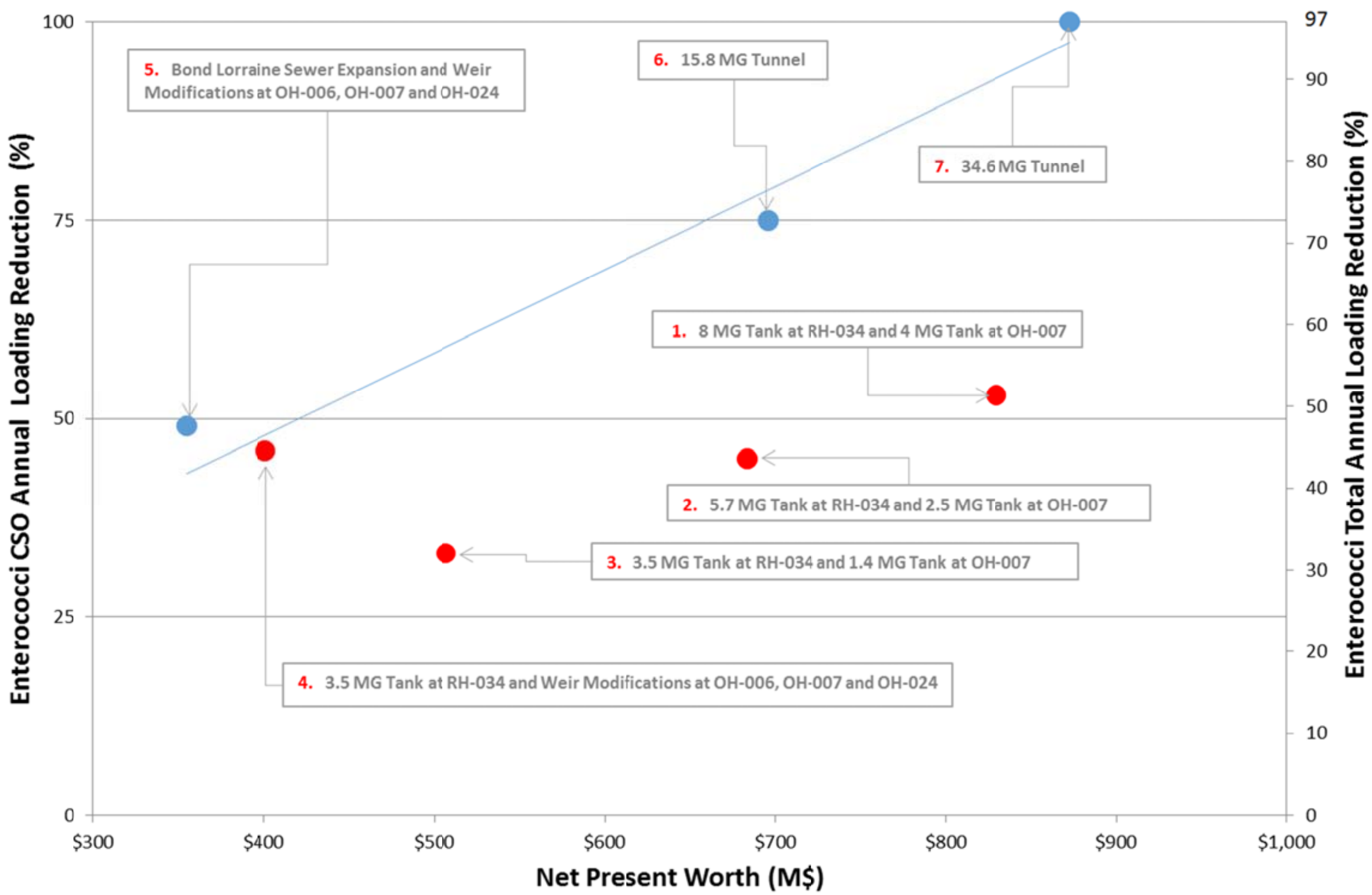


Figure 8-13. Cost vs. CSO Control (2008 Rainfall)



Note:
1) Alternatives labeled in red excluded from best-fit.

Figure 8-14. Cost vs. Enterococci Loading Reduction (2008 Rainfall)

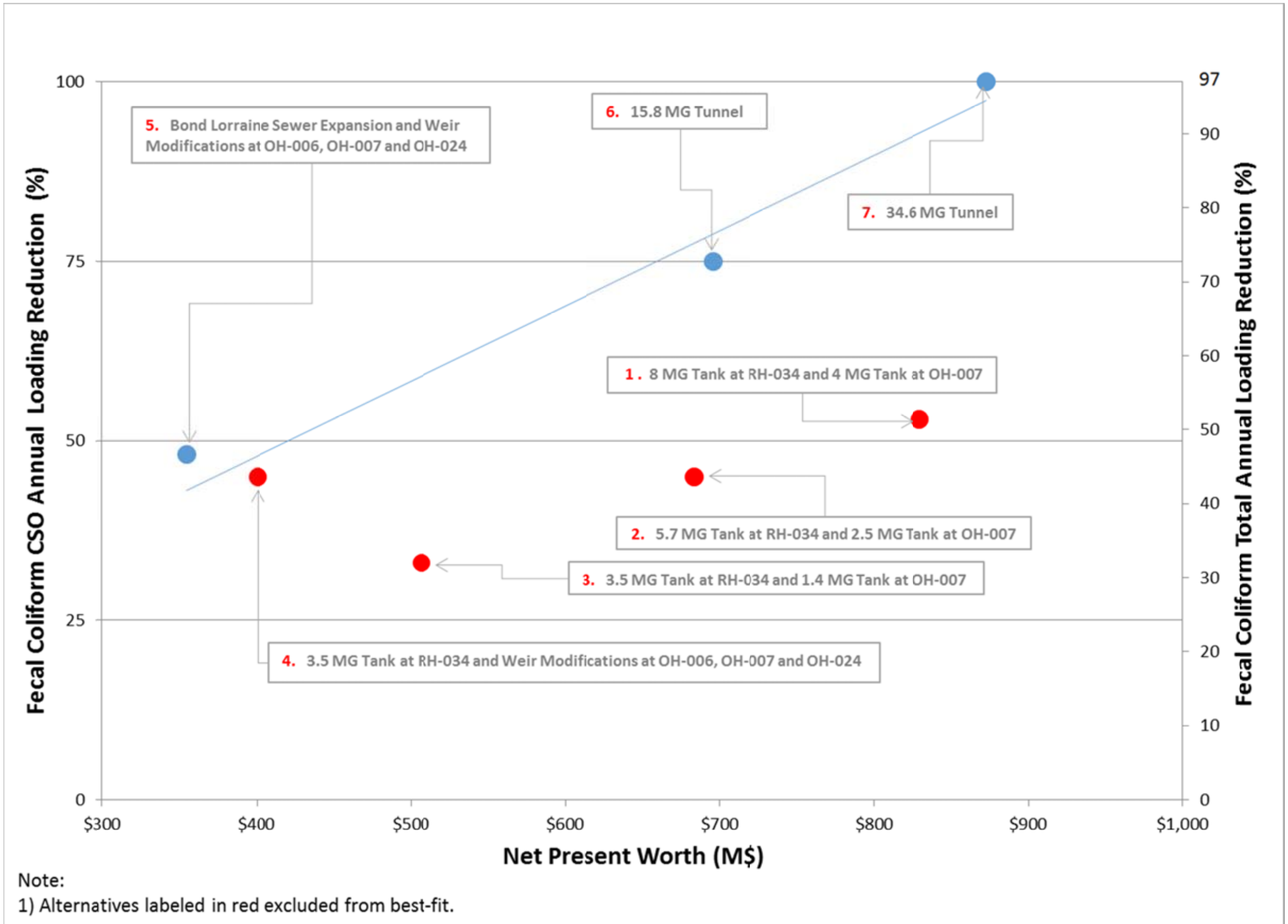


Figure 8-15. Cost vs. Fecal Coliform Loading Reduction (2008 Rainfall)

The resultant curves for all applicable standards and relevant criteria are presented as Figures 8-16 through 8-25 for ten locations along the Gowanus Canal, Stations GC-1 through GC-10. All of the curves are based on 2008 typical year water quality simulations. The annual attainment of the Primary Contact WQ Criteria under baseline conditions are slightly lower than with the current Class I criteria, with the lowest levels of attainment being 92 percent. However, this criterion is fully attained at all stations during the recreational season (May 1st through October 31st). Further, and again, this criterion is fully attained both annually and seasonally when the results from the broader 10-year water quality model runs are considered.

Figures 8-16 through 8-25 also show that, from a bacteria standpoint, and based on the 2008 model runs exclusively, all of the retained basin-wide alternatives will bring the waterbody into compliance with the Primary Contact WQ Criteria on an annual basis. But, as noted above, full compliance with the criterion is already projected for baseline conditions when evaluated under a 10-year timeframe.

8.5.c Time to Recovery Analysis

Analyses were conducted to evaluate the length of time fecal coliform concentrations would exceed target values of 1,000 cfu/100mL. This target value is discussed further in Section 8.7.a and represents a concentration above which primary contact would be unadvisable. The analyses were conducted for a rainfall event sequence that occurred on August 14, 2008 (0.96 inches) and August 15, 2008 (1.02 inches) and fell over approximately 4-hour periods each day. This event represents an approximate 90th percentile event on the cumulative distribution of event rainfall depths of the rainfall series recorded at La Guardia Airport in a 10-year period. Further details on the selection of this storm are presented in Section 6.0.

The results of this analysis are shown in Figure 8-26. The results represent the amount of time it takes after the end of an August 14-15, 2008, rainfall for the bacteria concentrations to return to the target levels at Station GC-6, the first station that is downstream of both Outfall RH-034 and Outfall OH-007.

As shown in Figure 8-26, the maximum baseline conditions time to recovery is 14 hours, well below the DEC target of 24 hours. The maximum reduction in time to recovery is realized by Alternative 7, a 34.6 MG Tunnel to provide 100% basin-wide CSO control. One hundred (100%) percent CSO control would bring the time to recovery to less than one hour. However, intermediate levels of CSO control can shorten the time to recovery only to a minimum of 10 hours, as illustrated by the time to recovery for Alternative 1 - EPA ROD (8 MG Tank at Outfall RH-034 and 4 MG Tank at Outfall OH-007). All alternatives lead to projected times to recovery ranging from 13 to 11 hours.

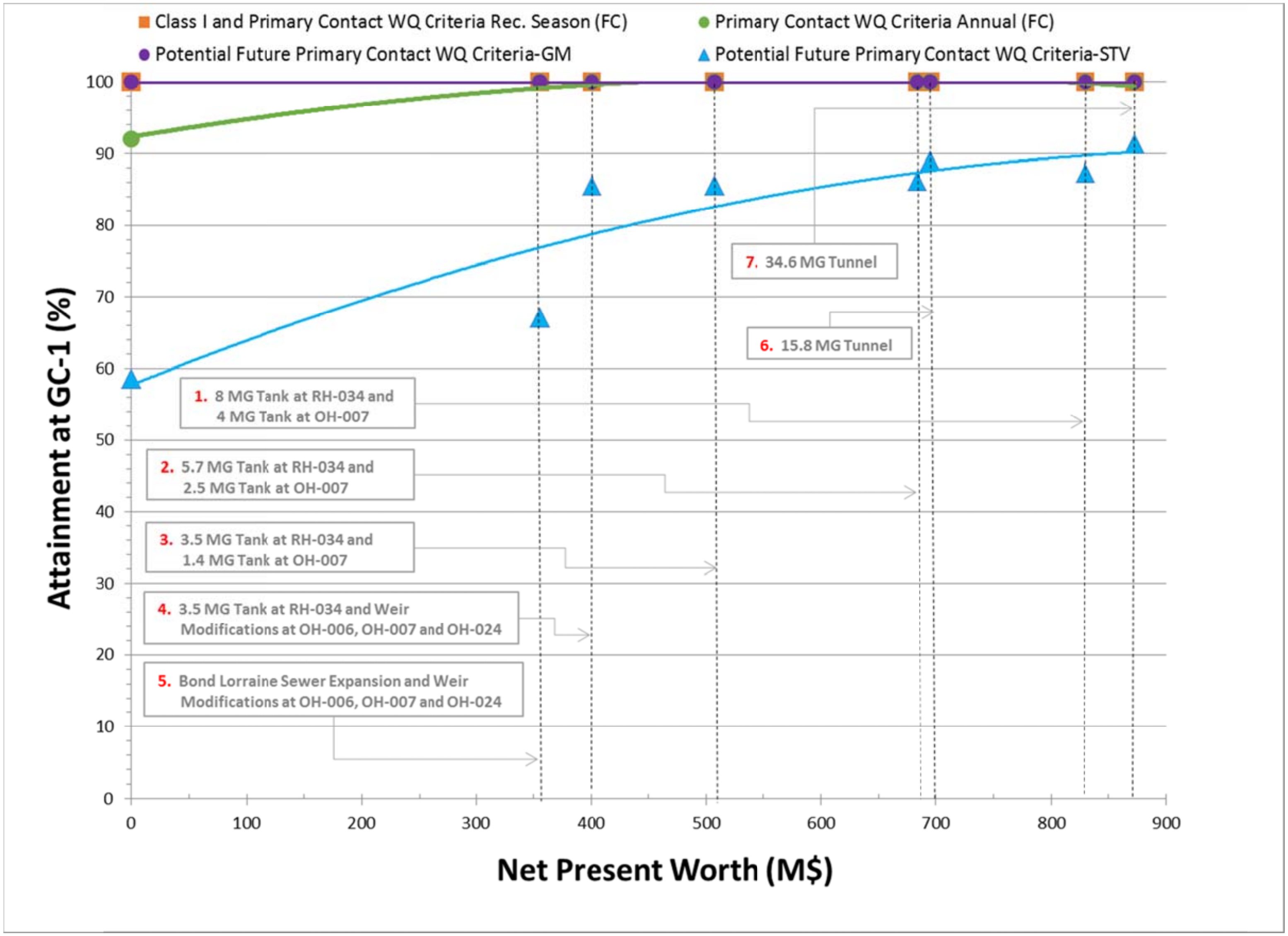


Figure 8-16. Cost vs. Bacteria Attainment at Station GC-1 (2008 Rainfall)

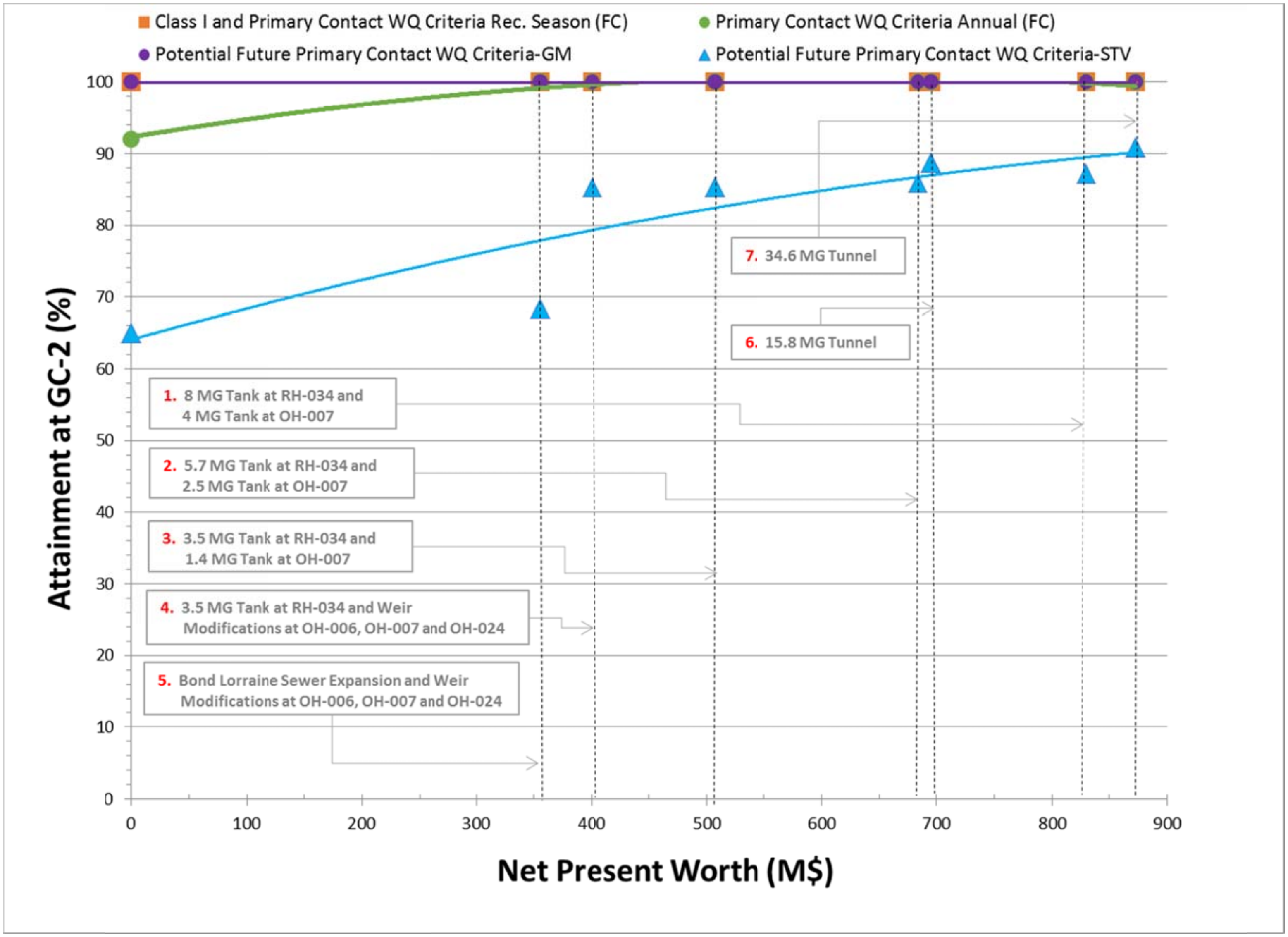


Figure 8-17. Cost vs. Bacteria Attainment at Station GC-2 (2008 Rainfall)

