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 Flushing Creek

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Environmental Protection

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

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TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

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 data analyses, the water quality modeling simulations and the alternatives analysis.
- Recommendations — A listing of recommendations that are consistent with the Federal CSO Control Policy and the Clean Water Act (CWA). In addition, recommendations regarding suggested site-specific targets for the Flushing Creek waterbody are provided.

1. BACKGROUND

This Long Term Control Plan (LTCP) for Flushing Creek was prepared pursuant to the Combined Sewer Overflow (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 New York City Department of Environmental Protection (DEP) is required to submit 11 waterbody-specific LTCPs to the New York State Department of Environmental Conservation (DEC) by December 2017. The Flushing Creek LTCP is the fourth of the LTCPs to be completed under the 2012 CSO Order on Consent.

The goal of each LTCP, as described in the LTCP Goal Statement in the 2012 CSO Order on Consent, 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. For this LTCP, in accordance 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). The PCM will be reviewed for the Citywide LTCP and the percent attainment targets will be reviewed and, based upon the PCM results, possibly modified.

Regulatory Requirements

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

DEC has designated the tidal Flushing Creek as a Class I waterbody, defined as "suitable for fish, shellfish and wildlife propagation and survival." The best usages of Class I waters are secondary contact recreation and fishing. Class I waters include a fecal coliform bacteria indicator criterion that is currently listed in the DEC WQS. DEC has publicly noticed a proposed rulemaking which, if promulgated, would in part amend Part 701 to require that the quality of Class I waters be suitable for "primary contact recreation" and to adopt corresponding total and fecal coliform standards in 6 NYCRR Part 703 (Proposed Rulemaking).

The criteria assessed in this LTCP include the applicable Existing WQ Criteria (Class I – Secondary Contact) (referred to hereinafter as Existing WQ Criteria) for Flushing Creek. The next higher classification category for Flushing Creek is Class SC[1] (referred to hereinafter as Primary Contact WQ Criteria). It should also be noted that the enterococci criteria do not apply to the tidal or freshwater sections of the Flushing Creek. As described above, the 2012 EPA RWQC recommended certain changes to the bacterial water quality criteria for primary contact. As such, this LTCP includes attainment analysis both for Existing WQ Criteria, for Primary Contact WQ Criteria and for the proposed 2012 EPA RWQC hereinafter referred to as the "Future Primary Contact WQ Criteria."

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

Table ES-1. Classifications and Standards Applied(1)

Analysis	Numerical Criteria Applied
Existing WQ Criteria(1)	I: Fecal Monthly GM ≤ 2,000
Primary Contact WQ Criteria(2)	SC: Fecal Monthly GM≤200
Future Primary Contact WQ Criteria(3)	Entero: rolling 30-day GM – 30 cfu/100mL Entero: STV – 110 cfu/100mL

Notes:

GM = Geometric Mean; STV = 90th Percentile Statistical Threshold Value

(1) DEC has publicly noticed a proposed rulemaking which, if promulgated, would amend 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 proposed total and fecal coliform standards for Class I are the same as the existing standards for Class SC waters.

(2) This water quality criteria is not currently assigned to Flushing Creek. For such criteria to take effect, DEC must first adopt the criteria in accordance with rulemaking and environmental review requirements.

(3) This Future Primary Contact WQ Criteria has not yet been proposed by DEC. For such criteria to take effect, DEC must first adopt the criteria in accordance with rulemaking and environmental review requirements.

The waterbody was calculated to attain the existing Class I fecal coliform water quality criterion of GM<=2000 cfu/100mL 96.7 percent of the time. Flushing Creek thus exceeds the DEC goal of 95 percent attainment and therefore can be said to be in full attainment of the Existing WQ Criteria. Therefore there is no gap between the baseline water quality conditions for fecal coliform bacteria and the water quality for the Existing WQ Criteria.

[1] The Flushing Creek LTCP evaluates compliance with various primary contact WQ numerical limits including the Primary Contact fecal coliform WQ Criteria (Class SC WQS). With the December 3, 2014 proposed rulemaking by DEC to change Class I fecal coliform bacteria criteria to 200 /100mL, Class SC and proposed Class I fecal coliform criteria would both retain the 200 /100 mL limitation. As such, the term Class SC criteria used in this LTCP is interchangeable with the proposed Class I numerical criteria when used in the context of bacteria WQ limits.

Further analyses of current Primary Contact WQ (Class SC) Criteria demonstrated that the attainment of the corresponding fecal coliform criterion of 200 cfu/100mL would be lower than 95 percent at all stations, both annually and seasonally for baseline and 100 percent CSO control conditions.

In addition, analyses on attainment with more stringent Future Primary Contact WQ Criteria indicated that the gap between the Future Primary Contact recreation criteria (GM of 30 cfu/100mL and statistical threshold value (STV) of 110 cfu/100mL) and the baseline conditions could not be closed even with complete removal of the Flushing Creek CSOs.

As both Primary Contact WQ Criteria (Class SC) and Future Primary Contact WQ Criteria would not be achieved with the removal of 100 percent CSO discharges from Flushing Creek, on an annual or recreational season (May 1st through October 31st) basis, a sensitivity analysis was performed for the 2008 conditions to assess whether complete removal of the CSO outfalls in nearby Flushing Bay would improve conditions. The results of that analysis indicated that complete removal of both Flushing Creek and Flushing Bay CSOs would improve annual and seasonal attainment of Primary Contact WQ Criteria (Class SC) as well as Future Primary Contact recreation GM criterion to 100 percent. However, attainment of the Future Primary Contact recreation STV criterion would not be accomplished.

A Use Attainability Analysis (UAA) for Flushing Creek is included with this LTCP. It is recognized that the UAA may need to be updated in June 2017 with the conclusion of the Flushing Bay LTCP; due to Flushing Creek's overall water quality attainment being impacted by Flushing Bay. DEP is proposing to submit a comprehensive UAA for both Flushing Bay and Flushing Creek, if required, when the Flushing Bay LTCP is completed in June 2017. A State Pollutant Discharge Elimination System (SPDES) Permit Variance is provided for the Flushing Bay CSO Retention Facility as requested by the DEC.

On December 3, 2014, DEC publicly noticed a proposed rulemaking which, if promulgated, would in part amend 6 NYCRR Part 701 to require that the quality of Class I waters be suitable for "primary contact recreation" and to adopt corresponding total and fecal coliform standards in 6 NYCRR Part 703. In developing the Flushing Creek LTCP, these proposed new regulations are referred to as Primary Contact WQ. At the conclusion of DEC rulemaking, the LTCP will be reviewed for impacts to the findings.

Flushing Creek Watershed

The Flushing Creek watershed is highly urbanized, comprised primarily of residential areas with some commercial, industrial, institutional and open space/outdoor recreation areas. The watershed comprises approximately 9,954 acres, located on the north shore of Queens County. The majority of the land surrounding the shores of Flushing Creek is industrial, commercial, vacant or used in support of transportation related features. The shoreline at the head of Flushing Creek, upstream of the Long Island Railroad (LIRR) tracks is surrounded by the Flushing Meadows-Corona Park, a notable open space/outdoor recreation area that occupies close to 20 percent of the Flushing Creek watershed. The watershed has undergone major changes as this part of NYC has developed. As it developed, the condition of the waterbody and its shoreline has been influenced by engineered sewer systems, filled-in wetlands and an overall "hardening" of the western shoreline with bulkheads. Flushing Creek watershed drainage characteristics are shown in Figure ES-1.

Figure ES-1. Flushing Creek Watershed Characteristics

The area is served by a complex collection system comprised of: combined, separate, and storm sewers; interceptor sewers and pumping stations; several CSO and stormwater outfalls; and a CSO retention tank. The majority of the watershed is served by the Tallman Island Wastewater Treatment Plant (WWTP). A smaller drainage area on the southeastern end of the watershed is served by the Bowery Bay WWTP. The major CSO and stormwater outfalls are shown in Figure ES-2. The sampling locations for Flushing Creek are shown in Figure ES-3.

The area is currently undergoing several zoning changes and planning efforts are underway for the area. Section 2 of the LTCP discusses these changes.

Green Infrastructure

DEP is planning to make significant investments in Green Infrastructure (GI) in the Flushing Creek watershed within the Tallman Island WWTP service area. DEP projects that GI penetration rates would manage 8 percent of the impervious surfaces within the Flushing Creek/Bay portion of the Tallman Island combined sewer service area and 13 percent of the impervious surfaces in the Flushing Creek/Bay portion of the Bowery Bay WWTP combined sewer service area by 2030. This accounts for ROW practices, public property retrofits, GI implementation on private properties, and for conservatively estimated new development trends based on DOB building permit data from 2000 to 2011 and has projected that data for the 2012-2030 period to account for compliance with the stormwater performance standard. The model has predicted a reduction in annual overflow volume of 46 million gallons (MG) from this GI implementation based on the 2008 baseline rainfall condition.

2. FINDINGS

Current Water Quality Conditions

Analysis of water quality in Flushing Creek was based on data collected from October 2013 to May 2014. Table ES-2 presents fecal coliform bacteria data collected at Stations OW-1, OW-2, OW-3, OW-4, OW-5 and OW-6 in Flushing Creek. The data in Table ES-2 shows the bacteria levels from the upstream (OW-1) to downstream (OW-6) locations. The sampling data were found to be below the Existing WQ Criteria for Class I for fecal coliform which is 2,000/100mL at all locations except the OW-3 and OW-4 for a wet weather condition. The Future Primary Contact WQ Criteria for enterococci of 30 cfu/100mL would be exceeded at several locations.

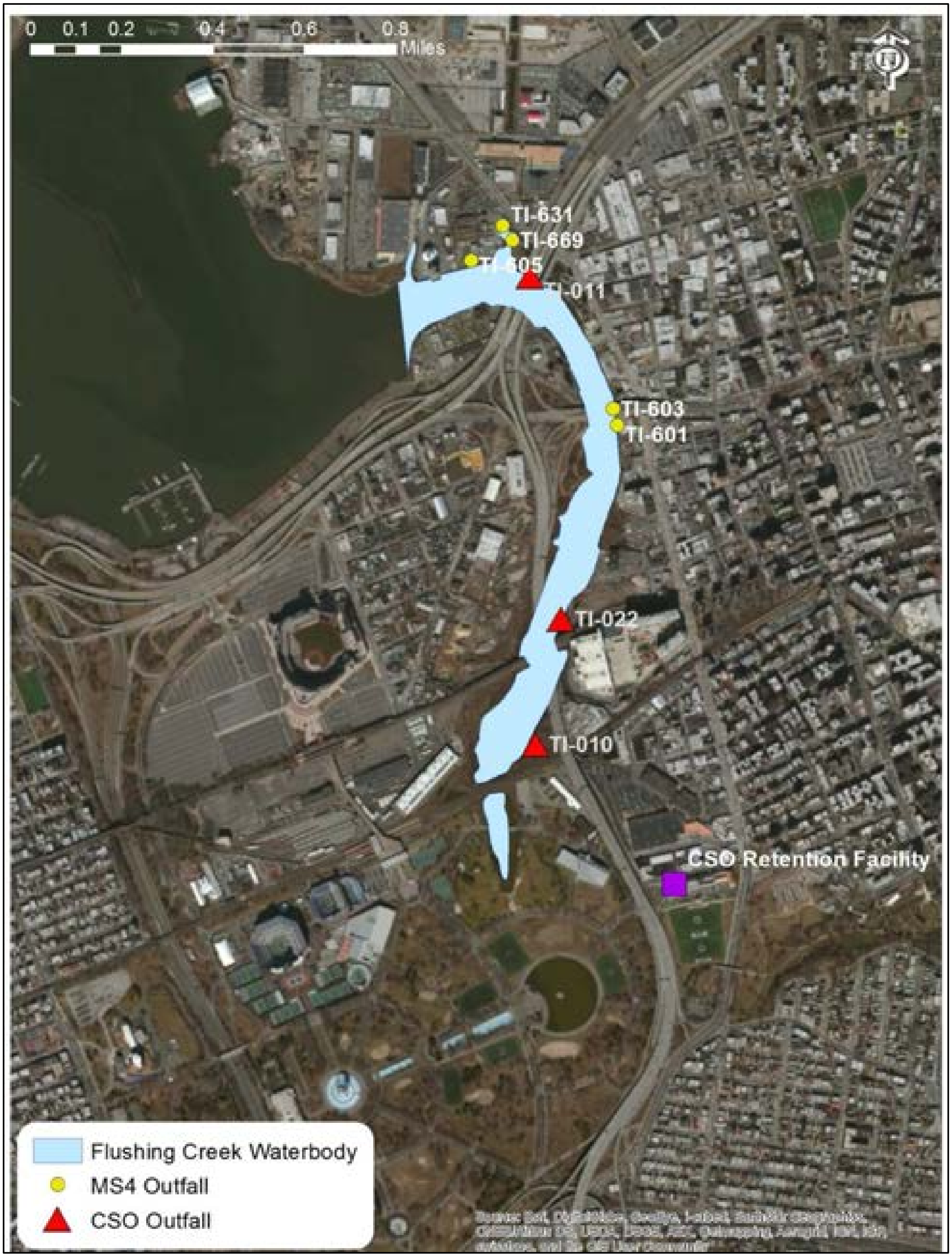

Figure ES-2. Flushing Creek CSO and DEP MS4 Discharge Locations

Figure ES-3. Field Sampling and Analysis Program (FSAP) and Harbor Survey Monitoring Program Sampling Locations

Table ES-2. Geometric Means of In-stream Bacteria Samples

Creek Station	Location	Enterococci (cfu/100mL)		Fecal Coliform (cfu/100mL)	
		Dry	Wet	Dry	Wet
OW-1	Willow and Meadow Lake	32	51	130	131
OW-2		20	99	100	433
OW-3	Flushing Creek	95	863	524	3,310
OW-4		23	494	119	2,176
OW-5		20	497	112	1,894
OW-6		14	221	77	910

Stations OW-1 and OW-2 are upstream of the tidal portion, while the stations below OW-2 are in the tidal saltwater section. The highest values for enterococci bacteria and fecal coliform were found in the tidal saltwater section of the Creek. The higher concentrations for dry weather fecal coliform and enterococci at OW-3 are being investigated by DEP for possible illicit discharges.

Baseline Conditions, 100 Percent CSO Control and Performance Gap

Analyses utilizing computer models were conducted as part of this LTCP to assess attainment with Existing WQ Criteria (Class I) and Future Primary Contact WQ Criteria for the Flushing Creek freshwater and tidal sections. The analyses focused on two primary objectives:

1. Determine the future 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. It should be also noted that Flushing Bay inputs impacts the Flushing Creek water quality attainments. This analysis is presented for Existing WQ Criteria and Future Primary Contact WQ Criteria.

2. Determine potential attainment levels with 100 percent of CSO controlled or no discharge of CSO to the waterbody, keeping the remaining non-CSO sources. This analysis is presented for the standards and bacteria criteria shown in Table ES-1.

DEP assessed water quality using the East River Tributary Model (ERTM). This model was verified with Harbor Survey data and the synoptic water quality data collected as part of the LTCP. Model outputs for fecal and enterococci bacteria as well as Dissolved Oxygen (DO) were compared with various monitoring data sets. The InfoWorks CS™ (IW) sewer system model was used to provide flows and loads from intermittent wet weather sources as input to the ERTM water quality model. All water quality models were calibrated to the data collected by the LTCP and Harbor Survey sampling programs and then used to make the water quality modeling projections.

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, Tallman Island and Bowery Bay WWTPs would receive peak flows at two times design dry weather flow

(2xDDWF), and waterbody-specific GI application rates would be based on the best available information. In the case of Flushing Creek, GI was assumed to have 8 percent coverage. The water quality assessments were conducted using continuous water quality simulations: a one-year (2008 rainfall) simulation for bacteria and DO assessment to support alternatives evaluation; and a 10-year (2002 to 2011 rainfall) simulation for bacteria for attainment analysis for the baseline, 100 percent CSO control and the preferred alternative model simulations.

The annual average baseline loadings for 2008 are presented in Table ES-3.

Table ES-3. Annual CSO, Stormwater, and Direct Drainage Volumes and Loads (2008 Rainfall)

Source	Volumetric Discharge (MG/yr)	Enterococci Load (cfu x 10^{12})	Fecal Coliform Load (org x 10^{12})	BOD Load (Lbs)
CSO	1,340	5,115	30,730	269,960
Stormwater/Direct Drainage	645	300	630	80,665
Meadow/Willow Lake	455	8	25	57,010
Total	**2,440**	**5,423**	**31,385**	**407,635**

Tables ES-4 and ES-5 show the simulation results for the maximum monthly GM for fecal coliform using a 10-year model simulation for the baseline and 100 percent CSO control. The tables present both the value of the maximum monthly GM and the percent attainment by year. Table ES-4 shows the calculated maximum monthly GMs and the attainment with the existing fecal coliform water quality criterion of 2,000 cfu/100mL. The table shows the fecal coliform concentrations are in attainment a high percentage of the time for the Existing WQ Criteria (2,000 cfu/100mL).

Table ES-5 shows the baseline simulation maximum GMs and attainment for the Primary Contact WQ Criteria or Class SC (200 cfu/100mL fecal coliform). The annual and recreational season (May 1st through October 31st) attainment percentages are shown. The annual attainment and recreational attainment are below 95 percent. The recreational season (May 1st through October 31st) attainment level is greater than 95 percent in 1 of the 10 years (2010).

Table ES-6 presents the 100 percent CSO control simulation for Primary Contact WQ Criteria (Class SC). It shows the annual attainment percentages are below 95 percent. However, the recreational season (May 1st through October 31st) attainment levels are greater than 95 percent in 6 of the 10 years.

Table ES-4. Calculated 10-Year Baseline Fecal Coliform Maximum Monthly GM Concentrations and Attainment of Existing WQ Criteria (Class I) - Percent of Months in Attainment

Station	(a) Maximum Monthly Fecal Coliform Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
	November	June	April	December	January	December	February	December	March	August	
OW-03	1,135	1,354	834	1,346	1,600	2,184	2,319	4,259	1,275	2,265	1,857
OW-04	1,134	1,296	773	1,324	1,438	2,331	2,379	4,275	1,190	2,146	1,829
OW-05	1,026	1,196	682	1,176	1,264	2,093	2,115	3,808	1,121	1,920	1,640
OW-06	941	1,038	520	1,025	1,129	1,807	1,775	3,508	1,015	1,571	1,433
Station	(b) Fecal Coliform – Annual Attainment (Percent of Months)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	100	100	100	100	100	92	92	92	100	92	97
OW-04	100	100	100	100	100	92	92	92	100	92	97
OW-05	100	100	100	100	100	92	92	92	100	100	98
OW-06	100	100	100	100	100	100	100	92	100	100	99

Table ES-5. Calculated 10-Year Baseline Fecal Coliform Maximum Monthly GM and Attainment of Class SC Criterion - Percent of Months in Attainment Baseline

Station	(a) Maximum Monthly Fecal Coliform Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
	November	June	April	December	January	December	February	December	March	August	
OW-03	1,135	1,354	834	1,346	1,600	2,184	2,319	4,259	1,275	2,265	1,857
OW-04	1,134	1,269	773	1,324	1,438	2,331	2,379	4,275	1,190	2,146	1,826
OW-05	1,026	1,196	682	1,176	1,264	2,093	2,115	3,808	1,121	1,920	1,640
OW-06	941	1,038	520	1,025	1,129	1,807	1,775	3,508	1,015	1,571	1,433
Station	(b) Fecal Coliform – Annual Attainment (Percent of Months)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	50	42	33	42	33	33	25	42	75	17	39
OW-04	58	42	42	42	33	33	42	42	75	25	43
OW-05	67	42	42	42	42	33	42	50	75	42	48
OW-06	75	50	42	50	42	50	50	58	75	42	53
Station	(c) Fecal Coliform – Recreational Season Attainment (Percent of Months)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	67	67	50	83	50	67	50	50	100	33	62
OW-04	83	67	67	83	50	67	67	50	100	50	68
OW-05	100	67	67	83	67	67	67	50	100	67	74
OW-06	100	83	67	83	67	83	83	50	100	67	78

Table ES-6. Calculated 10-Year Baseline Fecal Coliform Maximum Monthly GM and Attainment of Class SC Criterion - Percent of Months in Attainment with 100 Percent CSO Removal

Station	(a) Maximum Monthly Fecal Coliform Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
	November	December	December	December	January	December	February	December	March	March	
OW-03	303	365	230	442	482	522	457	1,114	453	459	483
OW-04	320	376	216	447	475	568	477	1,256	482	483	510
OW-05	392	426	260	493	535	680	565	1,529	557	540	598
OW-06	450	451	291	508	535	770	625	1,769	617	553	657
Station	**(b) Fecal Coliform – Annual Attainment (Percent of Months)**										
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Average**
OW-03	83	75	75	83	83	83	75	75	83	58	77
OW-04	83	75	83	83	83	83	83	75	83	67	80
OW-05	83	67	75	83	83	83	75	75	83	58	77
OW-06	83	67	92	67	83	83	75	75	83	75	78
Station	**(c) Fecal Coliform – Recreational Season Attainment (Percent of Months)**										
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Average**
OW-03	100	83	100	83	100	100	100	83	100	83	93
OW-04	100	83	100	83	100	100	100	83	100	83	93
OW-05	100	83	100	83	100	100	100	83	100	83	93
OW-06	100	83	100	83	100	100	100	83	100	83	93

The Future Primary Contact WQ Criteria for enterococci of 30 cfu/100mL and a 90 percent STV of 110 cfu/100mL is presented in Table ES-7 and Table ES-8. The results of these simulations do not meet the potential future enterococci criteria. As noted before, the Flushing Creek water quality is impacted by the Flushing Bay. The Flushing Bay LTCP is planned for June 2017 and will identify reductions in CSO loads that may impact Flushing Creek. DEP plans to update the model simulations results provided in these tables when the Flushing Bay LTCP is prepared.

Tables ES-7 and ES-8 represent the attainment levels of the enterococci criteria for the baseline and 100 percent CSO control simulations. Table ES-8 shows that with all CSO controlled, the attainment levels for the 30 day GM average between 61 and 67 percent, along with very low attainment of the STV values. This shows that even with all CSO removed the Future Primary Contact WQ Criteria for the 2012 RWQC criteria will not meet water quality criteria. Table ES-7 shows the baseline simulation with an average attainment of the 30 day GM ranging from 32 to 50 percent and very low compliance with the STV value.

Table ES-7. Recreational Season Maximum Rolling 30-day GM and Attainment with Future Primary Contact WQ Criteria with 2012 EPA RWQC for Enterococci for Baseline Simulation

Station	(a) Maximum Rolling 30 Day Enterococci Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	209	938	205	367	540	477	143	558	136	626	420
OW-04	205	863	183	318	504	447	146	526	126	577	390
OW-05	187	782	163	270	446	402	141	478	118	519	351
OW-06	173	703	129	217	392	350	126	456	105	436	309
Station	(b) Enterococci – Recreational Attainment with Future Primary Contact WQ Criteria with 30-Day GM of 30 cfu/100mL for Enterococci for Baseline Simulation (Percent)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	37	29	12	61	21	37	24	24	67	12	32
OW-04	43	41	29	70	26	47	34	28	68	19	41
OW-05	52	47	33	72	28	49	39	31	68	24	44
OW-06	59	51	42	78	32	52	46	37	70	33	50
Station	(c) Enterococci – Recreational Attainment with Future Primary Contact WQ Criteria with STV of 110 cfu/100mL for Enterococci for Baseline Simulation (Percent)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	3	0	0	17	0	0	0	0	1	0	2
OW-04	4	0	0	18	0	0	0	0	3	0	3
OW-05	4	0	0	18	0	0	0	0	6	0	3
OW-06	8	0	0	21	0	0	0	0	5	0	3

Table ES-8. Recreational Season Maximum Rolling 30-day GM and Attainment with Future Primary Contact WQ Criteria with 2012 EPA RWQC for Enterococci with 100 Percent CSO Removal

Station	(a) Maximum Rolling 30 Day Enterococci Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	90	272	92	127	156	176	62	155	65	154	135
OW-04	85	272	80	116	154	173	57	149	61	154	130
OW-05	98	325	83	124	182	194	67	181	66	189	151
OW-06	103	365	76	129	206	205	75	214	66	219	166
Station	(b) Enterococci – Recreational Attainment with Future Primary Contact WQ Criteria with 30-Day GM of 30 cfu/100mL for Enterococci (Percent)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	65	61	51	87	45	59	70	44	75	51	61
OW-04	78	67	61	90	61	61	81	52	83	57	69
OW-05	75	65	57	90	57	61	76	45	83	56	67
OW-06	78	66	58	90	58	60	75	44	84	56	67
Station	(c) Enterococci – Recreational Attainment with Future Primary Contact WQ Criteria with STV of 110 cfu/100mL for Enterococci (Percent)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	12	2	0	36	1	10	5	9	19	6	10
OW-04	11	2	0	37	1	10	5	14	24	7	11
OW-05	11	2	0	36	1	9	4	4	12	4	8
OW-06	11	2	0	35	1	0	4	3	12	2	7

Public Outreach

DEP followed a comprehensive public participation plan in ensuring engagement of interested stakeholders in the LTCP process. Stakeholders included local residents and, citywide and regional groups, a number of whom offered comments at two public meetings held for this LTCP. DEP has received comments from the Stormwater Infrastructure Matters Coalition (SWIM), Friends of Flushing Creek, Empire Dragon Boat Team and one citizen after the public meeting. DEP will continue to gather public feedback on waterbody uses and will provide related information to the public at the third Flushing Creek Public Meeting. The third meeting will present the final identified preferred alternative to the public after DEC's review of the LTCP.

The public commented that future development along Flushing Creek should be considered by DEP in the development of the alternatives. Additional information on the public outreach activities is presented in Section 7 and Appendix B, Public Meeting Materials.

Evaluation of Alternatives

A multi-step process was used to evaluate control measures and CSO control alternatives. The evaluation process considered factors related to environmental benefits, community and societal impacts and considerations related to implementation and Operation and Maintenance (O&M). Following the comments from technical workshops, the retained alternatives were subjected to a functional review, and cost performance, and cost attainment evaluations where economic factors were introduced. Table ES-9 presents the retained alternatives.

The Flushing Creek alternatives vary significantly in cost ranging in net present worth value from approximately $5M to $1.8B. DEP's preferred alternative, Alternative 3, TI-010 Outfall Disinfection at Tank and Diversion Structure 5 plus TI-011 Outfall Disinfection, is valued at a construction cost of $6.89M and a present worth of $16.3M. The annual O&M costs for this alternative were estimated to be $0.66M. The LTCP cost estimates are considered Association for the Advancement of Cost Engineering (AACE) Class 5 estimates (accuracy range of -50 percent to +100 percent), which is typical and appropriate for this type of planning evaluation. Therefore, the construction cost of the preferred alternative could range from $3.4M to $13.8M. This alternative would achieve a fecal coliform load reduction of 88 percent in the recreational season (May 1st through October 31st). The cost-effectiveness of the alternatives was assessed by determining percent attainment of applicable Existing WQ Criteria, Primary Contact WQ Criteria or Future Primary Contact WQ Criteria for 2008. Figure ES-4 presents the approximate mid-point of Flushing Creek and is presented as an example cost performance curve at Creek Station OW-5. The plot presents net present worth versus percent attainment for the Existing WQ Criteria (Class I), Primary Contact WQ Criteria (Class SC) and the Future Primary Contact WQ Criteria and the recreational season (May 1st through October 31st). Alternative 3 is the fourth line from the left axis. As indicated in Figure ES-4, alternatives with higher costs than Alternative 3 would not result in significant gains in attainment of WQ Criteria. Section 8 presents the attainment versus cost curves for locations OW-6, OW-4, and OW-3.

Table ES-9. Summary of Retained Alternatives

Alternative	Description
1A. TI-010 Tank Disinfection	Chlorinate influent to the Flushing Bay CSO Retention Facility during the recreational season just downstream of the influent screens. Contact time would be provided in the tank and downstream outfall sewers.
1B. TI-010 Outfall Disinfection at Diversion Chamber 3	Chlorinate flows entering Diversion Chamber No. 3 during the recreational season. Contact time would be provided in the tank and various sewers upstream, downstream and bypassing the tank.
1C. TI-010 Outfall Disinfection at Diversion Chamber 5	Raise the tank effluent weir and modify Diversion Chamber No. 5 gate control protocols. Chlorinate flows entering Diversion Chamber No. 5 during the recreational season. Tank would operate as an off-line tank when the upstream Hydraulic Grade Line (HGL) is between +2.0 and +2.5. Contact time would be provided in the outfall sewers that bypass the tank.
1D. TI-010 Outfall Disinfection at Tank and Diversion Chamber 5	Chlorinate influent flows to the Flushing Bay CSO Retention Facility just downstream of the influent screens and flows entering Diversion Chamber No. 5 during the recreational season. Contact time would be provided in the tank and outfall sewers that bypass the tank.
2. TI-011 Outfall Disinfection	Chlorinate flows in the TI-011 outfall just downstream of Regulator TI-R09 during the recreational season. Contact time would be provided in the TI-011 outfall.
3. TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection	Implement both Alternative 1D and 2 to maximize the volume of recreational season overflow to Flushing Creek that is disinfected.
4. 25% Control Tunnel	13-ft. dia., 4,530 LF tunnel to capture 25% of overflow from all three Flushing Creek CSOs. Includes a dewatering pump station (PS) and FM to the Tallman Island WWTP.
5. 50% Control Tunnel	24-ft. dia., 5,710 LF tunnel to capture 50% of overflow from all three Flushing Creek CSOs. Includes dewatering PS and High Rate Clarification (HRC) facility to process dewatering prior to discharging to Flushing Creek.
6. 75% Control Tunnel	32-ft. dia., 7,530 LF tunnel to capture 75% of overflow from all three Flushing Creek CSOs. Includes dewatering PS and HRC facility to process dewatering prior to discharging to Flushing Creek.
7. 100% Control Tunnel	40-ft. dia., 13,840 LF tunnel to capture 100% of overflow from all three Flushing Creek CSOs. Includes dewatering PS and HRC facility to process dewatering prior to discharging to Flushing Creek.

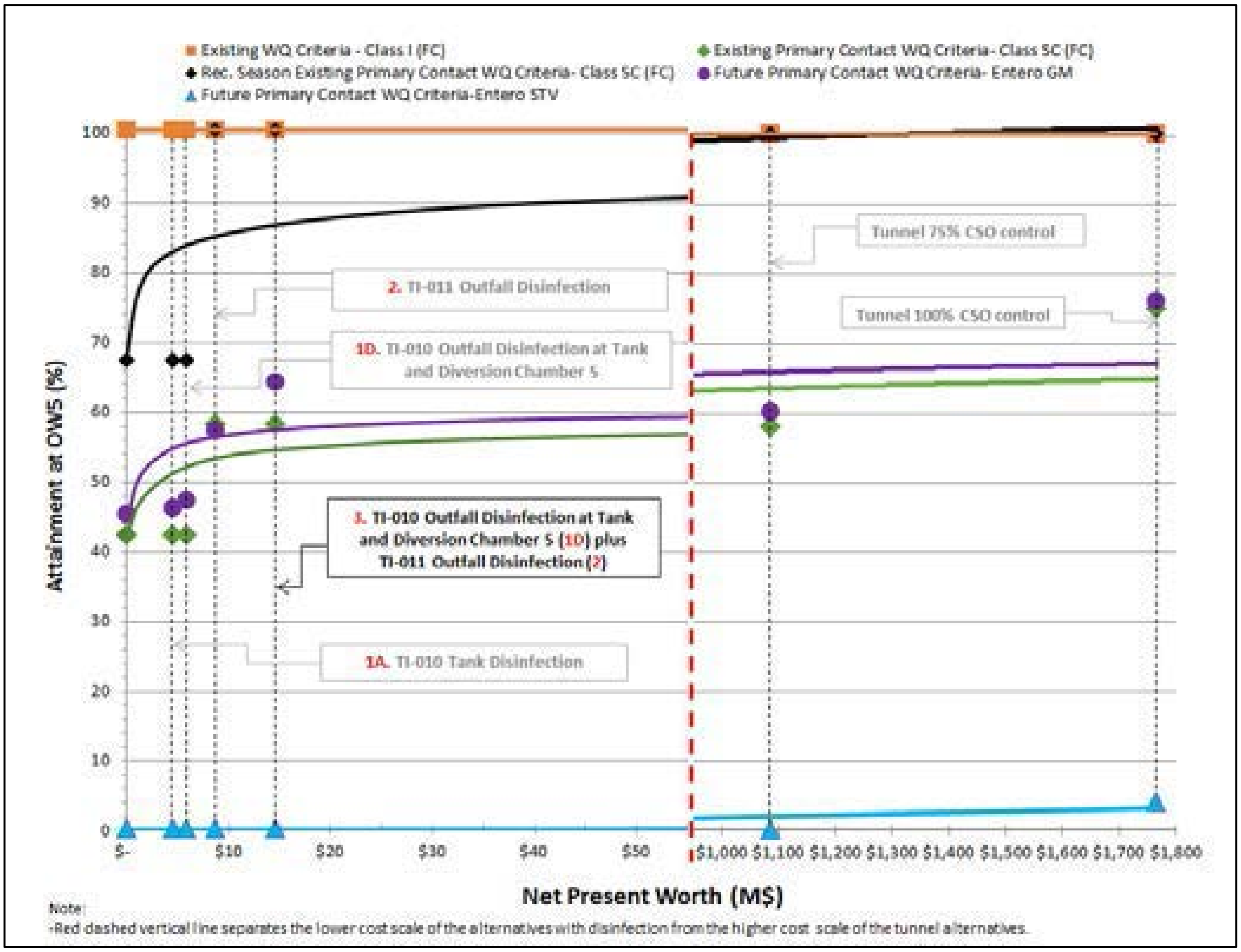

Figure ES-4. Cost vs. Bacteria Attainment at Station OW-5 (2008 Rainfall)

The preferred Alternative 3 consists of the following:

1. Disinfection at TI-010 and TI-011. TI-010 will include re-purposing the existing building to provide disinfection and TI-011 will build a new facility at the existing DEP site or a nearby site.