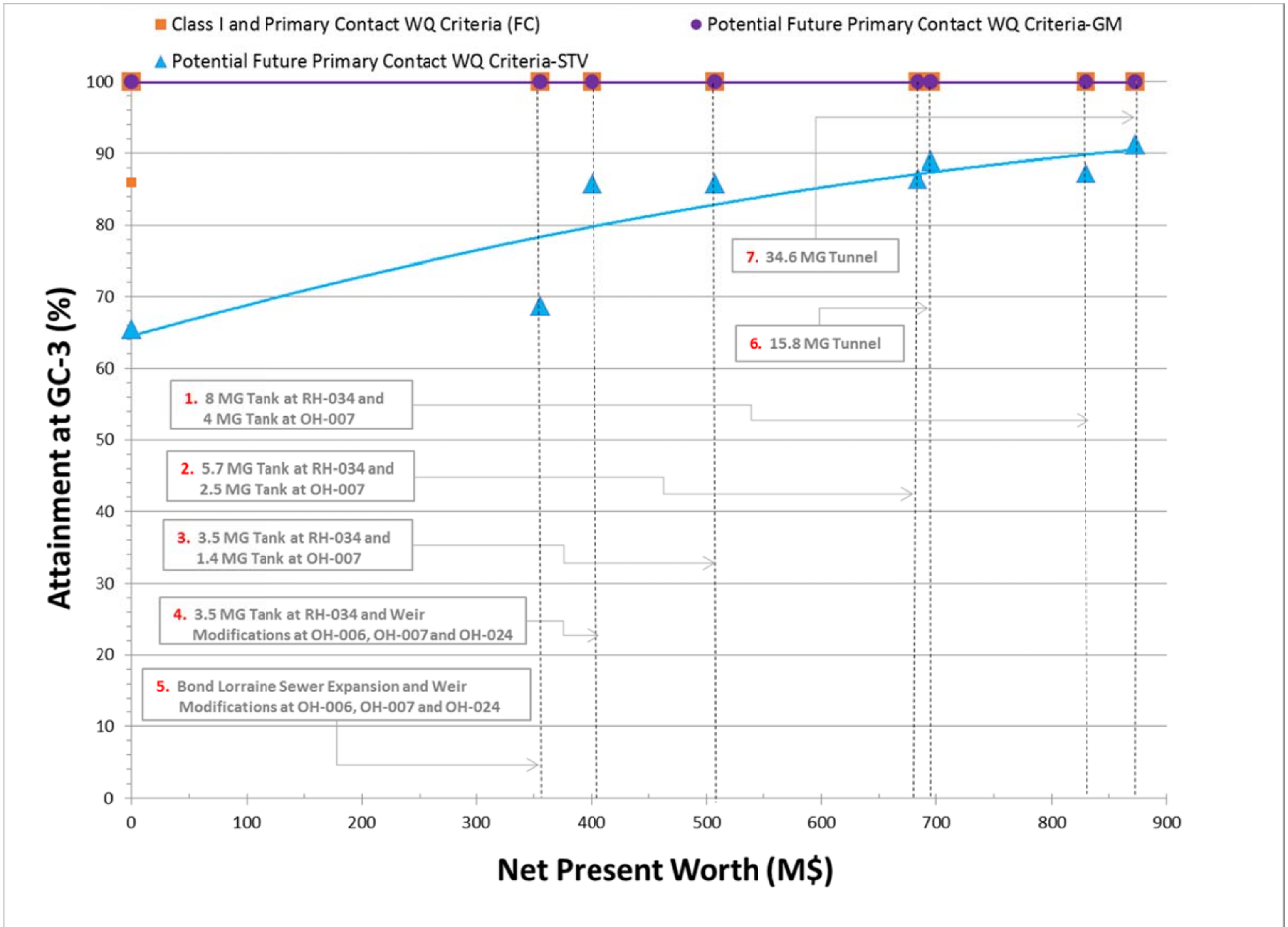


Figure 8-18. Cost vs. Bacteria Attainment at Station GC-3 (2008 Rainfall)

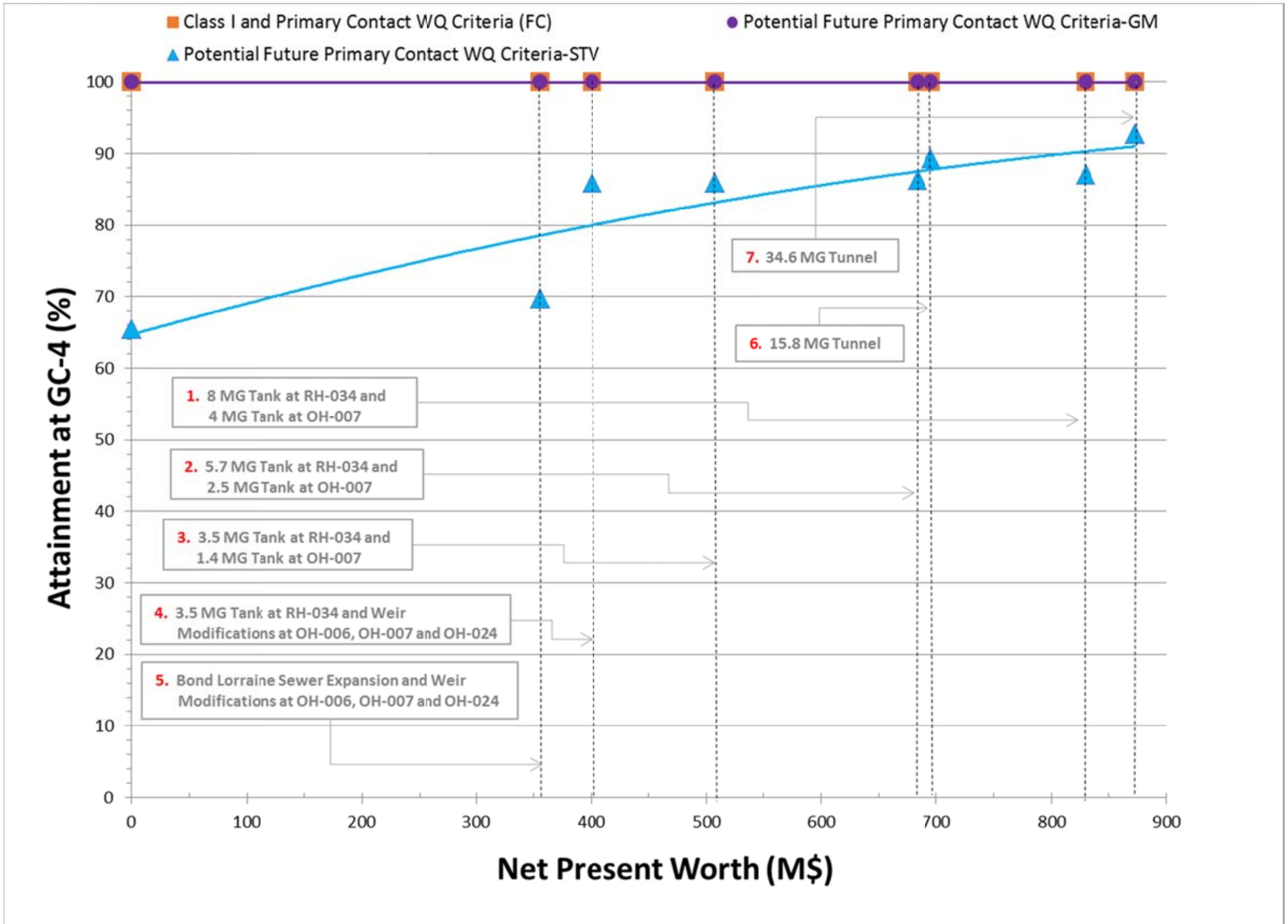


Figure 8-19. Cost vs. Bacteria Attainment at Station GC-4 (2008 Rainfall)

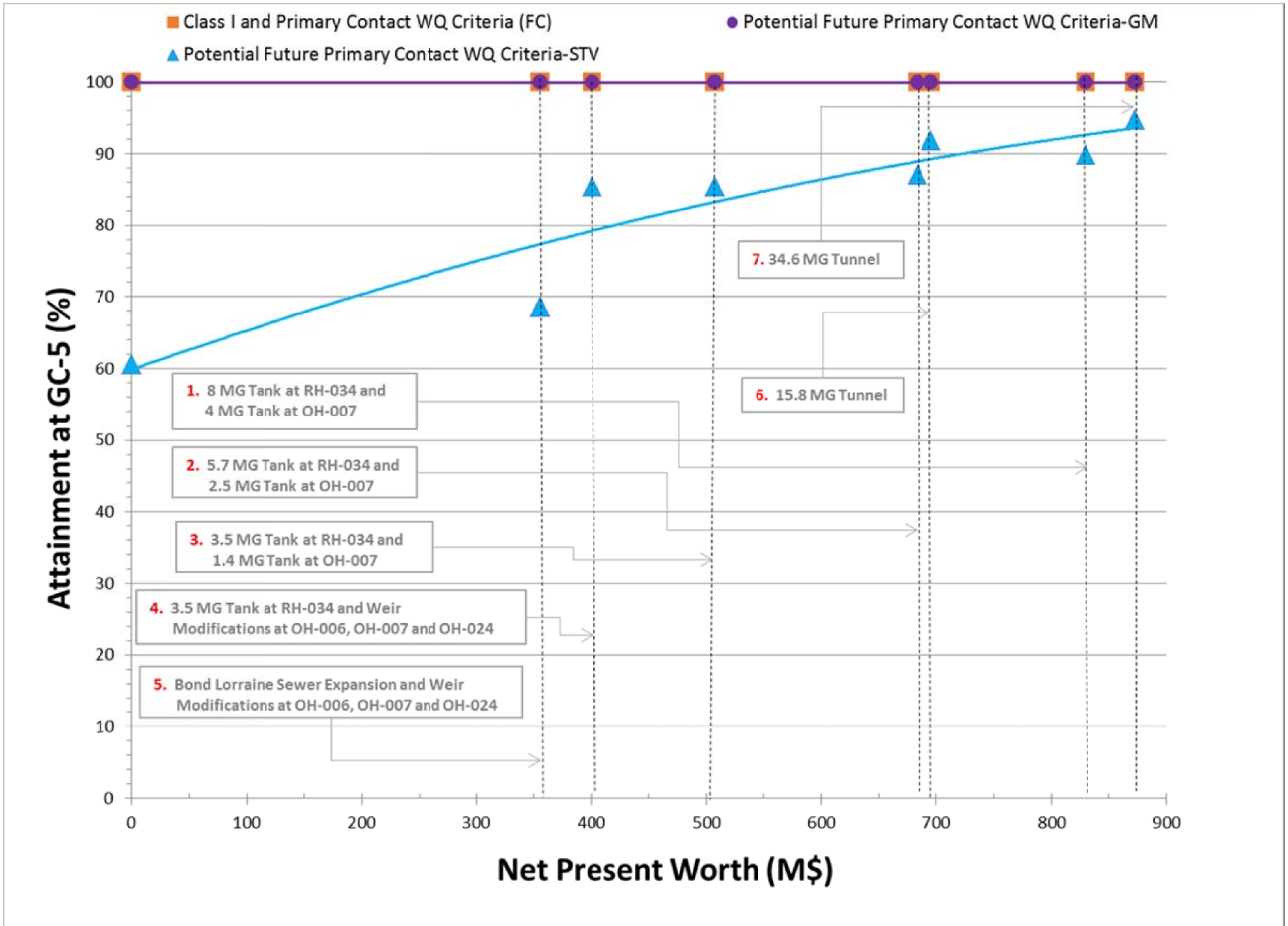


Figure 8-20. Cost vs. Bacteria Attainment at Station GC-5 (2008 Rainfall)

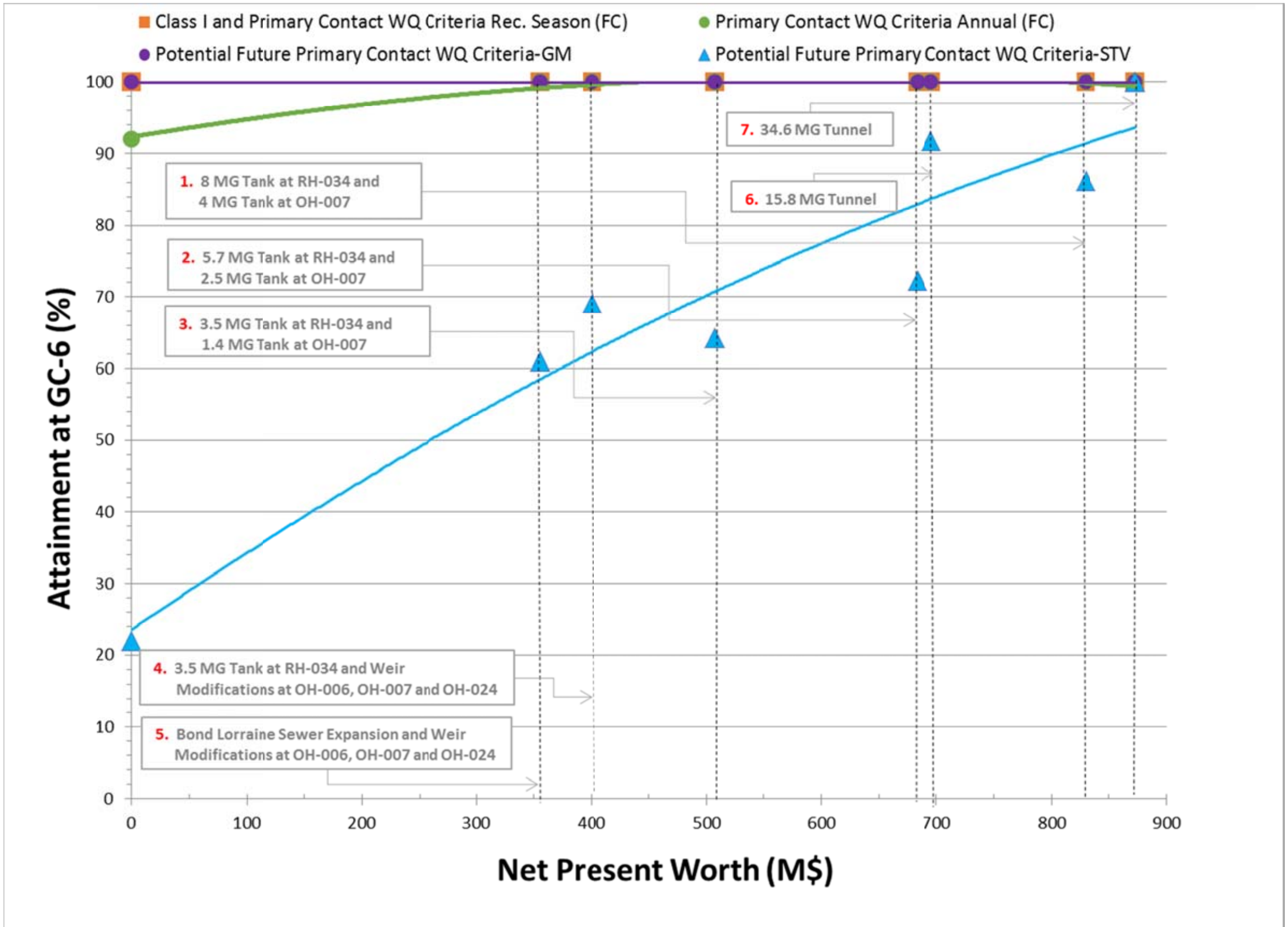


Figure 8-21. Cost vs. Bacteria Attainment at Station GC-6 (2008 Rainfall)

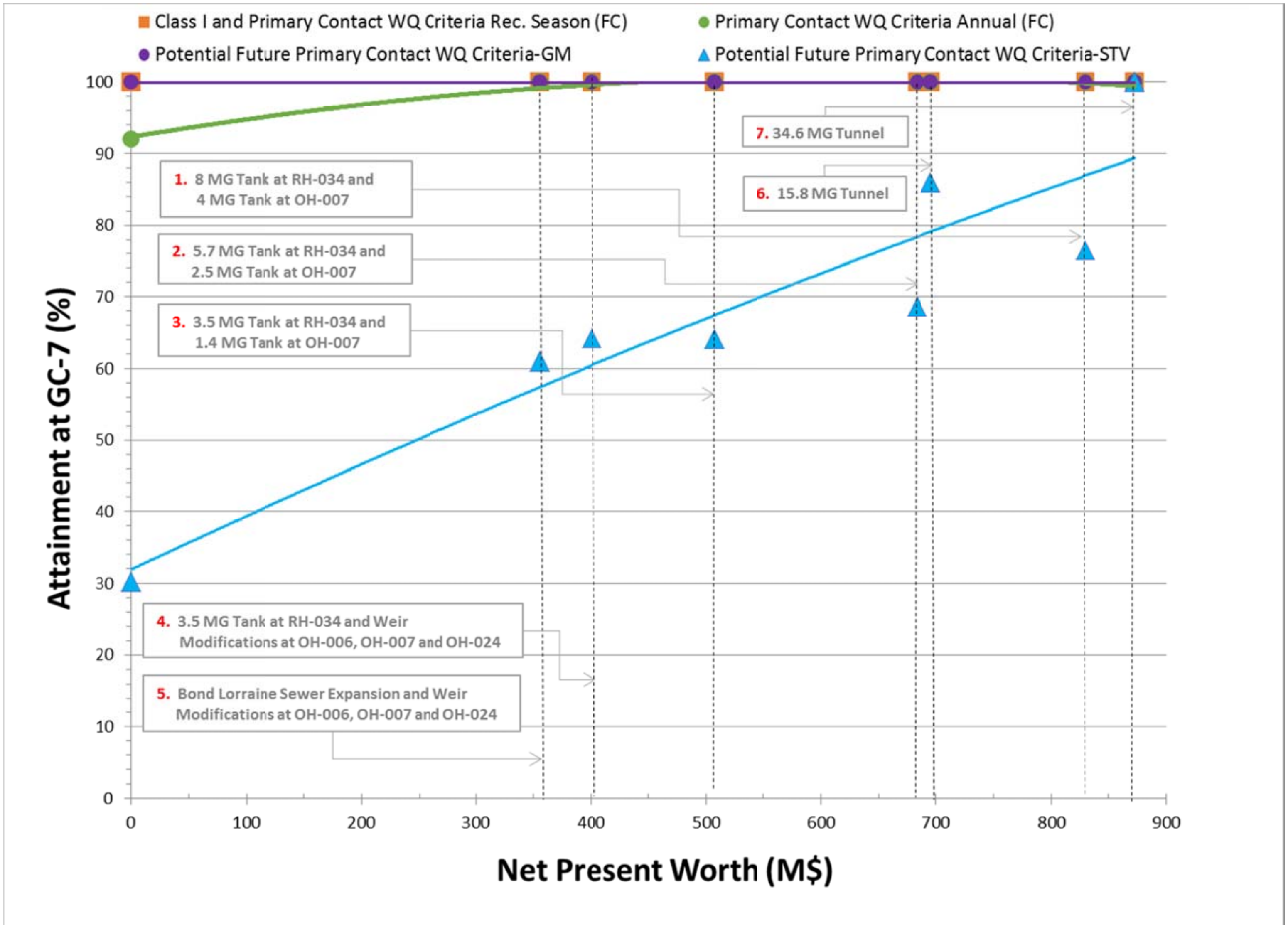


Figure 8-22. Cost vs. Bacteria Attainment at Station GC-7 (2008 Rainfall)

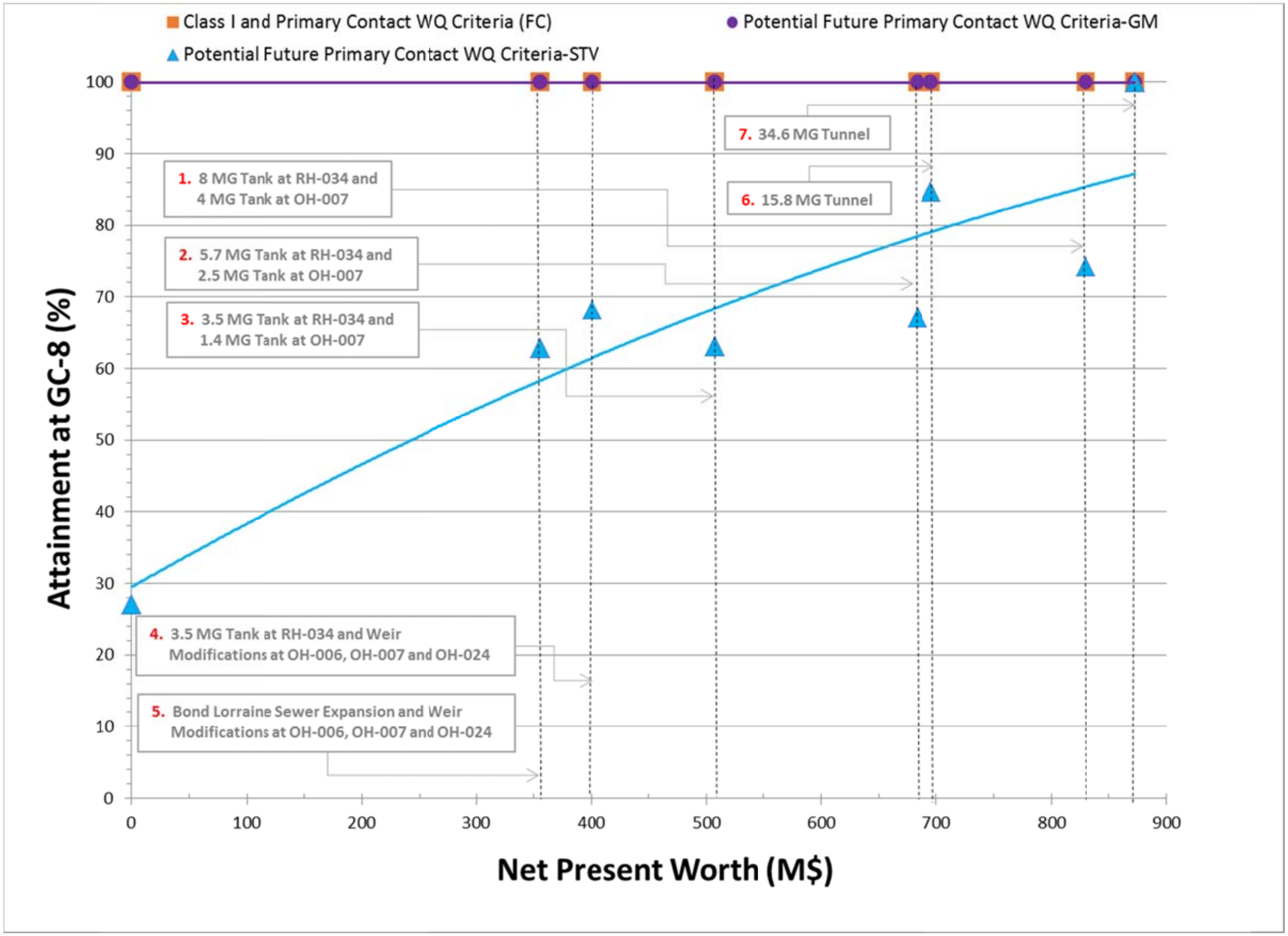


Figure 8-23. Cost vs. Bacteria Attainment at Station GC-8 (2008 Rainfall)

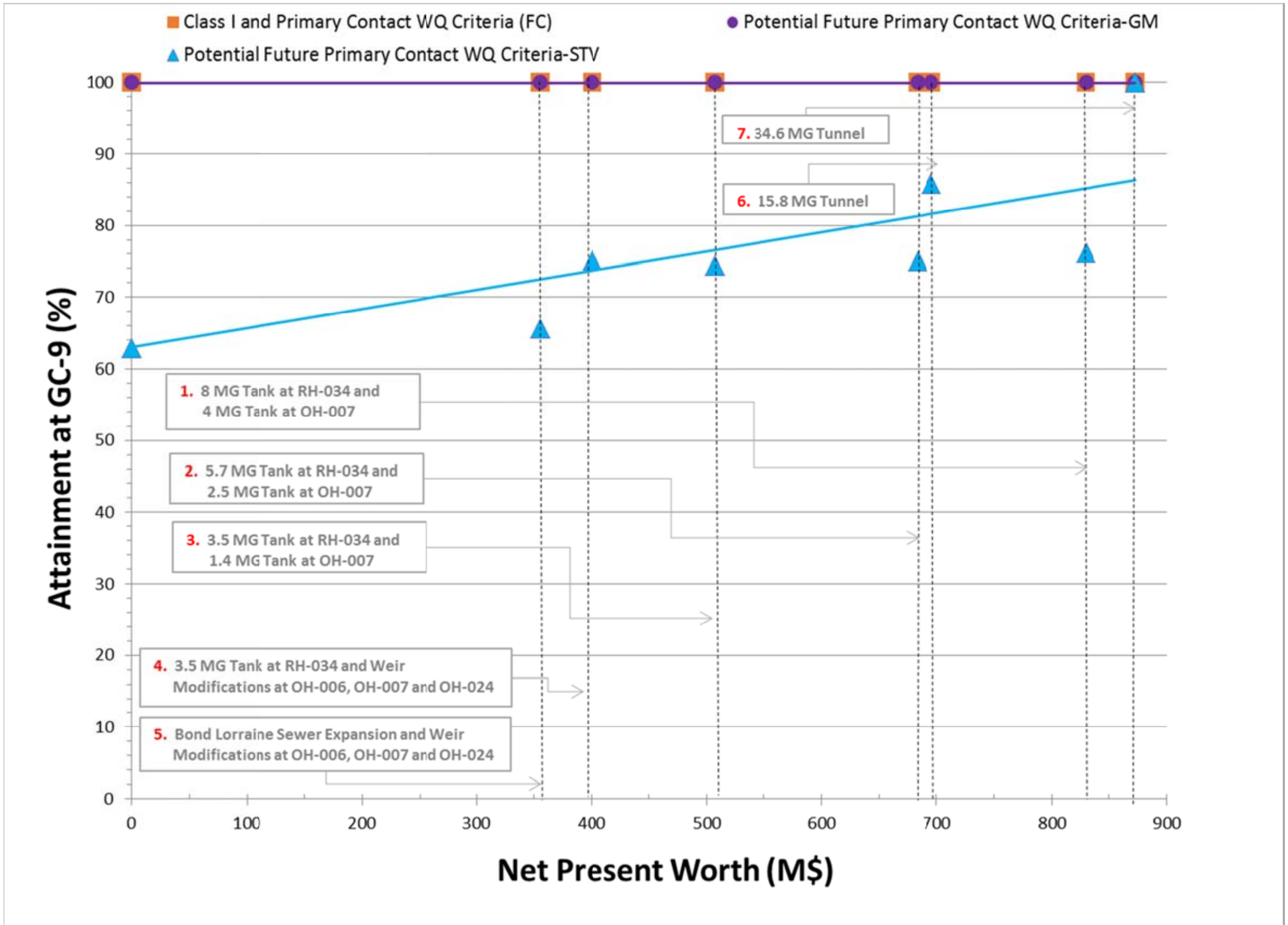


Figure 8-24. Cost vs. Bacteria Attainment at Station GC-9 (2008 Rainfall)

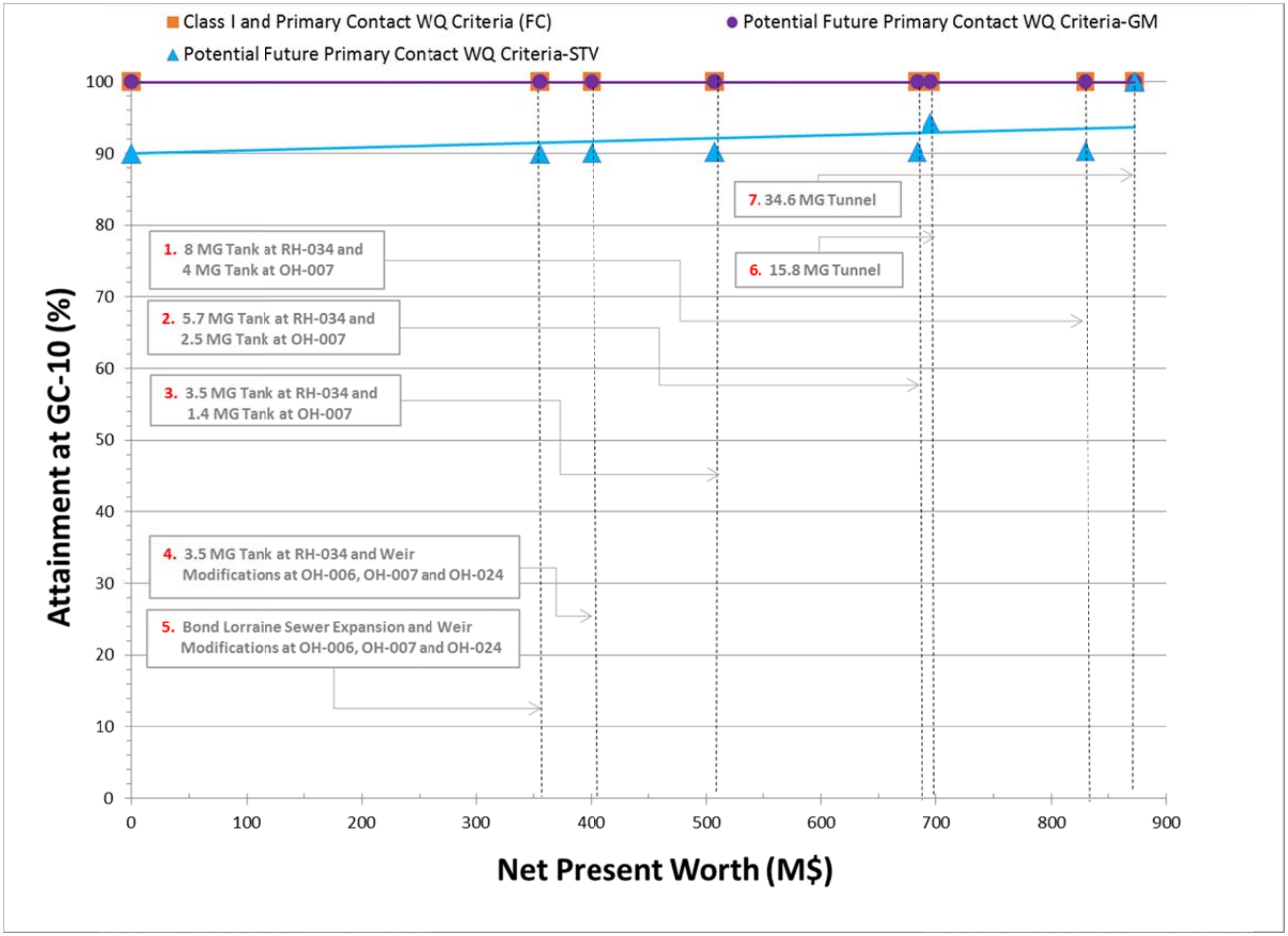


Figure 8-25. Cost vs. Bacteria Attainment at Station GC-10 (2008 Rainfall)

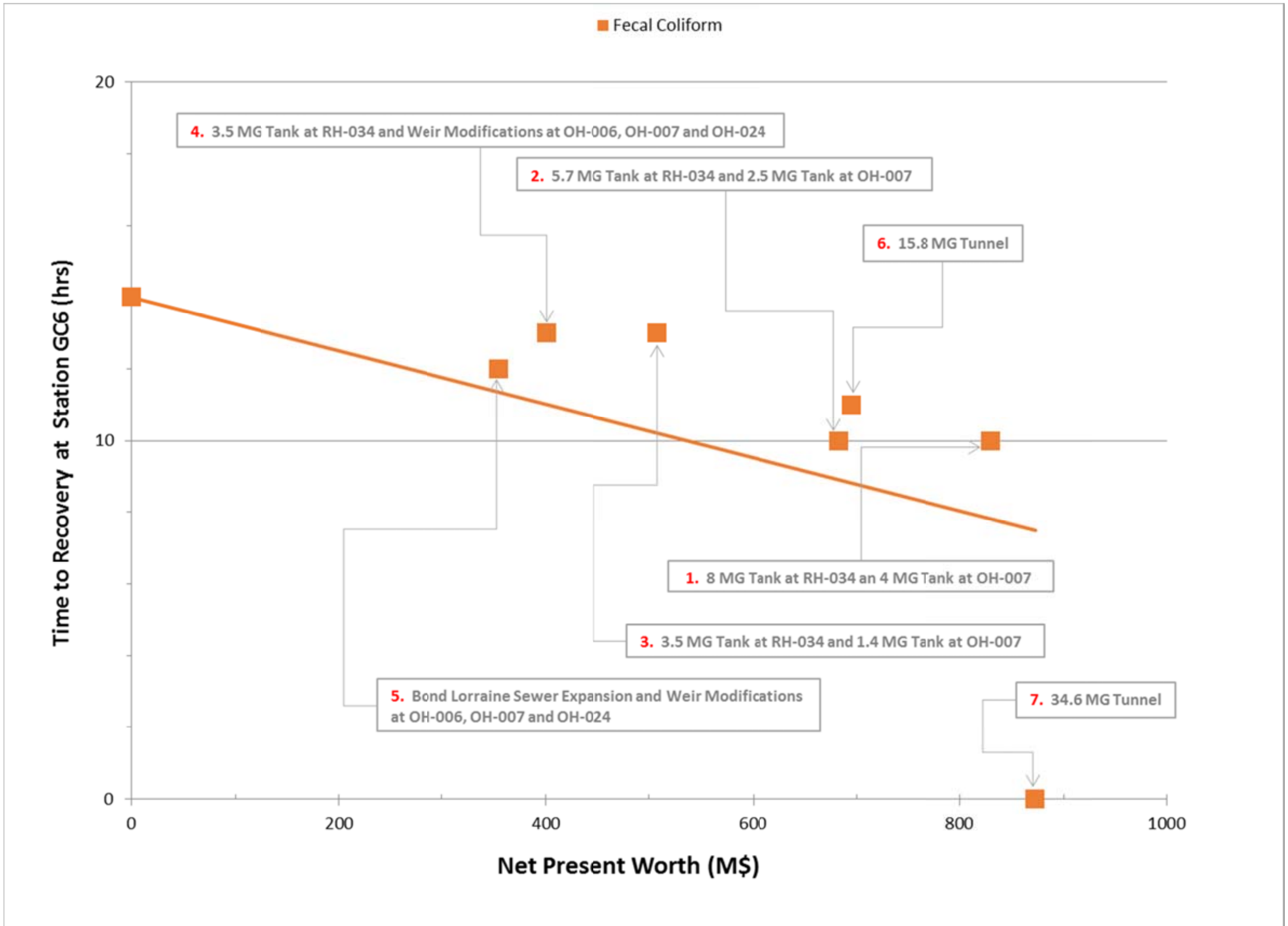


Figure 8-26. Time to Recovery at Station GC-6

8.5.d Conclusion on LTCP Preferred Alternative

The selection of the LTCP Preferred Alternative for any given waterbody typically includes multiple considerations, including public input, environmental and water quality benefits, capital and O&M costs, and projected attainment of WQS under baseline conditions.

For the Gowanus Canal LTCP, dramatic improvements in water quality have been achieved through an effective planning process between DEC and DEP to develop and implement infrastructure improvements in the Gowanus sewershed. These improvements, proposed in DEP's 2008 WWFP, and approved by DEC in 2009, have led to projected full compliance with the bacteria components of applicable WQS.

The Gowanus Canal Superfund program requires DEP to construct additional CSO controls to further reduce CSO discharges. As demonstrated throughout this section, this work will further improve the water quality in the Gowanus Canal beyond the current greatly improved state. Schedules for this work would be established pursuant to the Superfund program.