2. A 99 percent log kill is targeted without dechlorination. The need for dechlorination will be determined with the DEP study being conducted as part of a CSO TRC pilot study.

   The present worth costs of the Alternative 3 facilities total $16.3M. The estimated construction cost is $6.89M. The O&M annual costs are $0.66M. A breakdown of the costs is shown below:

   - TI-010 Outfall Disinfection at the Tank and Chamber 5 construction cost is $1.97M and the annual O&M cost is $0.35M.
   - TI-011 Outfall Disinfection construction cost is $4.92M with an annual O&M cost of $0.31M.

The preferred Alternative 3 is presented in Figures ES-5 and ES-6. The implementation schedule is presented in Section 9.

Figure ES-5. Alternative 3 – TI-010 Disinfection at the Tank and Diversion Chamber No. 5

Figure ES-6 . Alternative 3 – TI-011 Outfall Disinfection Downstream of Regulator TI-R09

3. RECOMMENDATIONS

Long Term CSO Control Plan Implementation, UAA and Summary of Recommendations

The LTCP analyses and recommendations for Flushing Creek LTCP are summarized below for the following items:

1. Water Quality Modeling Results
2. Identified UAA Site-specific Targets
3. Summary of Recommendations

Water Quality Modeling Results

The calculated percent attainment for the recreational season (May 1st through October 31st) for the Existing WQ Criteria, Primary Contact WQ Criteria and Future Primary Contact WQ Criteria for the preferred alternative (Alternative 3) is shown in Table ES-10. Annual attainment for the Existing WQ Criteria is shown in Table ES-11. It should be noted that Flushing Bay has an influence on the Flushing Creek attainment. The attainment estimates presented may be revised after the Flushing Bay LTCP is completed.

Table ES-10. Calculated 10-Year Bacteria Attainment for Preferred Plan – Recreational Season (May 1st – October 31st)

Station	Existing WQ Criteria (Class I)		Primary Contact WQ Criteria (Class SC)		Future Primary Contact WQ Criteria	
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
OW-3	Fecal ≤2,000	100	Fecal ≤200	78	Enterococci ≤30	45
					STV≤110	3
OW-4	Fecal ≤2,000	100	Fecal ≤200	82	Enterococci ≤30	55
					STV≤110	3
OW-5	Fecal ≤2,000	100	Fecal ≤200	90	Enterococci ≤30	59
					STV≤110	5
OW-6	Fecal ≤2,000	100	Fecal ≤200	92	Enterococci ≤30	62
					STV≤110	6

Table ES-11. Calculated 10-Year Bacteria Attainment for Preferred Plan – Annual Period

Station	Existing WQ Criteria (Class I)		Primary Contact WQ Criteria (Class SC)	
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
OW-3	Fecal ≤2,000	100	Fecal ≤200	67
OW-4	Fecal ≤2,000	100	Fecal ≤200	67
OW-5	Fecal ≤2,000	100	Fecal ≤200	75
OW-6	Fecal ≤2,000	100	Fecal ≤200	75

Attainment levels for the Existing WQ Criteria across the year meet the Class I criterion. Attainment of the Primary Contact WQ Criteria for fecal coliform (200 cfu/100mL) and Future Primary Contact WQ Criteria for enterococci (30 cfu/100mL) are presented in Tables ES-11 and ES-12 for the recreational season (May 1st through October 31st) and annual period. The attainment levels are below the 95 percent level for the Primary Contact WQ Criteria.

Attainment of the future STV upper 90th percentile values contained in the Future Primary Contact WQ Criteria is difficult if not impossible to achieve. Maximum enterococci concentrations achieved with the preferred alternative will not meet the Future Primary Contact WQ Criteria STV concentration of 110 cfu/100mL.

Identified UAA Site-Specific Targets

The Flushing Creek waterbody is influenced by CSOs discharged into Flushing Creek, as well as Flushing Bay. The analysis of impacts from the CSO discharges in Flushing Creek is provided in this LTCP. The impacts from Flushing Bay have yet to be determined and are planned for June 2017 with the completion of the Flushing Bay LTCP. The Flushing Bay LTCP recommendations will have an impact on the Flushing Creek water quality. The Flushing Creek UAA will be updated at that time to include the Flushing Bay LTCP findings.

A UAA is included in Appendix E. The estimated site-specific targets for Flushing Creek are provided. These site-specific targets may be revised with the completion of the Flushing Bay LTCP.

These site-specific targets are based on water quality model simulations that account for CSO and stormwater sources. Under these conditions, the bacteria water quality indicators would be less than the identified targets the majority of the time.

The recommended recreational and non-recreational season site-specific targets are summarized in Table ES-12 along with the Existing WQ Criteria, Primary Contact WQ Criteria and Future Primary Contact WQ Criteria for fecal coliform and enterococci. Recommended targets for the non-recreational and recreational season are discussed in Section 8.

A time to recover analysis was also done for Flushing Creek. Estimated times in hours are presented in Table ES-13 and described in Section 8. The longer times are associated with the higher rainfall intervals.

Table ES-12. Summary of Recommended Flushing Creek Bacteria Water Quality Targets

Location	Existing WQ Criteria (Class I)	Primary Contact WQ Criteria (Class SC)	Site-specific Targets (cfu/100mL)	Attainment(3) with Site-specific Targets (%)
Recreational Season	Fecal Coliform(1) ≤ 2000	Fecal Coliform(1) ≤ 200	Fecal Coliform ≤ 700	95
			Enterococci ≤ 180(2)	95
Non-Recreational Season	Fecal Coliform(1) ≤ 2000	Fecal Coliform(1) ≤ 200	Fecal Coliform ≤ 2,000	95

Notes:
(1) Monthly GM
(2) 30-day rolling average GM during recreational season
(3) At location OW-3. Attainment at all other locations is higher.

Table ES-13. Time to Recover (Hours) at Flushing Creek

Interval	OW-03		OW-04		OW-05		OW-06	
	Fecal(1)	Entero(2)	Fecal(1)	Entero(2)	Fecal(1)	Entero(2)	Fecal	Entero(2)
<0.1	-	-		-	-	-	-	-
0.1-0.4	8	17	5	11	-	5	-	-
0.4-0.8	21	45	17	48	13	49	3	49
0.8-1.0	42	65	44	63	45	62	44	62
1.0-1.5	56	84	55	85	56	80	54	78
>1.5	56(3)	84(3)	55(3)	85(3)	56(3)	80(3)	54(3)	78(3)

Notes:
"-" Indicates elevated median bacteria concentrations return to the 1,000 cfu/100mL and 110 cfu/100mL threshold levels prior to the end of the rainfall events.
(1) Threshold for Fecal coliform is 1,000 cfu/100mL.
(2) Threshold for Enterococci is 110 cfu/100mL.
(3) In a few cases, the time to recover was calculated to be less than the next smaller rain event bin. In those cases, both bins were set equal to the higher time to recover.

Summary of Recommendations

Water quality in Flushing Creek will be improved with the preferred alternative set forth and the implementation of the planned GI projects and recommendations made herein.

The Flushing Creek LTCP identified the following actions:

1. The LTCP includes a UAA with feasible site-specific WQ targets based on the projected performance of the selected CSO controls. A PCM program will be initiated after the LTCP improvements are operational. Based upon the results of such monitoring, the site-specific WQ targets may need to be reviewed.

2. A UAA is provided with site-specific targets for Flushing Creek. This UAA should be revisited upon completion of the Flushing Bay LTCP.

3. DEP will issue a wet weather advisory during the recreational season (May 1^{st} through October 31^{st}), alerting the public that the water may be unsafe for recreational uses. DEP will continue to operate the Flushing Bay CSO Retention Facility in accordance with its Wet Weather Operating Plan.

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

5. DEP will implement the design and construction of seasonal disinfection of the TI-010 Outfall Disinfection at the Flushing Bay CSO Retention Tank and Diversion Chamber 5 plus Outfall TI-011 Outfall Disinfection, which will provide DEP with the most efficient means of controlling a high percent of baseline CSO discharges and striving towards meeting Class SC Primary Contact WQ Criteria, particularly during the recreational season (May 1^{st} through October 31^{st}). The Capital Cost is estimated to be \$6.89M, annual O&M is \$0.66M, and the Total Present Worth is \$16.70M.

6. A SPDES Variance is included in Appendix C.

Flushing Creek Projects Outside the LTCP

Section 9 of the LTCP presents activities that DEP and the US. Army Corps of Engineers are collaborating on for a dredging and wetlands restoration analysis in Flushing Creek. DEP also identified additional wetland restoration opportunities in other parts of the Creek. These studies are being investigated to determine the water quality benefits and may be done by DEP. They are being evaluated outside the LTCP process.

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

1.0 INTRODUCTION

This Long Term Control Plan (LTCP) for Flushing Creek was prepared pursuant to the Combined Sewer Overflow (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 New York City Department of Environmental Protection (DEP) is required to submit ten waterbody-specific and one Citywide LTCP to the New York State Department of Environmental Conservation (DEC) by December 2017. The Flushing Creek LTCP is the fourth 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 New York City's (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 Clean Water Act (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 Flushing Creek LTCP and accompanying Use Attainability Analysis (UAA).

1.2 Regulatory Requirements (Federal, State, Local)

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

1.2.a Federal Regulatory Requirements

The CWA established the regulatory framework to control surface water pollution, and gave the EPA the authority to implement pollution control programs. The CWA established the National Pollutant Discharge Elimination System (NPDES) permit program. NPDES regulates point sources discharging pollutants into waters of the United States. CSOs and municipal separate storm sewer systems (MS4) are also subject to regulatory control under the NPDES program. In New York, the NPDES permit program is administered by the DEC, and is thus a State Pollution Discharge Elimination System (SPDES) program. New York State has had an approved SPDES program since 1975. Section 303(d) of the CWA and 40 CFR §130.7 (2001) require states to identify waterbodies that do not meet water quality standards (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.

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

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

Waterbody	DO/Oxygen Demand	Floatables
Flushing Creek	Delisted Category 4b Urban/Storm/CSOs	Delisted Category 4b CSOs, Urban/Storm

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

The State of New York (NYS) has established WQS for all navigable waters within its jurisdiction. Flushing Creek is classified as a Class I waterbody. A Class I waterbody is defined as “suitable for fish propagation and survival”. The best usages of Class I waters are “secondary contact recreation and fishing” (6 NYCRR 701.11)[1]. DEC has publicly noticed a proposed rulemaking which, if promulgated, would amend 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 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 Flushing Creek. 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. Flushing Creek 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 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 MOU to facilitate WQS reviews in accordance with the EPA CSO Control Policy. The last modification that occurred prior to 2012 was in 2009, which 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 Green Infrastructure (GI) into the LTCP process, as proposed under NYC’s Green Infrastructure Plan, and to update certain project plans and milestone dates. In doing so, some of the grey infrastructure projects noted in earlier Waterbody/Watershed Facility Plans (WWFP) were eliminated from the 2012 CSO Order on Consent.

[1] This LTCP is designed to meet the existing WQS that have been promulgated by DEC. To the extent that this LTCP provides, analyzes, or selects alternatives that may lead to achievement of targets beyond what are required under existing WQS, DEP provides these analyses and/or commitments in order to improve water quality beyond the requirements of the CSO Control Policy and other applicable law. DEP reserves all rights with respect to any administrative and/or rulemaking process that DEC may engage in to revise WQS.

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, analysis 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 2011, DEP issued the Flushing Creek WWFP. 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 2011 Flushing Creek WWFP on May 4, 2012.

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 Flushing Creek LTCP.

DEP shared the Flushing Creek alternatives and held discussions on formulation of various control measures, as well as coordinated public meetings and other stakeholder presentations with DEC. On a quarterly basis, DEC, DEP, and outside technical consultants also convened for a larger progress meeting that typically includes 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 further 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

A concerted effort was made during the Flushing Creek 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 City agencies as part of related programs.

The public participation efforts for this Flushing Creek LTCP are summarized in Section 7.0 in more detail.

2.0 WATERSHED/WATERBODY CHARACTERISTICS

This section summarizes the major characteristics of the Flushing Creek Watershed and Waterbody, building upon earlier documents that present a characterization of the area, most recently, the Waterbody/Watershed Facility Plan (WWFP) for Flushing Creek (DEP, 2011).

2.1 Watershed Characteristics

The Flushing Creek 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 Flushing Meadows-Corona Park, located along the banks of Flushing Creek, south of the Long Island Railroad (LIRR) tracks.

This subsection contains a summary of the watershed characteristics as they relate to the sewer system configuration, performance, and impacts to the adjacent waterbodies, as well as the modeled representation of the collection system used for analyzing system performance and combined sewer overflow (CSO) control alternatives.

2.1.a Description of Watershed

The Flushing Creek watershed comprises approximately 9,954 acres, located on the north shore of Queens County. The majority of the land surrounding the shores of Flushing Creek is industrial, commercial, vacant or used in support of transportation-related features. The shoreline at the head of the Creek, upstream of the LIRR tracks, is surrounded by Flushing Meadows-Corona Park, a notable open space/outdoor recreation area that occupies close to 20 percent of the Flushing Creek watershed. As described later in this section, the area is served by a complex collection system comprised of combined, separate, and storm sewers; interceptor sewers and pumping stations; several CSO and stormwater outfalls and a CSO retention tank. The majority of the watershed is served by the Tallman Island Wastewater Treatment Plant (WWTP). A smaller drainage area on the southwestern end of the watershed is served by the Bowery Bay WWTP.

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

The urbanization of Flushing Creek 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 Creek, or to a nearby CSS. Generally, the combined sewage is conveyed to the Tallman Island WWTP for treatment. Any combined sewage that exceeds the capacity of the CSS during wet weather overflows through the CSO, outfalls to the Creek. A smaller drainage area served by the Bowery Bay WWTP, on the southwestern end of the watershed, has a relief structure connected to the Tallman Island system and is therefore a small contributor of wet weather discharges to Flushing Creek. As shown in Figure 2-1, Flushing Creek is located between the western end of the Tallman Island WWTP tributary area and the eastern end of the Bowery Bay WWTP tributary area.

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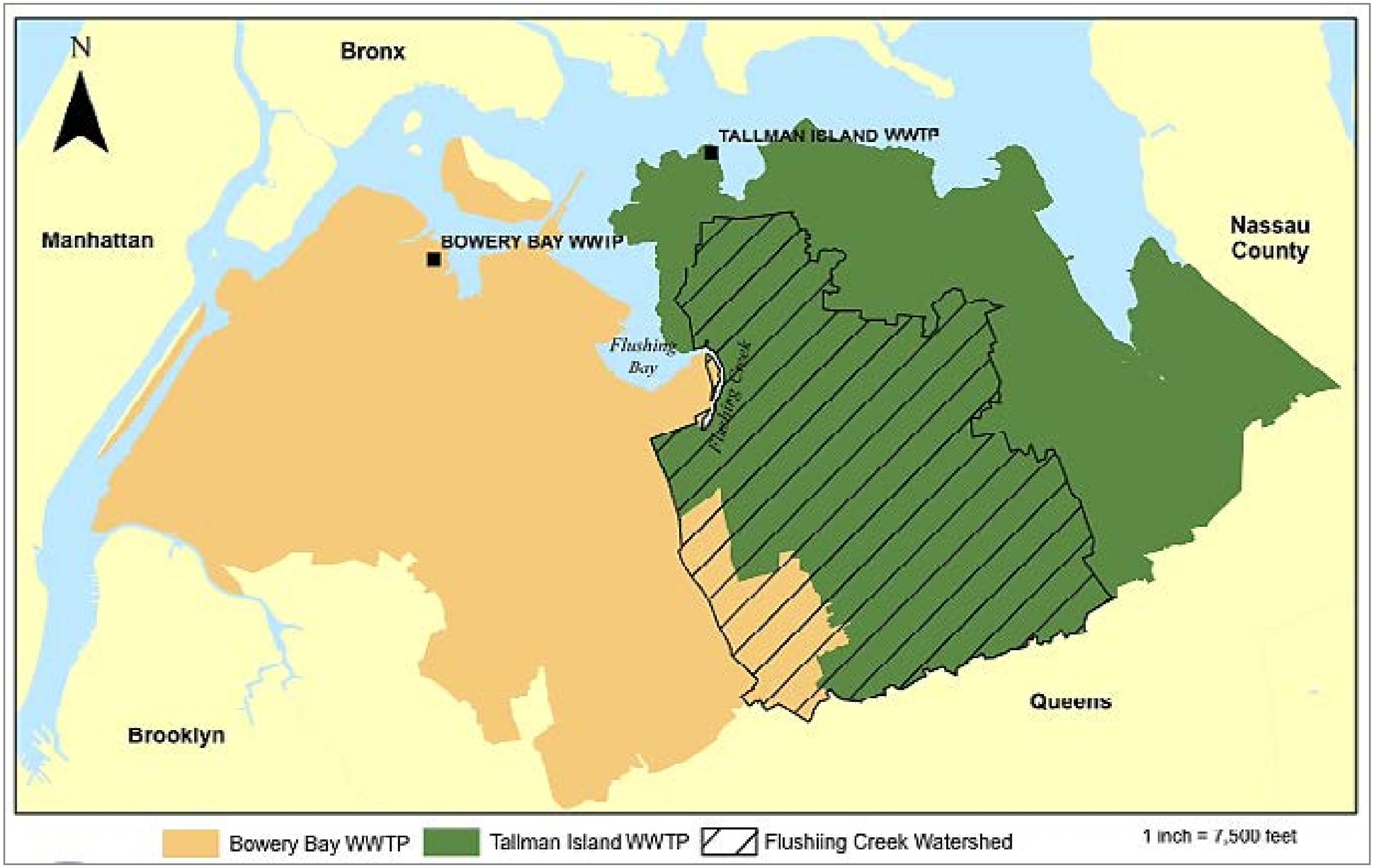

Figure 2-1. Flushing Creek Watershed and Associated WWTP Service Areas

As a residential community within NYC, several large and notable transportation corridors cross the watershed providing access between industrial, commercial and residential areas. These access routes include the Van Wyck Expressway, the Whitestone Expressway, the Long Island Expressway, the Grand Central Parkway, and the LIRR (Figure 2-2). These transportation corridors limit access to some portions of the waterbody and are taken into consideration when developing CSO control solutions.

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

Current land use for the watershed is shown in Figure 2-3, and generally aligns with the established zoning. Overall, residential use (including residential mixed with commercial use) accounts for the majority of the watershed area at 65 percent. Open space and outdoor recreational areas follow, occupying 18 percent of the watershed area. Industrial and manufacturing use accounts for only around one percent of the watershed area, but nearly all of it is concentrated in close proximity to the Creek. Table 2-1 shows the breakdown of current land uses within the watershed area.

The College Point area on the northeast side of the Creek is mostly industrial, with several commercial and institutional uses mixed in. Recent redevelopment on portions of the inland section of the College Point area includes the first phase of NYC's new Police Academy located to the west of the former Flushing Airport (which has been closed since 1984 and has returned to largely a wetland state). The former airport and much of the surrounding area lie within the Special College Point District which was established in 2009.

The Flushing Meadows-Corona Park occupies most of the southern tip of Flushing Creek. The park contains a variety of recreational amenities to serve adjacent communities, as well as two major sporting venues: Citi Field and the United States Tennis Association's (USTA) Billie Jean King National Tennis Center. Transportation and industrial uses can also be found adjacent to the park; the park itself is split into two parcels by the LIRR's Corona Yards. The Yards contain a storage area for subway cars as well as repair shops.

The mouth of the Creek supports large tracts of industrial areas, intermingled with vacant land. The largest industrial parcels, located directly adjacent to the water, are zoned for heavy industry, and include a New York City Department of Transportation (NYCDOT) Maintenance and Repair facility, and a NYCDOT asphalt plant. Near the mouth, the Willets Point peninsula spans along the western shore of Flushing Creek and the southern shore of Flushing Bay. Known as the Iron Triangle, current land uses in the unsewered, locked-in area primarily include automotive related businesses and junkyards. A 61-acre portion of the peninsula generally bounded by the Van Wyck Expressway, Northern Boulevard, 126th Street, and Willets Point Boulevard, was the subject of a comprehensive planning, rezoning, and redevelopment strategy adopted in 2008.

The 2008 Willets Point Development Plan aims at transforming a largely underutilized site with substandard conditions and substantial environmental degradation into a lively, mixed-use, and sustainable community. The Plan calls for up to 5,850 residential units, 1.7 million square feet of retail space, a 400,000 square foot convention center, a 700-room hotel, 500,000 square feet of office space, and 6,700 parking spaces. To provide quality-of-life amenities for residents and visitors, the program would also include an 850-seat school, 150,000 square feet of community facility space and a minimum of eight acres of public open space. In 2013, City Council adopted a series of actions to facilitate an initial phase of development on a 23-acre portion of the 61-acre Special Willets Point District along 126th Street that would set the stage for a long term redevelopment of the entire Special District.

The Willets Point development will require a comprehensive remediation of the site and, according to the Environmental Impact Statement (EIS), will create separate sanitary sewered areas associated with the Bowery Bay WWTP service area, as well as new separate stormwater sewers that will discharge exclusively to Flushing Bay through existing or new outfalls. As a result of this redevelopment, an increase in sanitary flows to the Bowery Bay WWTP is anticipated and is considered under the population growth of the baseline conditions of this Long Term Control Plan (LTCP), as projected in later sections.

To the west of Willets Point, the shoreline of Flushing Creek is also undergoing a transition in land use buoyed by Flushing's thriving downtown to the east. In support of Flushing's burgeoning downtown and Mayor de Blasio's Housing New York Plan, the New York City Department of City Planning (DCP) has initiated a neighborhood planning study for a 10-block area generally bounded by Northern Boulevard to the north, Roosevelt Avenue to the south, Prince Street to the east, and the Van Wyck Expressway and the Creek to the west. The 32-acre Flushing West study area consists of predominately underutilized commercial, warehouse and industrial sites that could be redeveloped to serve the needs of expanding Flushing's downtown further westward to the waterfront and provide opportunities for new open space amenities and permanently affordable housing. The study will result in a plan for a rezoning all or portions of the current C4-2, M3-1 and M1-1 districts and the creation of a Special District to guide and enhance the area's redevelopment. In addition to updating zoning, DCP and numerous City agencies will be working with the community to identify neighborhood needs for City services and potential infrastructure improvements, as well as opportunities for investments that will support the long term growth and sustainability of the area.

Several businesses, including a U-Haul storage building, a lumber yard, and a Korean supermarket, occupy portions of the waterfront properties within the Flushing West study area, and several large tracts are vacant. Farther inland, on the east side of College Point Boulevard the area is generally characterized by commercial uses, with several smaller blocks in the northeastern corner of the study area characterized by industrial, manufacturing, and auto-related uses. The study area lies to the west of Downtown Flushing's retail core at Roosevelt Avenue and Main Street, which contains stores and services.

Within the downtown, and on some blocks within the Flushing West study area, there has been substantial new construction in recent years, including new hotels, new retail and office uses and new market-rate residential buildings. A 15-story mixed-use hotel, retail and residential development were recently constructed on the west side of Prince Street at 38th Avenue and a new 12-story hotel opened recently at Roosevelt Avenue and College Point Boulevard. Just outside of the study area, Queens Crossing, a retail and office building opened in 2008 containing ground floor retail space, restaurants, a catering hall, a community facility, and office space. Directly south of the study area along the waterfront, on the opposite side of the LIRR tracks, Sky View Center, an 800,000 square foot shopping center opened in late 2010. Sky View Parc, a 448-unit luxury condominium development was built above the mall.

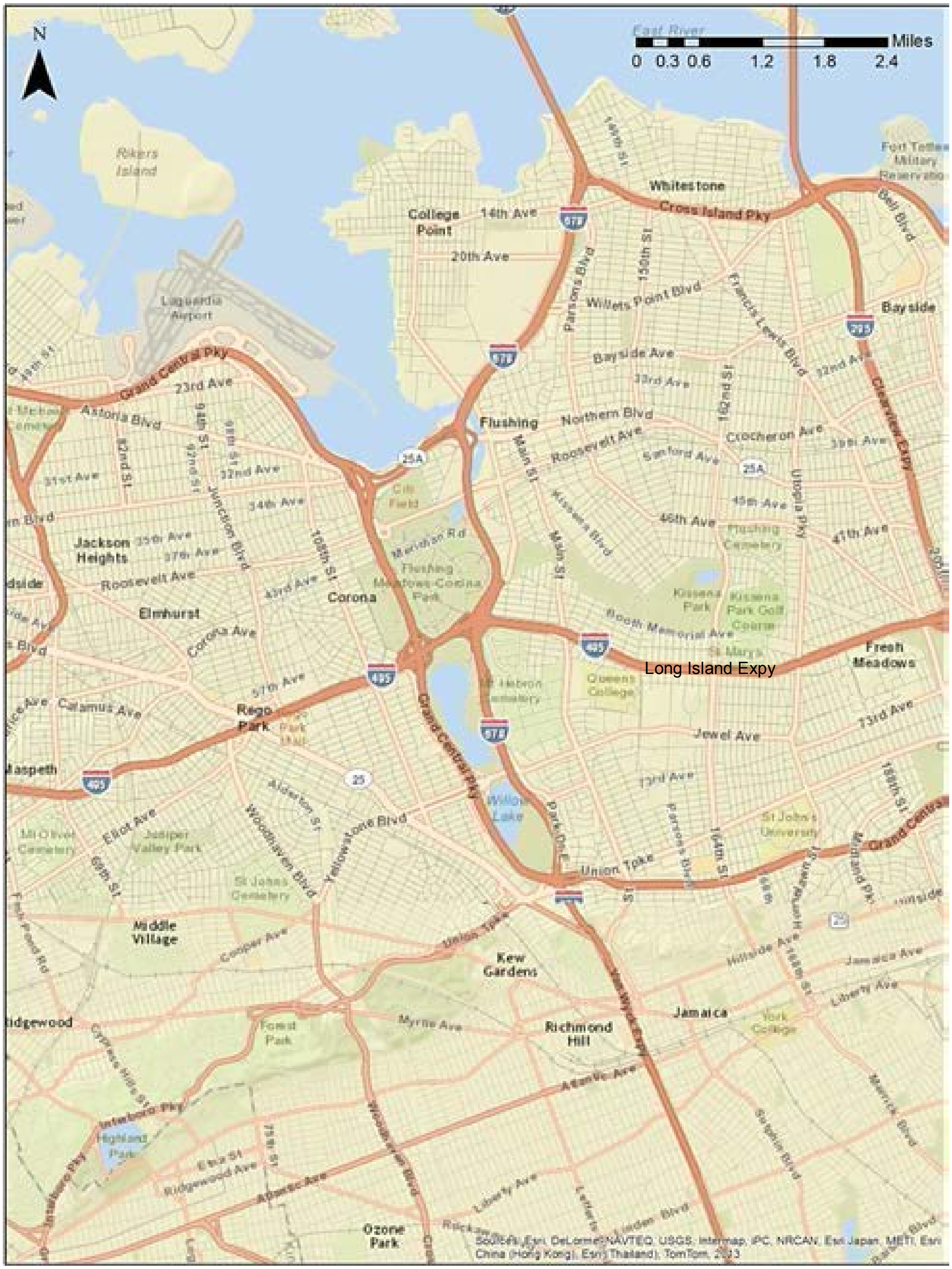

Figure 2-2. Major Transportation Features of Flushing Creek Watershed

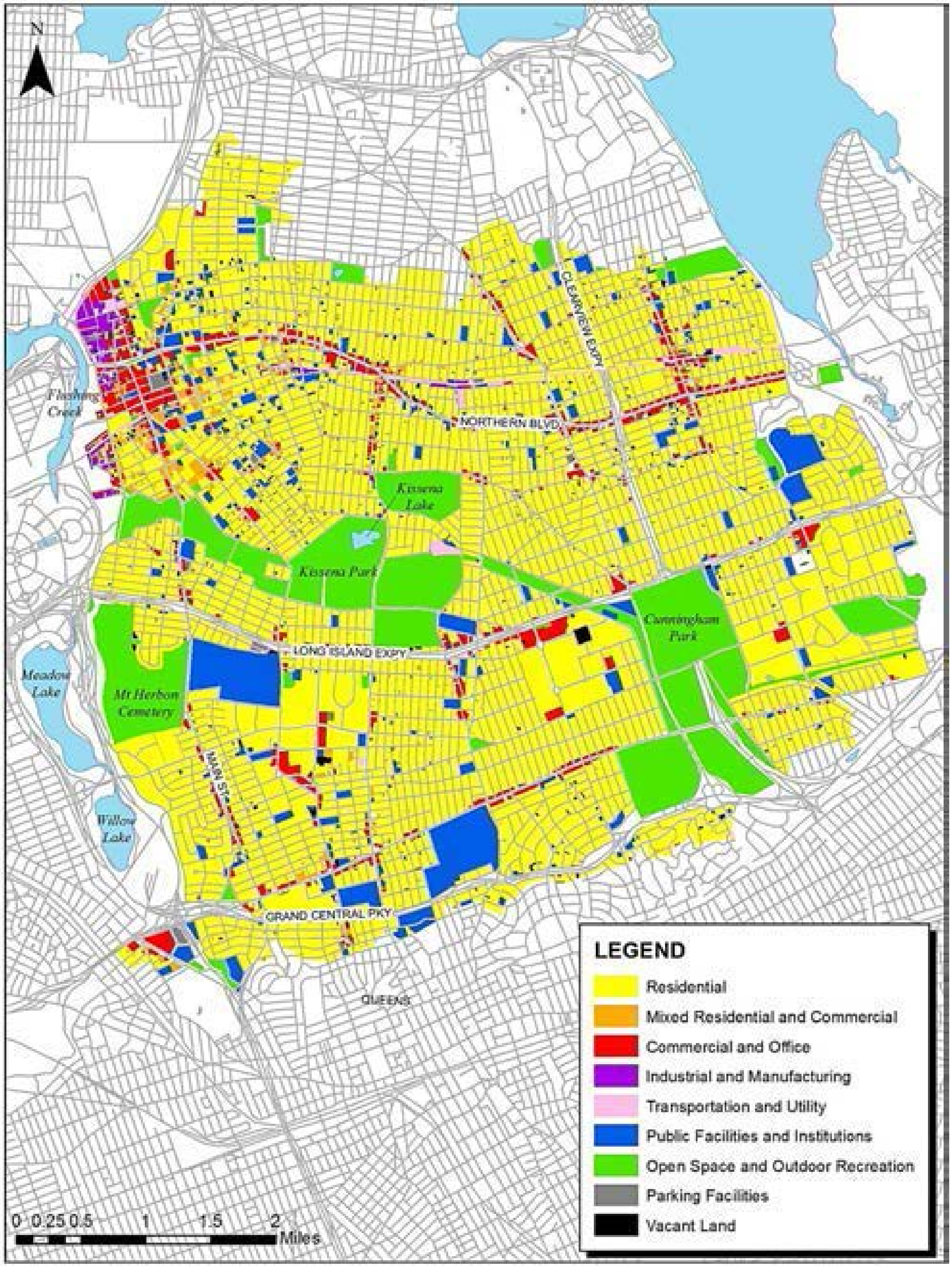

Figure 2-3. Land Use in Flushing Creek Watershed

Table 2-1. Existing Land Use within the Flushing Creek Drainage Area

Land Use Category	Percent of Area	
	Riparian Area (1/4-mile radius) (%)	Drainage Area (%)
Commercial	8	4
Industrial	11	0.6
Open Space and Outdoor Recreation	56	18
Mixed Use and Other	4	2
Public Facilities	5	8
Residential	1	65
Transportation and Utility	10	1
Parking Facilities	3	0.7
Vacant Land	2	0.7

To the east and south of Flushing's downtown lies the bulk of the Creek's watershed. This area is comprised of all or portions of several neighborhoods including: Queensboro Hill, Kew Gardens Hills, Utopia, Hillcrest, Fresh Meadows, Auburndale, Bayside, and Oakland Gardens. These neighborhoods share similar development patterns with lower-density residential buildings predominating and local commercial and service uses and mixed residential and commercial buildings concentrated along major corridors. Much of the area has been rezoned over the past several years to reinforce this scale and character. Two large open spaces, Kissena Park (237 acres) and Cunningham Park (358 acres), are also located in this portion of the watershed.