Data presented in Tables 8-16 through 8-18 show the attainment levels, without additional CSO controls, with regard to various water quality criteria, evaluated under a 10-year model run (2002-2011) and for the 2008 typical year for DO. The data reflected in these tables demonstrates that, with the exception of the primary contact chronic standard for DO, whose attainment level ranges from 87 percent to 94 percent at two of the water quality stations, full compliance with existing and Primary Contact WQ Criteria is achieved. Full compliance with the GM component of the Potential Future Primary Contact WQ Criteria is also achieved. Attainment of the STV component of the Potential Future WQ Criteria falls below 95 percent in most stations; therefore, the waterbody would not comply with this bacteria criterion. Nonetheless, implementation of any configuration of the Superfund remedy (two CSO tanks as included in Alternatives 1, 2 or 3) will improve water quality still further.

Table 8-16. Calculated 10-Year Bacteria Attainment for LTCP Baseline Conditions – Annual

Station	Existing WQ Criteria (Class I) (1)		Primary Contact WQ Criteria	
	Criterion (cfu/100mL)	Attainment (%)	Fecal Coliform Criterion (cfu/100mL)	Attainment (%)
GC-1	Fecal ≤ 2,000	100	Fecal ≤ 200	98
GC-2	Fecal ≤ 2,000	100	Fecal ≤ 200	99
GC-3	Fecal ≤ 2,000	100	Fecal ≤ 200	100
GC-4	Fecal ≤ 2,000	100	Fecal ≤ 200	100
GC-5	Fecal ≤ 2,000	100	Fecal ≤ 200	100
GC-6	Fecal ≤ 2,000	100	Fecal ≤ 200	98
GC-7	Fecal ≤ 2,000	100	Fecal ≤ 200	98
GC-8	Fecal ≤ 2,000	100	Fecal ≤ 200	99
GC-9	Fecal ≤ 2,000	100	Fecal ≤ 200	100
GC-10	Fecal ≤ 2,000	100	Fecal ≤ 200	100

Notes:
(1) Not currently designated to stations GC-1 through GC-7

Table 8-17. Calculated 10-Year Bacteria Attainment for LTCP Baseline Conditions - Recreational Season (May 1st through October 31st)

Station	Existing WQ Criteria (Class I)[1]		Primary Contact WQ Criteria		Potential Future Primary Contact WQ Criteria			
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
GC-1	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	70
GC-2	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	73
GC-3	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	73
GC-4	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	74
GC-5	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	66
GC-6	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	95	Enterococci STV ≤ 110	34
GC-7	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	95	Enterococci STV ≤ 110	35
GC-8	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	97	Enterococci STV ≤ 110	36
GC-9	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	99	Enterococci STV ≤ 110	59
GC-10	Fecal ≤ 2,000	100	Fecal ≤ 200	100	Enterococci ≤ 30	100	Enterococci STV ≤ 110	86

Notes:
(1) Not currently designated to stations GC-1 through GC-7

Table 8-18. Calculated 2008 DO Attainment Baseline Conditions - Annual

Station	Existing WQ Criteria		Primary Contact WQ Criteria			
	Criterion	Attainment (%)	Criterion[(1)]	Attainment (%)	Criterion[(2)]	Attainment (%)
GC-1	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-2	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-3	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-4	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-5	≥3.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100
GC-6	≥3.0 mg/L	100	≥4.8 mg/L	94	≥3.0 mg/L	98
GC-7	≥3.0 mg/L	100	≥4.8 mg/L	95	≥3.0 mg/L	99
GC-8	≥4.0 mg/L	100	≥4.8 mg/L	87	≥3.0 mg/L	100
GC-9	≥4.0 mg/L	100	≥4.8 mg/L	99	≥3.0 mg/L	100
GC-10	≥4.0 mg/L	100	≥4.8 mg/L	100	≥3.0 mg/L	100

Notes:
(1) Chronic standard.
(2) Acute standard.

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 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 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, can be used to determine if changes to the designated use is warranted, considering a potential adjustment to the designated use classification, as appropriate. As noted in previous sections, the Gowanus Canal meets existing WQS and is predicted to fully meet the primary contact fecal coliform bacteria criterion of 200 cfu/100mL with the implementation of the 2008 WWFP plan and the other control measures included in the Section 6.0 baseline conditions. As discussed above, DO criteria are achieved for the existing WQS under the existing classification. However, Class SC DO criteria, the next higher classification above Class I, would not be achieved. DO levels appear to be related to non-CSO related conditions in the Gowanus Canal. Based on the projected bacteria water quality for baseline conditions, it is anticipated that the Gowanus Canal could be upgraded to a higher classification, although a variance for DO levels would be required. However, consideration of upgrading the Gowanus Canal to Class SC should await completion of the construction associated with Superfund remedial measures as well as the results from the PCM.

DEP will implement additional CSO controls as are required in the EPA ROD, which will result in further reductions in CSO overflows. These additional CSO controls will improve the level of compliance with primary contact DO WQS as described later in this section.

8.6.a Use Attainability Analysis Elements

Cost-effectively maximizing the water quality benefits associated with CSO controls is a cornerstone of this LTCP. The 2012 CSO Order on Consent Goal Statement stipulates that, in situations where the proposed alternatives presented in the LTCP will not achieve the CWA Section 101(a)(2) goals, the LTCP will include a UAA. The analyses developed herein indicate that the Gowanus Canal is projected to fully attain the Primary Contact WQ Criteria and, as a result, that a separate UAA need not be performed.

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 Policy and subsequent guidance. Currently, SA, SB, and SC classifications are fully supportive of the CWA Section 101(a)(2) fishable/swimmable goals. However, DEC has proposed a rule to adopt a fecal coliform bacteria criterion of 200 cfu/100mL to SD and I classifications as well.

The 10-year water quality modeling analyses conducted for the Gowanus Canal, summarized in Tables 8-16 through 8-18, show that, upon implementation of the baseline projects, whose results were summarized in Section 8.5, the waterbody is predicted to fully comply with the Existing WQ Criteria (Classes SD and I) and the Primary Contact WQ Criteria. The Potential Future Primary Contact WQ Criterion of 30-day GM of 30 cfu/100mL for enterococci is fully met during the recreational season (May 1st through October 31st). The Potential Future Primary Contact WQ Criterion of the 90th Percentile STV of 110 cfu/100mL is projected to be below the DEC target of 95 percent attainment.

Overall, there has been significant water quality improvement in the Gowanus Canal due to the recent improvements made by DEP. The water quality meets current WQS and the Proposed Primary Contact WQ Criteria of 200 cfu/100mL fecal coliform both during the recreational season (May 1st through October 31st) and on an annual basis.

8.6.c Assessment of Highest Attainable Use

The 2012 CSO Order on Consent Goal Statement stipulates that, in situations where the proposed alternatives presented in the LTCP will not achieve the CWA Section 101(a)(2) goals, the LTCP will include a UAA. Because the analyses developed herein indicate that the Gowanus Canal is projected to fully attain primary contact bacteria water quality criteria, fully attain the Existing DO Criteria and largely attain the primary contact DO criteria, a UAA is not required under the 2012 CSO Order on Consent.

Table 8-19 summarizes the projected compliance of WQS with the baseline projects.

Table 8-19. LTCP Baseline Compliance with Classifications and Standards – 10 Year Model Simulation

Analysis	Numerical Criteria Applied		Compliance
Existing WQ Criteria Fish Survival (Class SD) and Boating/Fishing (Class I)	Gowanus Canal Above Hamilton Ave (Class SD)	Fecal - None	Yes
		DO never < 3.0 mg/L[4]	Yes
	Gowanus Bay Below Hamilton Ave (Class I)	Fecal Monthly GM ≤ 2,000	Yes
		DO never <4.0 mg/L[4]	Yes
Primary Contact WQ Criteria[1]	Saline Water	Fecal Monthly GM ≤ 200	Yes
		Daily Average DO ≥ 4.8 mg/L[3] [4]	No[5]
		DO never < 3.0 mg/L[4]	Yes
Potential Future Primary Contact WQ Criteria[2]	Entero: rolling 30-d GM – 30 cfu/100mL		Yes
	Entero: STV – 110 cfu/100mL		No

Notes:
GM = Geometric Mean; STV = 90 Percent Statistical Threshold Value
(1) This water quality standard is not currently assigned to the Gowanus Canal or Gowanus Bay.
(2) The Potential Future Primary Contact WQ Criteria have not yet been adopted by DEC.
(3) 24-hr average DO ≥ 4.8 mg/L with allowable excursions to ≥ 3.0 mg/L for certain periods of time. See Section 2.0 for the equation and calculation description.
(4) DO based on 2008 typical year model simulations.
(5) DO Attainment ranges from 87% to 94% at Stations GC-8 and GC-6.

In summary, applicable water quality criteria essentially are met.

8.7 Water Quality Goals

Based on the analyses of the Gowanus Canal, and the WQS associated with the designated uses, the following conclusions can be drawn for both existing and future water quality goals:

8.7.a Existing WQ Criteria

The Gowanus Canal is a Class SD and I waterbody that can support existing uses where applicable: kayaking and wildlife propagation in the lower Class I reach and wildlife propagation in the upper Class SD reach. The waterbody is in full attainment with its current classifications regarding bacteria and DO criteria. Furthermore, man-made features, shoreline access and industrial uses limit opportunity for and render infeasible primary contact recreation in the Gowanus Canal, the significant improvements in water quality notwithstanding.

8.7.b Primary Contact WQ Criteria

As presented in Section 8.5, this LTCP incorporates assessments for attainment with the proposed primary contact recreational WQS, both spatially and temporally, using 10-year simulations for bacteria runs and a typical year (2008) run for DO. Projected bacteria levels comply fully with primary contact standards.

DO levels largely comply with the primary contact standards except at Stations GC-6 and GC-8 at which attainment with the chronic standard ranges from 87 to 94 percent.

8.7.c Potential Future Water Quality Criteria

The Potential Future Primary Contact WQ Criteria is achieved for the GM 30 cfu/100mL enterococci criterion 100 percent of the time for the 10-year model simulations. However, the 110 cfu/100mL STV criterion, is not. DEP is committed to improving water quality in the Gowanus Canal, as evidenced by the water quality improvements that resulted from implementation of the 2008 WWFP recommendations. Further improvements are already planned, including the build-out of GI and completion of the multi-phase HLSS.

8.7.d Time to Recovery

The DEC has requested DEP to analyze the Time to Recovery for the Gowanus Canal. Time to Recovery is not a current water quality criterion, but is an assessment of the time it takes for bacteria levels to return to fecal coliform concentrations below 1,000 cfu/100mL concentration, the a level deemed safe by New York State Department of Health (DOH) for primary contact use. The results of the time to recovery analysis for the Gowanus Canal are presented in Table 8-20. DEC agreed with this analysis, which was conducted for the August 14-15, 2008, storm. Details on the selection of this storm are presented in Section 6.0.

Table 8-20. Time to Recovery in Gowanus Canal (August 14-15, 2008 Storm)

Class	Stations	LTCP Baseline Conditions Projected Time to Recovery (hours)
SD	GC-1 to GC-7	8 – 14
I	GC-8 to GC-10	7 – 10

As shown, the time to recovery to the 1,000 cfu/100mL fecal coliform concentration following rain events is below 14 hours for all locations along the Gowanus Canal, well below the 24 hour duration guideline agreed upon by DEC and the DEP.

8.8 Recommended LTCP Elements to Meet Water Quality Goals

As has been emphasized throughout this section, the analyses performed for the Gowanus Canal LTCP CWA assessments were conducted with consideration of the EPA Superfund program. EPA's ROD preliminarily estimated a range of CSO reductions from Outfalls RH-034 and OH-007 of 58-74%, with a capital cost estimate of $77M for construction of two CSO storage tanks. Because of the common focus of these two efforts, i.e., CSO reduction, the preparation of the LTCP was coordinated with the development of the following DEP Superfund reports:

1. Preliminary Remedial Design Report for CSO Facility at Red Hook Outfall RH-034.
2. Preliminary Remedial Design Report for CSO Facility at Owl's Head Outfall OH-007.
3. CSO Facility Site Recommendation Report for Red Hook Outfall RH-034.
4. CSO Facility Site Recommendation Report for Owl's Head Outfall OH-007.

These reports are being submitted to EPA on June 30, 2015, the same date that this LTCP is being submitted to DEC.

The evaluations performed as part of the referenced Superfund documents work will result in additional CSO controls, as required by EPA, and will result in further improvements to water quality.

8.8.a LTCP Findings

The Gowanus Canal LTCP process has yielded the following conclusions:

1. Current WQS are being met with the newly refurbished Flushing Tunnel and reconstructed Gowanus PS.

2. Water quality will further improve with the build-out of the planned GI and construction of the proposed HLSS, currently planned and thus included in the LTCP baseline but yet to be fully implemented. The LTCP evaluated alternatives to further reduce CSO loadings to the Gowanus Canal beyond baseline conditions and determined that these additional control measures had little to no impact on projected water quality criteria for primary contract recreation.

3. The Superfund program will require grey infrastructure improvements in the form of CSO storage tanks. The anticipated water quality improvements resulting from the Superfund alternatives are presented later in this section.

8.8.b Water Quality Projections with Baseline

No numerical bacteria criteria currently exist for Class SD waters in NYS, the classification of the upper reaches of the Gowanus Canal. The existing fecal coliform bacteria criterion for Class I waters, the classification of the majority of the Gowanus Canal, is a monthly GM below 2,000 cfu/100mL. However, DEC has proposed a rule to adopt total and fecal coliform bacteria criteria consistent with the swimmable goals of the CWA for all waters of NYS. To that end, the Gowanus Canal LTCP attainment analyses focused on attainment of the fecal coliform Primary Contact WQ criterion of 200 cfu/100mL proposed for Class I and Class SD waters. Additionally, an analysis of attainment of the Potential Future Primary Contact WQ Criteria was conducted. It is not known whether these criteria, if adopted, will apply to urban tributaries within NYC.

The water quality projections under baseline conditions are presented in Tables 8-21 and 8-22, respectively. As discussed in Section 6.0 and earlier in this Section 8.0, both the refurbished Flushing Tunnel and the reconstructed Gowanus Canal PS - two of the key CSO control components included in baseline conditions - have improved the water quality to a point where the proposed primary contact fecal coliform criterion of 200 cfu/100mL is met 100 percent of the time for the 10-year model simulations.

Table 8-21. Attainment of Primary Contact WQ Criteria (Fecal Coliform) and Potential Future Primary Contact WQ Criteria (Enterococci) (Baseline) – 10 Year Model Simulation

Station	Attainment of Primary Contact WQ Criterion (200 cfu/100mL) (%)	Attainment of Potential Future Primary Contact WQ Criteria	
		GM (30 enterococci/100mL) (%)	STV (110 cfu/100mL) (%)
GC-1	100	≥95	70
GC-2	100	≥95	73
GC-3	100	≥95	73
GC-4	100	≥95	74
GC-5	100	≥95	66
GC-6	100	≥95	34
GC-7	100	≥95	35
GC-8	100	≥95	36
GC-9	100	≥95	59
GC-10	100	≥95	86

As shown, both the Primary Contact WQ and the Potential Future Primary Contact WQ GM 30 cfu/100mL criteria are predicted to be achieved with the baseline projects. Again, the Potential Future Primary Contact WQ Criterion of 110 cfu/100mL STV is not projected to be achieved.

Table 8-22. Water Quality DO Criteria Attainment (Baseline) – 2008 Model Simulation

Class	Stations	Criteria		Attainment (%)
SD	GC-1 to GC-7	Designated	≥ 3 mg/L	98
I	GC-8 to GC-10		≥ 4 mg/L	95
SC/SB	GC-1 to GC-7	Next Higher Classification	≥ 4.8 mg/L(1)	94
	GC-8 to GC-10			87
	GC-1 to GC-7		≥ 3 mg/L(2)	98
	GC-8 to GC-10			100

Notes:

(1) Chronic Standard.

(2) Acute Standard.

With respect to DO, all existing criteria for Class I and SD waters are fully achieved. The DO criteria applicable to the next higher waterbody classifications are largely achieved. Thus, DO WQS are essentially being met in the Gowanus Canal.

8.8.c Water Quality Projections- EPA ROD Superfund

The ROD targets a range of TSS reductions of 58-74%, and identified tank ranges between 4 MG and 8 MG. Tank size will be refined during the remedial design phase. Accordingly, DEP evaluated TSS loading reductions associated with a range of tank sizes. Notably, all three tank alternatives significantly reduce the frequency of overflows from LTCP baseline conditions of over 40 per year to a maximum of between 12 and 13 per year. In addition, based upon 10-year model simulations, all Superfund tanks improve the attainment of the 110 cfu/100mL STV criterion for enterococci over baseline conditions. However, even the largest Superfund tanks do not lead to full compliance, i.e., attainment of the criterion at least 95 percent of the time.

Evaluations of the various tank sizes led to the conclusion that smaller tanks at the two outfalls can meet the ROD's TSS reduction estimates, and at considerably lower cost than if the 8 MG and 4 MG tanks were constructed. These findings became the basis for Alternatives 2 and 3 described in Section 8.2. Details of the investigations performed under the Superfund analysis are not included in this LTCP, but can be found in the reports referenced earlier in this section.

8.8.d Water Quality Compliance Projections with Implementation of LTCP Alternatives 1, 2 or 3

This section provides the WQS compliance projections for bacteria and DO for Alternatives 1, 2 or 3. The results are shown in Tables 8-23 and 8-24 for Stations GC-1 through GC-10. These alternatives include the tanks sizes listed in Table 8-7: 8 MG, 5.7 MG and 3.5 MG tanks at Outfall RH-034 and 4 MG, 2.5 MG and 1.4 MG tanks at Outfall OH-007. Each of these alternatives meets the Existing WQ Criteria and Proposed Primary Contact WQ Criteria. The Potential Future Primary Contact WQ Criteria would be met for the enterococci GM 30/100mL criterion. The STV 110 cfu/100mL criterion would not be met.