The zoning classifications within the riparian area comprised of blocks wholly or partially within a quarter mile of Flushing Creek are shown in Figure 2-4. All zoning sub-categories are summarized into their respective main categories of residential, commercial, manufacturing and parkland. The assessment area primarily consists of parkland and zoning for mixed residential and regional commercial uses (C4-2 and C4-4) and light to heavy industrial manufacturing uses (M1-1, M2-1, and M3-1). C4 districts are typically mapped in regional commercial centers such as Downtown Flushing. Typical development in C4 zoning districts is comprised of medium-density residential uses, as well as specialty and department stores, theaters, and other commercial and office uses. M districts allow for a range of industrial and manufacturing activities. Light manufacturing uses are permitted in all M districts; more potentially noxious uses are limited to M3 districts. Some community facility and commercial uses, including hotels and professional and government offices are permitted in M1 districts; however, these uses are not allowed in M2 and M3 districts. The riparian area also contains portions of an R6 zoning district, a medium-density residential district.

2.1.a.2 Permitted Discharges

There are several permitted stormwater and CSO discharge points. These are discussed in more detail in Section 2.1.c. There are no dry weather permitted discharges associated with this waterbody.

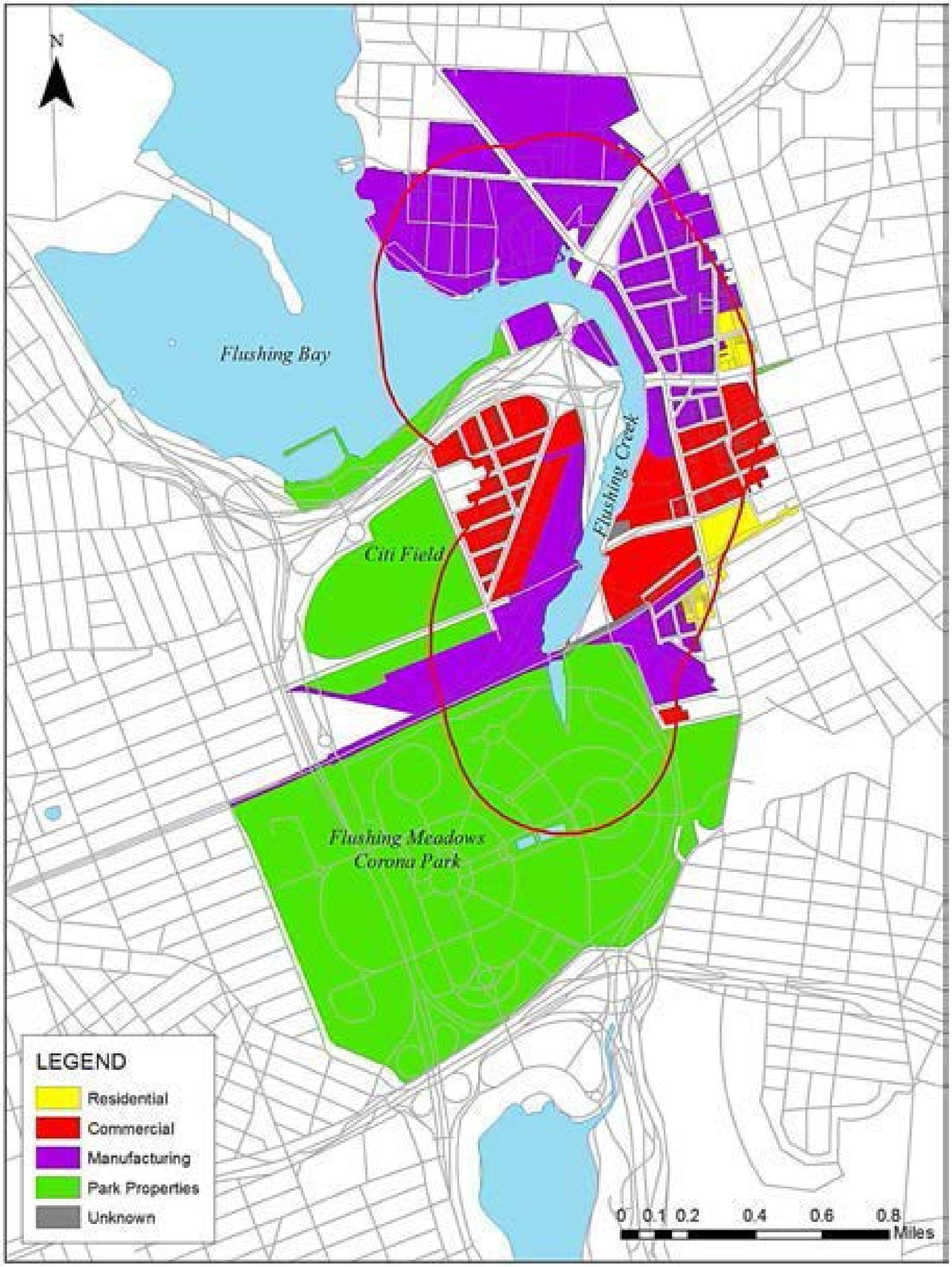

Figure 2-4. Quarter Mile Riparian Zoning in the Flushing Creek Vicinity

2.1.a.3 Impervious Cover Analysis

Impervious surfaces within a watershed are those characterized by an artificial surface that prevents infiltration, 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 directly flows into the sewer system and/or into a separate stormwater system. The impervious surface is important when characterizing a watershed and CSS performance, as well as construction of 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 New York State Department of Environmental Conservation (DEC) in 2009. Efforts to update the models and the impervious surface representation were completed in 2012.

As NYC started to focus attention on the use of Green Infrastructure (GI) to manage street runoff 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 runoff (Directly Connected Impervious Areas [DCIA]) to the sewer system from those impervious surfaces that may not contribute runoff 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 might not contribute runoff to the CSS.

In 2009 and 2010, New York City Department of Environmental Protection (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^{TM} (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. The result of the recalibration efforts was a slight increase in the amount of runoff that enters the Tallman Island WWTP CSS.

2.1.a.4 Population Growth and Projected Flows

DEP routinely develops water consumption and dry weather wastewater flow projections for DEP planning purposes. Water and wastewater demand projections were developed by DEP in 2012; an average per capita water demand of 75 gallons per capita per day was determined to be representative of future uses. The year 2040 was established as the planning horizon, and populations for that time were developed by the 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 Tallman Island (TI) WWTP and Bowery Bay (BB) 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. 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 Tallman Island and Bowery Bay WWTP service areas.

2.1.a.5 Update Landside Modeling

The majority of the Flushing Creek watershed is represented within the overall Tallman Island WWTP system IW model. A smaller portion of the watershed, at the southwestern end, is served by the Bowery Bay WWTP and, therefore, is represented within the corresponding IW model. Several modifications to both collection systems have occurred since the models were calibrated in 2007. Given that both models have been used for analyses associated with the annual reporting requirements of the State Pollutant Discharge Elimination System (SPDES) permit, Best Management Practices (BMPs) and Post-Construction Compliance Monitoring (PCM) for the Flushing Bay CSO Retention Facility, many of these changes have already been incorporated into the models. Major changes to the modeled representation of the collection systems that have been made since the 2007 update include:

<u>Tallman Island IW Model</u>

- Representation of the Flushing Bay CSO Retention Facility and dewatering operations.
- Representation of the Alley Creek CSO Retention Tank and dewatering operations.
- Inclusion of the Bowery Bay drainage areas that contribute CSOs to Flushing Bay CSO Retention Facility. Because the overflows from three of the Bowery Bay high level sewershed regulators are conveyed to this tank through the Park Avenue outfall, this model update was performed to avoid the need to run the Bowery Bay model as precursor to every Tallman Island model run.
- New Whitestone Interceptor representation, per final design.
- Modified weirs at Regulators 10, 10A and 13, per final design.
- Raised Regulator TI-09.

<u>Bowery Bay IW Model</u>

- New subcatchment representing the Lutheran Cemetery was added.
- Corona Avenue Vortex Facility was taken out from the model because it was out-of-service since 2011.
- BB-006 outfall pipe dimensions were revised.
- 24^{th} Street weir model setup was revised.
- Updated representation of several weirs.

In addition to changes made to the modeled representations of the collection system configuration, several other changes have been made to the models, including:

- ***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. As part of the update and model recalibration, data from the GIS repository for interceptor sewers were used. The models will continue to evolve and be updated as more information becomes available from this source and other field information.

- ***Interceptor Sediment Cleaning Data.*** DEP has completed a citywide interceptor sediment inspection and cleaning program. From April 2009 to May 2011, approximately 136 miles of NYC's interceptor sewers were inspected. 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 for sections 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, a review of 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, thirteen of NYC's IW landside models underwent recalibration after the updates and enhancements were complete. This effort and calibration results are included 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 October 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 in spatial extent. 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 Flushing Creek LTCP. A comprehensive discussion of the recalibration efforts can be found in the IW Citywide Recalibration Report (DEP, 2012a).

2.1.b Review and Confirm Adequacy of Design Rainfall Year

DEP has consistently applied the 1988 annual precipitation characteristics to the landside IW models to develop pollutant loads from combined and separately sewered drainage areas. The year 1988 was considered to be representative of long term average conditions, and therefore was previously used for analyzing facilities where "typical" rather than extreme conditions serve as the basis of design, in accordance with U.S. Environmental Protection Agency (EPA) CSO Control policy of using an "average annual basis" for analyses. The selection of 1988 as the average condition was re-considered, however, in light of the increasing concerns over climate change, with the potential for more extreme and possibly more frequent storm events. Recent landside modeling analyses in NYC have used the 2008 precipitation pattern to drive the runoff-conveyance processes, along with the 2008 tide observations, which DEP believes to be more representative than 1988 conditions as it also includes some extreme storms.

The Flushing Creek WWFP was based on 1988 rainfall conditions, but future baseline/alternative runs are 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 2-2.

Table 2-2. 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 Flushing Creek watershed/sewershed is located within the Borough of Queens (Queens County, within NYC) political jurisdiction. Most of the watershed is served by the Tallman Island WWTP and associated collection system. The locations of the wastewater treatment facility and the respective sewershed boundaries are as shown in Figure 2-5. Additionally, overflows from approximately 660 acres of the Bowery Bay High Level Interceptor drainage area (4 regulators) are conveyed to the Flushing Bay CSO Retention Facility through the Park Avenue outfall. The following sections describe the major features of the Tallman Island WWTP tributary area and the Bowery Bay WWTP area tributary to Flushing Creek.

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

Tallman Island WWTP Drainage Area and Sewer System

Most of the Flushing Creek watershed is served by the Tallman Island WWTP. The Tallman Island sewershed includes sanitary and combined sewers, as summarized in Tables 2-3 and 2-4. The Tallman Island service area includes:

- Sixteen pumping stations, with five serving combined system areas;
- Forty-nine combined sewer flow regulator structures; and
- Twenty-four CSO discharge outfalls, two of which are permanently bulkheaded.

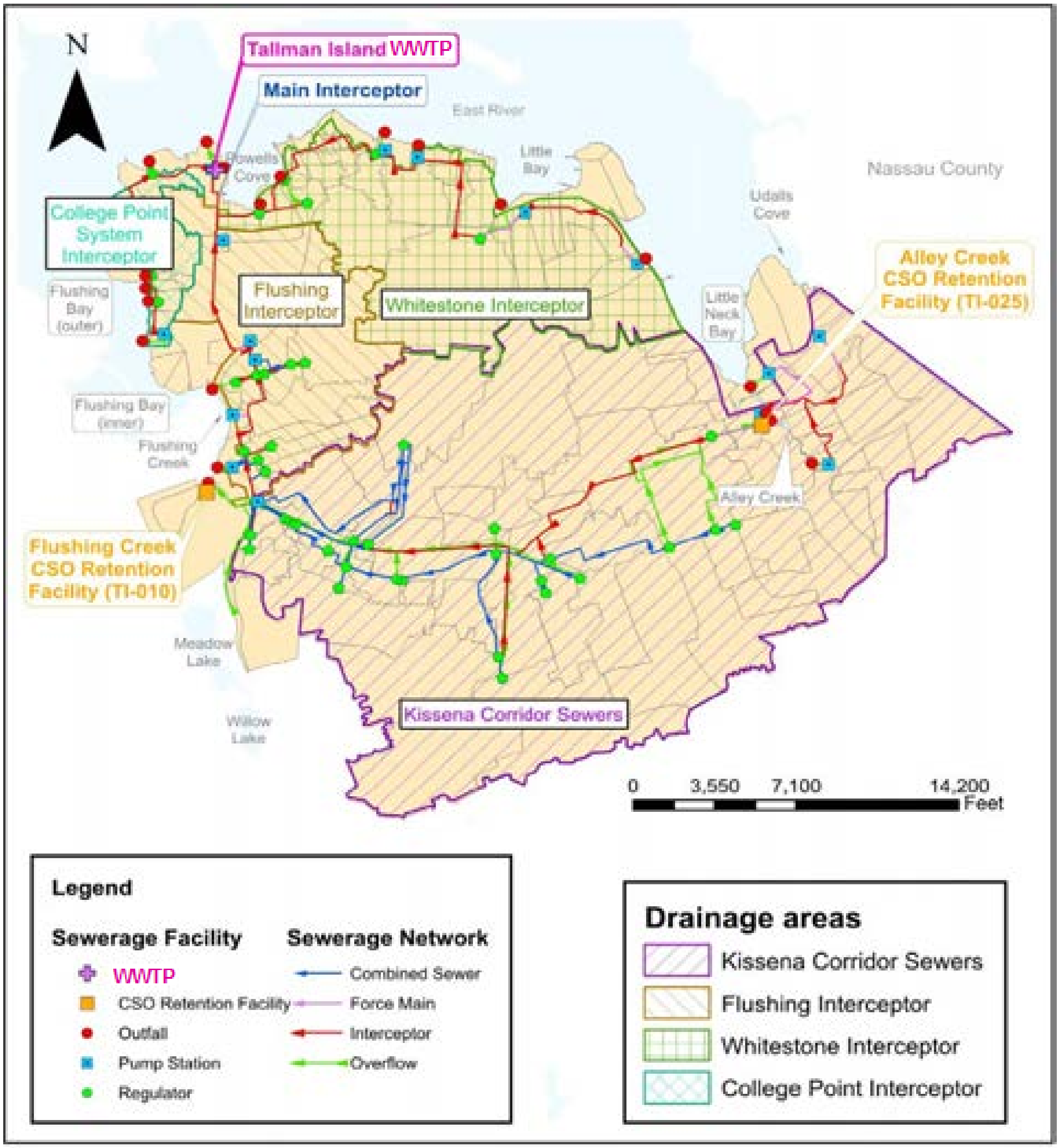

Figure 2-5. Tallman Island WWTP Service Area Collection System

Table 2-3. Tallman Island WWTP Drainage Area[1]: Acreage Per Sewer Category

Sewer Area Description	Area (acres)
Combined	**8,712**
Separate • Fully-separated • Watershed separately sewered, but with sanitary sewage subsequently flowing into a combined interceptor, and stormwater discharging either directly to receiving water or into a combined interceptor	**5,903** (923 acres) (4,980 acres)
Total	**14,615**

Notes:
(1) An additional 3,080 acres of area, for facility planning and certain permitting purposes, are considered to be part of the Tallman Island drainage area, but do not contribute to the WWTP. These include areas with direct drainage of stormwater to water courses (either directly or via storm sewers), other areas not served by piped drainage systems (e.g., parks and cemeteries), and areas that use "on-site" septic systems (Douglas Manor on Douglaston Peninsula).

Table 2-4. Tallman Island WWTP Drainage Area: Acreage by Outfall/Regulator

Outfall	Outfall Drainage Area	Regulator	Regulator Drainage Area	Regulated Drainage Area Type	Receiving Water
East River					
TI-003	494.5	R10A	224.6	Separate	Powells Cove
		R10B	269.9	Combined	Powells Cove
		R10	114.2	Separate	Powells Cove
TI-004	68.1	R11	68.1	Combined	East River
TI-005	179.3	R12	179.3	Separate	East River
TI-019	27	R02	27	Combined	East River
TI-020	60.1	R01	60.1	Combined	East River
TI-023	769.9	R13	769.9	Combined	Little Bay
Alley Creek and Little Neck Bay					
TI-006	597.3	24th Ave PS	74.8	Separate	Little Neck Bay
		Clear View PS	522.5	Separate	Little Neck Bay
TI-007	1074.9	Old Douglaston PS	1074.9	Combined and Separate	Alley Creek
TI-008	1044.4	R46	404.4	Combined	Alley Creek
		R47	455.9	Combined and Separate	Alley Creek
		R49	80.5	Separate	Alley Creek
TI-024	376.2	New Douglaston PS	77.1	Separate	Alley Creek
TI-025	1550.7	Alley Creek Tank	1550.7	Combined and Separate	Alley Creek

Table 2-4. Tallman Island WWTP Drainage Area: Acreage by Outfall/Regulator

Outfall	Outfall Drainage Area	Regulator	Regulator Drainage Area	Regulated Drainage Area Type	Receiving Water
Flushing Creek					
TI-010	6416.0	R29	122.9	Combined and Separate	Flushing Creek
		R30	787	Combined and Separate	Flushing Creek
		R31	503.4	Combined, Separate and Other	Flushing Creek
		R32	2.7	Combined	Flushing Creek
		R33	2.5	Combined	Flushing Creek
		R34	7.6	Combined	Flushing Creek
		R35	43.6	Combined	Flushing Creek
		R37	366	Combined	Flushing Creek
		R39	35.3	Combined	Flushing Creek
		R40	135.4	Combined	Flushing Creek
		R40A	119.8	Combined	Flushing Creek
		R41	529	Combined and Other	Flushing Creek
		R43	515.7	Combined, Separate and Other	Flushing Creek
		R44	141.4	Combined	Flushing Creek
		R45	613.1	Combined	Flushing Creek
		R45A	1043.3	Combined	Flushing Creek
		R50	343.6	Combined	Flushing Creek
		R59	68.6	Combined	Flushing Creek
TI-011	943.2	R09	278.2	Combined and Separate	Flushing Creek
		R51	369.4	Combined	Flushing Creek
		R52	16.3	Combined	Flushing Creek
		R53	46.3	Combined	Flushing Creek
		R54	28.1	Combined	Flushing Creek
TI-022	308.2	R55	156.8	Combined	Flushing Creek
		R56	85	Combined	Flushing Creek
		R57	14.6	Combined	Flushing Creek
		R58	51.8	Combined	Flushing Creek
Flushing Bay					
TI-012	13	122nd St PS	13	Separate	Flushing Bay
TI-013	28.3	R08	Disconnected from R08	Separate	Flushing Bay
TI-014	18.5	R07	18.5	Combined	Flushing Bay
TI-015	18.6	R06	18.6	Combined	Flushing Bay
TI-016	73.5	R05	73.5	Combined	Flushing Bay
TI-017	3.5	R04	3.5	Combined	Flushing Bay
TI-018	30.9	R03	30.9	Combined	Flushing Bay

Notes:
For locations with regulators in series, the incremental regulator drainage area is listed.

The Tallman Island WWTP is located at 127-01 134th Street, in the College Point section of Queens, on a 31-acre site adjacent to Powells Cove, leading into the Upper East River, and bounded by Powells Cove Boulevard. The Tallman Island WWTP serves the sewered area in the northeast section of Queens, including the communities of Little Neck, Douglaston, Oakland Gardens, Bayside, Auburndale, Bay Terrace, Murray Hill, Fresh Meadows, Hillcrest, Utopia, Pomonok, Downtown Flushing, Malba, Beechhurst, Whitestone, College Point, and Queensboro Hill, as shown on Figure 2-6. The total sewer length that feeds into the Tallman Island WWTP, including sanitary, combined, and interceptor sewers, is 490 miles.

The Tallman Island WWTP has provided full secondary treatment since 1978. 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 Tallman Island WWTP has a design dry weather flow (DDWF) capacity of 80 million gallons per day (MGD), and is designed to receive a maximum flow of 160 MGD (two times design dry weather flow [2xDDWF]) with 120 MGD (one and one-half times design dry weather flow [1.5xDDWF]) receiving secondary treatment. Flows over 120 MGD receive primary treatment and disinfection.

The Tallman Island WWTP includes four principal interceptors: the Main Interceptor, the College Point Interceptor, the Flushing Interceptor, and the Whitestone Interceptor.

- The Main Interceptor is a direct tributary to the Tallman Island WWTP, and picks up flow from the College Point and Flushing interceptors.
- The College Point Interceptor carries flow from sewersheds to the west of the treatment plant, discharges into the Powell's Cove Pump Station, which discharges into the Main Interceptor within the WWTP premises.
- The Flushing Interceptor is an extension of the Main Interceptor south of the Whitestone connection, and serves most of the areas to the south in the system. The Flushing Interceptor also receives flow from the southeast areas of the system, along the Kissena Corridor Interceptor (via trunk sewers upstream of the TI-R31 regulator), and from the Douglaston area. The Alley Creek sewershed drains to the Tallman Island WWTP via the Kissena Corridor Interceptor.
- The Whitestone Interceptor conveys flow from the area east of the treatment plant along the East River. Until recently, the Whitestone Interceptor use to discharge to the Main Interceptor from the west side, shortly upstream of the College Point Interceptor connection, via gravity discharge. As proposed in the Flushing Creek WWFP, the Whitestone Interceptor was extended and disconnected from the Flushing Interceptor. The new extension was certified construction completion on December 12, 2014.

This service area also includes two CSO retention facilities planned, designed and constructed based on the East River Facility Planning and WWFP. The first one is the Flushing Bay CSO Retention Facility with a total capacity of 43.4 million gallons (MG) (28.4 MG of off-line storage and 15 MG of in-line storage in large outfall pipes). This facility has been operational since May 2007. Post-event, retained flow is pumped to the upper end of the Flushing Interceptor, upstream of Regulator TI-009. This regulator was reconstructed in 2005 to provide adequate capacity to convey both sanitary flows and dewatered flow from the retention tank subsequent to wet weather periods.

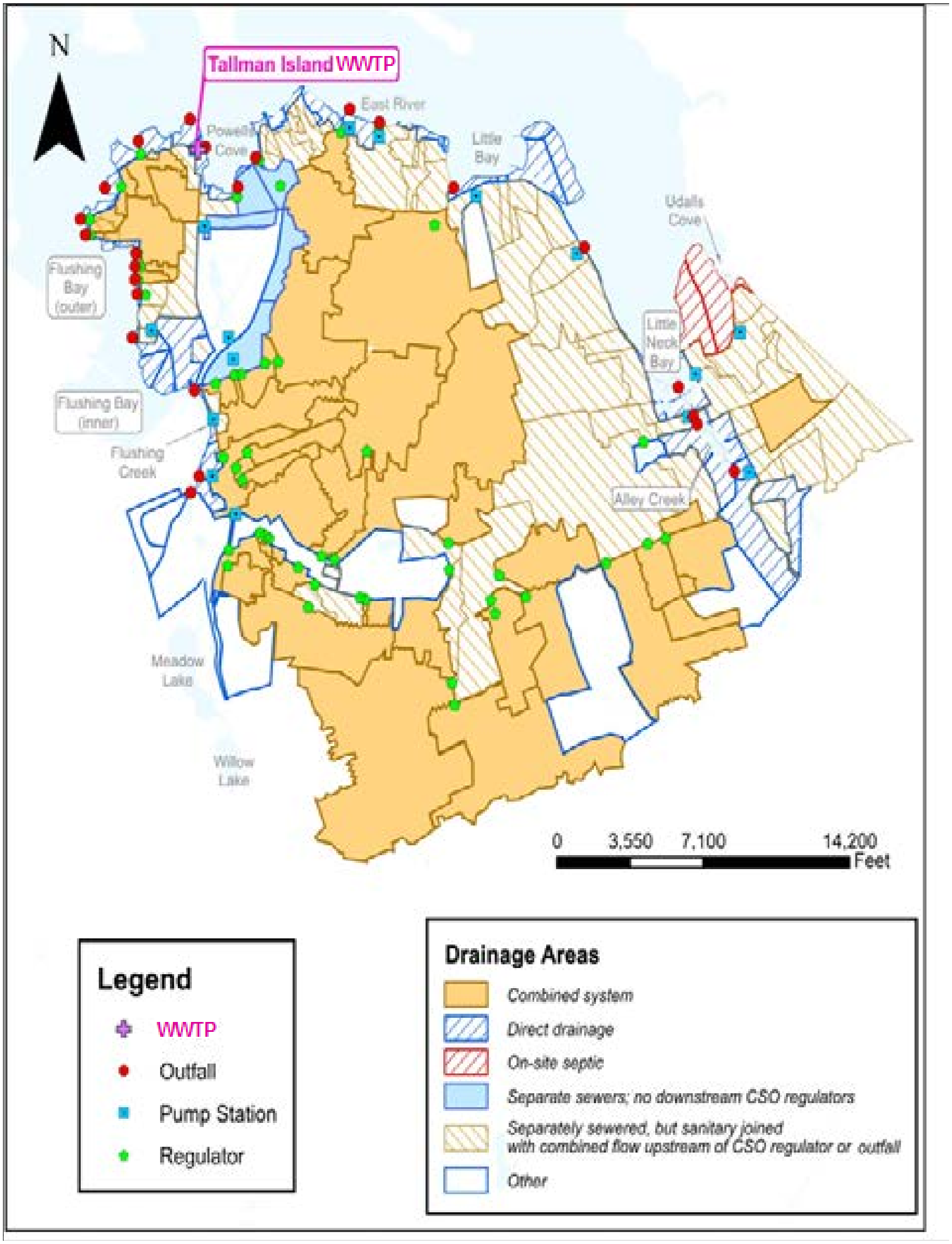

Figure 2-6. Tallman Island WWTP Drainage Areas

The second facility is the Alley Creek Retention Tank, built in 2010, which was operational as of March 11, 2011. This retention tank has an off-line storage capacity of 5 MG. During wet weather, flows are directed to the off-line storage tank by the diversion weir in Chamber 6 of the Alley Creek CSO Retention Tank. When the retention tank reaches capacity, excess water overflows the storage basin and is discharged to Alley Creek through Outfall TI-025, after receiving floatables control. Post-event dewatering of this tank is accomplished through the upgraded Old Douglaston Pump Station, which has a peak capacity of 8.5 MGD.

Tallman Island Non-Sewered Areas

Some areas within the Tallman Island service area are considered direct drainage areas and on-site septic areas, as shown in Figure 2-6, where stormwater drains directly to receiving waters without entering the CSS. These are shoreline areas adjacent to other waterbodies and were delineated based on topography and the resultant direction of stormwater sheet flow.

Tallman Island Stormwater Outfalls

There are five permitted stormwater outfalls discharging to Flushing Creek, as shown on Figure 2-7: TI-601, TI-603, TI-605, TI-631 and TI-669. These outfalls are currently included in the WWTP's SPDES permit. These outfalls drain stormwater runoff from the separate sanitary sewer areas around Flushing Creek. While runoff from these areas does not enter the combined system, the stormwater discharges from the separate sewer areas to Flushing Creek impact the Creek's water quality to a limited extent, as stormwater loads from SSS are smaller in magnitude compared to CSO loads. 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 biochemical oxygen demand (BOD), total suspended solids (TSS), total coliform, fecal coliform, and enterococci to use in calculating pollutant loadings from the various sources. Table 2-6 shows EMC stormwater concentrations for NYC stormwater discharges to Flushing Creek. Previously collected citywide sampling data from Inner Harbor CSO Facility Planning Study (DEP, 1994) was combined with data for the EPA Harbor Estuary Program (HydroQual, 2005a) to develop these stormwater concentrations. The IW sewer system model (Section 2.1.a.5) is used to generate the flows from NYC storm sewer outfalls and the concentrations noted in Table 2-6 are associated with these flows to develop pollutant loadings.

Tallman Island/Flushing Creek 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 Tallman Island SPDES permitted CSO outfalls to Flushing Creek are TI-010, TI-011 and TI-022. The locations of Flushing Creek SPDES CSO outfalls are shown on Figure 2-7. TI-010 is the CSO outfall for the Flushing Bay CSO Retention Facility and discharges tank overflows, as well as tank bypass flows.

Bowery Bay WWTP Drainage Area and Sewer System

Most of the Flushing Creek watershed is served by the Tallman Island WWTP. However, three drainage areas served by the Bowery Bay WWTP associated with its High Level Interceptor may contribute flows to the Flushing Bay CSO Retention Facility during wet weather.

Figure 2-7. Flushing Creek SPDES Permitted Outfalls

Wastewater flows to the Bowery Bay WWTP through two interceptors. The Low Level Interceptor flows east toward the plant and the High Level Interceptor flows west toward the plant, separated by a 29-foot elevation differential. The Low Level Interceptor serves approximately 3,502 acres in the western side of the Bowery Bay sewershed, carrying flow from individual drainage basins along the East River extending to Newtown Creek. The High Level Interceptor serves approximately 8,383 acres in the central and eastern part of the Bowery Bay sewershed, carrying flows from individual drainage basins extending from Steinway Creek, Bowery Bay itself, and Flushing Bay. Figure 2-8 shows the Bowery Bay Collection System. It is the High Level Interceptor drainage area, particularly the 660 acres that overflow to the Flushing Bay CSO Retention Facility, and the 29 acres of direct drainage to Flushing Creek that are directly applicable to this report. The drainage areas of the Bowery Bay WWTP service area are depicted in Figure 2-9.

The Bowery Bay High Level Interceptor conveys flows from 8,383 acres of sanitary and combined sewersheds. The major conveyance and regulation components of the sub-system associated with this interceptor are 7 combined sewer pump stations and 19 diversion regulator structures.

The portion of the drainage system tributary to the Bowery Bay High Level Interceptor located east of Meadow Lake and Willow Lake is the area that is directly applicable to Flushing Creek. Dry weather sanitary flow from areas tributary to Bowery Bay regulators 14, 15, 27, and 28 is conveyed westward in the Bowery Bay Collection System, while wet weather overflows are carried in an outfall sewer into the Tallman Island system, contributing to the Flushing Bay CSO Retention Facility. Table 2-5 shows the drainage areas contributing to the Flushing Bay CSO Retention Facility.

Table 2-5. Bowery Bay WWTP High Level Interceptor Drainage Area contributing to Flushing Creek: Acreage by Outfall/Regulator

Outfall	Outfall Drainage Area	Regulator	Regulator Drainage Area (acres)	Regulated Drainage Area Type	Receiving Water
Flushing Creek					
TI-010	6,416	14	135	Combined	Flushing Creek
		15	165	Combined	
		27	238	Combined	
		28	131	Combined	
		Total	**669**	**Combined**	

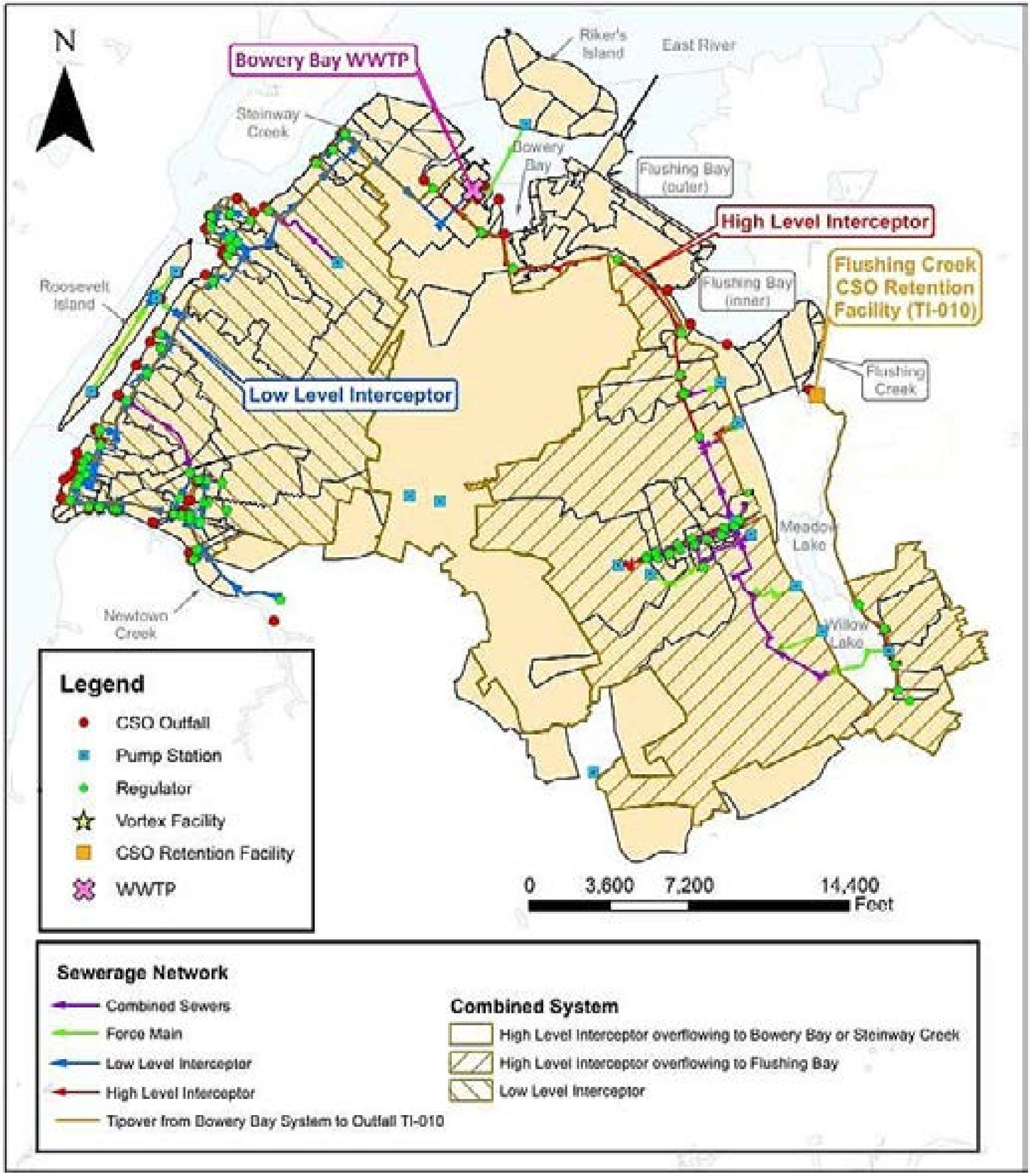

Figure 2-8. Bowery Bay WWTP Collection System

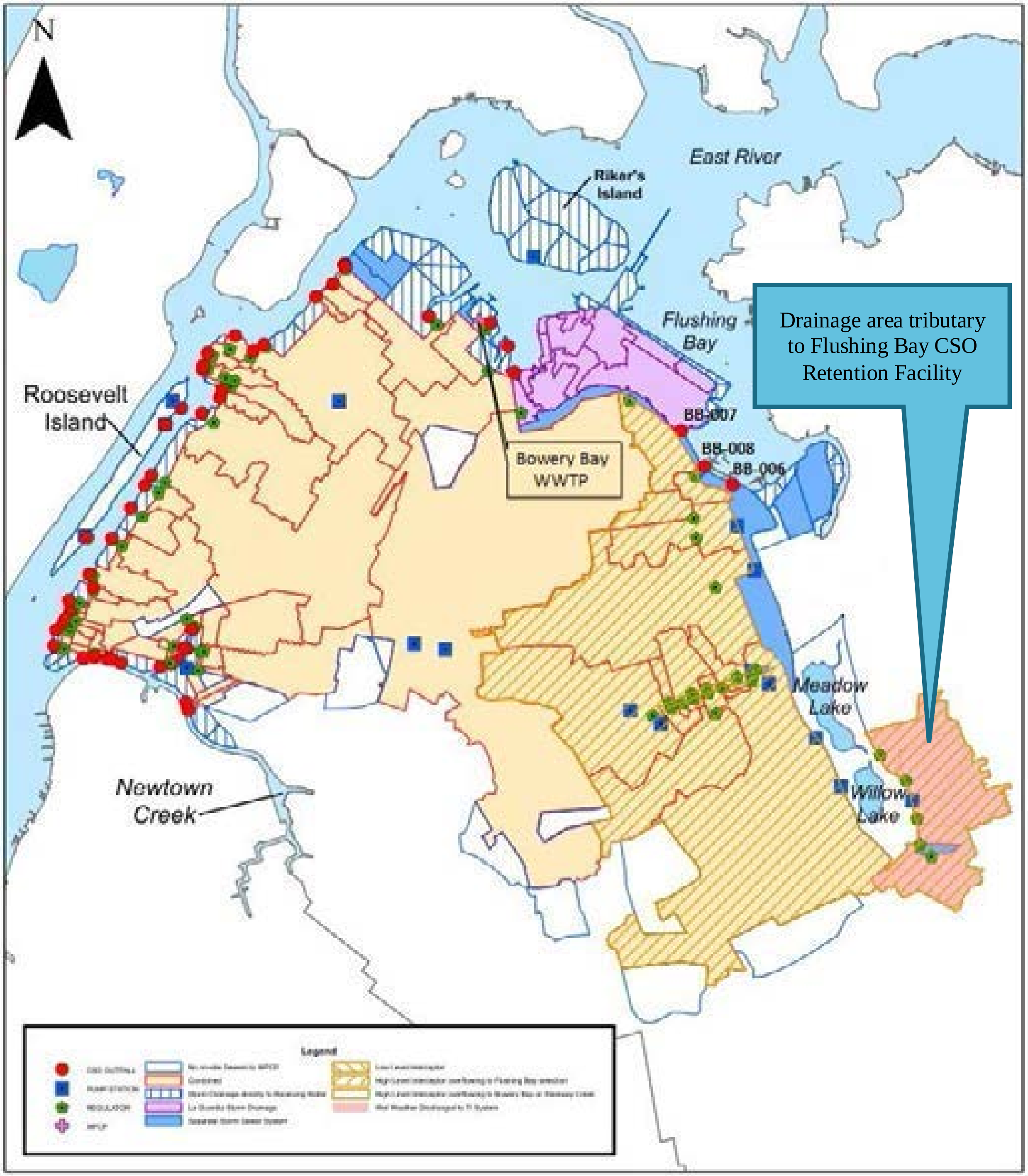

Figure 2-9. Bowery Bay WWTP Drainage Areas

Bowery Bay Non-Sewered Areas

Some areas within the Bowery Bay service area are considered direct drainage areas and on-site septic areas, as shown in Figure 2-9, where stormwater drains directly to receiving waters without entering the CSS. Generally, these are shoreline areas adjacent to waterbodies, and were delineated based on topography and the resultant direction of stormwater sheet flow. In addition, the non-sewered area known as the "Iron Triangle" located within the Willets Point area generates runoff flows on dirt roads and automotive repair industry related properties, making near surface groundwater flow a potential source of pollutants to Flushing Creek. The Willets Point redevelopment referred to earlier will include build-out of sanitary sewers tributary to the Bowery Bay WWTP CSS and storm sewers discharging through outfalls along Flushing Bay. This redevelopment is part of Reach 11 - Queens Upper East River of the Vision 2020 New York City Comprehensive Waterfront Plan. The Willets Point/Downtown Flushing redevelopments are located within Recommendation Area 4 shown in Figure 2-10.

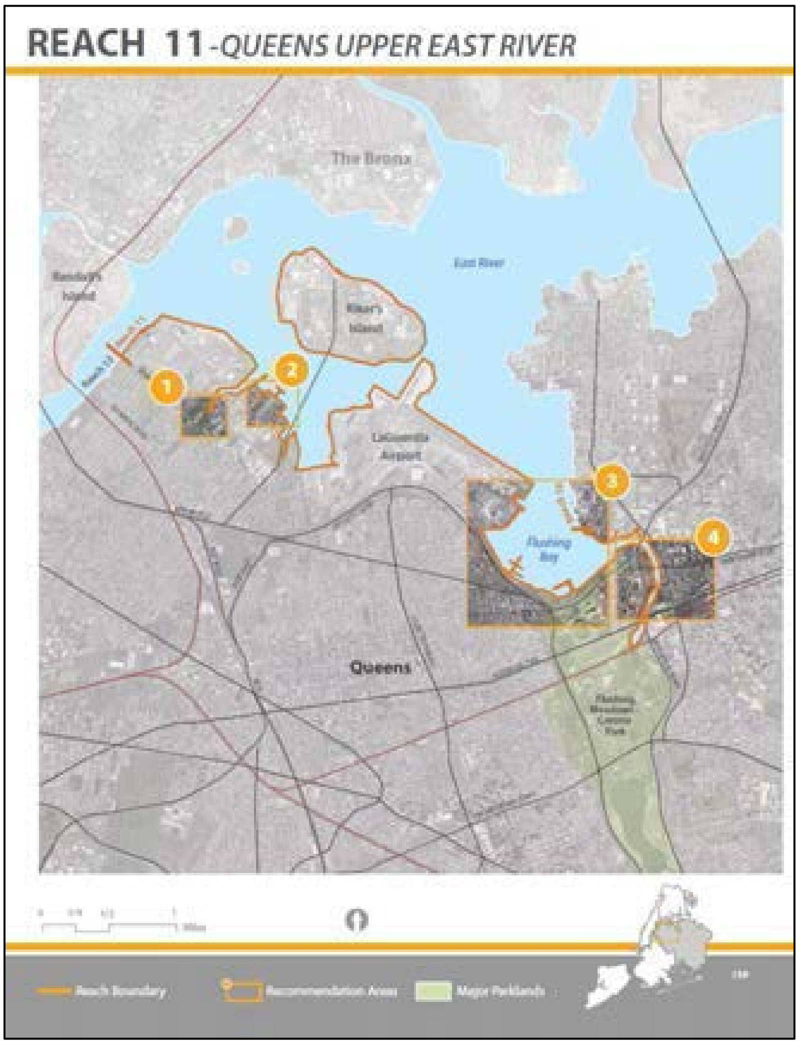

Figure 2-10. NYC Vision 2020 – Reach 11 Comprehensive Waterfront Plan

Bowery Bay Stormwater Outfalls

There are two SPDES permitted stormwater outfalls (BB-601 and BB-602) associated with the Bowery Bay WWTP sewershed served by the High Level Interceptor. Both discharge to Flushing Bay near the mouth of the Creek. These outfalls drain stormwater runoff from the separate sanitary sewer areas around the Willets Point area. While runoff from these areas does not enter the combined system, the direct stormwater discharges to Flushing Bay can impact water quality in the Creek. However, since they discharge to the Bay and because their contribution is much smaller than that of CSOs, any impact is very limited.

Bowery Bay CSOs

The Bowery Bay WWTP service area contributes CSOs to Flushing Creek though the Flushing Bay CSO Retention Facility. Additionally, three Bowery Bay SPDES permitted CSO outfalls associated with the High Level Interceptor, namely BB-006, BB-007 and BB-008, shown on Figure 2-9, discharge to Flushing Bay. It should be noted that BB-006 discharges the largest annual CSO volume citywide. Previous studies have demonstrated that wet weather discharges to Flushing Bay from the Bowery Bay WWTP system affect the water quality of the Creek in the long term, including both bacteria and DO.

2.1.c.2 Stormwater and Wastewater Characteristics

The pollutant concentrations found in wastewater, combined sewage, and stormwater can vary based on a number of factors, including flow rate, runoff contribution, and the matrix of the waste discharged to the system from domestic and non-domestic customers. Since the matrix of these waste streams can vary, it can be challenging to identify a single concentration of pollutants 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 carbonaceous biochemical oxygen demand (CBOD), TSS, total coliform, fecal coliform, and enterococci to use in calculating pollutant loadings from various sources. Table 2-6 shows both the sanitary and stormwater concentrations assigned to the service areas of the collection systems that discharge to Flushing Creek. Influent dry weather samples at the WWTPs were used to model sanitary concentrations (HydroQual, 2005b). Previously collected citywide sampling data from Inner Harbor Facility Planning Study (DEP, 1994) was combined with data for the EPA Harbor Estuary Program (HydroQual, 2005a) to develop the stormwater concentrations. The stormwater concentration data cited below are the most recent available.

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

Table 2-6. Sanitary and Stormwater Discharge Concentrations Tallman Island and Bowery Bay WWTP Service Areas

Constituent	Sanitary Concentration	Stormwater Concentration
$CBOD_5$ (mg/L) (1)	140	15
TSS (mg/L) (1)	130	15
Total Coliform Bacteria (MPN/100mL) (2,3)	$25x10^6$	150,000
Fecal Coliform Bacteria (MPN/100mL) (2,3)	$4x10^6$	35,000
Enterococci (MPN/100mL) (2,3)	$1x10^6$	15,000

Notes:
(1) HydroQual, 2005b.
(2) HydroQual Memo to DEP, 2005a.
(3) Bacterial concentrations expressed as "most probable number" (MPN) of cells per 100mL.

CSO pollutant concentrations can be extremely variable and are a function of many factors. Generally, CSO concentrations are a function of local sanitary sewage and runoff entering the combined sewers. For the modeling analyses, CSO concentrations were calculated based on a mass balance of the Tallman Island WWTP sanitary sewage concentrations and EMC stormwater runoff concentrations during each hour of each storm event. Influent dry weather samples at the NYC WWTPs were used to model sanitary concentrations (DEP process control records; HydroQual, 2005b). These sanitary sewage influent concentrations were summarized in Table 2-6. The concentrations of the stormwater entering the CSS were taken as those values shown in the same table. The IW model is run in the water quality mode and traces the amount of sanitary sewage and the amount of stormwater at each location within the model. When there is a CSO discharge, its pollutant concentrations will have the calculated mix of sanitary sewage and storm runoff pollutants for each hour of overflow. CSO concentrations were measured in 2014 to provide site-specific information. The CSO overflow bacteria concentrations were characterized by direct measurements of outfalls TI-010 (3 storm events) and TI-011 (6 storm events) during various storm events in late 2013/early 2014. These concentrations are shown in Figures 2-11 and 2-12, showing cumulative frequency distribution graphics. Individual sample points are shown, as well as the trend line that best fits the data distribution. For the TI-010 through-tank effluent, measured fecal coliform concentrations are log-normally distributed as is typical for this type of data and values range from 45,500 to 510,000 cfu/100mL (Figure 2-11). Similarly, enterococci concentrations are also log-normally distributed and range from 33,000 to 200,000 cfu/100mL. For the TI-011 overflows, measured fecal coliform concentrations are log-normally distributed as is typical for this type of data and values range from 36,400 to 6,820,000 cfu/100mL (Figure 2-12). Similarly, enterococci concentrations are also log-normally distributed and range from 20,000 to 736,000 cfu/100mL. Additionally, it is noted that TI-011 overflows have higher bacteria concentration than TI-010 overflows, due to the larger stormwater contribution to the system upstream of Outfall TI-010.

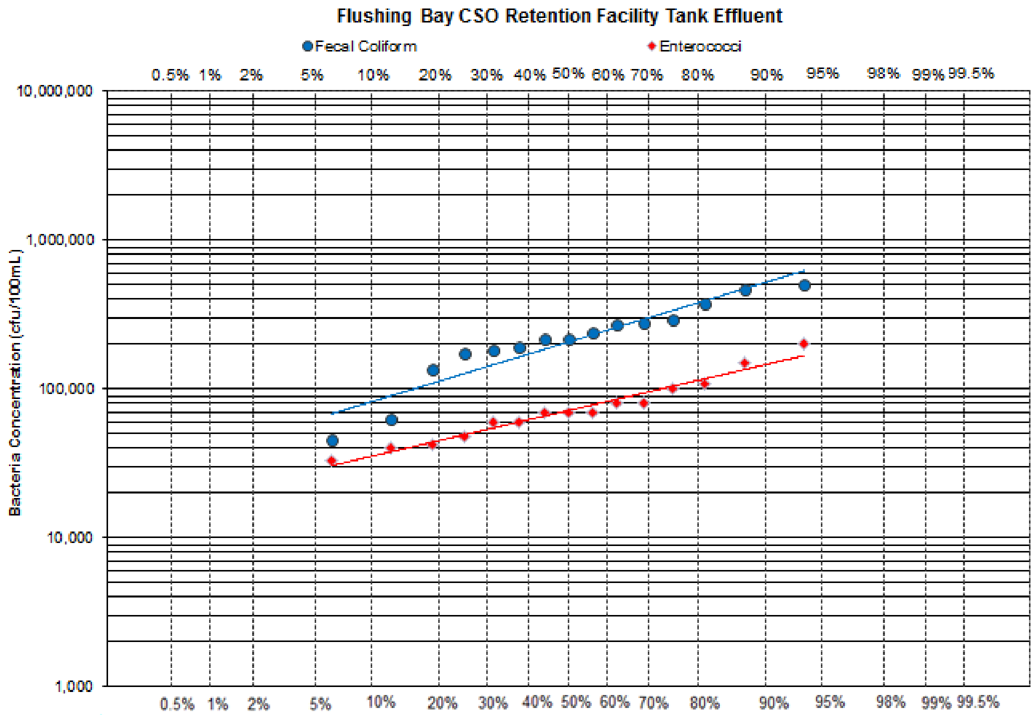

Figure 2-11. TI-010 Flushing Bay CSO Retention Facility Through-Tank Effluent Bacteria Concentrations

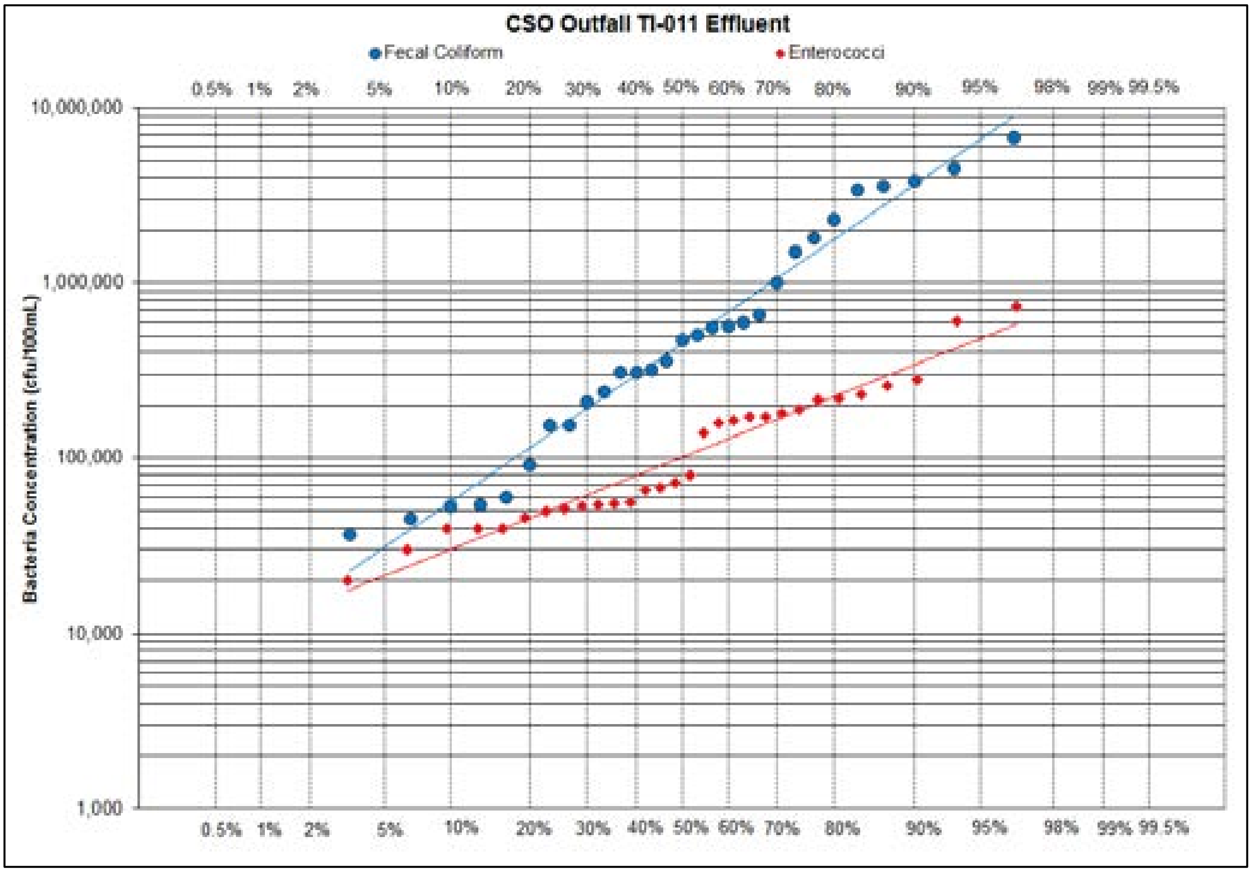

Figure 2-12. TI-011 Effluent Bacteria Concentrations

Stormwater overflow concentrations are assigned an EMC for inclusion in the water quality model calibration and LTCP baseline analyses. Historical information and data collected from sampling events were used to guide the selection of concentrations of BOD, TSS, total coliform, fecal coliform, and enterococci to use in calculating pollutant loadings from the various sources. Table 2-7 shows EMC stormwater concentrations for NYC stormwater discharges to Flushing Creek from the separate stormwater collection systems. Previously collected citywide sampling data from Inner Harbor CSO Facility Planning Study (DEP, 1994) was combined with data for the EPA Harbor Estuary Program (HydroQual, 2005a) to develop these stormwater concentrations. The IW sewer system model (Section 2.1.a.5) is used to generate the flows from NYC storm sewer outfalls and concentrations noted in Table 2-7 are associated with the flows used to develop pollutant loadings.

Additionally, flows were continuously monitored downstream of Meadow Lake and Willow Lake for a period of approximately six months, and outflow quality parameters were measured for specific events throughout the same period. These are continuous sources of flow and potential vectors of contamination to Flushing Creek. Both freshwater impoundments are surrounded by open lawn and outdoor recreational areas.

Sampling, data analyses, and water quality modeling calibration resulted in the assignment of flows and pollutant loadings to these sources for inclusion in the calibration of the water quality model for the 2013 and 2014 period. Model versus salinity data comparisons suggested that there was an unaccounted for freshwater source in the Creek. A groundwater flow was added to the model at the head end of the Creek to better reproduce the salinity data.

Table 2-7. Flushing Creek Source Loadings Characteristics

Source	Flow (MGD)	Enterococci (org./100mL)	Fecal Coliform (cfu/100mL)	BOD-5 (mg/L)
Stormwater	IW	15,000	35,000	15
Sanitary	IW	600,000	4,000,000	110
CSOs (TI-010 and TI-011)	IW	Monte Carlo	Monte Carlo	Mass Balance
CSOs (TI-022)	IW	Mass Balance	Mass Balance	Mass Balance
Direct Drainage	IW	6,000	4,000	15
Meadow/Willow Lake DW	IW	Monte Carlo	Monte Carlo	15
Groundwater	3.25	0	0	0

Furthermore, Microbial Source Tracking data was collected for two dry and two wet weather events at receiving water Stations OW-2 and OW-3, in the freshwater and saline portion of the Creek, respectively. The results obtained are summarized in Table 2-8 below. The main goal of the Marine Sources Tracking (MST) analysis was the identification of human markers in the freshwater portion of the Creek. However, salinity measurements at freshwater Station OW2 were routinely in excess of 1 part per thousand (ppt) during both dry and wet weather sampling, strongly suggesting that tidal flows are routinely passing through the tide gates at the Porpoise Bridge and mixing with freshwater upstream. As a result, the analysis proved to be inconclusive as there is a high possibility that the markers identified upstream of the tide gates could have originated in the tidal, CSO-impacted portion of the Creek. The presence of saline water obfuscates the source of the human genetic markers detected, although several potential sources exist along the waterbody. The Monitoring Section within DEP has been notified of the potential for illicit connections in the vicinity of Flushing Creek, and has added an investigation of the area to its priorities list.

Table 2-8. Microbial Source Tracking Results

Location	OW2				OW3			
Date Received at Lab	Human 1	Human 2	Bird	Dog	Human 1	Human 2	Bird	Dog
4/5/2014 (Dry Weather)	Positive (d)	Trace (d)	Absent	Absent	Positive (d)	Positive (d)	Absent	Absent
4/9/2014 (Wet Weather)	Positive (d)	Absent (d)	Absent	Absent	Positive (d)	Positive (d)	Absent	Absent
5/1/2014 (Wet Weather)	Positive (d)	Positive (d)	Trace	Absent	NS	NS	NS	NS
5/2/2014 (Wet Weather)	NS	NS	NS	NS	Positive (d)	Positive (d)	Trace	Positive (d)
5/8/2014 (Dry Weather)	Positive (d)	Positive (d)	Absent	Absent	Positive (d)	Positive (d)	Absent	Absent

Notes:
(d) detected in duplicate sample
NS – Not Sampled

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. Since the IW model was updated in the Alley Creek and Flushing Creek drainage areas after this effort was completed, the model results reported in this subsection, while relevant for their intended use to document overall system-wide performance beyond the Flushing Creek watershed, may differ slightly from volumes reported in this LTCP report. The hydraulic analyses can be divided into the following major components:

- Annual simulations to estimate the number of annual hours that the WWTPs are 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. Because the portion of the Bowery Bay WWTP collection system discharging to Flushing Creek is small when compared to that of the Tallman Island WWTP system, and through a highly regulated outfall (TI-010), the following summary of the 2012 recalibration effort is presented for the Tallman Island WWTP exclusively.

Annual Hours at 2xDDWF for 2008 with Projected 2040 DWFs

Model simulations were conducted to estimate the annual number of hours that the Tallman Island WWTP would be expected to treat 2xDDWF for the 2008 precipitation year, which contained a total precipitation of 46.26 inches, as measured at JFK Airport. These simulations were conducted using projected 2040 DWFs for 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.
- Tallman Island WWTP at 2xDDWF capacity of 160 MGD.
- No sediment in the combined sewers (i.e., clean conditions).
- Sediment in interceptors representing the sediment conditions after the inspection and cleaning program completed in 2011 and 2012.
- No green infrastructure.

The CEG conditions applicable to the Tallman Island service area included the two CSO retention facilities, the Whitestone Interceptor extension and associated sewer/regulator improvements. Due to the construction of Flushing Bay CSO Retention Facility tank and associated Regulator TI-09 improvements in 2005, and completion of the Alley Creek Retention Tank in 2011, the recalibrated models include both of these facilities. The Whitestone Interceptor and associated sewer/regulator improvements therefore constitute the primary difference between pre-CEG and CEG scenarios. Key observations/findings are summarized below:

- Simulation of the 2008 annual rainfall year resulted in a prediction that the Tallman Island WWTP would operate at its 2xDDWF capacity for 49 hours under the no-CEG condition. When the CEG conditions were applied in the model, the annual number of hours at 2xDDWF increased to 99 hours.

- The total volume (dry and wet weather combined) treated at the plant annually for the 2008 non-CEG condition was predicted to be about 24,038 MG, while the 2008 with CEG condition resulted in a prediction that 24,301 MG would be treated at the plant – an increase of 263 MG.

- The total Annual Average Overflow Volume (AAOV) predicted for the outfalls in the Tallman Island service area were as follows:
    - 2008 non-CEG: 2,163 MG
    - 2008 with CEG: 2,098 MG

The above results indicate an increase in the number of hours at the 2xDDWF operating capacity, an increased annual volume being delivered to the WWTP, and a decrease in AAOV from the outfalls in the service area.

Estimation of Peak Conduit/Pipe Flow Rates

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

The selected single-event was simulated in the model for two conditions, the first being prior to implementation of CEG conditions, and the second with the CEG conditions implemented. The maximum flow rates and maximum depths predicted by the model for each sewer segment in the model 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 between 66 and 77 percent (by length) of the interceptor sewer segments would exceed full-pipe capacity flow for the non-CEG and CEG scenarios, respectively. About 30 to 37 percent (by length) of the upstream combined sewers would exceed their full-pipe flow under the same scenarios.
- Between 78 and 93 percent (by length) of the interceptors were predicted to flow at full depth or higher. Between 56 and 59 percent (by length) of the combined sewers were also predicted to flow at full depth, and 72 percent of the combined sewers flowed at least 75 percent full.
- The results for the system condition with CEG improvements showed that the overall peak plant inflow and hydraulic gradient line (HGL) near the plant improved, in comparison to the non-CEG conditions in the Tallman Island service area.
- About 72 percent of the combined sewers (by length) reached a depth of at least 75 percent under the CEG simulations.

Based on the review of various metrics, the Tallman Island system generally exhibits full or near-full pipe flows during wet weather, allowing little potential for in-line storage capability.

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

DEP has made substantial improvements to the Alley Creek drainage system, a major contributor to the Tallman Island conveyance and treatment system, in which over $90M were spent under Contract ER-AC1 to help eliminate historical flooding issues. These drainage system improvements took place between December 2002 and December 2006, and consisted of installing larger combined sewers in certain segments of the sewershed to increase conveyance capacity; constructing storm sewers in select drainage areas to reduce volume of stormwater entering the combined system; and constructing associated combined and stormwater outfalls to discharge the excess wet weather flows. These drainage area improvements have substantially mitigated these historical flooding issues.

DEP maintains the operation of the collection systems throughout the five boroughs using a combination of reactive and proactive maintenance techniques. NYC's "Call 311" system routes complaints of sewer issues to DEP for response and resolution. Though not every call reporting flooding or sewer back-ups (SBUs) correspond to an actual issue with the municipal sewer system, each call to 311 is responded to. Sewer functionality impediments identified during a DEP response effort are corrected as necessary.

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 2-13 illustrates the intercepting sewers that were cleaned in the Borough of Queens, encompassing the entire Flushing Creek watershed. Throughout 2013, a total of 20,441 feet of intercepting sewers were cleaned in the Tallman Island WWTP and Bowery Bay WWTP conveyance systems leading to the removal of 111 cubic yards of sediment.

DEP also conducted a sediment accumulation analysis to quantify levels of sediments in the CSS and verify that the baseline assumptions are valid for this CSO LTCP. For this analysis, the normal approximation to the hypergeometric distribution was used to randomly select a sample subset of sewers representative of the modeled system as a whole, with a confidence level commensurate to that of the IW watershed model itself. Field crews investigated each location, and estimated sediment depth using a rod and tape. Field crews also verified sewer pipe sizes shown on the 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 City was approximately 1.25 percent, with a standard deviation of 2.02 percent; the mean sediment accumulation in the Tallman Island drainage area was 1.00 percent, with a standard deviation of 1.63 percent.