Table 8-23. Attainment of Primary Contact WQ and Potential Future Primary Contact WQ Criteria with Alternatives 1, 2 and 3 – 2008 Model Simulation for Alternative 1 and 10 Year Model Simulations for Alternatives 2 and 3

Station	Alternatives 1, 2 and 3 Attainment with Primary Contact WQ Criteria (200 cfu/100mL fecal coliform) (%)	Attainment with Potential Future Primary Contact WQ Criteria for Enterococci					
		GM (30 cfu/100mL)			STV (110 cfu/100mL)		
		Alternative 1 (%)	Alternative 2 (%)	Alternative 3 (%)	Alternative 1(1) (%)	Alternative 2 (%)	Alternative 3 (%)
GC-1	100	≥95	≥95	≥95	87	87	86
GC-2	100	≥95	≥95	≥95	87	87	87
GC-3	100	≥95	≥95	≥95	87	87	86
GC-4	100	≥95	≥95	≥95	87	87	87
GC-5	100	≥95	≥95	≥95	90	87	84
GC-6	100	≥95	≥95	≥95	86	71	68
GC-7	100	≥95	≥95	≥95	77	71	69
GC-8	100	≥95	≥95	≥95	74	74	62
GC-9	100	≥95	≥95	≥95	76	75	72
GC-10	100	≥95	≥95	≥95	90	90	87

Notes:
(1) Alternative 1 is based on the 2008 model simulation and Alternatives 2 and 3 are based on the 10 year model simulations

Table 8-24. Water Quality Criteria Dissolved Oxygen Attainment with LTCP Alternatives 1, 2 and 3 - 2008 Model Simulation

Class	Stations	Criteria		Attainment		
				Alternative 1 (%)	Alternative 2 (%)	Alternative 3 (%)
SD	GC-1 to GC-7	Designated	≥ 3 mg/L	99	99	99
I	GC-8 to GC-10		≥ 4 mg/L	96	96	96
SC/SB	GC-1 to GC-7	Next Higher Classification	≥ 4.8 mg/L(1)	95	95	95
	GC-8 to GC-10			88	88	88
	GC-1 to GC-7		≥ 3 mg/L(2)	99	99	99
	GC-8 to GC-10			100	100	100

Notes:
(1) Chronic Standard
(2) Acute Standard

The water quality benefits achieved with Alternatives 1, 2 and 3 include reductions in CSO discharges to the Gowanus Canal. However, the 10-year water quality model runs do not show an appreciable elevation in WQS attainment. In all instances, the primary benefit will be fewer overflows to the Gowanus Canal and a greater removal of floatables.

The compliance with WQS realized by Alternatives 1, 2 and 3 is summarized in Table 8-25.

Table 8-25. Alternatives 1, 2 and 3 – Compliance with Classifications and Standards - 2008 Model Simulation for Alternative 1 and 10 Year Model Simulations for Alternatives 2 and 3

Analysis	Numerical Criteria Applied		Compliance
Existing WQ Criteria Fish Survival (Class SD) and Boating/Fishing (Class I)	Gowanus Canal Above Hamilton Ave (Class SD)	Fecal - None	Yes
		DO never < 3.0 mg/L[4]	Yes
	Gowanus Bay Below Hamilton Ave (Class I)	Fecal Monthly GM ≤ 2,000	Yes
		DO never <4.0 mg/L[4]	Yes
Primary Contact WQ Criteria[1]	Saline Water	Fecal Monthly GM ≤ 200	Yes
		Daily Average DO ≥4.8 mg/L[3] [4]	No[5]
		DO never < 3.0 mg/L[4]	Yes
Potential Future Primary Contact WQ Criteria[2]	Entero: rolling 30-d GM – 30 cfu/100mL		Yes
	Entero: STV – 110 cfu/100mL		No

Notes:

GM = Geometric Mean; STV = 90 Percent Statistical Threshold Value

(1) This water quality standard is not currently assigned to the Gowanus Canal or Gowanus Bay.
(2) The Potential Future Primary Contact WQ Criteria have not yet been adopted by DEC.
(3) 24-hr average DO ≥ 4.8 mg/L with allowable excursions to ≥ 3.0 mg/L for certain periods of time. See Section 2.0 for the equation and calculation description.
(4) DO based on 2008 typical year model simulations.
(5) DO Attainment is 88% at Station GC-8.

The estimated construction and O&M costs for the Alternatives 1, 2 and 3, as well as the corresponding NPWs are shown in Table 8-26.

Table 8-26. Cost of Alternatives 1, 2 and 3

Alternative		Capital Cost ($M)	Annual O&M ($M)	NPW ($M)
1	8 MG Tank at Outfall RH-034	490	1.2	508
	4 MG Tank at Outfall OH-007	311	0.7	321
	Total	801	1.9	829
2	5.7 MG Tank at Outfall RH-034	450	0.9	462
	2.5 MG Tank at Outfall OH-007	213	0.5	221
	Total	663	1.4	683
3	3.5 MG Tank at Outfall RH-034	369	0.6	378
	1.4 MG Tank at Outfall OH-007	124	0.3	129
	Total	493	0.9	507

A comparison of the attainment results between Alternatives 1, 2 and 3 and a scenario where no additional CSO controls are constructed reveals that both existing and the primary contact WQS are largely met under all cases. As required in the EPA ROD, DEP will implement additional CSO controls which will result in still further reductions in CSO overflows and loadings, and improved water quality conditions.

8.8.e Conclusion

DEC and DEP have achieved dramatic improvements in water quality in the Gowanus Canal through an effective process that resulted in significant infrastructure improvements in the sewershed. These improvements were proposed in the 2008 WWFP submitted by DEP to DEC that was approved by DEC in 2009. That work included:

- Gowanus PS upgrade – increase capacity from 20 to 30 MGD and add screening facility to outfall for floatables control.
- Flushing Tunnel upgrade – three new pumps increasing average design flow to 215 MGD, and making it possible for more continuous flushing even during periods of low tide, with additional screening.
- Total project capital cost - $190M.

These WWFP projects, when coupled with the planned GI build-out and the proposed HLSS that collectively comprise the LTCP baseline conditions, are projected to achieve full compliance with designated WQS.

In accordance with EPA Superfund requirements to reduce TSS loadings to the Canal, DEP has evaluated a range of alternatives including various CSO storage tank sizes for Outfalls RH-034 and OH-007. Such tanks, while reducing TSS loadings, also significantly reduce the frequency of overflows from LTCP baseline conditions of over 40 per year to a maximum of approximately 12 to 13 per year. These tanks will, to a certain extent, improve the level of attainment with the potential future enterococci criteria. Schedules for construction of the two tanks would be established pursuant to the Superfund program.

As noted above, the baseline projects have led to projected full compliance with designated WQS. As a result, DEP is proposing upgrading the designated Class SD portion of the Gowanus Canal to a Class I. DEP plans to extend the period of PCM to assess the potential for even further upgrades to the waterbody classification (e.g., Class SC) as it appears, based on the monitoring to date, that water quality might support the uses associated with this classification during the recreational period. The Gowanus Canal should be considered for further upgraded WQS upon completion of the Superfund remediation work and results of water quality conditions after a longer trend of data can be analyzed from further PCM.

9.0 LONG-TERM CSO CONTROL PLAN IMPLEMENTATION

The evaluations performed for this Gowanus Canal LTCP concluded that the recommendations being implemented by DEP as part of the DEC-approved 2011 WWFP, plus the planned GI penetration throughout the watershed as part of the citywide GI plan as incorporated into the LTCP program, have significantly improved the water quality of the waterbody. It is projected that the Gowanus Canal will meet and exceed the Existing WQ Criteria classification of SC and I for bacteria. It is therefore recommended that DEP continue with implementation of the WWFP and GI projects, including PCM and other ongoing monitoring programs.

In addition, and in accordance with EPA Superfund requirements, DEP will be constructing additional CSO storage which will meet the EPA TSS target loading reductions; such work will lead to the reduction of the number of CSO overflow events from over 40 per year to between 12 and 13 per year. Selection of tank locations and tank sizes, and schedule will be established through the Superfund program which will be overseen by EPA. The schedule for this tank construction and work will be informed by future EPA decisions including site selection, tank sizing, and other factors, some of which may be beyond the control of DEP (including certain site remediation work). The schedule for the RH-034 site, in particular, could be impacted by sequencing of work which may be dependent on actions beyond the control of DEP, or activities that may need to be coordinated with other regulatory programs.

9.1 Adaptive Management (Phased Implementation)

Adaptive management, as defined by 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, DEP will continue to apply the principles of adaptive management based on its annual evaluation of PCM data which will be collected to optimize the operation and effectiveness once the planned LTCP components are constructed.

Finally, the findings from the EPA ROD Superfund studies could have a bearing on the Gowanus Canal and possible post-LTCP CSO control measures.

9.2 Implementation Schedule

The implementation schedule for the Gowanus Canal LTCP will be based on the planned grey infrastructure from the WWFP and the planned GI build-out. The completion dates of the LTCP components are listed in the CSO Order as follows:

1. High Level Storm Sewers (HLSS) Project
2. GI Build-out

Additional CSO controls required by the Superfund program will be determined according to the process required by that program. Thus, storage alternatives have been presented as a range of tank sizes. These alternatives will be reviewed by EPA and the final schedule will be established in accordance with the Superfund process.

9.3 Operation Plan/O&M

DEP is committed to effectively operating the Gowanus Canal LTCP components as they are built-out during the implementation period.

9.4 Projected Water Quality Improvements

As previously noted, the construction and build-out of the LTCP components are expected to result in improved water quality in the Gowanus Canal and full attainment of the Existing WQ Criteria, currently Class SD and I.

9.5 Post-Construction Monitoring Plan and Program Reassessment

As discussed in Section 4.0, a PCM program will continue as part of the implementation of the LTCP. Specifically these include the WWFP components described in that section plus the build-out of the GI described in Section 5.0, which collectively comprises the LTCP Baseline Conditions of Section 6.0. DEP will continue to perform its ongoing monitoring programs including Harbor Survey Monitoring and Sentinel Monitoring of the shoreline, the former being described in Section 4.0.

9.6 Consistency with Federal CSO Control Policy

The Gowanus Canal LTCP was developed to comply with the requirements of the Federal or EPA CSO Control Policy and associated guidance documents, and the CWA. The LTCP revealed that the Gowanus Canal currently attains the Existing WQ Criteria and will meet the Primary Contact WQ Criteria (Class SC). The Potential Future Primary Contact WQ Criteria will also be met with the exception of the enterococci 110 STV criteria.

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 WWTPs. 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 9-1, from FY 2005 through FY 2014, 59 percent of DEP's capital spending was for wastewater and water mandates. Figure 9-2 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.

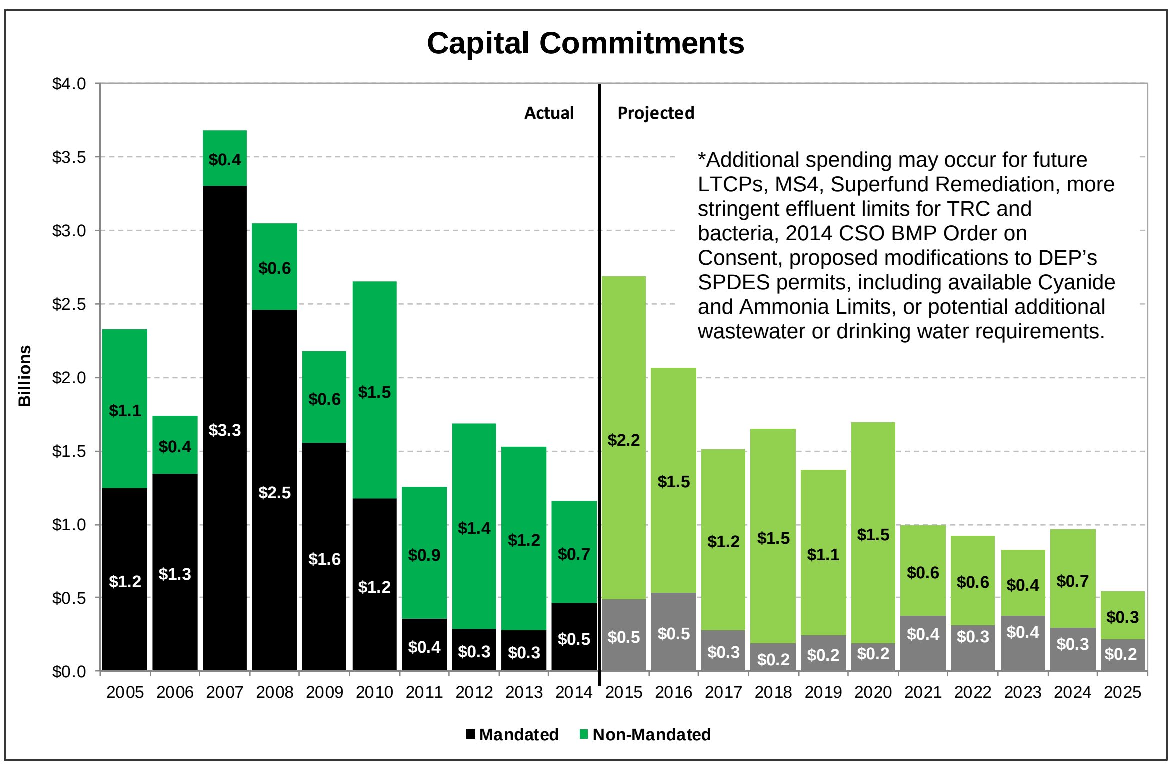


Figure 9-1. Historical and Projected Capital Commitments

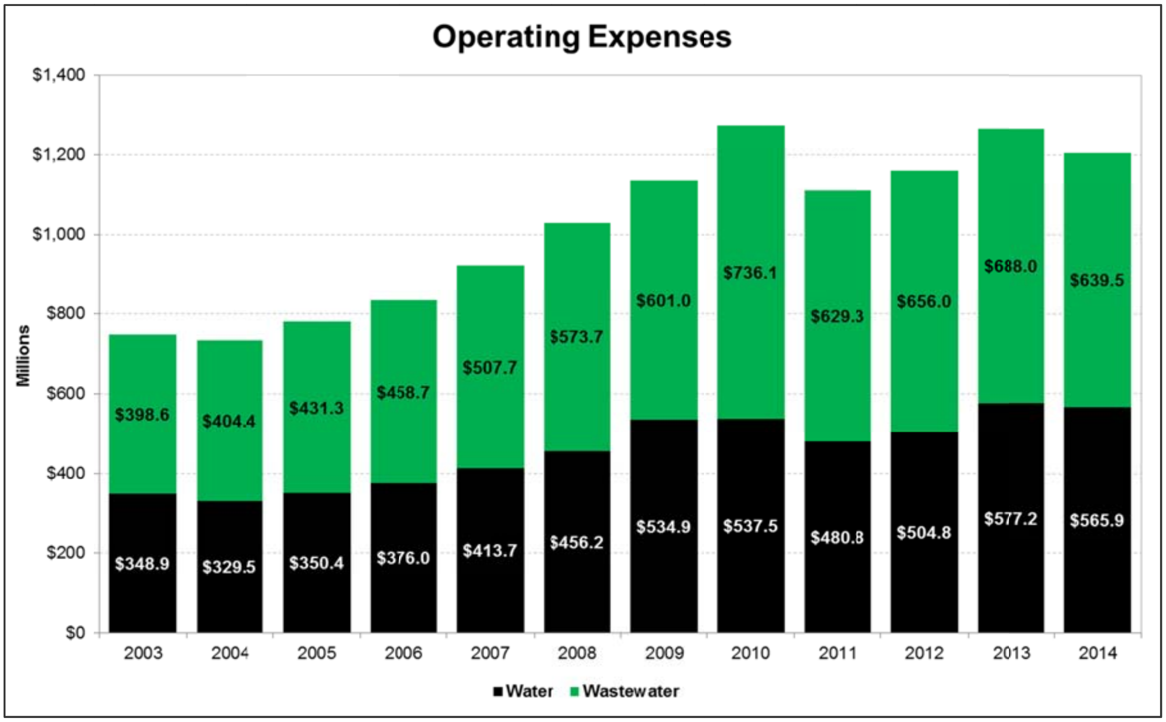


Figure 9-2. Historical Operating Expenses

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. 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 26^{th} 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 ROD recommended tanks. Potential Superfund costs for the Gowanus Canal range from $507M to $829M. Similar Superfund mandated CSO controls at Newtown Creek could add costs of $1B-$2B

Potential, Unbudgeted Drinking Water Regulation

- Hillview Reservoir Cover

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 groundbreaking 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 Federal Emergency Management Agency (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 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 9-3, 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.

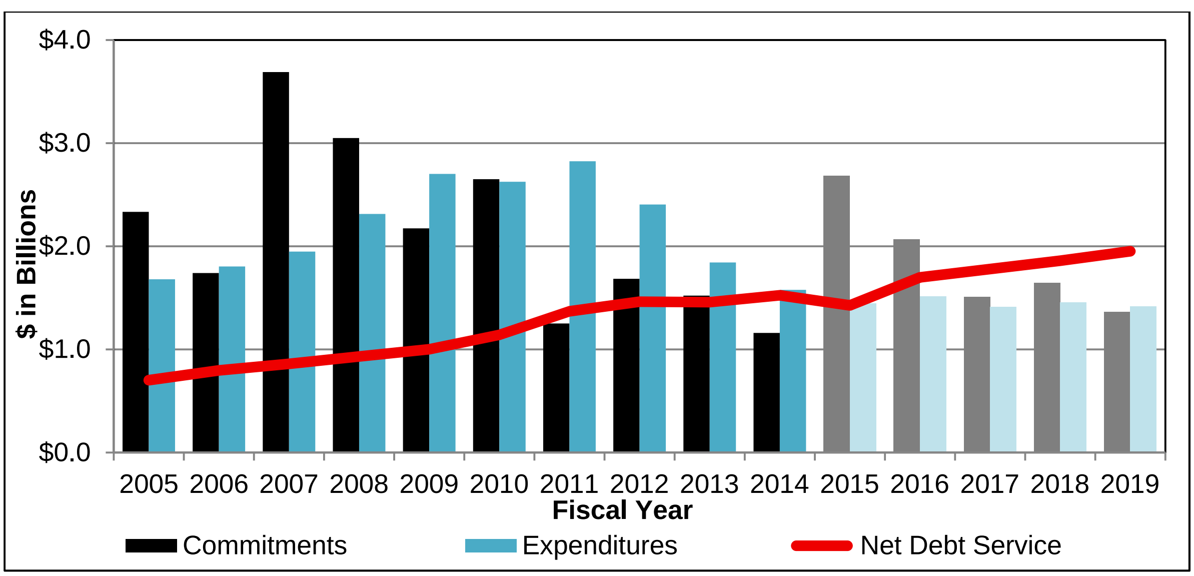


Figure 9-3. Past Costs and Debt Service

Actual Projected

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 9-4 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.

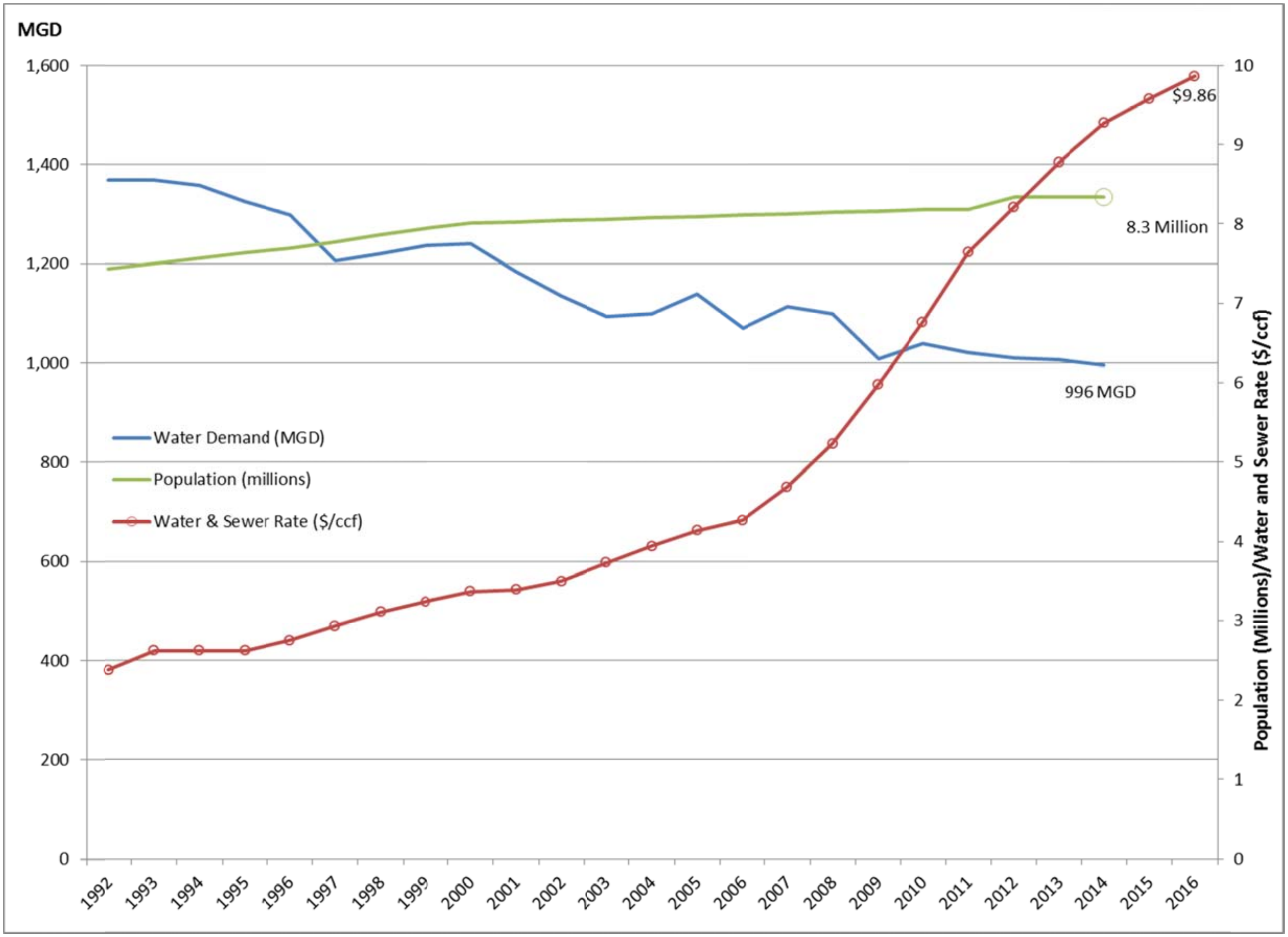


Figure 9-4. Population, Consumption Demand, and Water and Sewer Rates Over Time

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

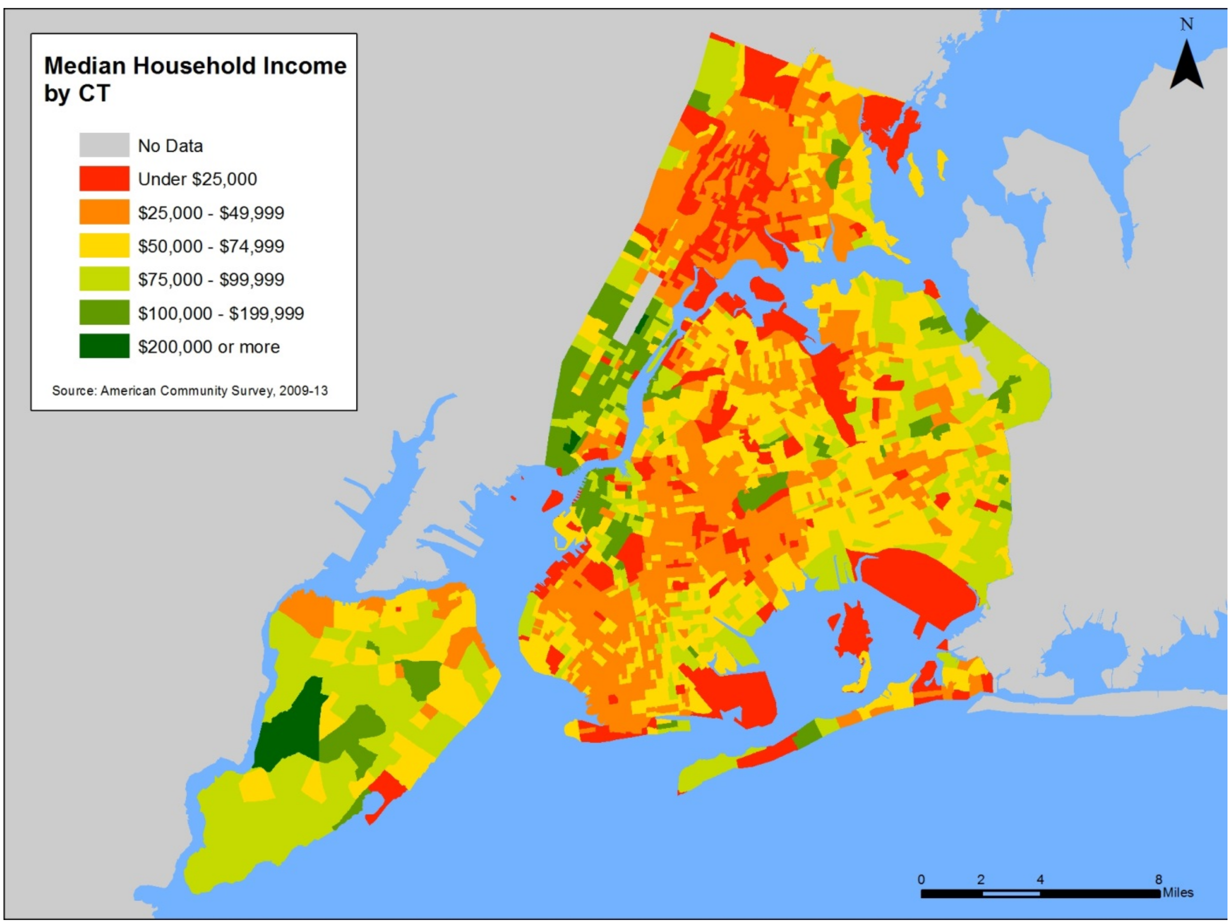
In 2013, the latest year for which Census data is available, the MHI in NYC was $52,223. As shown in Table 9-2, across the NYC boroughs, MHI ranged from $32,009 in the Bronx to $72,190 in Manhattan.

Figure 9-5 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 9-5. Median Household Income by Census Tract

As shown in Figure 9-6, 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.

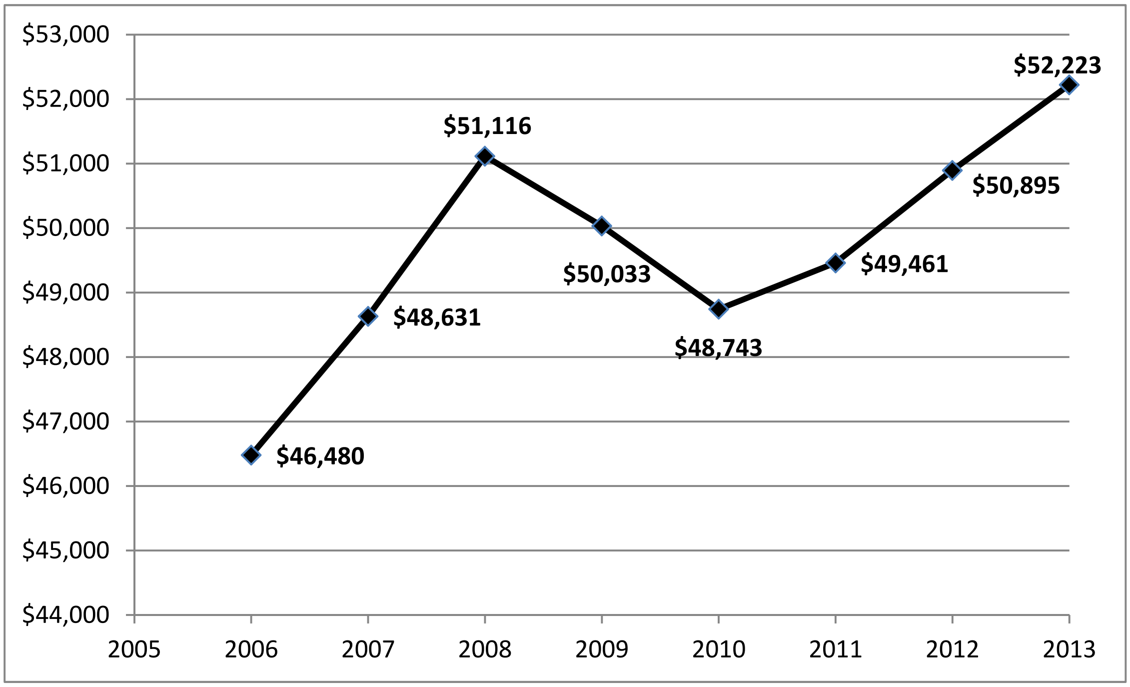


Figure 9-6. NYC Median Household Income Over Time

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 9-7, 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 9-7. Income Distribution for NYC and U.S.

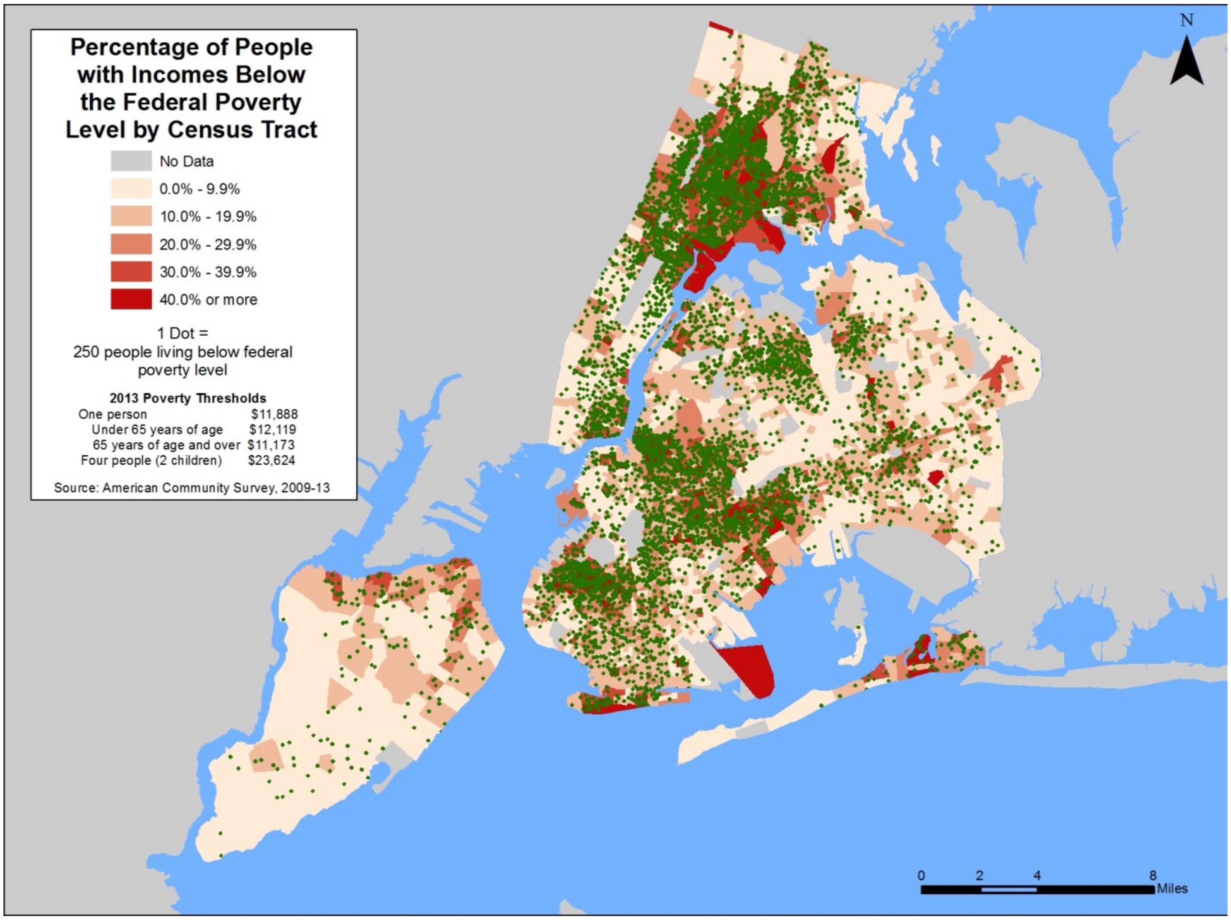
9.6.c.3 Poverty Rates

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 9-8 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 9-8. 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).

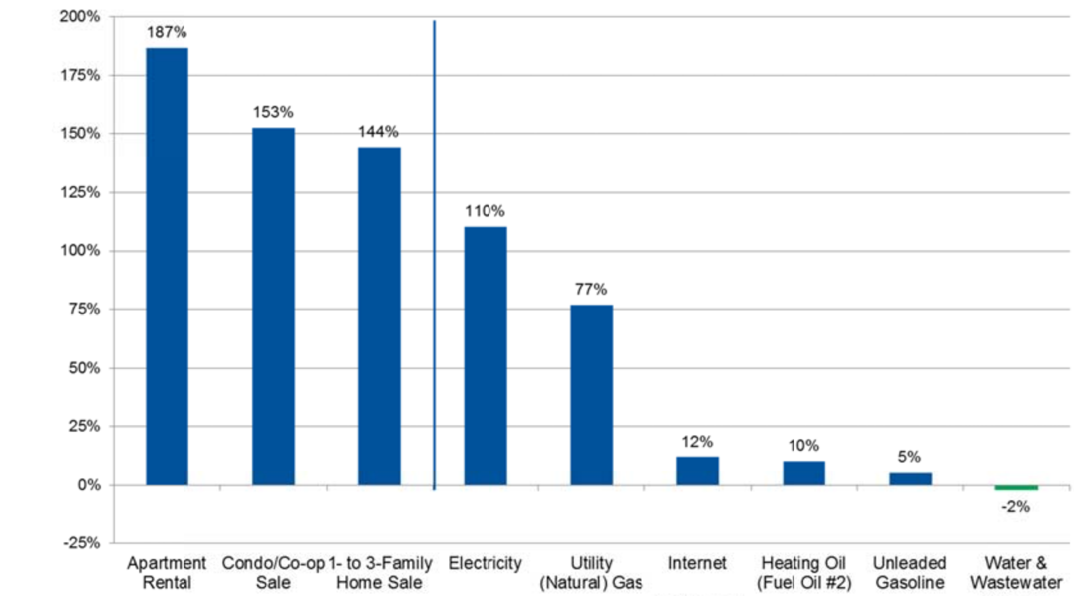
Nationwide, the SPM indicates that there are 6.39 percent more people in poverty than the official poverty threshold would indicate. The SPM also indicates that inside Metropolitan Statistical Areas the difference is 11.45 percent more people in poverty, and within "principal cities," the SPM-implied 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 9-9. 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 9-9. 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 9-10 (NYC Housing, 2014).

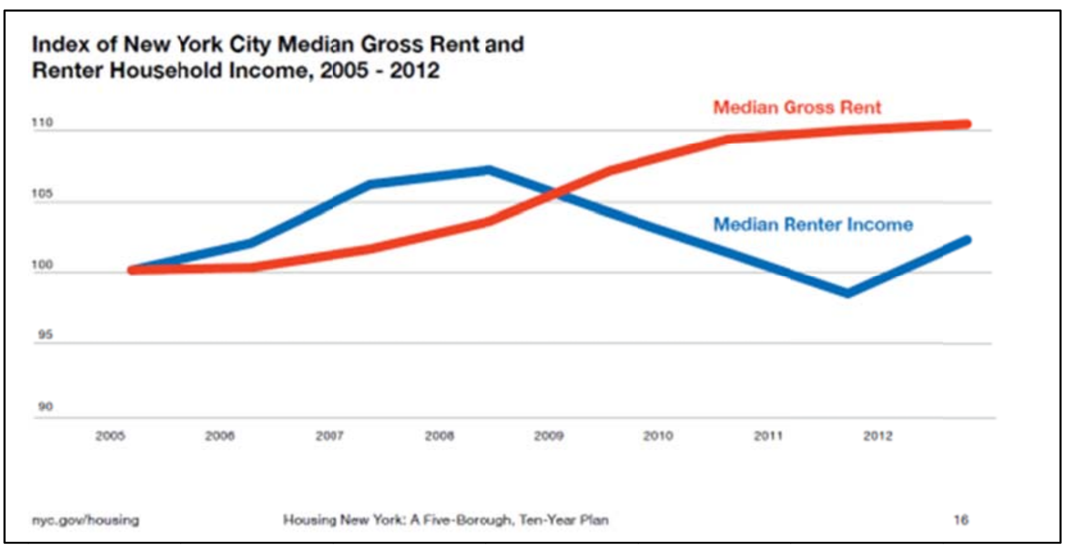


Figure 9-10. Median Gross Rent vs. Median Renter Income

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 9-11 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 9-12. 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.