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

The majority of the Flushing Creek basin is served by the Tallman Island WWTP service area. The Tallman Island WWTP underwent upgrades for Biological Nutrient Removal (BNR) and improvements that enable the collection system and treatment facility to deliver, accept, and treat influent at twice the plant's design flow during storm events.

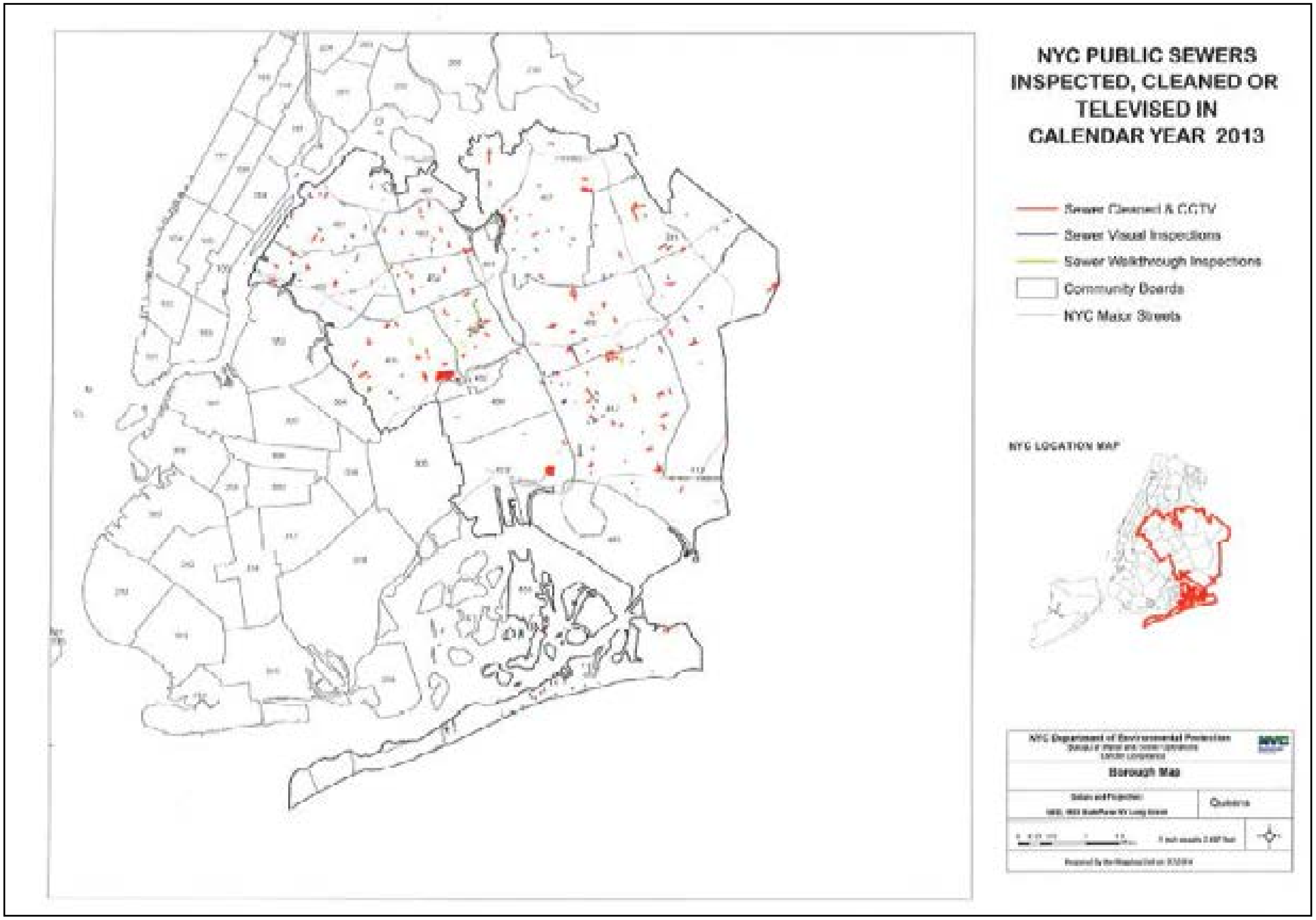

Figure 2-13. Sewers Inspected and Cleaned in Queens Throughout 2013

2.2 Waterbody Characteristics

This section of the report describes the features and attributes of Flushing Creek. Characterizing the features of these waterbodies 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

Flushing Creek is a tidal waterbody located in Queens, New York. Flushing Creek is tributary to Flushing Bay, and the Bay is tributary to the East River. Water quality in Flushing Creek is influenced by CSO and stormwater discharges. The following section describes the present-day physical and water quality characteristics of Flushing Creek, 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 Clean Water Act (CWA), the State of New York has established water quality standards (WQS) for all navigable waters within its jurisdiction. The State has developed a system of waterbody classifications based on designated uses that include five saline classifications for marine 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 Flushing Creek as Class I.

Numerical standards corresponding to these waterbody classifications are as shown in Table 2-9. Dissolved oxygen (DO) is the numerical standard that DEC uses to establish whether a waterbody supports aquatic life uses. Total and fecal coliform bacteria concentrations are the numerical standards that DEC uses to establish whether a waterbody supports recreational uses. In addition to numerical standards, New York State (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 2-9, these narrative criteria apply to all five classes of marine waters. Narrative WQS criteria are presented in Table 2-10.

Table 2-9. New York State Numerical Surface WQS (Saline)

Class	Usage	Dissolved Oxygen (mg/L)	Total Coliform (MPN/100mL)	Fecal Coliform (MPN/100mL)	Enterococci (MPN/100mL)(7)
SA	Shellfishing for market purposes, primary and secondary contact recreation, 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) Median most probable number (MPN) value in any series of representative samples.
(4) Monthly median value of five or more samples.
(5) Monthly 80th percentile of five or more samples.
(6) Monthly geometric mean of five or more samples.
(7) This standard, although not promulgated by DEC, is now an enforceable standard in New York State 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 promulgated by the EPA Beach Act that is only applicable to coastal waters.
(9) DEC has publicly noticed a proposed rulemaking which, if promulgated, would amend 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 Park 703.

Table 2-10. New York State Narrative WQS

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

Note that the enterococci criterion of 35 cfu/100mL listed in Table 2-9 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 geometric mean (GM) basis during recreational season (May 1st through October 31st). Furthermore, this criterion is not applicable to the tributaries of the Long Island Sound and the East River tributaries and therefore would not apply to Flushing Creek under current water quality classifications.

Currently, DEC is conducting its federally-mandated "triennial review" of the NYS WQS, in which States are required to review their WQS every three years. DEC has publicly noticed a proposed rulemaking which, if promulgated, would amend 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 Flushing Creek LTCP evaluates compliance with various primary contact water quality (WQ) numerical limits including the primary contact fecal coliform WQ Criteria (Class SC WQS). With the December 3, 2014 proposed rulemaking by DEC to change Class I fecal coliform bacteria criteria to 200 /100mL, Class SC and proposed Class I fecal coliform criteria would both retain the 200/100mL limitation. As such, the term Class SC criteria used in this LTCP is interchangeable with the proposed Class I numerical criteria when used in the context of bacteria WQ 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 Interstate Environmental Commission (IEC). The IEC includes all tidal waters of greater NYC. Flushing Creek is interstate water and is regulated by IEC as Class B-1 waters. Numerical standards for IEC-regulated waterbodies are shown in Table 2-11, while narrative standards are shown in Table 2-12.

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 marine classifications in New York Harbor do not spatially overlap exactly.

Table 2-11. 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 2-12. 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. For example, DMA is a private club located in Little Neck Bay with a permit to operate a beach by New York City Department of Health and Mental Hygiene (DOHMH). DOHMH uses a 30-day moving GM of 35 cfu/100mL. If the GM exceeds that value, the beach is closed pending additional analysis. An 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 pollution events.

Flushing Creek is classified I (secondary contact recreation use). Flushing Creek is used infrequently for primary contact recreation. These reference levels, according to the EPA documents, are not regulatory criteria, but are to be used as determined by the State agencies in making 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 Flushing Creek shoreline authorized by the DOHMH for operation of a bathing beach.

In December 2012, the EPA released Recreational Water Quality Criteria (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 2-13, and includes limits for both the GM (30-day) and a statistical threshold value (STV). 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 2-13. 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 (marine and fresh)	35	130	30	110
E. coli (fresh)	126	410	100	320

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

2.2.a.2 Physical Waterbody Characteristics

Flushing Creek is located in northern Queens, NY. Flushing Creek opens into the southeast end of Flushing Bay. Flushing Bay opens to the East River, between College Point and Rikers Island, north of LaGuardia Airport. At the northern end of the airport, there is a narrow short strait connecting Flushing Bay and Bowery Bay. The Bay has a navigational channel formally known as Flushing Bay Navigational Channel that extends into the Creek up to the Whitestone Expressway overpass.

Flushing Creek is located at the southeastern end of Flushing Bay. The tidal tributary runs northward and its mouth opens to Flushing Bay. The shoreline at the head of the Creek, upstream of the LIRR tracks, is surrounded by the Flushing Meadows-Corona Park. The 897-acre park contains open lawn areas, two lakes, facilities for active landside recreation, a mini-golf course and a museum, amongst other facilities supporting the local community. To the south, tidal Flushing Creek ends at the Porpoise Bridge/Dam where tide gates designed to control the saltwater progression were installed when the Creek was channelized in the early past century and the man-made Willow and Meadow Lakes were created. Freshwater flows to Flushing Creek include the minimal sustained flows from these lakes, stormwater and CSO discharges. Flushing Creek water quality is also influenced by the waters of Flushing Bay and East River.

Flushing Creek is within the Coastal Zone Boundary as designated by the DCP. The DCP has also designated all of Flushing Creek as a Significant Natural Waterfront Area (SNWA). As designated by the DCP, an SNWA is a large area of concentrated natural resources, such as wetlands and natural habitats, which possesses a combination of important coastal ecosystem features.

Furthermore, proposed redevelopment and rezoning of the Iron Triangle area of Willets Point contemplates revitalization of the waterfronts and habitats of the western shore of Flushing Creek and southern shore of Flushing Bay.

Shoreline Physical Characterization

The shorelines of Flushing Creek are composed of a mix of natural areas, bulkhead, and rip-rap as shown in Figure 2-14. The shoreline from the head of the Creek to Roosevelt Avenue within Flushing Meadows-Corona Park is composed mainly of natural, vegetated shorelines with small areas of bulkhead associated with bridge abutments. North of Roosevelt Avenue, the eastern shoreline is generally composed of bulkhead, with an area of rip-rap located between Roosevelt Avenue and 39th Avenue. In addition, an area of natural, vegetated shoreline is located between 39th Avenue and 37th Avenue and just west of the Van Wyck Expressway. The western shoreline north of Roosevelt Avenue is a mix of natural and altered areas. An area of natural, vegetated shoreline extends from Roosevelt Avenue to 36th Road. North of 36th Road, the shoreline is a mix of bulkhead and rip-rap. Figures 2-15 and 2-16 show the typical shoreline characteristics along the Creek. Figure 2-15 shows the bulkhead that typically fortifies much of the shoreline and the typical rip-rap protection found intermittently throughout. Figure 2-16 shows the natural shorelines of the Creek within the Flushing Meadows-Corona Park.

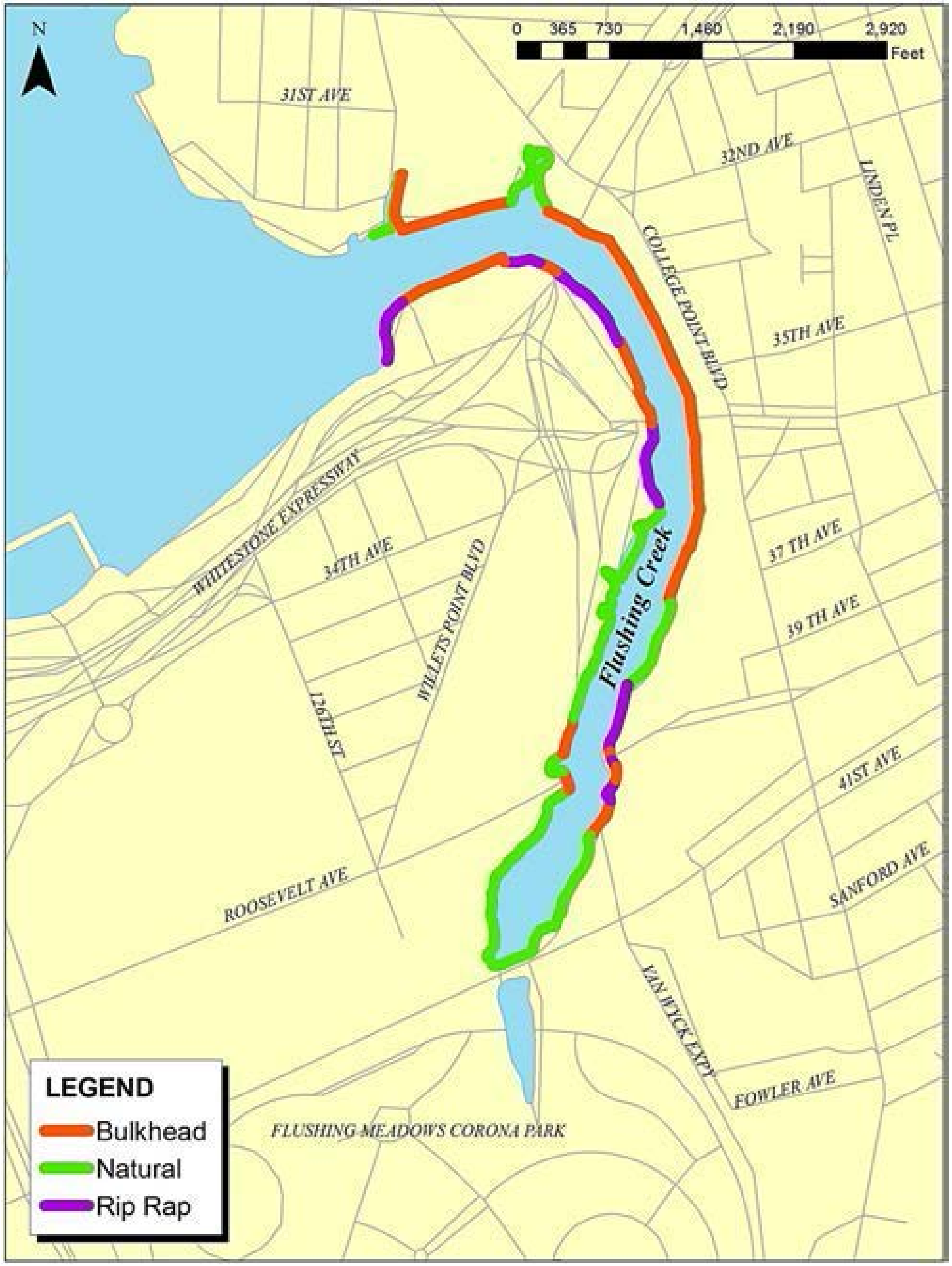

Figure 2-14. Shoreline Characteristics

Figure 2-15. Shoreline View of Flushing Creek from Whitestone Expressway (Looking South)

Figure 2-16. Shoreline of Flushing Creek (Looking North)

Shoreline Slope

Shoreline slope has been qualitatively characterized along shoreline banks where applicable, and where the banks are not channelized or otherwise developed with regard to physical condition. Steep is defined as greater than 20 degrees, or 80-foot vertical rise for each 200-foot horizontal distance perpendicular to the shoreline. Intermediate is defined as 5 to 20 degrees. Gentle is defined as less than 5 degrees, or 18-foot vertical rise for each 200-foot horizontal distance. In general, the three classification parameters describe the shoreline slope well for LTCP purposes. Gentle and intermediate slopes characterize the natural or vegetated shorelines of Flushing Creek.

Waterbody Sediment Surficial Geology/Substrata

The riverbed of Flushing Creek is predominantly composed of mud/silt/clay with a small proportion of sand, according to data from previous studies. Sampling conducted by HydroQual in 2003 indicated a composition of 93.47 percent mud/silt/clay, 6.22 percent sand and 0.3 percent pebbles. The last maintenance dredging in Flushing Creek occurred in 2003 with the removal of 43,000 cubic yards of material.

Waterbody Type

Flushing Creek is a tidal tributary and receives freshwater from stormwater and CSOs, groundwater inflows and from the man-made freshwater lakes located upstream of the tidal portion of the Creek.

Tidal/Estuarine Systems Biological Systems

Tidal/Estuarine Wetlands

The United States Fish and Wildlife Service National Wetlands Inventory (NWI) maps show limited tidal/estuarine wetlands throughout the Flushing Creek study area. The NWI mapped wetlands are shown in Figure 2-17, and Table 2-14 summarizes the classification used.

Table 2-14. NWI Classification Codes

NWI Classification	Description
E2EM1P	Estuarine, inter-tidal, emergent-persistent, irregular
E2FLN	Estuarine, inter-tidal, flat, regular
PEM1C	Palustrine, emergent, persistent, seasonal
PEM1E	Palustrine, emergent, broad-leaved deciduous, seasonally flooded
PUBF	Palustrine, unconsolidated bottom, semi-permanent
PUBZ	Palustrine, unconsolidated bottom, intermittently exposed/permanent

Aquatic and Terrestrial Communities

The DCP Plan for the Queens Waterfront (DCP, 1993) reports a diverse range of species supported by the habitat in the Flushing Creek area. A more detailed summary of the aquatic and terrestrial communities can be found in the 2011 Flushing Creek WWFP.

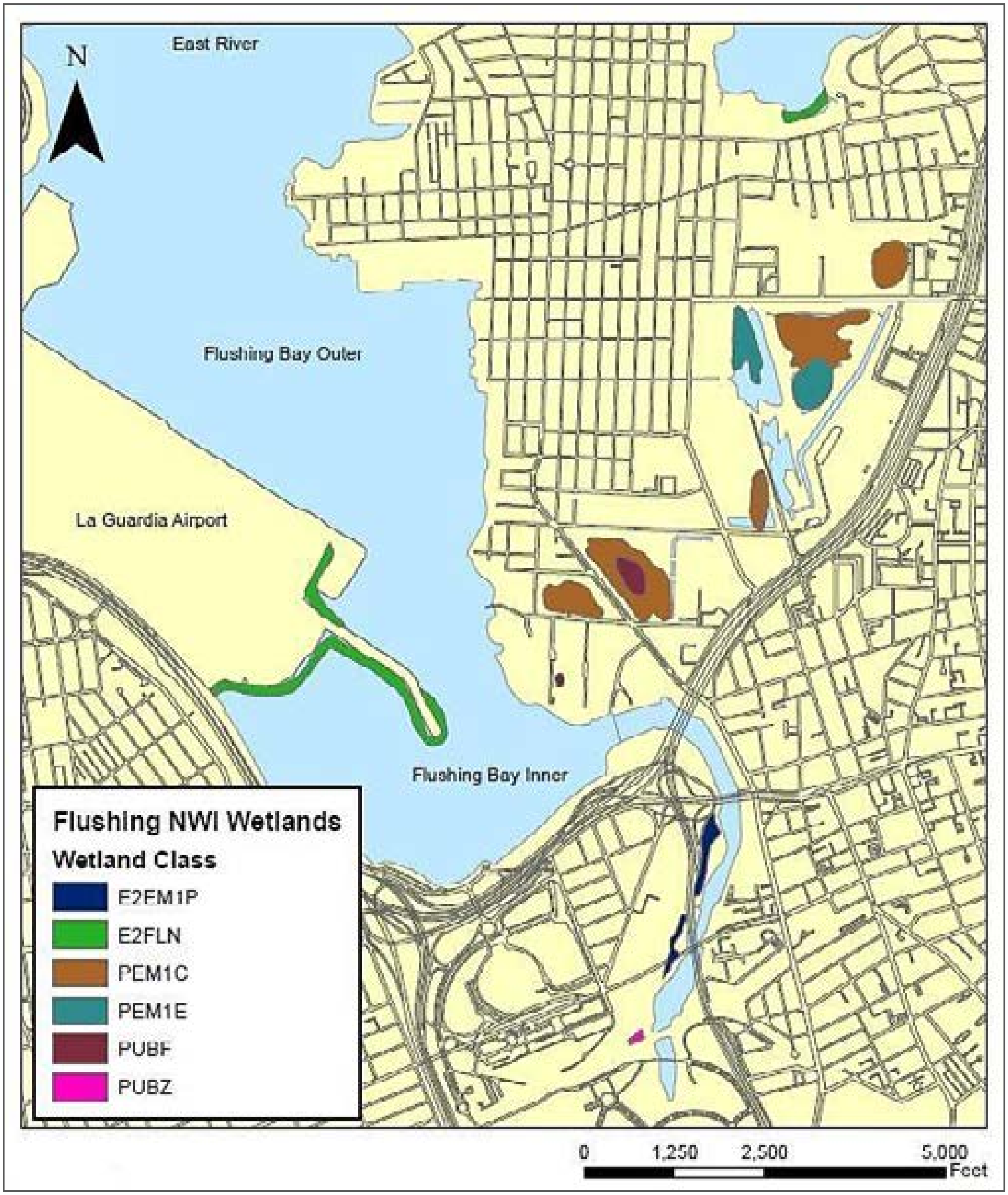

Figure 2-17. National Wetlands Inventory Source: NYS GIS Clearinghouse-2014

Freshwater Systems Biological Systems

There are three generalized freshwater wetlands areas within the Flushing Creek watershed shown in the DEC Freshwater Wetlands Maps. These areas are mapped in the former Flushing Airport property, around the Willow Lake and in the vicinity of Kissena Lake in Kissena Park.

The NWI maps show four areas of freshwater (palustrine) wetlands in the Flushing Creek study area, as indicated in Figure 2-17. Most of these palustrine wetlands are located in the College Point and former Flushing Airport area and one other small wetlands area is mapped on the western shore of the Creek, near the Porpoise Bridge.

2.2.a.3 Current Public Access and Uses

The freshwater portion of Flushing Creek, its shoreline, areas immediately adjacent to the water and much of the surrounding drainage area of the Creek are within Flushing Meadows-Corona Park. Access to the Willow and Meadow Lakes is provided for by the park but no facilities for primary contact recreation are available. The park does not provide regular secondary contact recreation opportunities. The major uses of the lakes are passive, non-contact recreation. There are walkways and open lawn areas that offer views of the lakes.

In tidal Flushing Creek, 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.

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 Flushing Creek 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
Flushing Creek	None	None	No	No[4]	None[5]	None[5]	None

Notes:
(1) Classifications or Designations per CSO Policy.
(2) NOAA.
(3) Department of State - Significant Coastal Fish and Wildlife Habitats.
(4) Existing uses include secondary contact recreation and fishing, Class I.
(5) These waterbodies contain salt water.

There are no sensitive areas identified in Flushing Creek.

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 Harbor Survey Monitoring (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 5 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. The LTCP process has begun to focus on those areas within the Harbor that remain impacted. 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, chlorophyll 'a', and Secchi transparency as the water quality parameters of concern. Data are presented in four sections, each delineating a geographic region within the Harbor. Flushing Creek is located within the Upper East River – Western Long Island Sound (UER-WLIS) section. This area contains nine open water monitoring stations and five tributary sites. Figure 2-18 shows the location of Stations FLC1 and FLC2 of the HSM tributaries program.

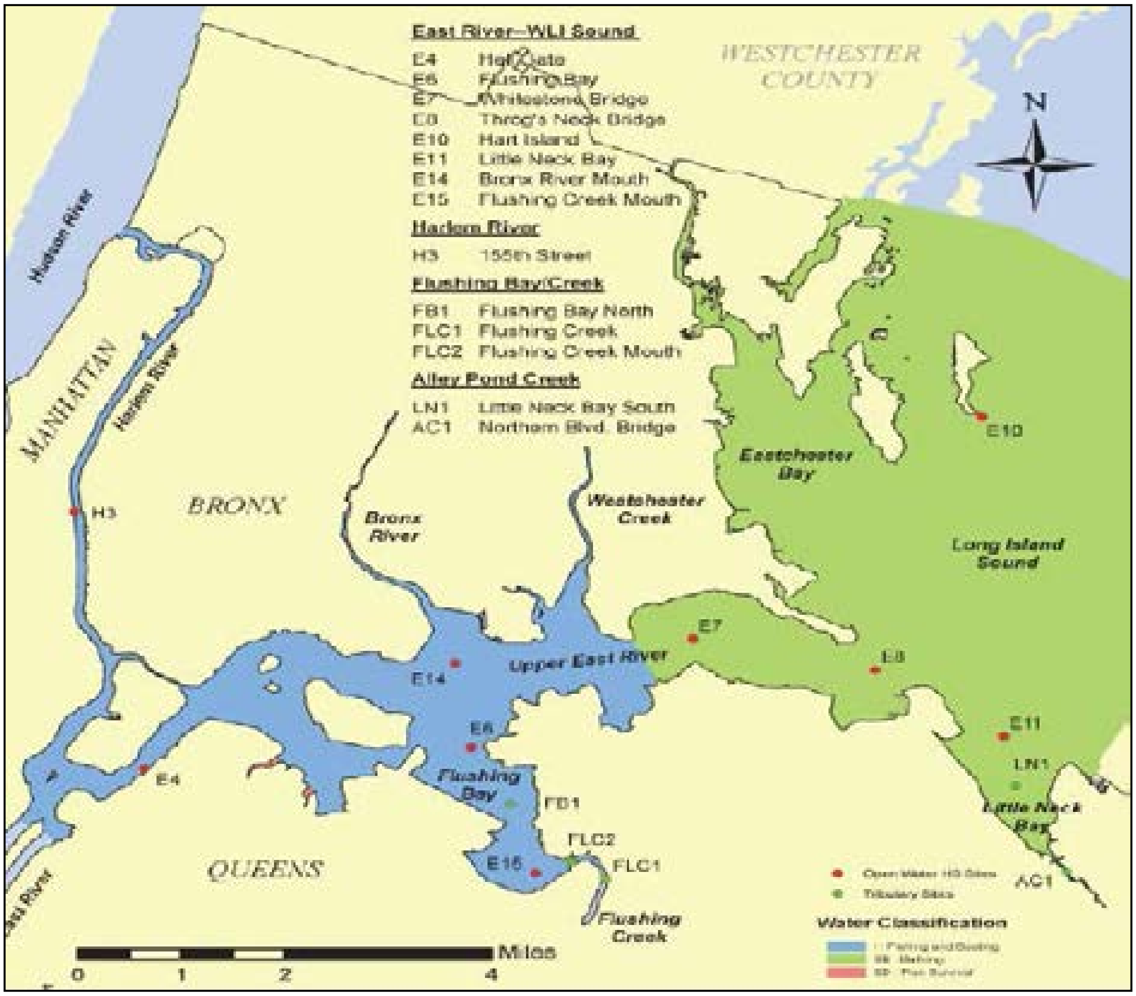

Figure 2-18. Harbor Survey UER-WLIS Region

Fecal coliform and enterococci are indicators of human waste and pathogenic bacteria. According to 2013 data from January 3, 2013 to December 12, 2013, fecal coliform annual geometric means representative of all weather conditions are below the Creek's monthly GM corresponding classification criterion at Stations FLC1 and FLC2, with values of 1760 cfu/100mL and 770 cfu/100mL, respectively. The computed enterococci GMs are 106 cfu/100mL and 40 cfu/100mL, for Stations FLC1 and FLC2, respectively.

DO is the oxygen in a waterbody available for aquatic life forms. Throughout the years, average DO levels in Flushing Creek have been measured below the compliance requirement of 4.0 mg/L. In 2013, the average surface DO at Station FLC1 was measured at 5.89 mg/L, while the average bottom DO was measured at 5.61 mg/L. For FLC2, DO was measured at 6.65 mg/L, while the average bottom DO was measured at 6.53 mg/L During summer months, the Flushing Creek surface waters failed to meet their classification requirement, consistent with data collected for previous summers. Hypoxia is another water quality condition associated with DO, and occurs when DO levels fall below 3.0 mg/L. DO measurements below 3.0 mg/L were taken at Stations FLC1 and FLC2 in Flushing Creek during the summer period of 2013, also consistent with observations from prior summers.

Chlorophyll 'a' is the green pigment in algae and plankton. The amount of chlorophyll 'a' is a gauge of primary productivity, which is used to measure ecosystem quality. A concentration of 20 µg/L or above is considered eutrophic. In a state of eutrophication, phytoplankton reproduction rates greatly increase, causing a depletion of DO. The average for the Creek since chlorophyll 'a' level collection started in 2008 is 16.65 µg/L. This is a common condition for confined bodies of water. The average chlorophyll 'a' reading for the Creek was 11.8 µg/L in 2013, indicating an improvement in the ecosystem quality for that year.

Secchi 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. 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 FLC1 was 2.5 ft. and 2.8 ft. for FLC2. Both stations in Flushing Creek reported a significant number of low transparency values (under 3.0 feet).

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

Data collected within Flushing Creek are available from sampling conducted by DEP's HSM program between 2007 and 2014, and from sampling conducted from November 2013 through May 2014 during the development of the LTCP. The sampling locations of both sampling programs are depicted in Figure 2-19. Figures 2-20 and 2-21 show the GM of both datasets over the concurrent sampling period along with data ranges (minimum to maximum and 25th percentile to 75th percentile) for fecal coliform and enterococci, respectively. For reference purposes, Figure 2-20 also shows the monthly GM water quality criterion for fecal coliform.

Sampling locations for OW1 and OW2 are upstream of the tidal portion of Flushing Creek, which is the subject of this LTCP. Data from these two locations was collected to provide the inputs to the tidal creek from the freshwater segment of the system.

Overall, the fecal coliform levels measured throughout the LTCP sampling program result in geometric means for the period generally uniform and below that of the applicable monthly GM criterion for fecal coliform (2,000 cfu/100mL) except at Stations OW3 and OW5 for wet weather, as shown in Figure 2-20. These wet weather excursions above the numerical criterion are explained by the CSO and stormwater impacts typical of wet weather conditions. Similarly, proportional wet weather upper excursions at these locations are seen for the enterococci levels measured as well, as seen in Figure 2-21.

In both Figures, slightly higher bacteria levels were observed during dry weather at Station OW3, when compared to upstream locations. DEP is investigating to determine whether there are any potential dry weather bacteria loadings in this area.

Under the PCM program, DEP's Harbor Survey program collected bacteria data supporting the evaluation of the Creek's WQ conditions from June 2006 through the end of 2013. However, the dataset did not capture fecal coliform concentrations over 4,000 cfu/100mL. This dataset would not represent accurate WQ conditions. The dataset would represent high fecal coliform presence, but not magnitudes above 4,000 cfu/100mL. Due to the above, statistical evaluation of bacteria levels in the Creek was conducted for the recent years of 2012 and 2013 exclusively, when coherent analytical results are available. Figure 2-22 (fecal coliform) and Figure 2-23 (enterococci), respectively, present the GM, 25th percentile, 75th percentile, minimum and maximum bacteria results measured at Harbor Survey locations FLC1 and FLC2, in Flushing Creek. The statistics shown indicate the dry or wet weather bacteria levels in the Creek

Figure 2-19. Field Sampling and Analysis Program (FSAP) and Harbor Survey Monitoring Program Sampling Locations

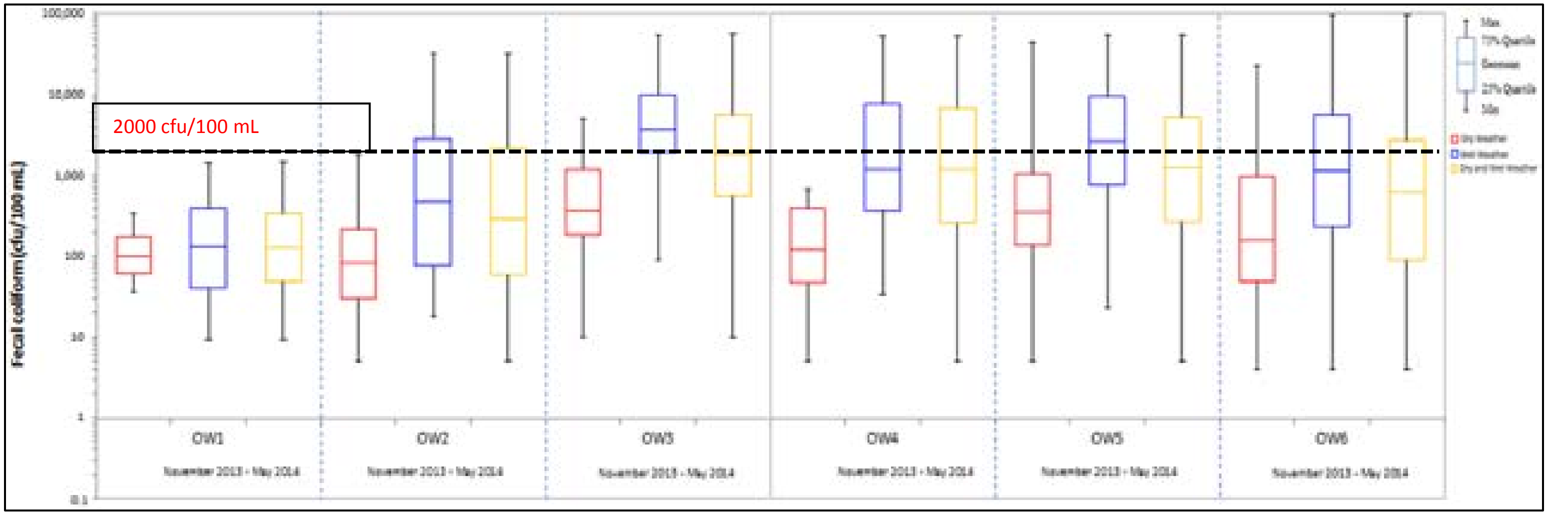

Figure 2-20. Fecal Coliform Concentrations at Flushing Creek LTCP Monitoring Stations

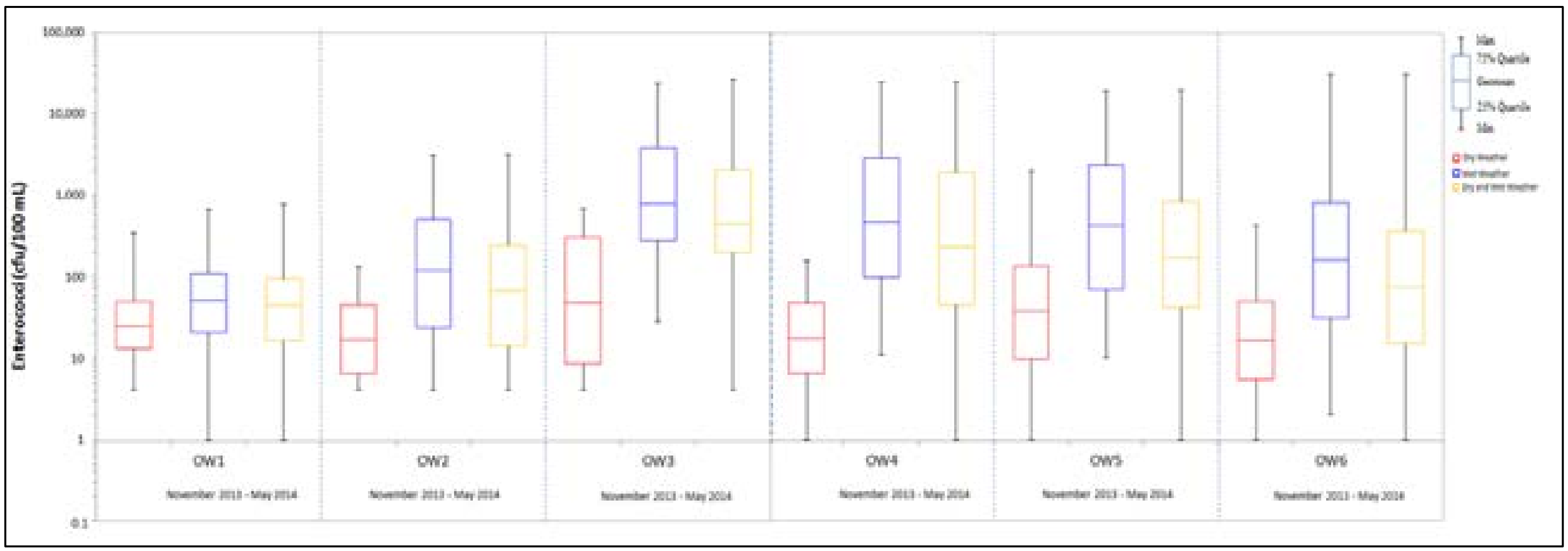

Figure 2-21. Enterococci Concentrations at Flushing Creek LTCP Monitoring Stations

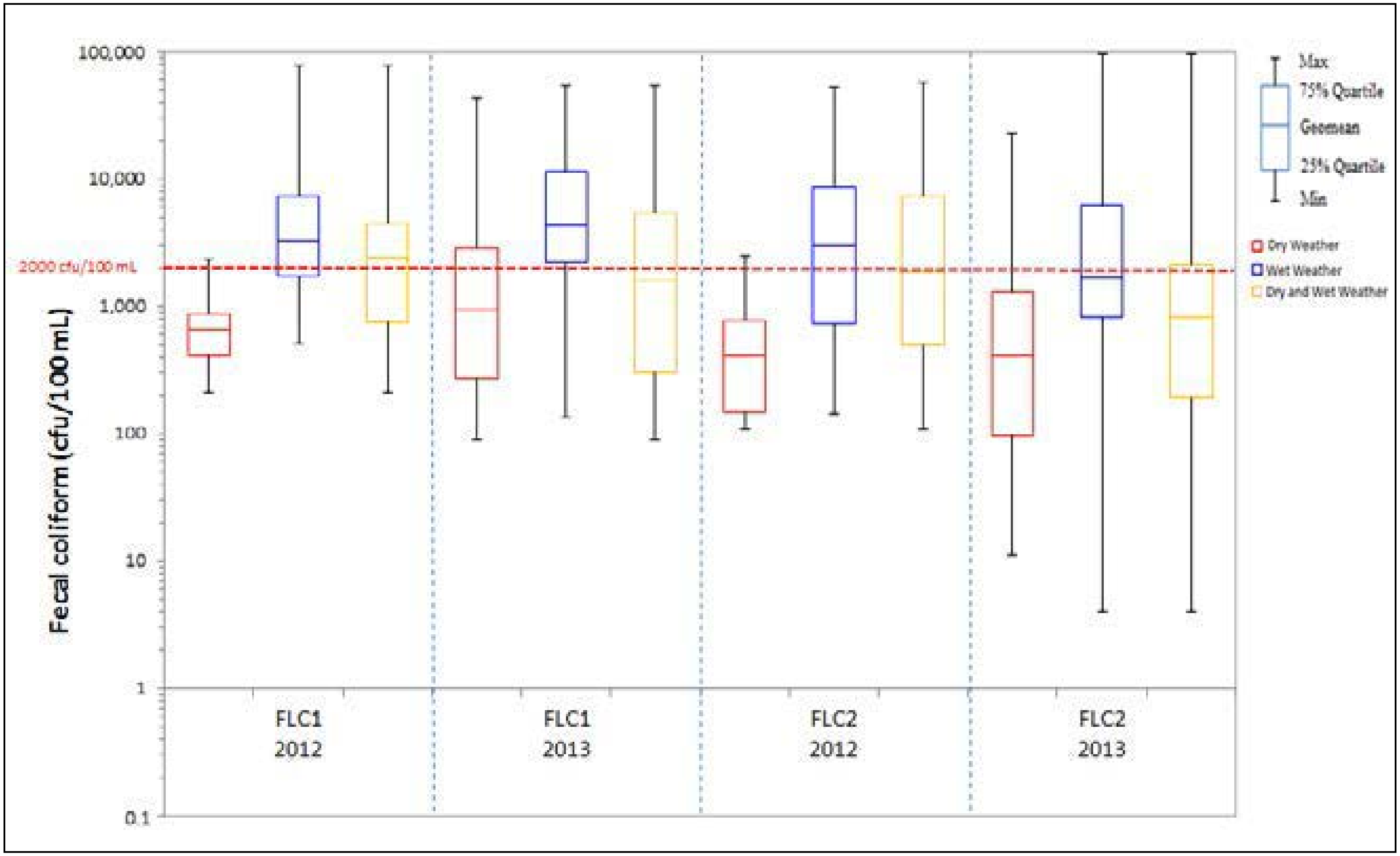

Figure 2-22. Fecal Coliform Concentrations at Flushing Creek Harbor Survey Monitoring Stations

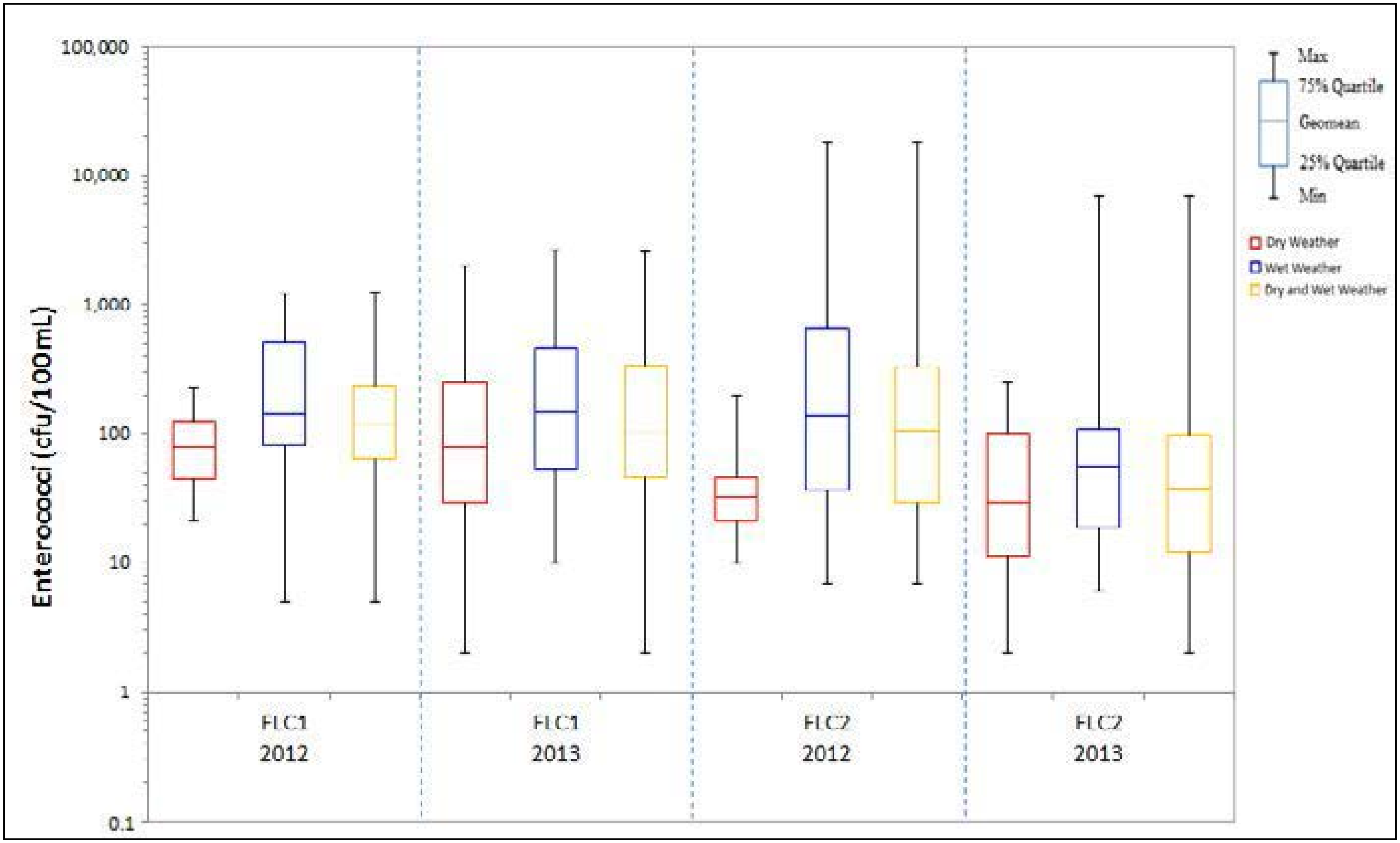

Figure 2-23. Enterococci Concentrations at Flushing Creek Harbor Survey Monitoring Stations

are consistent throughout both years with fecal coliform GM around 2,000 cfu/100mL at Station FLC1. It is worth noticing the improved fecal coliform levels at Station FLC2, in which the GM drops from 1,900 cfu/100mL in 2012 to about 800 cfu/100mL in 2013, explained by the decrease in wet weather bacteria levels measured in 2013, despite the effect that different rainfall conditions may have in the annual statistics shown.

Data collected by the Citizen Testing Group which is publicly available at the Riverkeeper Group website was also gathered. However, this dataset does not contain data for the period concurrent with the LTCP dataset, the sampling locations are not in alignment with the LTCP sampling locations and there are only two Citizen sampling locations spaced widely apart. A direct comparison of the Citizen Testing dataset with that of the LTCP, Harbor Survey and Sentinel Monitoring programs is therefore, not possible due to the significant differences between the sampling points.

However, the Citizen Testing data was reviewed and high-concentrations of enterococci were found in two dry weather samples collected at the Citizen Testing location in Willow Lake. There are no known CSO discharges in this area. DEP has ongoing field investigations in Flushing Creek to determine possible bacteria sources.

The DO values measured in Flushing Creek throughout 2014 are consistent with those of previous years, both in terms of year-round average as well as averages and minima during the summer period. Statistics derived from DO values of the summer periods gathered throughout recent years are shown in Table 2-16 below. In this table, the statistics shown for the year 2000 are representative of pre-Flushing Bay CSO Retention Facility operation. Statistics shown for other years are derived from measurements taken post-Flushing Bay CSO Retention Facility operation. Figure 2-24 depicts the statistics of the LTCP dataset measured during late 2013/early 2014.

Table 2-16. Summer Period DO Statistics for HSM Station FLC1 (2000; 2008-2014)

Year	DO (mg/L) (July-August)		
	Average	Min	Max
2000	3.71	0.13	12.91
2008	3.22	1.05	5.99
2009	3.22	0.91	6.77
2010	3.42	1.94	5.39
2011	3.14	0.14	7.15
2012	3.84	1.65	6.72
2013	3.67	1.80	6.13
2014	4.52	1.40	8.75

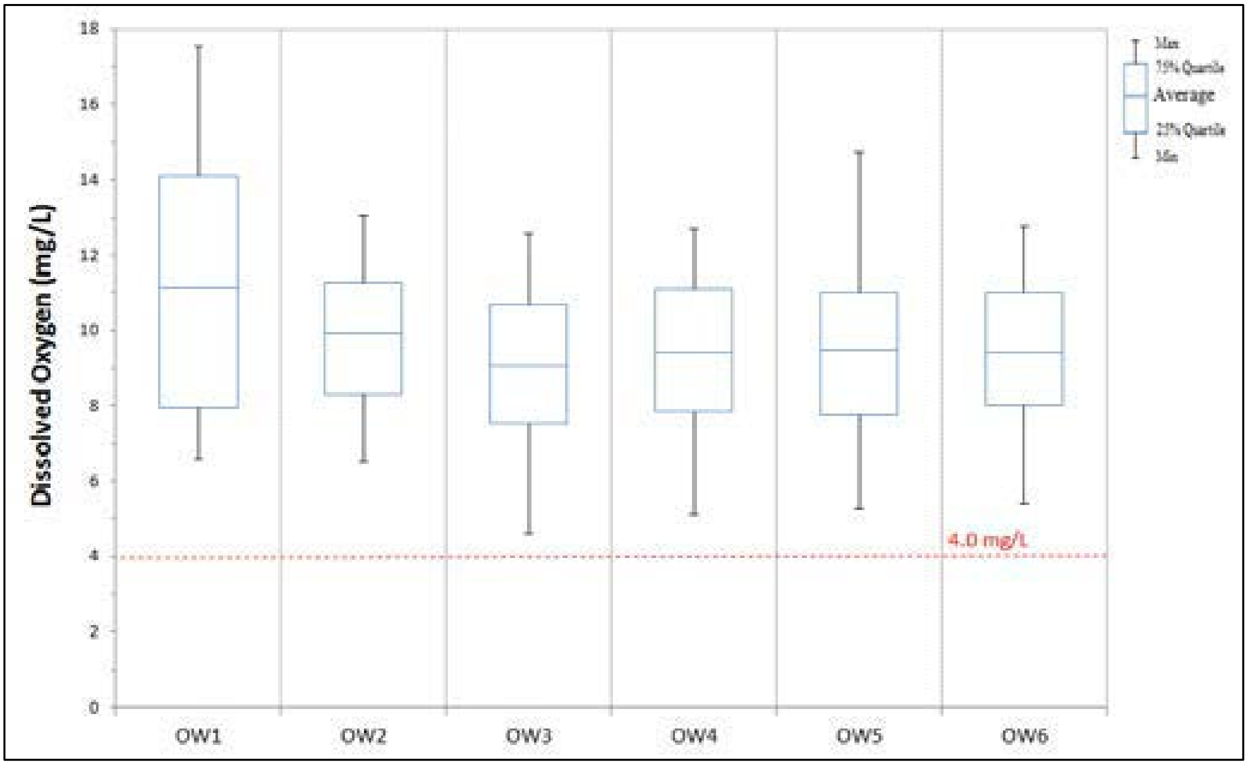

Figure 2-24. DO Concentration at Flushing Creek LTCP WQ Stations (November 2013 – May 2014)

3.0 CSO BEST MANAGEMENT PRACTICES

The State Pollutant Discharge Elimination System (SPDES) permits for all 14 Waste Water Treatment Plants (WWTP) in New York City (NYC) require Department of Environmental Protection (DEP) to report annually on the progress of the following 13 combined sewer overflow (CSO) best management practices (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 U.S. Environmental Protection Agency (EPA) National Combined Sewer Overflow Policy, which were developed by the EPA to represent BMPs that would serve as technology-based CSO controls. They were intended to be "determined on a best professional judgment basis by the National Pollutant Discharge Elimination System (NPDES) permitting authority" and to be 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 are shown in Table 3-1.

On May 8, 2014 the DEP and New York State Department of Environmental Conservation (DEC) entered into an administrative Consent Order[1], referred to as the 2014 CSO BMP Order on Consent, which is an extension and replacement of 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

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

Compliance identifying the milestones that have been completed and new dates for the milestones to be completed.

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 2013 Best Management Practices Annual Report (2013 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 brief summaries of each BMP and their respective relationships 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 combined sewer system (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 maximization of flow to the WWTP can be ensured. 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, as well as an evaluation of hydraulic capacity, so that regulators and weirs can be adjusted to maximize the use of system capacity for CSO storage, thereby reducing the amount of overflow. DEP provides general information in the 2013 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 Long Term Control Plans (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 two times design dry weather flow (2xDDWF) through the plant headworks; a minimum of 2xDDWF through the primary treatment works (and disinfection works, if applicable); and a minimum of one and one-half times design dry weather flow (1.5xDDWF) through the secondary treatment works during wet weather. The actual process control set points may be established by the WWOP required in BMP 4.

NYC's WWTPs are physically capable of receiving a minimum of twice their permit-rated design flow through primary treatment and disinfection per their DEC-approved WWOPs. The maximum flow that can reach a particular WWTP, however, 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 are trained as to 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, as per Section VIII (3) and (4) of the SPDES permits. Analyses presented in the 2013 BMP Annual Report indicate that DEP's WWTPs generally complied with this BMP during 2013.

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.

The Tallman Island WWTP WWOP, dated July 2010, was approved by DEC in September 2010. A July 2011 version was submitted to DEC on July 14, 2011. No formal response has been provided by DEC to that submittal. The WWOP was submitted to DEC in December 2014.

The Bowery Bay WWTP WWOP, dated March 2009, was conditionally approved by DEC in May 2009. The WWOP was submitted to DEC in December 2014.

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 information per SPDES permit requirements. 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. An examination of the data for regulators, pump stations and WWTP's revealed that there was no dry weather bypassing to Flushing Creek due to regulators, pump stations or WWTP bypasses in 2013.

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 2013 BMP Annual Report, the average total metals discharged by all regulated industries to the WWTPs was 13.9 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 0.2 lbs/day of total metals from regulated industries bypassed to CSOs in 2013 (DEP, 2014).

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 City programs and an implementation schedule to reduce the water quality impacts of street and toilet litter.

3.8 Combined Sewer Replacement

This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer Systems and the CSO's), requiring all combined sewer replacements to be approved by the New York State Department of Health (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. No projects are reported for the Tallman Island and Bowery Bay WWTP service area in the 2013 BMP Annual Report.

3.9 Combined Sewer Extension

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.

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 2013 BMP Annual Report. According to the report, one private sewer extension was completed in 2013.

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 2013, conditions did not require DEP to prohibit additional sewer connections or sewer extensions.

3.11 Septage and Hauled Waste

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. This BMP addresses NMC 1 (Proper Operations and Regular Maintenance Programs for the Sewer System and the CSOs). 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 2013 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 New York City Department of Health and Mental Hygiene (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 Flushing Creek. Bathing beaches are explicitly prohibited in the upper East River and its tributaries by Local Law.

3.14 Characterization and Monitoring

Previous studies have characterized and described the Tallman Island and Bowery Bay WWTP collection system and the water quality for Flushing Creek (see Chapters 3 and 4 of the Flushing Creek WWFP, 2011). Additional data was collected and are 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 the DEC. Additional quarterly and one comprehensive report summarizing one year of known or suspected CSO discharges will be submitted to the 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 11 annual reports to-date, covering calendar years 2003 through 2013. 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

Combined sewer overflow (CSO) facility planning in Flushing Creek began under the East River CSO Facility Planning Project, which focused on quantifying and assessing the impacts of CSO discharges to the Upper East River, Western Long Island Sound and their tributaries. During this planning period Flushing Creek was part of the Flushing Bay CSO planning area, and the recommendation for Flushing Bay made in 1989 featured a storage facility with 43 million gallons (MG) of capacity: 28 MG in the tank and 15 MG in the upstream sewers. The Flushing Bay CSO Retention Facility was constructed in phases to provide abatement in the Tallman Island Wastewater Treatment Plant (WWTP) drainage area at CSO outfall TI-010 which discharges to the head of Flushing Creek.

A major upgrade is also underway to construct an extension of the Whitestone Interceptor. This project is aimed at improving the wet weather conveyance capacity to the Tallman Island WWTP. When this project is completed, it is projected to significantly increase the number of hours during which the Tallman Island WWTP will reach two times design dry weather flow (2xDDWF).

4.1.a Completed Projects

The 43 MG Flushing Bay CSO Retention Facility became operational in May 2007 and was accepted by New York State Department of Environmental Conservation (DEC) in January 2011. The bid cost for this facility was $292M. Including change orders, the total cost of this facility was $333M. The facility was constructed largely underground on Fowler Avenue in Queens near Corona Park, and was designed to capture wet weather flow from the Kissena Corridor sewers that previously discharged from outfall TI-010, along with some CSO generated in the adjacent Bowery Bay WWTP service area on the east side of Willow and Meadow Lakes. The tankage in the facility is 28 MG, but the hydraulics are such that 15 MG of additional in-line storage upstream is induced, such that any event at or below 43 MG is fully captured and pumped into the Flushing Interceptor for treatment at the Tallman Island WWTP. The portion of events larger than 43 MG in excess of that threshold passes through the facility where it is screened for floatables and heavy settleable solids are passively removed. The peak flow rate is 1,400 million gallons per day (MGD); a diversion allows the infrequent flows that exceed this to bypass the tank.

Another project that will benefit water quality in Flushing Creek is nearing completion. New York City Department of Environmental Protection (DEP) has been working to maximize wet weather flow to the Tallman Island WWTP under work originally motivated by a prior Consent Order referred to as the Omnibus IV Order. The Tallman Island portion of that Order was included in the current 2012 CSO Order on Consent. Regulator modifications to increase flows to the WWTP were as follows:

- Demolition of non-working sluice gates and raising of the overflow weir at TI-09;
- Bulkheading the overflow side of the regulator TI-10 and demolition of parts of the regulator;
- Raising the overflow spill elevation at TI-10A; and
- Enlargement of the orifice opening at regulator TI-13.

Interceptor improvements implemented to improve conveyance include:

- Disconnecting the Whitestone Interceptor from the Main Interceptor and constructing a new 2,100 foot interceptor from the disconnection point to the WWTP; and
- Surveying and inspecting a 1,500 foot section of the interceptor between Ulmer Street south of 26th Avenue and Ulmer Street north of the Whitestone Expressway to prepare for reconstruction.

The currently-estimated construction cost of the aforementioned improvements is $20M (according to the most up-to-date cost estimate available upon the writing of this report). Construction of the new Whitestone Interceptor was completed in 2014, and the new section of interceptor has been activated. The Construction Completion Milestone for this project is July 2015 and all work is on or ahead of schedule.

4.1.b Ongoing Projects

The Whitestone Expressway Outfall Project currently under construction by the New York City Department of Design and Construction (DDC) may impact water quality in Flushing Creek. Designated as Capital Project No. SE-809, the project involves the construction of new stormwater collection sewers along portions of Linden Place (about 500 linear feet), Farrington Street (about 375 linear feet), 31st Drive (about 450 linear feet), 31st Road (about 750 linear feet), Ulmer Street (about 500 linear feet), Higgins Street (about 500 linear feet), College Point Boulevard (about 500 linear feet) and the Whitestone Expressway service roads (about 3,140 linear feet). These new storm sewers would be served by a new 7-foot-6-inch wide by 9-foot-high wide outfall to Flushing Creek extending west from College Point Boulevard about 360 feet from the intersection of the southerly terminus of the Whitestone Expressway Southbound Service Road. In addition to handling drainage from local streets, the outfall will handle runoff from a segment of the Whitestone Expressway (Interstate 678) where it passes over the outfall site. Drain pipes leading from the expressway are being tied into the proposed outfall. This project will separate storm flows from a drainage area of approximately 244 acres that currently has combined sanitary and storm sewers leading to CSO. The proposed action would therefore reduce the drainage area currently served by combined sewers which may provide water quality benefits for Flushing Creek.

4.1.c Planned Projects

There are no grey infrastructure projects planned by New York City (NYC) to impact Flushing Creek. For private development such as Willets Point, refer to Section 2.

4.2 Other Water Quality Improvement Measures Recommended in Facility Plans (dredging, floatables, aeration)

DEP is working with the U.S. Army Corp of Engineers (USACE) on potential dredging and environmental restoration projects within Flushing Creek. The overall goal of these efforts is to restore the natural state and functioning of the system to support biodiversity, expand habitat for fish, aquatic insects and other wildlife, and enhance water quality. Restoration activities may range from a removal of fill that inhibits natural hydrologic function, to wetland planting and upstream constructed wetland. Wetlands are among the most biologically productive natural ecosystems known, comparable to tropical rain forests in their productivity and species diversity. 85 percent of waterfowl and migratory birds use wetlands. They also have aesthetic value, providing open space and opportunities for education and research. Appendix D contains a Letter from USACE regarding this restoration project.

In addition to the USACE/DEP restoration effort, DEP is evaluating the potential for approximately two to four more acres of wetland restoration.The estimated cost of this additional restoration is $35M.

4.3 Post-Construction Monitoring

The Post-Construction Compliance Monitoring (PCM) Program is integral to the optimization of the Flushing Creek Long Term Control Plan (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 Flushing Creek and the actions identified in this LTCP, with the ultimate goal of fully attaining compliance with current water quality standards (WQS) or supporting a Use Attainability Analysis (UAA) to revise such standards, as appropriate. The data collection monitoring contains three basic components:

1. The Flushing Bay CSO Retention Facility Wet Weather Operating Plan (WWOP) as appended to the Tallman Island WWTP WWOP;

2. Receiving water data collection in Flushing Creek using DEP Harbor Survey Monitoring (HSM) locations; and

3. Modeling of the collection system and receiving waters to characterize water quality using the existing InfoWorks CS™ (IW) and East River Tributaries models (ERTM), respectively.

The details provided herein are limited to the Flushing Creek 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 for Flushing Creek includes sample collection at two locations within the Creek (stations FLC1 and FLC2), a long term HSM station (E15), and Flushing Bay station FB1. Figure 4-1 presents a map of these locations. PCM in Flushing Creek commenced in the summer of 2007 upon DEC approval of the PCM Plan for Flushing Creek and Flushing Bay. Results from the PCM for this waterbody have been reported annually from that time to present. All stations related to the Flushing Creek PCM program have been sampled a minimum of twice per month from May through September and monthly during the remainder of the year.

Since this data was collected prior to the actions identified in this LTCP becoming operational, a pre-control baseline can be established. Monitoring will continue for several years after the actions identified in this LTCP are in place, as part of the adaptive management approach, in order to assess if the water quality improvements are similar to those predicted by the models (i.e., difference between the projected and actual performance). Build-out of green infrastructure (GI) will factor into this schedule as well.

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

The parameters related to water quality that are measured include: dissolved oxygen, fecal coliform, enterococci, chlorophyll 'a', and Secchi depth. Except for enterococci, these parameters have been used by NYC to identify historical and spatial trends in water quality throughout New York Harbor for decades.

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

The Flushing Creek monitoring results that were associated with the DEP PCM program for 2013 are presented on Figures 4-2 through 4-5. The results are shown for dissolved oxygen (DO), fecal coliform bacteria, enterococci bacteria, and total suspended solids (TSS), respectively. The top panel of each figure shows the daily rainfall for 2013 (at LaGuardia Airport). The second presents the reported overflow volumes discharged from the Flushing Bay CSO Retention Facility during the same period. The third panel shows the measured constituent concentrations for the stations in Flushing Creek, and the bottom panel shows the measured constituent concentrations for the stations in Flushing Bay. Applicable New York State (NYS) WQS are also shown (Class I).

On Figure 4-2, the DO-monitoring results for Flushing Creek show excursions below the criterion (4.0 mg/L) from June through early September. In Flushing Bay, DO values attained the criterion in all but three samples: one measurement in August and two locations during the same sampling event in September.