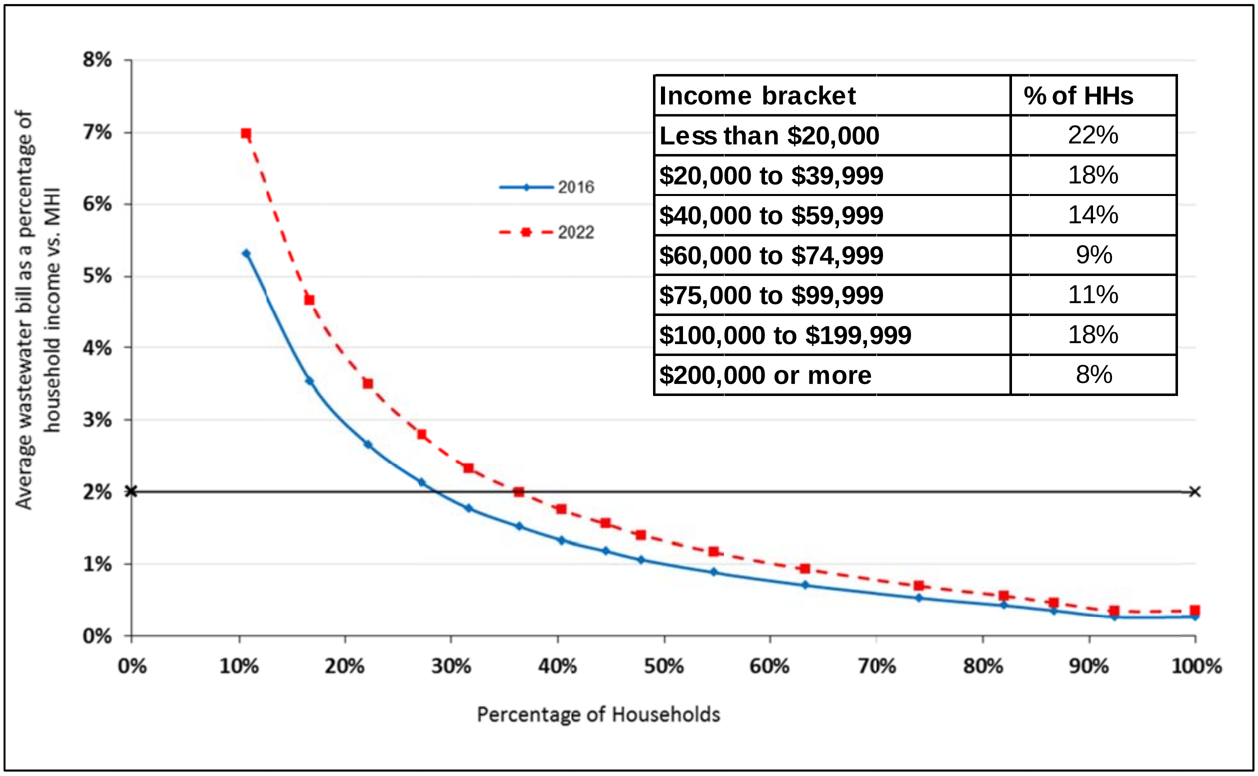


Figure 9-11. Estimated Average Wastewater Household Cost Compared to Household Income (FY 2016 and FY 2022)

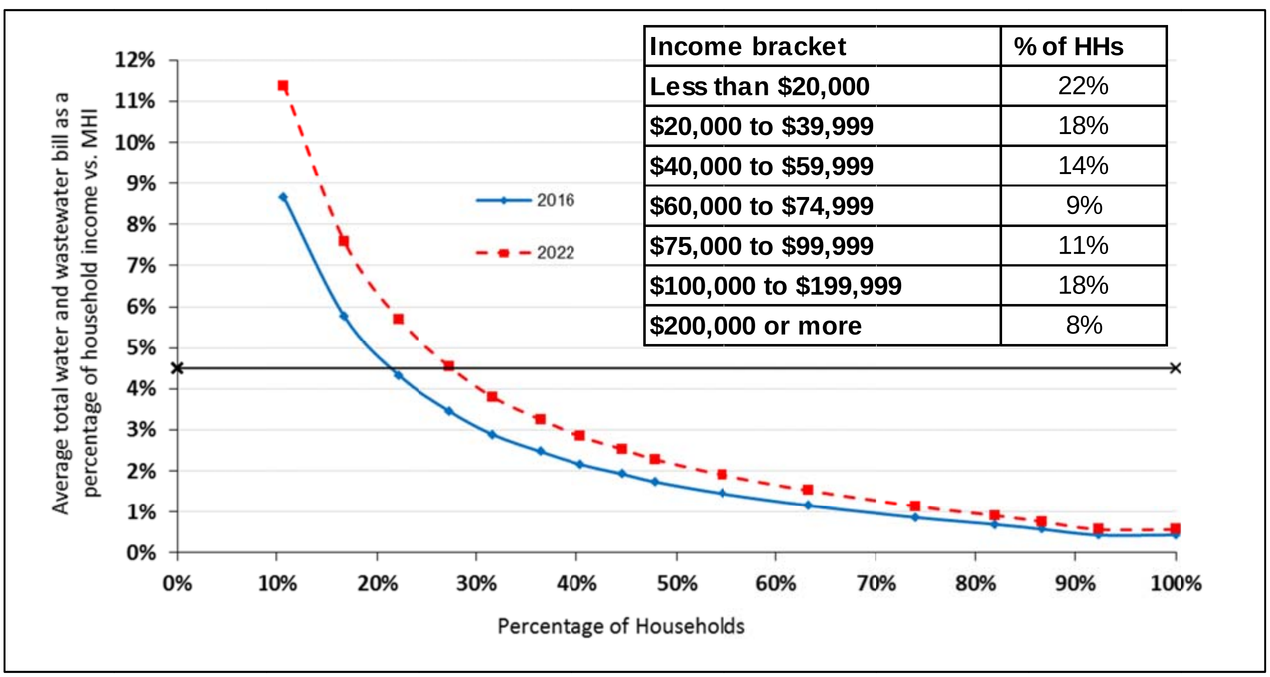


Figure 9-12. Estimated Average Total Water and Wastewater Cost as a Percentage of Household Income (FY 2016 and FY 2022)

9.6.f.1 Estimated Costs for Waterbody CSO Preferred Alternative

As discussed in Section 8.5, the preferred LTCP alternative for the Gowanus Canal does not include any additional CSO controls as projected attainment levels with current or potential WQS are very high. The preferred LTCP alternative, current baseline conditions, includes the recently-completed control measures from the 2008 WWFP (refurbished flushing tunnel and reconstructed Gowanus PS), plus the planned GI build-out and proposed HLSS in the watershed. To-date, approximately $485M has been committed to grey CSO control infrastructure in the Gowanus Canal system.

As discussed in Section 9.6.a.3 - Future System Investment, NYC will incur costs associated with the EPA ROD requirements. These costs are considered separate from the LTCP costs and are included as potential future household cost impact scenarios in Section 9.6.f.3 below.

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.

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 the 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 the 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 percent CSO control scenario would result in a three percent rate increase; the LTCP preferred alternatives plus 50 percent 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 Gowanus Canal 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 Gowanus Canal 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 26th 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 Gowanus Canal 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 Gowanus Canal is included in Section 8.0.

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

The Gowanus Canal is currently attaining the Class I bacteria criteria. The assessment of the waterbody indicates that the Gowanus Canal can support bathing water quality (Class SC), however, swimming in the Gowanus Canal is not recommended, nor is it suitable for that use because of natural and manmade features, such as lack of access and large boat traffic. In addition, consideration of upgrading of the Gowanus Canal to an SC classification should await completion of the Superfund remedial work and related post-construction compliance monitoring.

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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
B:	Billion
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
CEG:	Cost Effective Grey
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
DOC:	Dissolved Organic Carbon
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
FEMA:	Federal Emergency Management Agency
FMPV:	Full Market Property Value
FSAP:	Field Sampling Analysis Program
FS:	Feasibility Study
FT:	Abbreviation for “Feet”
FY:	Fiscal Year
GC:	Gowanus Canal
GC-PATH:	Gowanus Canal Water Pathogen Model
GC-STEM:	Gowanus Canal Sediment Transport and Eutrophication Model
GC WQM:	Gowanus Canal Water Quality Model
GHG:	Greenhouse Gases
GI:	Green Infrastructure
GIS:	Geographical Information System
GM:	Geometric Mean
G.O.:	General Obligation

GRTA:	NYC Green Roof Tax Abatement
HDPE:	High Density Polyethylene
HEAP:	Home Energy Assistance Program
HGL:	Hydraulic Grade Line
HLSS:	High Level Storm Sewers or can referenced as High Level Sewer Separation
Hp:	Horsepower
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
MGP:	Manufacturing Gas Plant
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
MWFA:	New York City Municipal Water Finance Authority
NAPL:	Non-Aqueous Phase Liquid
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
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
O&M:	Operation and Maintenance
OGI:	Office of Green Infrastructure
OH:	Owls Head
OLTPS:	Mayor's Office of Long Term Planning and Sustainability
OMB:	Office of Management and Budget
ONRW:	Outstanding National Resource Waters
OpX:	Operational Excellence
PAH:	Polycyclic Aromatic Hydrocarbons
PBC:	Probable Bid Cost
PCM:	Post-Construction Compliance Monitoring
POC:	Particulate Organic Carbon
POTW:	Publicly Owned Treatment Plant
ppm:	Parts per Million
ppt:	Parts per thousand
PRAP:	Proposed Remedial Action Plan
PS:	Pump Station or Pumping Station
Q:	Symbol for Flow (designation when used in equations)
RH:	Red Hook
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

RPM:	Revolutions per Minute
RTB:	Retention Treatment Basin
RTC:	Real-Time Control
RWQC:	Recreational Water Quality Criteria
S&P:	Standard and Poor
SBMT:	South Brooklyn Marine Terminal
SBU:	Sewer back-up
SCA:	NYC School Construction Authority
SCADA:	Supervisory Control and Data Acquisition
SGS:	Stormwater Greenstreets
SIU:	Significant Industrial User
SPDES:	State Pollutant Discharge Elimination System
SPM:	Supplemental Poverty Measure
SSS:	Sanitary Sewer Systems
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
TMDL:	Total Maximum Daily Load
TNTC:	Too Numerous to Count
TOC:	Total Organic Carbon
TPL:	Trust for Public Land
TRC:	Total Residual Chlorine

TSS:	Total Suspended Solids
UAA:	Use Attainability Analysis
ULURP:	Uniform Land Use Review Procedure
U.S.:	United States
USACE:	United States Army Corps of Engineers
USEPA:	United States Environmental Protection Agency
USFWS:	United States Fish and Wildlife Service
UV:	Ultraviolet Light
WDAP:	Water Debt Assistance Program
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)**
Gowanus Canal	OH-003	7A,7B,7C	372.8
Gowanus Canal	OH-004	7D	5.9
Gowanus Canal	OH-005	Carrol St CSO	0.5
Gowanus Canal	OH-006	19th St-3rd Ave	15.6
Gowanus Canal	OH-007	2nd Avenue PS CSO	57.6
Gowanus Canal	OH-023	Bush Terminal CSO	0.9
Gowanus Canal	OH-024	23st-3rd Ave Relief	26.4
Gowanus Canal	RH-030	CSO4	16.2
Gowanus Canal	RH-031	CSO3	16.7
Gowanus Canal	RH-033	R-25	0.3
Gowanus Canal	RH-034	CSO	137.5
Gowanus Canal	RH-035	CSO2	5.4
Gowanus Canal	RH-036	R-22	1.8
Gowanus Canal	RH-037	R-23	0.4
Gowanus Canal	RH-038	R-24	0.6
		Total CSO	**658.6**

InfoWorks Non-CSO Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Discharge, (MG/Yr)**
Gowanus Canal	OH-607	NA	4.5
Gowanus Canal	OH-616	NA	13.8
Gowanus Canal	OH-403	NA	6.3
Gowanus Canal	OH--12	NA	1.5
Gowanus Canal	OH--74	NA	2.6
Gowanus Canal	OH--75	NA	21.5
Gowanus Canal	OH--80	NA	10.7
Gowanus Canal	OH--81	NA	6.3
Gowanus Canal	OH--82	NA	6.9
Gowanus Canal	OH--83	NA	26.3
Gowanus Canal	OH--84	NA	2.5
Gowanus Canal	OH--85	NA	2.5
Gowanus Canal	OH--90	NA	6.7
Gowanus Canal	OH-344	NA	19.6
Gowanus Canal	OH-415	NA	7.0

InfoWorks Non-CSO Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Discharge, (MG/Yr)**
Gowanus Canal	OH-419	NA	19.7
Gowanus Canal	OH-514	NA	1.1
Gowanus Canal	OH-519	NA	4.7
Gowanus Canal	OH-590	NA	3.1
Gowanus Canal	OH-902	NA	2.7
Gowanus Canal	RH-601	NA	1.5
Gowanus Canal	RH--71	NA	10.6
Gowanus Canal	RH--72	NA	4.1
Gowanus Canal	RH-329	NA	3.8
Gowanus Canal	RH-393	NA	28.9
Gowanus Canal	RH-523	NA	9.6
Gowanus Canal	RH-524	NA	17.5
Gowanus Canal	RH-525	NA	3.0
Gowanus Canal	RH-857	NA	13.3
Gowanus Canal		**Total Non-CSO**	**262.3**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Discharge (MG/Yr)**
Gowanus Canal	Flushing Tunnel	NA	80,554.1
		Total	**80,554.1**

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Discharge (MG/Yr)**
Gowanus Canal	CSO	0.8	658.6
	Non-CSO	0.3	262.3
	Flushing Tunnel	98.9	**80**,554.1
		Total	**81,475.0**

**Annual CSO, Non-CSO,
Local Sources Enterococci Loads (2008 Rainfall)**

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{12}**
Gowanus Canal	OH-003	7A,7B,7C	4354.4
Gowanus Canal	OH-004	7D	47.6
Gowanus Canal	OH-005	Carrol St CSO	3.9
Gowanus Canal	OH-006	19th St-3rd Ave	156.8
Gowanus Canal	OH-007	2nd Avenue PS CSO	573.2
Gowanus Canal	OH-023	Bush Terminal CSO	8.5
Gowanus Canal	OH-024	23st-3rd Ave Relief	273.7
Gowanus Canal	RH-030	CSO4	168.6
Gowanus Canal	RH-031	CSO3	167.2
Gowanus Canal	RH-033	R-25	2.5
Gowanus Canal	RH-034	CSO	1272.5
Gowanus Canal	RH-035	CSO2	52.0
Gowanus Canal	RH-036	R-22	16.4
Gowanus Canal	RH-037	R-23	2.9
Gowanus Canal	RH-038	R-24	5.9
		Total CSO	**7,106.2**

InfoWorks Non-CSO Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{12}**
Gowanus Canal	OH-607	NA	8.5
Gowanus Canal	OH-616	NA	26.1
Gowanus Canal	OH-403	NA	11.9
Gowanus Canal	OH--12	NA	0.3
Gowanus Canal	OH--74	NA	0.6
Gowanus Canal	OH--75	NA	4.9
Gowanus Canal	OH--80	NA	2.4
Gowanus Canal	OH--81	NA	1.4
Gowanus Canal	OH--82	NA	1.6
Gowanus Canal	OH--83	NA	6.0
Gowanus Canal	OH--84	NA	0.6
Gowanus Canal	OH--85	NA	0.6
Gowanus Canal	OH--90	NA	1.5
Gowanus Canal	OH-344	NA	4.5
Gowanus Canal	OH-415	NA	1.6
Gowanus Canal	OH-419	NA	4.5
Gowanus Canal	OH-514	NA	0.2

InfoWorks Non-CSO Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{12}**
Gowanus Canal	OH-519	NA	1.1
Gowanus Canal	OH-590	NA	0.7
Gowanus Canal	OH-902	NA	0.8
Gowanus Canal	RH-601	NA	2.8
Gowanus Canal	RH--71	NA	2.4
Gowanus Canal	RH--72	NA	0.9
Gowanus Canal	RH-329	NA	0.9
Gowanus Canal	RH-393	NA	6.6
Gowanus Canal	RH-523	NA	2.2
Gowanus Canal	RH-524	NA	4.0
Gowanus Canal	RH-525	NA	0.7
Gowanus Canal	RH-857	NA	4.0
		Total Non-CSO	**104.3**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{12}**
Gowanus Canal	Flushing Tunnel	NA	118.2
		Total	**118.2**

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Org.x10^{12}**
Gowanus Canal	CSO	97.0	7,106.2
	Non-CSO	1.4	104.2
	Flushing Tunnel	1.6	118.2
		Total	**7,328.6**

**Annual CSO, Non-CSO,
Local Sources Fecal Coliform Loads (2008 Rainfall)**

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{12}**
Gowanus Canal	OH-003	7A,7B,7C	8322.4
Gowanus Canal	OH-004	7D	90.5
Gowanus Canal	OH-005	Carrol St CSO	7.9
Gowanus Canal	OH-006	19th St-3rd Ave	302.1
Gowanus Canal	OH-007	2nd Avenue PS CSO	1095.0
Gowanus Canal	OH-023	Bush Terminal CSO	16.5
Gowanus Canal	OH-024	23st-3rd Ave Relief	523.9
Gowanus Canal	RH-030	CSO4	324.7
Gowanus Canal	RH-031	CSO3	322.0
Gowanus Canal	RH-033	R-25	5.2
Gowanus Canal	RH-034	CSO	2444.6
Gowanus Canal	RH-035	CSO2	100.4
Gowanus Canal	RH-036	R-22	32.4
Gowanus Canal	RH-037	R-23	5.8
Gowanus Canal	RH-038	R-24	1.2
		Total CSO	**13,605.2**