Figure 4-1. Location of Facility and Water Quality Monitoring Stations Used for Flushing Creek Post-Construction Compliance Monitoring

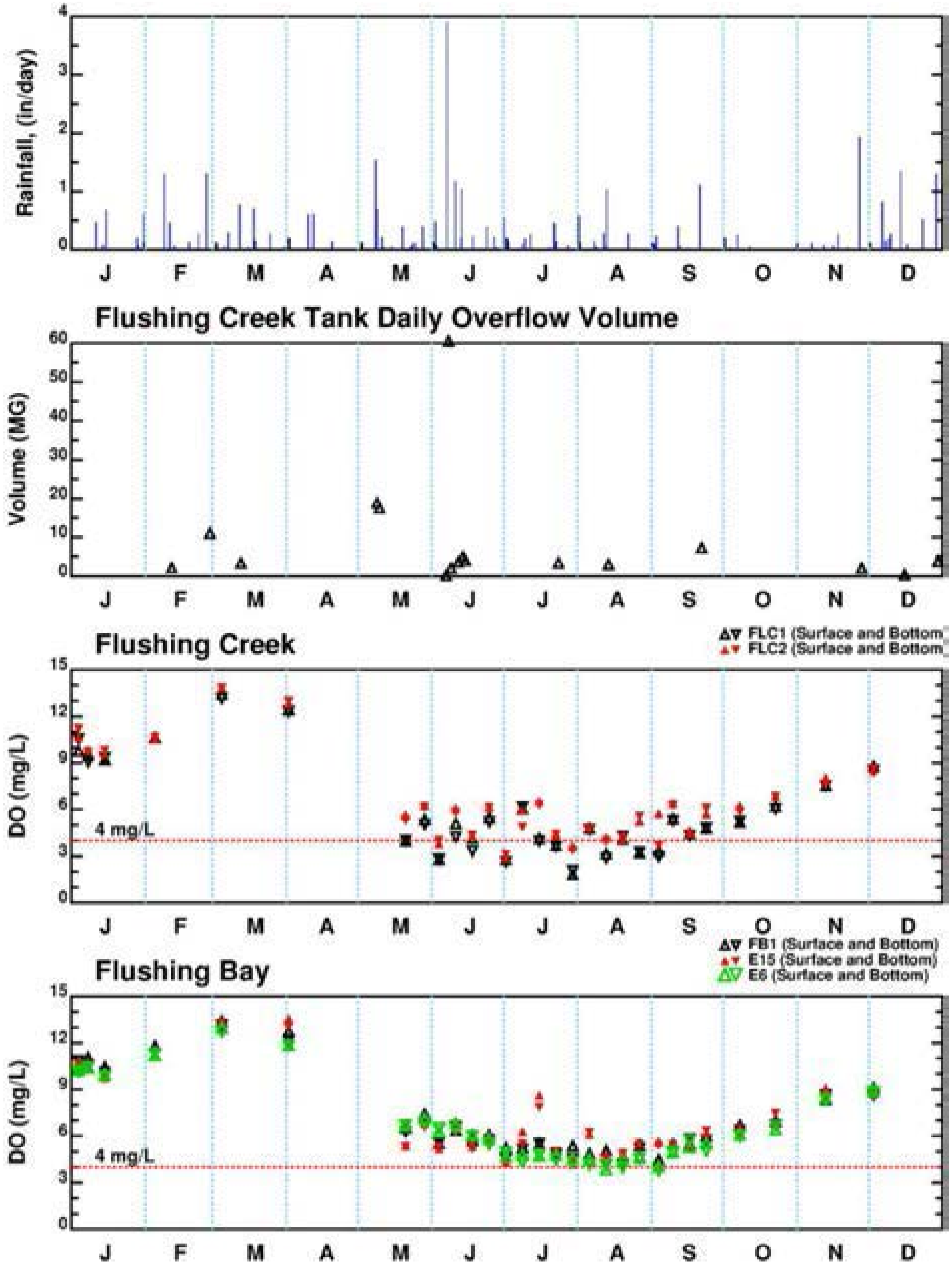

Figure 4-2. Flushing Bay CSO Retention Facility,
Ambient Water Quality Monitoring – Dissolved Oxygen, 2013

Figure 4-3 presents the fecal coliform concentrations measured in Flushing Creek and Flushing Bay. In Flushing Creek, discrete values were generally above the geometric mean (GM) criterion (2,000 cfu/100mL), especially during the summer. In Flushing Bay, ten discrete measurements were above the criterion, but the vast majority of measurements were less than that level. These discrete measurements above the criterion generally occurred near the beginning and ending of the recreational season (May 1st through October 31st).

As shown on Figure 4-4, enterococci levels in Flushing Creek are generally elevated with many values above 100 cfu/100mL and some values above 1,000 cfu/100mL. In Flushing Bay, most samples were less than 35 cfu/100mL but there were eight values above 100 cfu/100mL both within and outside the recreational season (May 1st through October 31st).

Figure 4-5 presents the results of TSS sampling in Flushing Creek and Flushing Bay. TSS concentrations were generally below 20 mg/L in both Flushing Creek and Flushing Bay. Higher TSS concentrations do not appear to be correlated to rainfall.

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

The Flushing Bay CSO Retention Facility effluent is monitored using ISCO 2150 flow meters mounted on the invert of each of the three effluent channels. Acoustic Doppler velocity and pressure transducer level measurements are collected to calculate flow (area-velocity method), and each cell level is measured and used to verify overflow times. The data interval is set to fifteen (15) minutes during conditions with measured velocity less than 0.5 feet per second to conserve storage space during periods of negligible flow, and when the velocity exceeds this threshold, the units begin logging data at one minute intervals. Each unit has an internal data storage of approximately 395 kilobytes which translates into approximately 79,000 pieces of data across the following parameters: velocity, level, total flow rate, input voltage, velocity signal, and velocity spectrum. The data interval was extended from one minute to five minutes to allow the system to log eleven (11) days of constant flow measurement.

Flow Monitoring

DEP monitors water-surface elevations and pump-down rates at various locations within the Flushing Bay CSO Retention Facility. Based on these measurements and other information, DEP estimates daily inflow and infiltration (I/I), wet weather retained volume, pump-back volume, overflow periods and overflow volumes. Table 4-1 presents a summary of the monthly overflow estimates, respectively.

Analysis[1] of gauge-adjusted radar rainfall data indicates that, in 2013, with 113 storms totaling 36.83 inches, 2013 had less total rainfall and smaller storms than the long term average in NYC. Monthly rainfall ranged from 0.37 to 7.89 inches.

[1] *Analyses of rainfall statistics performed using EPA's SYNOP program using minimum inter-event time of 4 hours and minimum storm threshold of 0.01 inches.*

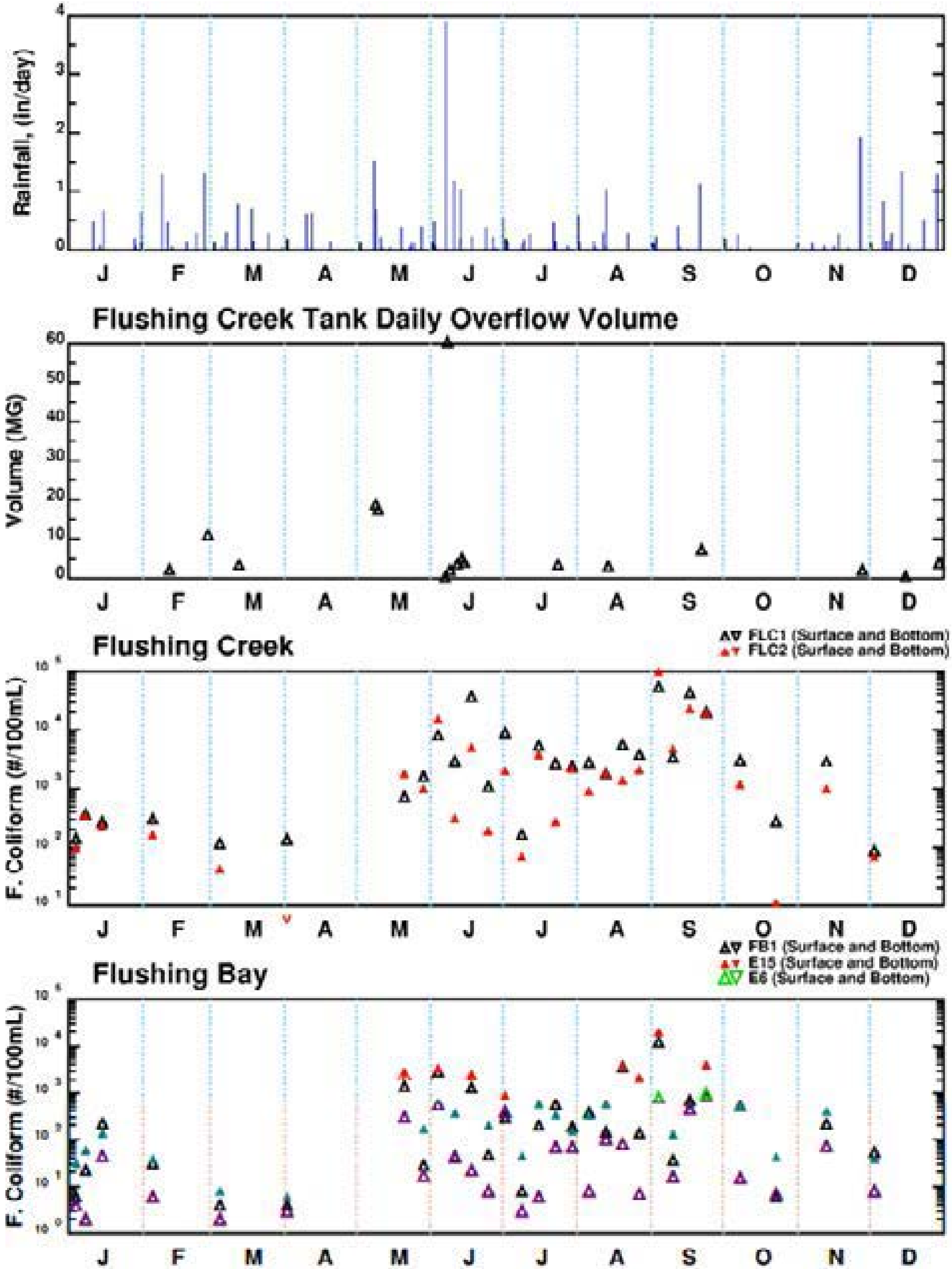

Figure 4-3. Flushing Bay CSO Retention Facility, Ambient Water Quality Monitoring – Fecal Coliform Bacteria, 2013

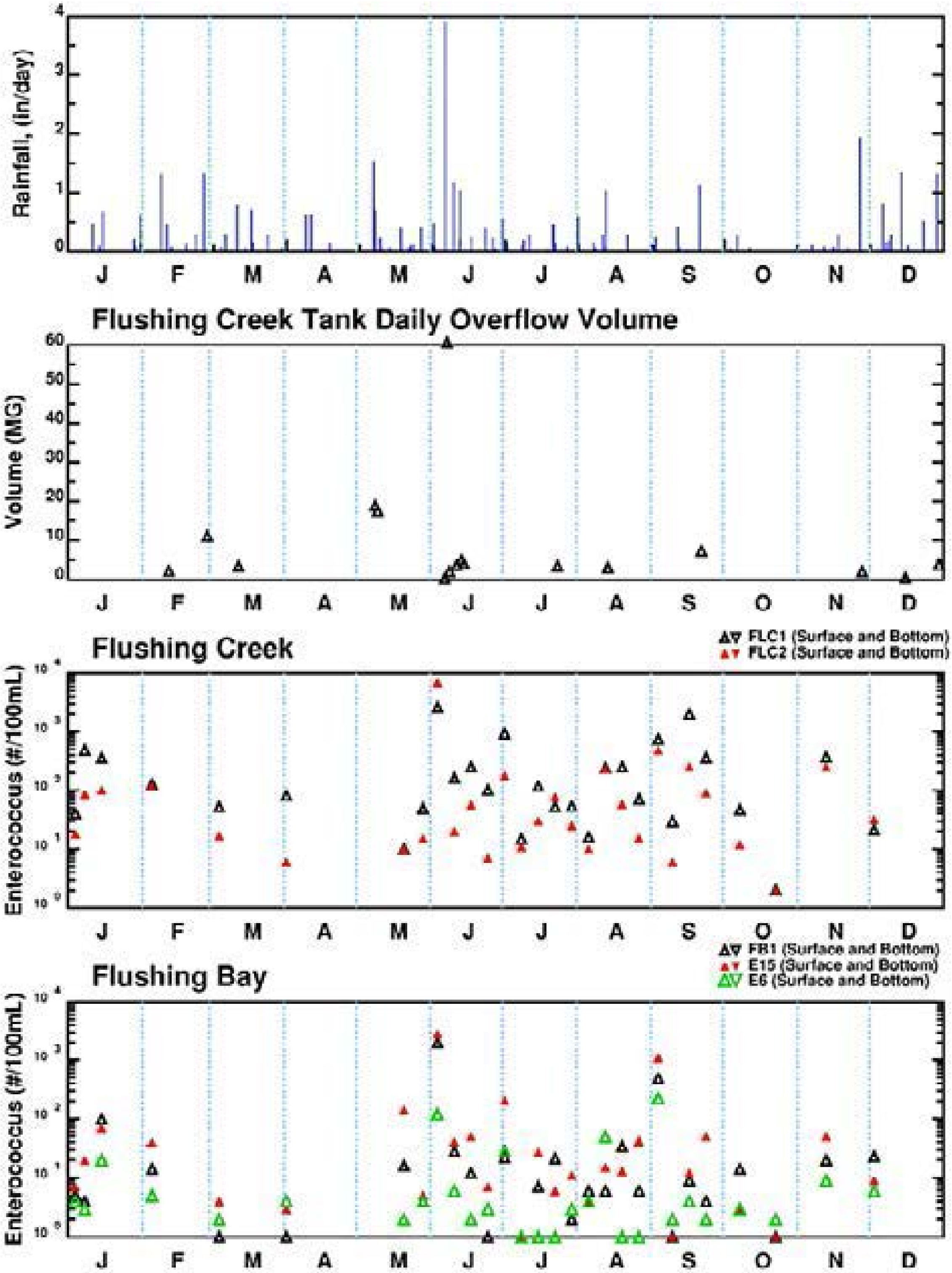

Figure 4-4. Flushing Bay CSO Retention Facility, Ambient Water Quality Monitoring – Enterococci Bacteria, 2013

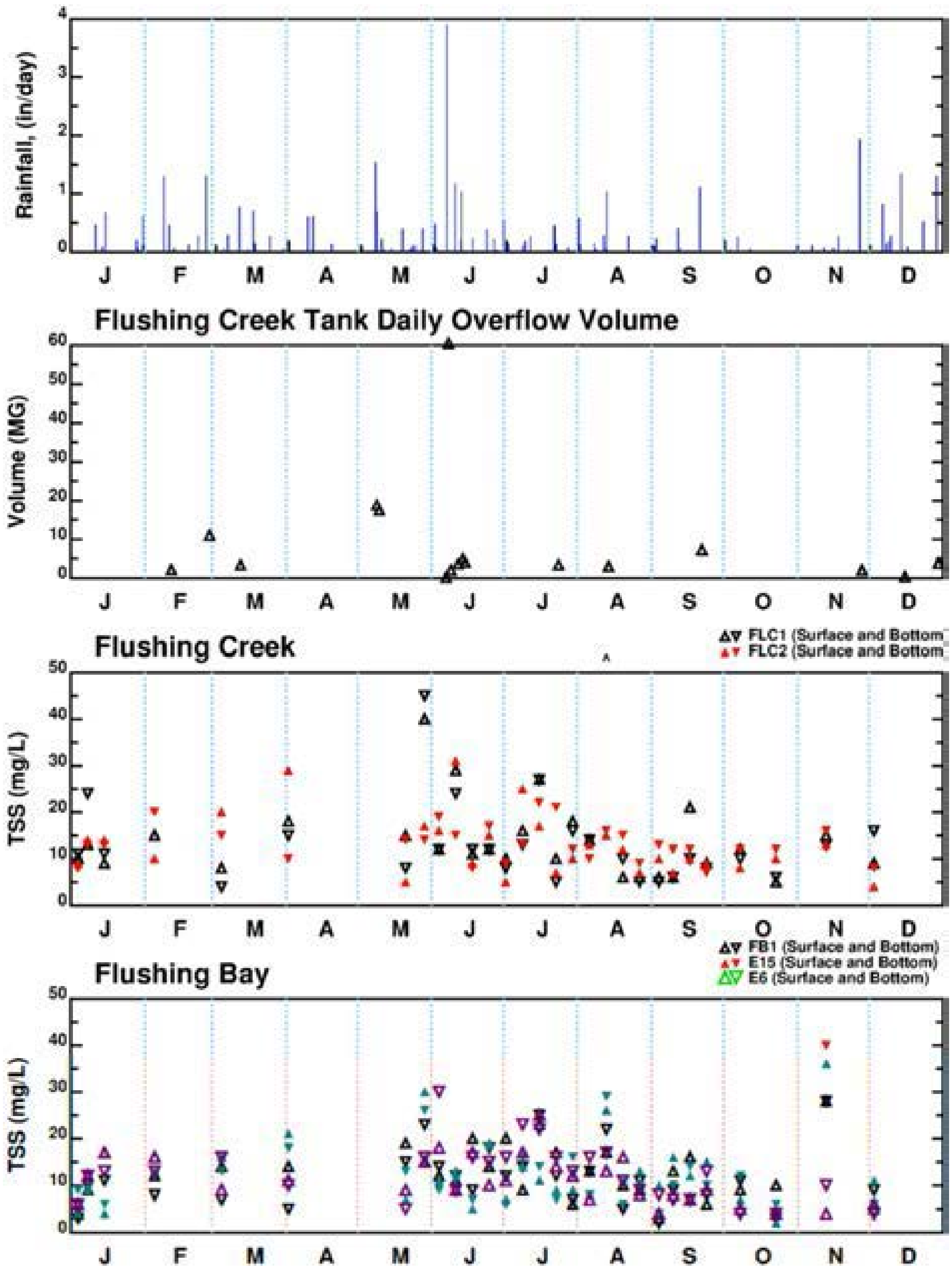

Figure 4-5. Flushing Bay CSO Retention Facility, Ambient Water Quality Monitoring – TSS, 2013

As summarized in Table 4-1, the Flushing Bay CSO Retention Facility monitoring data showed that the facility overflowed during 14 storm events in 2013, or about once a month, meaning that the Flushing Bay CSO Retention Facility fully captured flow generated during the other 99 rainfall events (88 percent). DEP reported that the tank retained a total of 2,483 MG of combined sewage for pump-back and treatment at the Tallman Island WWTP. A more detailed discussion of this information, including detailed discharge monitoring reports and methodology, can be found in the *Post Construction Compliance Monitoring and CSO Retention Facility Overflow Summary for Calendar Year 2013* (DEP, June 2014).

DEP recently completed a CSO Flow Monitoring Pilot Study, one of the primary goals of which is to better understand the monitoring technology's ability to measure CSO overflows from regulator structures as well as at CSO storage facilities. The current measurement approach employed at the Flushing Bay CSO Retention Facility relies on a temporary setup to overcome limitations in the permanent metering array that were identified during facility start-up. As a result, managing the meters as currently configured requires a maintenance contract. Generally, a 3-man crew is used and access to the meters requires confined space safety protocols to be used. The duty conditions contribute to operational issues: meter fouling, difficulty calibrating and verifying results, and assuring confidence in the data collected. A plan is in place to replace the temporary ISCO setup with a more permanent configuration.

Table 4-1. Flushing Bay CSO Retention Facility - Estimated Monthly Retained Volume and Overflows, 2013

Month	Rain(1) Near Flushing Bay Tank (in)	Retained Volume(2,3) (MG)	Monthly Recorded Overflow Volume(2) (MG)
January	2.20	217	0
February	3.65	232	13
March	2.46	242	3
April	1.49	164	0
May	4.03	197	36
June	7.89	290	75
July	2.64	225	3
August	2.59	211	3
September	2.08	190	7
October	0.37	122	0
November	2.64	158	2
December	4.79	236	4
Totals	**36.83**	**2,484**	**146**

Notes:
(1) Rainfall based on gauge-adjusted radar rainfall (provided by Vieux & Associates) for tank drainage area, as used for all model calculations.
(2) Based on water-level measurements and pump-back values from monthly operation reports provided to DEC.
(3) Retained volume includes combined sewage and I/I retained in the tank and pumped back for treatment at WWTP.

Even during dry weather, the Flushing Bay CSO Retention Facility collects a combination of I/I from the influent sewers and seepage. To quantify the I/I, DEP tracks the tank pump-down during dry weather periods and estimates the overall I/I on a daily and monthly basis. These I/I estimates are summarized in the Flushing Bay CSO Retention Facility monthly operating reports. In 2013, the average I/I rate was about 4.3 MGD, with monthly average values ranging from 3.7 to 5.2 MGD. The Flushing Bay CSO Retention Facility is operated such that I/I volumes are pumped back to the WWTP prior to anticipated wet weather events to maximize the rate of capture of combined sewage at the facility. This minor inflow is contained in the IW modeling assumptions.

Effluent Quality

Overflow effluent water quality sampling was performed on 15 different days with overflow including most overflow events. Observed BOD_5 concentrations ranged from 7 to 49 mg/L and averaged about 27 mg/L for the year, while TSS concentrations ranged from 12 to 84 mg/L and averaged about 33 mg/L. Oil and grease (O&G) concentrations measured less than 5.0 mg/L for all but two of the seven samples taken, and the higher of the other two was 7.0 mg/L. Only trace settleable solids were detected in any of the seven samples taken. Disinfection of tank overflows is not performed, and fecal coliform concentrations exceeded the concentration able to be analyzed in each of the four samples taken (denoted by TNTC or “too numerous to count”). Flushing Bay CSO Retention Facility sampling results are shown in Table 4-2.

In addition, limited effluent quality data were collected as part of the development of the LTCP in an attempt to better quantify the loadings to Flushing Creek. Overflow events were sampled in late 2014. Bacteria data from the sampling events was presented in Section 2.0.

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 agreed-upon 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 National Oceanic and Atmospheric Administration (NOAA) rain gauge being taken to represent the rainfall over the entire drainage area. In reality, storms move through the area 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 the observed.

Table 4-2. Flushing Bay CSO Retention Facility – Effluent Quality Data, 2013

Overflow begin Date (Mo/Da)	Rain(1) Near Flushing Bay Tank (in)	Overflow Volume(4) (MG)	BOD5 (mg/L)	TSS (mg/L)	Oil & Grease (mg/L)	Settleable Solids (mL/L)	Fecal Coliform GM cfu/100mL
2/9(2)	1.30	No	-	-	-	-	-
2/11(2)	0.47	2	45	46	NR	NR	NR
2/27	1.31	11	41	35	7.0	Trace	TNTC
3/12	0.78	3	49	15	NR	NR	NR
5/8	1.53	19	46	48	NR	NR	NR
5/9	0.70	18	39	60	NR	NR	NR
6/6(3)	3.91	63	16	15	NR	NR	NR
6/11	1.19	4	17	16	<5.0	Trace	TNTC
6/13(3)	1.24	9	16	12	NR	NR	NR
7/23	0.14	3	21	27	5.8	Trace	TNTC
8/13	1.04	3	18	21	NR	NR	NR
9/21	1.12	7	26	30	NR	NR	NR
11/27(2)	1.93	2	10	32	<5.0	Trace	TNTC
12/15(2)	1.35	<0.5	9	24	<5.0	Trace	TNTC
12/29	1.30	4	48	84	NR	NR	NR

Notes:

(1) Rain events per EPA SYNOP analysis with 4-hr inter-event time and 0.01 minimum. Rain, based on gauge-adjusted radar rainfall (provided by Vieux & Associates) for tank drainage area, as used for all model calculations.

(2) Snow or snow melt associated with this event. Because model assumes all precipitation is rain, model-calculated overflows may exceed observed during initial event rather than later during periods of snow melt (such as February 11).

(3) Storm spanned multiple calendar days. Discrete daily water quality concentrations are shown where available.

(4) DEP reported volumes based on trend analysis of measured in-tank water elevations and hydraulic calculations.

"No" = no overflow was observed during this storm, therefore no samples were collected (-).
“NR” = no data reported. Sampling not required when facility not manned.
“TNTC”= Too Numerous to Count.

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

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

5.0 GREEN INFRASTRUCTURE

By capturing stormwater runoff and managing it through the processes of volume retention, infiltration, evapotranspiration, and re-use, green infrastructure (GI) can reduce stormwater discharge to combined sewer systems (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 New York State Department of Environmental Conservation (DEC) by June 20, 2016. By 2030, DEP is required to control the equivalent of stormwater generated by one inch of precipitation on ten percent of impervious surfaces citywide in combined 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 combined sewer overflows (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 other 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 implementing an all-grey strategy. In addition to its primary objective, enhancing water quality in New York City (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 City agencies, is tasked with designing and constructing GI practices, which capture and manage by infiltration and evapotranspiration, the 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 designed other projects on City-owned properties that include pervious pavement, rain gardens, retention/detention systems and green and blue roofs. The Area-wide implementation strategy

[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.

and other implementation details initiated by OGI to achieve the milestones in the 2012 CSO Order on Consent are described in more detail below and in the 2012 and 2013 *Green Infrastructure Annual Report* available on DEP's website.

5.2 City-wide 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, as well as considering other CSO control projects undertaken through the Waterbody/Watershed Facility Plans (WWFPs), or 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 GI Program, DEP will continue to review and expand the number of targeted areas to ensure sufficient GI implementation toward 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 GI Program, which allows for factoring in field conditions, costs, and other challenges in implementation into the program 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 as much as 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. It 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 City-owned property within the target areas. DEP coordinates on a regular basis with partner agencies to review designs for new projects and to gather current capital plan information to identify opportunities to integrate GI into planned public projects.

DEP manages several of its own design and construction contracts for right-of-way and on-site GI practices. Additionally, the New York City Economic Development Corporation (EDC), 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 City 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.

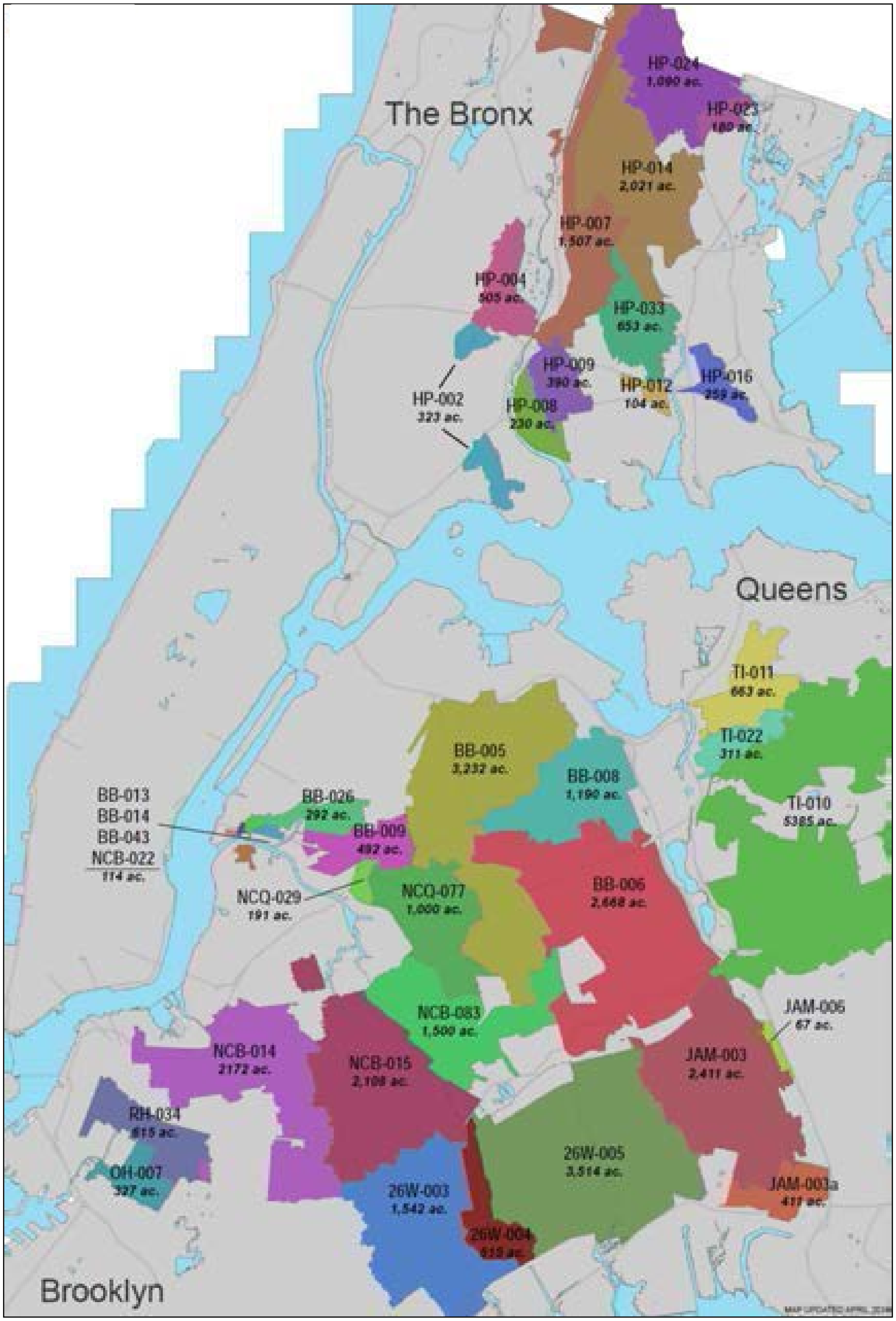

Figure 5-1. Target CSO Tributary Areas for Green Infrastructure Implementation

DEP also created an educational video on the Green Infrastructure Program. This video gives a brief explanation of the environmental challenges caused 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.

In order 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 right-of-way. The brochure also includes frequently asked questions and answers, and explains the co-benefits of GI.

DEP notifies abutting property owners in advance of right-of-way 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.

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

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

The *Green Infrastructure Annual Report* contains 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 constructed GI.

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, to determine the most cost-effective, adaptable, and efficient GI strategies that can be implemented citywide. Specifically, the pilot monitoring has 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 through 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 pilot individual GI practices have been constructed and monitored as part of the citywide pilot program for GI. These practices include: right-of-way 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 and 2011, as construction for each of the monitoring sites was completed. Pilot Monitoring Program results will assist in validating modeling methods and parameters. Results are further discussed 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 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 Post-Construction Compliance Monitoring (PCM) Report was submitted to DEC in August 2014. 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 right-of-way GI installations in 2012 and the permeable pavement retrofit projects at New York City Housing Authority's (NYCHA) Seth Low Houses in 2013. The total design and construction costs were approximately $1.5M. In the 19-acre Newtown Creek Green Infrastructure Demonstration Project, DEP constructed 19 ROWBs, two rain gardens, and a subsurface storm chamber system on the site of NYCHA's Hope Gardens Houses. The projects were completed in 2013, and costs totaled approximately $1.6M for design and construction. For more detailed information on the Demonstration Projects, see the *2012 Green Infrastructure Annual Report.*

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

5.3.b Public Projects

Green Infrastructure Schoolyards

The "Schoolyards to Playgrounds" program, one of PlaNYC 2030's initiatives aimed at ensuring that all New Yorkers live within a ten-minute walk from a park, is a collaboration between the non-profit Trust for Public Land (TPL), DPR, New York City Department of Education (DOE), and New York City School Construction Authority (SCA) to renovate public school playgrounds and extend playground access to surrounding neighborhoods. In 2011, DEP joined TPL, SCA, and DOE funding up to $5M for construction of up to ten GI schoolyards each year for the next four years. The partnership is a successful component of DEP's strategy to leverage public-private partnerships to improve public property using GI retrofits.

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

5.3.c Performance Standard for New Development

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

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

5.3.d Other Private Projects (Grant Program)

Green Infrastructure Grant Program

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

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

[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, total suspended solids (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 Post-Construction Compliance Monitoring Report documented the performance of installed GI practices in the demonstration areas and was submitted to DEC in August 2014. 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 right-of-way as well as on-site at City-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 took place 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 InfoWorks CS™ (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 pollutant load reduction through stormwater capture in Flushing Creek 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 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 Green Infrastructure Plan have been refined over time to better characterize the retention and detention functions.

5.4.b Opportunities for Cost-Effective CSO Reduction Analysis

There were no additional GI-related opportunities identified for CSO reduction above the baseline penetration rate (as described below) to report in this section.

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

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

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

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

- WQS
  - Fecal Coliform
  - Total Coliform
  - Dissolved Oxygen

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

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

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

Green Infrastructure Baseline Penetration Rate – Flushing Creek

Based on the above criteria, Flushing Creek's characterization ultimately determined that the waterbody is a target area for the GI Program. This particular waterbody has a total tributary combined sewer impervious area of 5,923 acres. DEP projects that GI penetration rates would manage 8 percent of the impervious surfaces within the Flushing Creek/Bay portion of the Tallman Island combined sewer service area and 13 percent of the impervious surfaces in the Flushing Creek/Bay portion of the Bowery Bay WWTP combined sewer service area by 2030. This accounts for ROW practices, public property retrofits, GI implementation on private properties, and for conservatively estimated new development trends based on DOB building permit data from 2000 to 2011 and has projected that data for the 2012-2030 period to account for compliance with the stormwater performance standard. The model has predicted a reduction in annual overflow volume of 46 million gallons (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 GI Program will meet the citywide requirements to manage the equivalent of one inch of rain on 10 percent of impervious surfaces in the combined sewered area as set forth in the 2012 CSO Order on Consent. Figure 5-2 below shows the current contracts in progress in Flushing Creek that will be accounted for as the GI Program progresses toward the 2030 goal. The current Area-wide contracts in the Flushing Creek CSO TDA are in TI-010, TI-011, and TI-022. As more information on field conditions, feasibility, and costs becomes known, and GI projects progress forward, DEP will continue to model the GI penetration rates and make the necessary adjustments at that time.