InfoWorks Non-CSO Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{12}**
Gowanus Canal	OH-607	NA	20.4
Gowanus Canal	OH-616	NA	62.7
Gowanus Canal	OH-403	NA	28.6
Gowanus Canal	OH--12	NA	0.2
Gowanus Canal	OH--74	NA	0.4
Gowanus Canal	OH--75	NA	3.3
Gowanus Canal	OH--80	NA	1.6
Gowanus Canal	OH--81	NA	1.0
Gowanus Canal	OH--82	NA	1.0
Gowanus Canal	OH--83	NA	4.0
Gowanus Canal	OH--84	NA	0.4
Gowanus Canal	OH--85	NA	0.4
Gowanus Canal	OH--90	NA	1.0
Gowanus Canal	OH-344	NA	3.0
Gowanus Canal	OH-415	NA	1.1
Gowanus Canal	OH-419	NA	3.0
Gowanus Canal	OH-514	NA	0.2

InfoWorks Non-CSO Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^12**
Gowanus Canal	OH-519	NA	0.7
Gowanus Canal	OH-590	NA	0.5
Gowanus Canal	OH-902	NA	2.0
Gowanus Canal	RH-601	NA	6.8
Gowanus Canal	RH--71	NA	1.6
Gowanus Canal	RH--72	NA	0.6
Gowanus Canal	RH-329	NA	0.6
Gowanus Canal	RH-393	NA	4.4
Gowanus Canal	RH-523	NA	1.5
Gowanus Canal	RH-524	NA	2.6
Gowanus Canal	RH-525	NA	0.5
Gowanus Canal	RH-857	NA	10.1
		Total Non-CSO	**164.0**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^12**
Gowanus Canal	Flushing Tunnel	NA	429.6
		Total	**429.6**

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Org.x10^12**
Gowanus Canal	CSO	95.8	13,605.2
	Non-CSO	1.2	164.0
	Flushing Tunnel	3.0	429.6
		Total	**14,198.8**

**Annual CSO, Non-CSO,
Local Sources BOD_5 Loads (2008 Rainfall)**

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Gowanus Canal	OH-003	7A,7B,7C	228,019.8
Gowanus Canal	OH-004	7D	3,591.1
Gowanus Canal	OH-005	Carrol St CSO	325.8
Gowanus Canal	OH-006	19th St-3rd Ave	9,525.0
Gowanus Canal	OH-007	2nd Avenue PS CSO	35,250.0
Gowanus Canal	OH-023	Bush Terminal CSO	541.6
Gowanus Canal	OH-024	23st-3rd Ave Relief	16,141.8
Gowanus Canal	RH-030	CSO4	9,887.4
Gowanus Canal	RH-031	CSO3	12,223.1
Gowanus Canal	RH-033	R-25	197.2
Gowanus Canal	RH-034	CSO	84,091.9
Gowanus Canal	RH-035	CSO2	3,314.8
Gowanus Canal	RH-036	R-22	1,094.3
Gowanus Canal	RH-037	R-23	243.2
Gowanus Canal	RH-038	R-24	359.5
		Total CSO	**402,806.5**

InfoWorks Non-CSO Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Gowanus Canal	OH-607	NA	561.0
Gowanus Canal	OH-616	NA	1,734.2
Gowanus Canal	OH-403	NA	793.4
Gowanus Canal	OH--12	NA	193.3
Gowanus Canal	OH--74	NA	327.9
Gowanus Canal	OH--75	NA	2,713.0
Gowanus Canal	OH--80	NA	1,347.4
Gowanus Canal	OH--81	NA	793.6
Gowanus Canal	OH--82	NA	865.0
Gowanus Canal	OH--83	NA	3,319.0
Gowanus Canal	OH--84	NA	318.3
Gowanus Canal	OH--85	NA	310.6
Gowanus Canal	OH--90	NA	843.4
Gowanus Canal	OH-344	NA	2,464.0
Gowanus Canal	OH-415	NA	878.6
Gowanus Canal	OH-419	NA	2,480.3
Gowanus Canal	OH-514	NA	143.8

InfoWorks Non-CSO Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Gowanus Canal	OH-519	NA	597.1
Gowanus Canal	OH-590	NA	391.4
Gowanus Canal	OH-902	NA	339.3
Gowanus Canal	RH-601	NA	185.6
Gowanus Canal	RH--71	NA	1,341.8
Gowanus Canal	RH--72	NA	513.9
Gowanus Canal	RH-329	NA	473.7
Gowanus Canal	RH-393	NA	3,643.9
Gowanus Canal	RH-523	NA	1,209.3
Gowanus Canal	RH-524	NA	2,205.3
Gowanus Canal	RH-525	NA	371.9
Gowanus Canal	RH-857	NA	1,676.8
		Total Non-CSO	**33,036.7**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Gowanus Canal	Flushing Tunnel	NA	863,376.2
		Total	**863,376.2**

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Lbs**
Gowanus Canal	CSO	31.0	402,806.5
	Non-CSO	2.5	33,036.7
	Flushing Tunnel	66.5	863,376.2
		Total	**1,299,219.4**

Appendix B: Long Term Control Plan (LTCP) Gowanus Canal Meeting #1 – Summary of Meeting and Public Comments Received

On November 19, 2014, DEP hosted a Public Kickoff Meeting to initiate the water quality planning process for long term control of combined sewer overflows in the Gowanus Canal waterbody. The two-hour event, held at Public School 32, 317 Hoyt Street in Brooklyn, provided overview information about DEP's Long Term Control Plan (LTCP) Program, presented information on the Gowanus Canal watershed characteristics and status of waterbody improvement projects, obtained public information on waterbody uses in Gowanus Canal, and described additional opportunities for public input and outreach. The presentation can be found at http://www.nyc.gov/dep/ltcp. Approximately 50 stakeholders from different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event and two reporters from local Brooklyn papers.

The Gowanus Canal LTCP Kickoff Public Meeting was an opportunity for public participation in the LTCP. As part of DEP's LTCP Public Participation Plan, Gowanus Canal 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 Gowanus Canal waterbody-specific LTCP. Specific questions asked during the public kickoff meeting are summarized below with DEP's responses to each.

- Is sewage being brought to the Canal?
    - *The Flushing Tunnel and Pump Station do not bring sewage to the canal. They bring clean river water from the Buttermilk Channel to the head end of the canal. It is clean river water and is improving the water quality in the canal significantly.*
- Where is the 3 times the flow mentioned in the presentation going?
    - *The flows go to the Red Hook Wastewater Treatment Plant (WWTP) for treatment. The plant is designed for 2 times the dry weather flow.*
- Does the City monitor bioswale performance?
    - *Yes, DEP constructed three Neighborhood Demonstration Areas and installed equipment to monitor the performance of individual bioswales. Equipment was also installed in the sewers to monitor the performance of multiple bioswales within the same tributary area. A Post-Construction Compliance Monitoring Report will be available on the website in early 2015.*
- What is being done to control runoff for non-city properties such as the new Atlantic Yards?
    - *In 2012 the City promulgated a new stormwater rule for new construction and major building alteration projects. The rule requires these projects to detain significantly more stormwater on their property than what the previous rule required. These projects can also use green infrastructure practices such as rain gardens and perforated pipes to meet the new detention requirement.*

- Why is DEP in the process of suing the DEC?
  - *The issues associated with the current litigation are complex. DEP and DEC are working to determine the best plan for water quality improvements. The social and economic impacts are being evaluated. DEP hopes a resolution will be reached in the near future.*
- Why is DEP just getting going on this since the guidance dates back to 1994?
  - *DEP has been working on CSO issues for over two decades with significant progress made in improving water quality throughout the City during that time period. The recently completed upgrade of the Gowanus Flushing Tunnel and Wastewater Pumping Station is one example of the projects that the City has invested in to reduce CSOs and improve water quality. DEP and DEC have worked together in 2012 to develop schedules for the LTCPs and related work which will set the direction for future water quality improvements throughout the City.*
- What are the water quality objectives for the Gowanus Canal?
  - *The DEP and DEC goal is to improve the water quality in the canal. The recent operation of the Flushing Tunnel and Pump Station brings clean water from the East River to the head end of the canal and significant improvement in water quality has resulted. The canal may be upgraded to Class SB in the future.*
- Did you include hurricane Sandy in the modeling forecasts?
  - *The water quality modeling is done for a full 10 year period to account for fluctuations in rainfall. Sandy was not a high rainfall event and is not included in the 10 year modeling data. Most of the damage was due to tidal surge and wind.*
- Is DEP going to look at other data such as citizens' data?
  - *DEP will look at all data. Please submit any data to DEP.*
- How do DEP and EPA goals intersect?
  - *DEP uses a toolbox of alternatives for the evaluation step. The EPA tanks are included in the toolbox. Different levels of CSO control and cost are evaluated with a cost effective preferred alternative ultimately recommended for DEC and EPA review.*
- Does the use of weir adjustments cause house flooding?
  - *The hydraulic sewer analysis is required to say hydraulically neutral. This means an increase in the water levels in the sewers is not allowed. Any adjustments in weirs must not cause an increase in the water levels.*
- Will DEP and EPA coordinate the sewer construction along Carroll Street?
  - *The high level storm sewer (HLSS) study and design work is underway. The schedule for these projects will be coordinated when the design work is completed.*

- Citizen data shows there is more pollution in the turning basins; can HLSS be discharged to the turning basins?
  - *DEP will look into the option of discharging to the turning basins. Other projects may be planned for the turning basins.*
- Shouldn't all planning be coordinated with EPA to save time?
  - *DEP is coordinating with EPA and DEC. The consent decrees all have schedules that have been reviewed and approved by EPA and DEC as appropriate.*
- Superfund is based on toxins, are toxins being monitored?
  - *Yes, sampling, analysis and modeling of the chemical constituents is being done.*
- Will the cost of the EPA tanks be included in the DEP budgets?
  - *Yes, construction costs are paid for by the rate payers of the City. The cost of the tanks will become part of the DEP budget once the concept is approved.*
- Odors in the canal continue and are worse than other neighborhoods. Can the odors be reduced? Raw sewage exists in the canal.
  - *Odors will be reduced with the Flushing Tunnel and future improvements.*
- Is there higher water use for Gowanus Canal citizens?
  - *DEP's recent records show flows to the wastewater treatment plants (WWTPs) are declining. This is due to water conservation and improved sewer controls. The WWTPs have excess capacity at this time.*
- How is the CSO pilot project going?
  - *The CSO flow monitoring pilot project data analysis is ongoing. Preliminary conclusions are that CSO flow monitoring is challenging in the existing regulators due to complex hydraulics and infrastructure configuration. Based on previous NYC investments in calibrated models and telemetry, the effectiveness of these tools in estimating and predicting CSOs, the need to minimize instrumentation complexity and operation and maintenance requirements, DEP has chosen to implement CSO flow monitoring on a temporary basis for critical outfalls under the CSO LTCP program. This decision allows DEP to make strategic investments to gain valuable insight into the collection system and CSO outfall dynamics while minimizing the long-term burden of ongoing O&M, instrumentation replacement and recalibration requirements.*
- Is DEP looking at synthetic and natural Green Infrastructure mitigation? Can more trees be incorporated?
  - *Green infrastructure promotes the natural movement of water by collecting and managing stormwater runoff from streets, sidewalks, parking lots and rooftops and directing it to*

engineered systems that typically feature, stones, soils, plants and trees. Over the course of 2015, DEP will construct approximately 90 bioswales in the Gowanus watershed and many will include trees. DEP also works with City agencies such as the Department of Parks and Recreation and New York City Housing Authority to design green infrastructure practices such as rain gardens which may feature new trees as well.

- Why not wait until the EPA work is completed?
    - *EPA is targeting chemicals and DEC is targeting water quality. DEP is working on integrating both agencies objectives into a common approach that is cost effective and affordable.*
- Aren't we playing catch-up with these programs?
    - *The programs are working with agreed upon consent orders and schedules. DEP has fourteen WWTPs operational, 90 pump stations and they meet secondary standards. DEP also has plans to improve the treatment processes to meet more stringent water quality regulations.*
- With the increase in development in the area, is additional flow being considered?
    - *DEP is working with the Bridging Gowanus group and the zoning department and is aware of the newer developments being planned. The impacts to the entire system are small for these developments. The local sewers and new connections are reviewed in the planning and permit reviews. The LTCP includes population projects through 2040.*
- The DEP website does not have a Gowanus Canal page, how does the public comment?
    - *The information presented tonight will be posted tomorrow on the DEP website listed in the handouts. Questions can be posted to the site or sent to the representatives listed in the handout.*
- Will CSO flows increase at the head end of the canal?
    - *Flow projections for the outfall at the head of the canal (RH-034) are declining. The projects have reduced for 182 MG to 142 MG. These projections are still being developed and the values may change somewhat.*

Long Term Control Plan (LTCP) Gowanus Canal Meeting # 2 – Summary of Meeting and Public Comments Received

On May 14, 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 Gowanus Canal waterbody. The two-hour event was held at Public School 32, 317 Hoyt Street in Brooklyn. DEP presented information on the LTCP process, Gowanus Canal 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 35 stakeholders from 20 different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event and one representative from the local media.

The Gowanus Canal LTCP Meeting #2 was an opportunity for public participation in the LTCP. As part of DEP's LTCP Public Participation Plan, Gowanus Canal 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 Gowanus Canal waterbody-specific LTCP. Specific questions asked during the public meeting #2 are summarized below with DEP's responses to each.

- Why is there foaming in the Canal? People are referring to it as the "Gowanus milk shake" and it appears to be some type of soap.
    - *DEP responded that an investigation is underway to determine the cause of the foaming. Preliminary thoughts are that it is due to the aeration/air entrainment but DEP will continue to investigate.*
- Why has visibility in the Canal gotten worse? It used to be you could see to the bottom in some locations.
    - *Algae from Buttermilk Channel are suspected. Investigations of the cause are continuing.*
- There is a history of dry-weather discharges in the Canal. Has this stopped?
    - *DEP responded that there has been an investigation into past discharges over the past 20-25 years and those results indicate that dry weather discharges have decreased drastically.*
- How do the measurements in the turning basins change?
    - *The bacteria and dissolved oxygen levels are reasonably consistent between the Canal and the turning basins. They seem to be well mixed.*
- Has DEP used flow metering?
    - *DEP has performed flow measurements throughout the City. Recently Outfalls OH-007, OH-026 and RH-034 have been studied. The model predictions and flow metering measurement have corresponded. DEP is a co-author of a recent study being published by WERF (Water Environment Research Federation) that presents the technical findings of the metering efforts.*

- If the park location is chosen for a retention facility, is there funding?
    - *There is no current funding assigned for construction as DEP is still in the siting and design phase. Whatever alternatives are chosen, DEP will allocate funding.*
- Is it possible to send flow from Outfall OH-003 to Outfall OH-007?
    - *No, the regulators do not allow this.*
- Does the DEP include population and development growth in the plan?
    - *Yes, the plan includes projected development and growth.*
- Are you going to recommend a smaller tank than the ROD recommended?
    - *We are looking at smaller tanks that meet the criteria as they are less costly. No decision has been made.*
- Has the DEP talked with land owners about the possibility of eminent domain?
    - *Yes, DEP has talked with the land owners.*
- The Bond-Lorraine Sewer is still a flooding problem and should be repaired. In addition the impacts of climate change should be considered.
    - *The DEP has a separate group that is studying the impacts of climate change and the impact on the sewer system.*
- Why is the DEP not using more Green Infrastructure?
    - *DEP has already installed 18 green infrastructure assets and will begin construction on 92 bioswales in the public right of way in June 2015. Preliminary investigations have also begun to retrofit two New York City Housing Authority properties with green infrastructure. DEP will continue to work with city agencies to identify other opportunities for green infrastructure. DEP also offers a grant program for private property owners to install green infrastructure on their property. The GI Program is a 20-year program and more green infrastructure will be added to the Gowanus watershed over time.*
- *How are bioswales maintained and how does DEP select the locations?*
    - *City crews regularly maintain the bioswales. They are responsible for removing litter, preserving the grading, and caring for the tree and plants. In selecting bioswale locations, DEP begins by conducting a hydraulic analysis. Then walkthroughs are conducted with the Departments of Transportation and Parks & Recreation to review potential locations. If potential locations meet City requirements for access and pedestrian safety, then geotechnical investigations and surveys are performed. This step requires collecting and testing the underlying soil to ensure it can absorb stormwater. If the soil conditions are*

acceptable, the design team then prepares construction drawings (including specific bioswale placements) in conjunction with utility companies to avoid and eliminate conflicts with existing service lines.

- Why is a head house needed for the new facility?
  - *The head house is where the mechanical and electrical equipment are kept. It includes items such as electrical power, odor control equipment, pumps and other equipment needed to operate the facility/tank.*
- What is the annual operation cost?
  - *DEP has yet to determine this.*
- Can a new pool facility be built at the park to replace the old one?
  - *The City Parks Department would determine the feasibility of this. DEP would work with the Parks Department as needed.*
- What kind of absorption is expected with a bio swale?
  - *A 20x5 bioswale can manage approximately 2,992 gallons of stormwater runoff.*
- Will the GI improvements be coordinated with NYCHA (New York City Housing Authority)?
  - *DEP works closely with the New York City Housing Authority on identifying opportunities for green infrastructure improvements on NYCHA properties. Preliminary investigations are currently underway at Gowanus and Wyckoff Houses.*
- Can more rainfall runoff be absorbed by green infrastructure as opposed to catch basins?
  - *Green infrastructure practices such as bioswales, green roofs, and rain gardens collect and manage stormwater runoff. DEP is currently planning, designing, and constructing green infrastructure practices in the CSO areas of the Gowanus Canal watershed. Even with these green infrastructure practices, catch basins will continue to be an important component of the City's drainage system.*