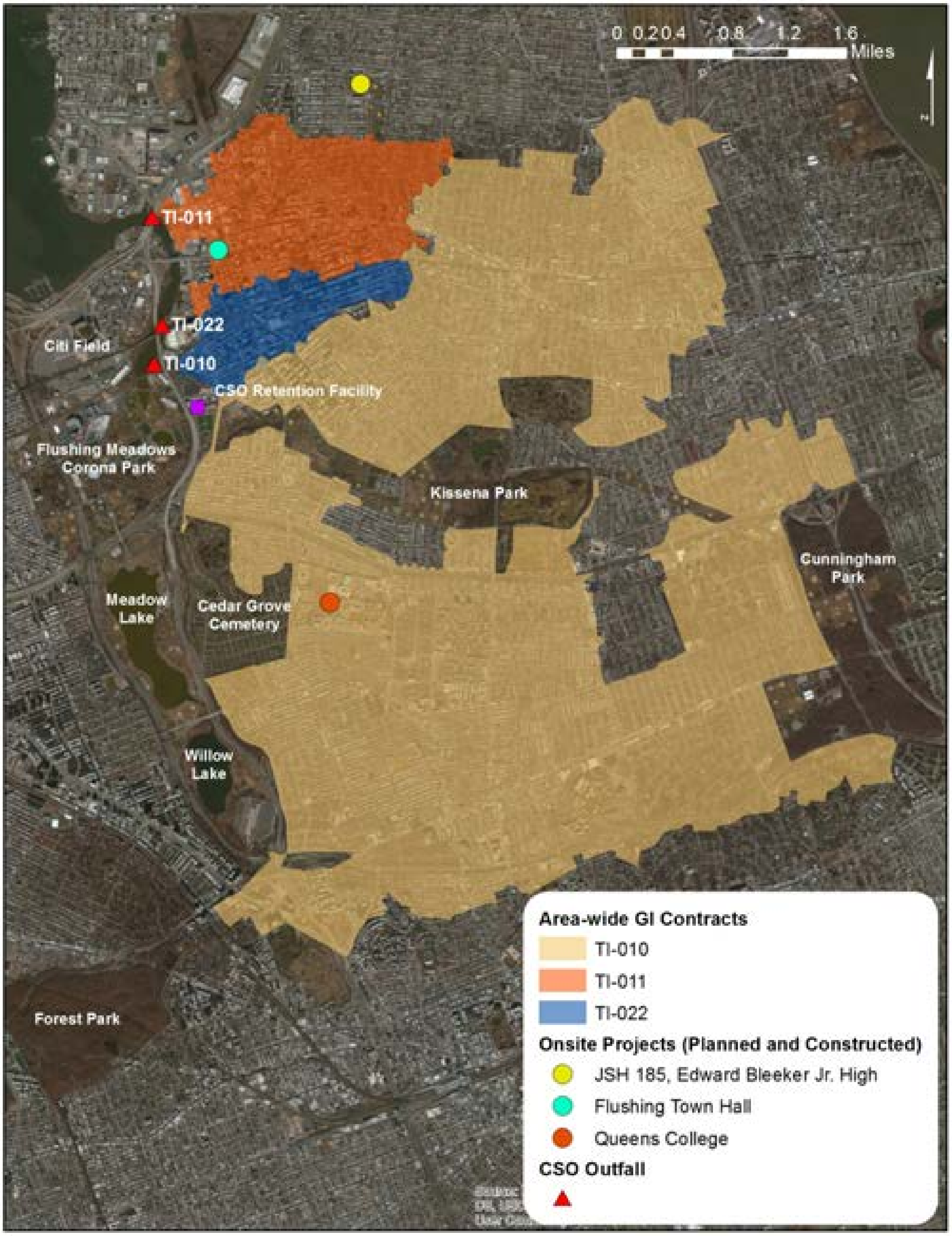

Figure 5-2. Green Infrastructure Projects in Flushing Creek

6.0 BASELINE CONDITIONS AND PERFORMANCE GAP

Key to development of the Flushing Creek Long Term Control Plan (LTCP) is the assessment of water quality in comparison to the applicable water quality standards (WQS) within the waterbody. Water quality was assessed using the East River Tributaries (ERTM) water quality model, verified with both Harbor Survey data and the synoptic water quality data collected in 2014 as part of the LTCP development. The ERTM water quality model was used to simulate ambient bacteria concentrations within Flushing Creek for a set of baseline conditions as described in this section. The InfoWorks CS™ (IW) sewer system model was used to provide flows and loads from intermittent wet weather sources as input to the ERTM water quality model.

Continuous water quality simulations were performed to evaluate the gap between the calculated bacteria levels under baseline conditions and the Existing WQS, Primary Contact WQS, and Future Primary Contact WQS. As described in this section, a one-year (using average 2008 rainfall) simulation was performed for bacteria and dissolved oxygen (DO). This shorter term continuous simulation served as a basis for evaluation of control alternatives that are described in Section 8.0. A 10-year (2002-2011) simulation was performed for bacteria, to assess the baseline conditions, evaluate the performance gap, and analyze the impacts of the final alternative.

This section of the LTCP describes the baseline conditions and the bacteria concentrations and loads calculated by the IW model and the resulting bacteria concentrations calculated by the ERTM water quality model. It also describes the gap between calculated baseline bacteria concentrations and the WQS, when the calculated baseline concentrations exceed the criteria. These analyses are presented for several WQS:

- Existing WQ Criteria (Class I).
- Existing Primary Contact WQ Criteria (Class SC) and proposed fecal coliform Class I bacteria criteria.
- Future Primary Contact WQ Criteria (2012 EPA Recreational Water Quality Criteria [RWQC]).

It should be noted that the enterococci criterion does not apply to the East River Tributaries, such as Flushing Creek, under the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000 for Existing WQS. Therefore Flushing Creek water quality assessments for existing Class SC and proposed Class I criteria considered the fecal coliform criterion only. Future Primary Contact WQ Criteria assessments do take into account both enterococci and fecal coliform criteria for primary contact recreation.

6.1 Define Baseline Conditions

Establishing baseline conditions is an important step in the LTCP process as the baseline conditions will be used to compare and contrast the effectiveness of combined sewer overflow (CSO) controls and to predict whether water quality goals would be attained after the implementation of the LTCP. Baseline conditions for this LTCP were developed in accordance with guidance established by New York State Department of Environmental Conservation (DEC) to represent future conditions. Specifically, these conditions included the following assumptions:

- The dry weather sanitary flows and loads to the wastewater treatment plants (WWTPs) are based on CY2040 projections.
- The Tallman Island and Bowery Bay WWTPs receiving peak flows at two times design dry weather flow (2xDDWF).
- Updated satellite flyover impervious data and recalibrated landside models based on updated impervious data in conjunction with additional flow monitoring.
- The typical rainfall conditions are based on National Oceanic and Atmospheric Administration (NOAA) precipitation data from JFK.
- Grey infrastructure includes those projects recommended in the 2011 Waterbody/Watershed Facility Plan (WWFP).
- Green Infrastructure (GI) in 8 percent of the impervious surfaces within the Flushing Creek/Bay portion of the Tallman Island combined sewer service area and 13 percent of the impervious surfaces in the Flushing Creek/Bay portion of the Bowery Bay WWTP combined sewer service area.

The previously described mathematical models were used to calculate the CSO volume and pollutants loads and their impacts on water quality. The performance gap between calculated WQS was assessed herein by comparing the baseline conditions with WQS. In addition, complete control (100 percent removal) of the CSO discharges was evaluated. Further analyses were conducted for CSO control alternatives in Section 8.

Prior to initiating the Flushing Creek LTCP process, the IW model was used to develop stormwater flows, conveyance system flows, and CSO volumes for the defined set of future or baseline conditions listed above. However, based on more recent rainfall data, as well as the public comments received on the WWFP, it was recognized that some of the baseline condition model input data needed to be updated to reflect more current meteorological conditions, as well as current operating characteristics of various collection and conveyance system components. Furthermore, the mathematical models were also updated from their configurations and levels of calibration developed and documented during the earlier WWFP. IW model alterations for this LTCP reflect a better understanding of dry and wet weather sources, catchment areas, and new or upgraded physical components of the system. In addition, a model recalibration report was issued in 2012 (*InfoWorks Citywide Recalibration Report – December 2012*) that used improved impervious surface satellite data. Minor improvements have also been made as part of this LTCP. For example, water quality model updates included more refined model segmentation. Changes to, and recalibration of, the IW and water quality models are discussed in *Flushing Creek LTCP – Sewer System and Water Quality Modeling – October 2014.* The new IW model network was then used to calculate CSO overflows and loads for the baseline conditions and was used as a tool to evaluate the impact on CSO overflows of potential alternative operating strategies and other possible physical changes to the collection system.

Following are the baseline modeling conditions primarily related to dry weather flow (DWF) rates, wet weather capacity for the Tallman Island and Bowery Bay WWTPs, sewer conditions, precipitation conditions, and tidal boundary conditions. Each of these is briefly discussed in the following:

- **Wet Weather Capacity**: The rated wet weather capacity at the Tallman Island WWTP is 160 MGD (2xDDWF). A project is nearing completion that will disconnect the Whitestone Interceptor from the Flushing Interceptor and make changes to regulators 10, 10A and 13 in order to enhance the conveyance capacity of the collection system. On May 8, 2014, DEC and New York City Department of Environmental Protection (DEP) entered into an administrative consent order that includes an enforceable compliance schedule to ensure that DEP maximizes flow to and through the WWTP during wet weather events.

The rated wet weather capacity at the Bowery Bay WWTP is 300 MGD (2xDDWF). Grey infrastructure projects were proposed in the Flushing Bay WWFP to modify regulators along the high level interceptor to increase the amount of wet weather flow reaching the high level side of the WWTP. This work has been designed and construction is scheduled for some portions of the work in 2015.

- **Sewer Conditions**: The IW model was developed to represent the sewer system on a macro scale, including all conveyance elements greater than 48-inches in equivalent diameter, along with all regulator structures and CSO outfall pipes. Post-cleaning levels of sediments were also included for the interceptors in the collection system, to better reflect actual conveyance capacities to the WWTPs. In addition, sewer separation projects in College Point and the Whitestone area, just east of the Van Wyck Expressway, were included in the IW model, as well as the plan for storm sewers in the Willets Point area.

6.1.a Hydrological Conditions

Previous water quality evaluations of the Flushing Creek watershed, performed in development of the WWFP, used the 1988 precipitation characteristics as the representative typical precipitation year. However, for this LTCP, the precipitation characteristics for 2008 were used for water quality modeling of the baseline condition, as well as for alternatives evaluations. JFK 2008 was selected from among 30 years of data for the four NOAA gages covering New York City because it was closest to the average of the 120 independent time series as determined by having the lowest variance score based on five unweighted statistics (annual total, July total, November total, number of very wet days, and average peak storm intensity) (Climate Change and Population Growth Effects on New York City Sewer and Wastewater Systems, 2013.). In addition to the 2008 precipitation pattern, the observed NOAA tide data at three monitoring locations (Sandy Hook, the Battery and Kings Point) was used in conjunction with NOAA correction factors to determine the tidal conditions at the specific CSO outfalls. In addition, longer 10 year (CY2002 – CY2011) simulations are performed for pathogens for the baseline conditions, 100 percent CSO reduction, and for the preferred plan to better represent projected long term water quality attainment for a variety of meteorological conditions.

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 New York City (NYC). In 2012, DEP completed detailed analysis for water demand and wastewater flow projections. This analysis was further updated in 2014. A detailed Geographical Information System (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 Department of City Planning (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 up to 2040 sanitary flows. These projections also reflect water conservation measures that have already significantly reduced flows to the WWTPs and freed up capacity in the conveyance system.

6.1.c BMP Findings and Optimization

A list of Best Management Practices (BMPs), along with brief summaries of each and their respective relationships to the United States Environmental Protection Agency (EPA) Nine Minimum Controls (NMCs) were reported in Section 3.0 as they pertain to Flushing Creek 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 combined sewer system, thereby improving water quality conditions.

The following provides an overview of the elements of various DEP, State Pollutant Discharge Elimination System (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 Flushing Creek:

- Sentinel Monitoring: In accordance with BMPs #1 and #5, DEP collects quarterly samples of bacteria water quality at the mouth of Flushing Creek in dry weather to assess whether dry weather sewage overflows occur or illicit connections to storm sewers exist. No evidence of illicit sanitary sewer connections was observed based on these data and no illicit sources were included 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 BMP #3, the plant treats wet weather flows up to 2xDDWF that are conveyed to the Tallman Island and Bowery Bay WWTP's. DEP follows the wet weather operating plan and receives and treats 2xDDWF regularly at the Bowery Bay WWTP. Cleaning of the interceptor sediments has increased the ability of the Tallman Island WWTP system to convey 2xDDWF to the treatment plant.
- Wet Weather Operating Plans (WWOP): The Tallman Island and Bowery Bay WWOP's (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

The Flushing Creek LTCP includes the following grey projects recommended in the Flushing Creek 2011 WWFP:

- Construction of a 28 MGD CSO Retention Tank, which induces an additional 15 MG of inline storage in the collection system.
- Modifications to the regulator structures that discharge to outfalls TI-010, TI-010A and TI-013 to retain more wet weather flow in the Whitestone Interceptor and divert it to the Tallman Island WWTP.

- Construction of an extension of the Whitestone Interceptor from its existing junction with the Flushing Interceptor to the Tallman Island WWTP.

The Flushing Creek LTCP includes the following grey projects recommended in the Flushing Bay 2011 WWFP:

- Modifications to regulator structures BBH-04, BBH-05, BBH-06, BBH-09, BBH-010 that discharge to outfalls BBH-005, BBH-006, BBH-007, BBH-008 to reduce CSO discharges to Flushing Bay and allow more wet weather flow to be delivered to the Bowery Bay WWTP.
- Modification to regulator structure BBH-02 that discharge to outfall BBH-002 and construction of a new low-lying sewer to allow more wet weather flow to be delivered to the Bowery Bay WWTP.

These capital projects were included in the 2012 Order on Consent with construction completion milestones of July 2015 for the work on the Whitestone Interceptor. Construction completion of the modifications associated with BBH-02 is required by December 2016. Construction completion of the other Bowery Bay regulator modifications is required by June 2018.

As discussed in Section 5.0, the Flushing Creek watershed is not targeted for a high level of GI build-out, but Flushing Bay is one of the more promising areas for GI build-out in NYC. DEP has projected a 13 percent level of GI implementation for the Flushing Bay portion of the Bowery Bay WWTP drainage system, which has been assumed in the baseline model.

6.1.e Non-CSO Discharges

In several sections of the Tallman Island and Bowery Bay WWTP drainage areas, stormwater drains through storm sewers, and/or directly to receiving waters without entering the combined system or separate storm sewer system. These areas were depicted as “Stormwater Drainage” or “Direct Drainage” in Figure 2-6 and Figure 2-9 (Section 2.0), and were delineated based on topography and the direction of stormwater runoff flow in those areas. In general, shoreline areas adjacent to waterbodies comprise the direct drainage category and stormwater originates from more inland areas. Stormwater areas drain about 745 acres from the Tallman Island WWTP area and about 62 acres from the Bowery Bay WWTP area. Direct drainage from the Tallman Island WWTP area and the Bowery Bay WWTP area each has 29 acres totaling 58 acres of direct drainage. In addition, there is drainage entering Flushing Creek at its head end and flowing out of the Porpoise Dam that drains Flushing Meadow Park (Meadow and Willow Lake area). This area totals 891 acres.

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

The IW model was used to develop CSO volumes for the baseline conditions. It incorporated the implementation of the GI build-out and operation of the planned Flushing Creek and Flushing Bay WWFP projects. Using these overflow volumes, pollutant loadings from the CSOs were generated using the enterococci, fecal coliform, and Biochemical Oxygen Demand (BOD) concentrations. These loadings provided input to the receiving water quality model, ERTM. ERTM was validated using the 2014 monitoring data collected in Flushing Creek during this LTCP as well as Harbor Survey data for the same period. The assessment included comparing the cumulative frequency distribution of 2014 collected concentration data against the cumulative frequency distribution of the model for storms of similar sizes from the pre-WWFP simulation. May 2014 was used as the sampling cut off point in order to provide enough time to process the samples, calibrate and run the model for alternatives analysis and include the results in the LTCP by the submission date. The modeling calibration analyses are provided in the technical memorandum *"Flushing Creek LTCP Sewer System and Water Quality Modeling, October 2014."*

In addition to CSO pollutant loadings, storm sewer discharges, discharges from upstream areas (Flushing Meadows Park) and direct drainage also impact the water quality in Flushing Creek. The pollutant concentrations assigned to the various sources of pollution to Flushing Creek are summarized in Table 6-1. Concentrations in Table 6-1 represent measured concentrations for CSO and sanitary sewage quality and are values considered typical for stormwater and direct drainage for the Flushing Creek drainage area.

Table 6-1. Pollutant Concentrations for Various Sources in Flushing Creek

Pollutant Source	Enterococci (cfu/100mL)	Fecal Coliform (cfu/100mL)	BOD_5 [1] (mg/L)
Stormwater[2]	15,000	35,000	15
Direct Drainage[3]	6,000	4,000	15
CSOs (TI-010 and TI-011)	Monte Carlo	Monte Carlo	Mass Balance
CSOs (other)	Mass Balance	Mass Balance	Mass Balance
Sanitary Sewage[2]	600,000	4,000,000	110
Meadow/Willow Lake	Monte Carlo	Monte Carlo	15

Notes:
(1) 2011, 2012, 2013 DEP Process Control TI and BB WWTP operational records.
(2) HydroQual Memo to DEP, 2005a.
(3) NYS Stormwater Manual, Charles River LTCP, National Stormwater Data Base for commercial and industrial land uses.

Typical (2008) baseline volumes of CSO, stormwater, Flushing Meadows Lake outflow and direct drainage to Flushing Creek are summarized in Table 6-2. The specific SPDES permitted outfalls associated with these sources were shown in Figure 2-7. Additional tables can be found in Appendix A. The information in these tables is provided for the 2008 rainfall condition.

Table 6-2. Annual CSO, Stormwater, and Direct Drainage Volumes and Loads (2008 Rainfall)

Source	Volumetric Discharge (MG/yr)	Enterococci Load (cfu x 10^{12})	Fecal Coliform Load (org x 10^{12})	BOD Load (Lbs)
CSO	1,201	4,776	29,937	234,532
Stormwater/Direct Drainage	624	291	607	78,005
Meadow/Willow Lake	456	8	24	57,010
Total	**2,281**	**5,075**	**30,568**	**369,547**

For the modeling simulations, CSO effluent concentrations for Outfalls TI-010 and TI-011 were assigned based on a Monte Carlo analysis. The Monte Carlo analysis is a statistical calculation that was conducted to produce a set of randomly generated bacteria concentrations for each hour of overflow that have the same statistical properties (geometric mean, standard deviation) of the fecal coliform and enterococci concentrations including ranges and distribution of the observed Flushing Bay CSO Retention Facility and TI-011 outfall discharge bacteria data. As discussed in Section 2.0, the Flushing Bay CSO Retention

Facility overflow, retention facility bypass, and TI-011 bacteria source loadings were determined by using the monitored concentrations, shown in Figure 2-11 and Figure 2-12, and IW modeled overflow volumes.

For the modeling simulations, CSO effluent concentrations for other CSO outfalls in the area (TI-022, BB-006, BB-007, BB-008) were calculated using the stormwater and sanitary concentrations assigned in Table 6-1, multiplied by the flow calculated by the IW model. The model provides a calculated fraction of flow from stormwater and flow from sanitary sources, as follows:

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

where: C_{cso} = CSO concentration
C_{san} = sanitary concentration
C_{sw} = stormwater concentration
fr_{san} = fraction of flow that is sanitary
fr_{sw} = fraction of flow that is stormwater

Loadings to the ERTM model, summarized in Appendix A and Table 6-2, were based on measured concentrations and IW modeling of the flows.

An example of the IW CSO concentration calculation for CSO enterococci concentration is presented below using sanitary and storm runoff concentrations from Table 6-1:

38,400 cfu/100mL = 0.04 x 600,000 cfu/100mL + 0.96 x 15,000 cfu/100mL

In this example, the assumption is that the CSO contains 4 percent sanitary sewage and 96 percent stormwater. The calculated enterococci concentration of 38,400 cfu/100mL would represent about an 18^{th} percentile concentration in the TI-011 distribution and a 13^{th} percentile concentration in the TI-010 distribution (Section 2, Figures 2-11 and 2-12).

In order to fully assess Flushing Creek bacteria levels, pollutant loadings to the Creek must be established. CSO pollutant loadings and storm sewer/direct drainage discharges are two sources of bacteria to the tidal Creek. However, there are additional discharges from the areas upstream of the head end of the Creek (Flushing Meadows Park). Bacteria loadings to the head end of Flushing Creek in the ERTM water quality model were defined as the calculated IW flows emanating from runoff to the Meadow and Willow Lake areas and the associated fecal or enterococci concentrations. These bacteria concentrations were randomly assigned based on the sampling data using a Monte Carlo statistical approach. Figure 6-1 provides a summary of the fecal coliform and enterococci concentrations measured at sampling location OW-02, which was considered as representative of the outflow from the Flushing Meadows Park system (Meadow/Willow Lakes). It should be noted that the park was incorporated into the IW model as a model catchment area and flows from the system simulated based on rainfall.

Table 6-2 provides the total annual average source loadings. Refer to Figure 2-7 for the location of the Flushing Creek SPDES permitted outfalls.

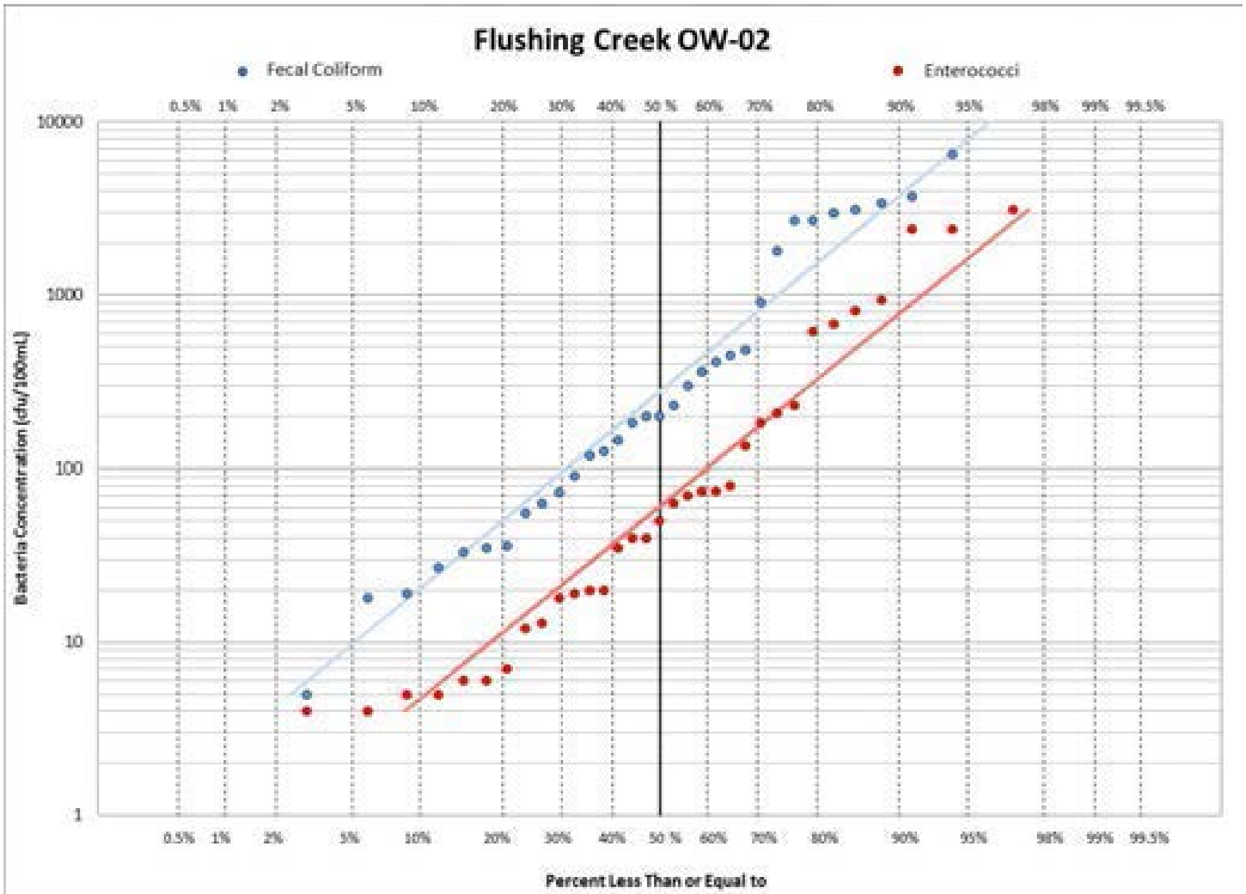

Figure 6-1. Measured Fecal Coliform and Enterococci Concentrations at Location OW-02

6.3 Performance Gap

Concentrations of bacteria and DO in Flushing Creek are controlled by a number of factors, including the volumes of all sources of pollutants into the waterbody and the concentrations of the respective pollutants. Since almost all of the flow and pollutant loads discharged into this waterbody are the result of runoff from rainfall events, the frequency, duration and amounts of rainfall strongly influence Flushing Creek's water quality. The Flushing Creek portion of the ERTM model was used to simulate bacteria and DO concentrations in the Creek for the baseline conditions, using 2002-2011 rainfall and tidal data. Hourly model calculations were saved for post-processing and comparison with the existing (Class I), Primary Contact WQ Criteria (Class SC), and Future Primary Contact WQ Criteria as further discussed below 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. Accordingly, the analysis of Flushing Creek attainment is presented in three separate sections:

- Existing WQ Criteria (Class I);

- Primary Contact WQ Criteria (Class SC[1]) and proposed fecal coliform Class I bacteria Criteria ; and
- Future Primary Contact WQ Criteria (2012 EPA RWQC).

Within these sections, analyses are developed to reflect the differences in attainment both spatially and temporally. The spatial assessment mainly focuses on the area of the waterbody under evaluation herein: Flushing Creek from head of the Creek to the mouth represented at Stations OW-03, OW-04, OW-05 and OW-06. However, as noted in the discussions that follow, there are calculated spatial differences in the projected attainment of water quality criteria with each of those locations. The temporal assessment focuses on compliance with the applicable water quality criteria over the entire year or in the case of bacteria, during the recreational season of May 1 through October 31 inclusive.

A summary of the criteria that were applied is shown in Table 6-3.

Table 6-3. Classifications and Criteria Applied for Gap Analysis(1)

Analysis	Numerical Criteria Applied
Existing WQ Criteria(1)	I: Fecal Monthly GM ≤ 2,000
Primary Contact WQ Criteria(2)	SC: Fecal Monthly GM≤200
Future Primary Contact WQ Criteria(3)	Entero: rolling 30-d GM – 30 cfu/100mL Entero: STV – 110 cfu/100mL

Notes:
GM = Geometric Mean; STV = 90th Percentile Statistical Threshold Value.
(1) DEC has publicly noticed a proposed rulemaking which, if promulgated, would amend 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 proposed total and fecal coliform standards for Class I are the same as the existing standards for Class SC waters.
(2) This water quality criteria is not currently assigned to Flushing Creek. For such criteria to take effect, DEC must first adopt the criteria in accordance with rulemaking and environmental review requirements.
(3) This Future Primary Contact WQ Criteria has not yet been proposed by DEC. For such criteria to take effect, DEC must first adopt the criteria in accordance with rulemaking and environmental review requirements.

DEC has recently advised DEP that it plans to adopt the 30-day rolling geometric mean (GM) for enterococci of 30 cfu/100mL, with a not-to-exceed 90th percentile statistical threshold value (STV) of 110 cfu/100mL, which is the more stringent of the recommendations presented in the 2012 EPA RWQC. As such, analyses in this LTCP are performed using the 30-day rolling GM of 30 cfu/100mL and the STV of 110 cfu/100mL for enterococci.

[1] The Flushing Creek LTCP evaluates compliance with various primary contact WQ numerical limits including the Primary Contact fecal coliform WQ Criteria (Class SC WQS). With the December 3, 2014 proposed rulemaking by DEC to change Class I fecal coliform bacteria criteria to 200 /100mL, Class SC and proposed Class I fecal coliform criteria would both retain the 200 /100 mL limitation. As such, the term Class SC criteria used in this LTCP is interchangeable with the proposed Class I numerical criteria when used in the context of bacteria WQ limits.

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

Model results are shown in the tables below for Flushing Creek (Stations OW-03, OW-04, OW-05, and OW-06) with 2008 rainfall and tidal conditions. As described in Section 2.0, Flushing Creek is currently designated as a Class I waterbody and has a fecal coliform criterion. Although evaluated in this section, the recreational season GM enterococci criterion is currently not applicable to Flushing Creek.

10-Year Long Term Simulation

A 10-year baseline simulation of bacteria water quality was performed for the baseline loading conditions, to assess year-to-year variations in water quality. The results of these simulations are summarized in Table 6-4. The table summarizes the calculated maximum monthly GMs and the attainment with the existing fecal coliform water quality criterion of not-to-exceed 2,000 cfu/100mL.

Table 6-4. Calculated 10-Year Baseline Fecal Coliform Maximum Monthly GM Concentrations and Attainment of Existing WQ Criteria (Class I) - Percent of Months in Attainment

Station	(a) Maximum Monthly Fecal Coliform Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
	November	June	April	December	January	December	February	December	March	August	
OW-03	1,135	1,354	834	1,346	1,600	2,184	2,319	4,259	1,275	2,265	1,857
OW-04	1,134	1,296	773	1,324	1,438	2,331	2,379	4,275	1,190	2,146	1,829
OW-05	1,026	1,196	682	1,176	1,264	2,093	2,115	3,808	1,121	1,920	1,640
OW-06	941	1,038	520	1,025	1,129	1,807	1,775	3,508	1,015	1,571	1,433
Station	**(b) Fecal Coliform – Annual Attainment (Percent of Months)**										
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Average**
OW-03	100	100	100	100	100	92	92	92	100	92	97
OW-04	100	100	100	100	100	92	92	92	100	92	97
OW-05	100	100	100	100	100	92	92	92	100	100	98
OW-06	100	100	100	100	100	100	100	92	100	100	99

This table shows that the predicted fecal coliform concentrations under baseline conditions are in attainment a high percent of the time (>97 percent) annually with the Existing WQ Criterion of a monthly GM of 2,000 org/100mL. Attainment is achieved for all periods with the exception of a single month in each of the years 2007, 2008, 2009 and 2011. Also shown is that fecal coliform concentrations are calculated to be in attainment 92 percent of the time or higher at all locations for each of the 10 years within the simulation period. It should be noted that because the waterbody is classified for secondary contact recreation, there is no enterococci limit for the Existing WQ Criteria. Except for 2011, attainment for the Existing WQ Criteria is achieved during the recreational season 100 percent of the time as the one month out of attainment occurs outside of the recreational period for all years except 2011.

In total, the waterbody was calculated to attain the existing fecal coliform water quality criterion 116 of the 120 months during this 10-year simulation period. This equates to a 96.7 percent level of attainment. Flushing Creek thus exceeds the DEC goal of 95 percent attainment and therefore can be said to be in full attainment of the criterion. Therefore there is no gap between the baseline water quality conditions for fecal coliform bacteria and the water quality for the Existing WQ Criteria.

2008 Rainfall Annual Simulation – Dissolved Oxygen

Water quality model simulation of DO concentrations and estimates of attainment with the numerical WQS are presented in Table 6-5. Water quality calculations indicate that the overall attainment of the Class I criterion of 4 mg/L is 85 percent for the year at Station OW-03. Even though there are excursions below the DO criteria in a few summer months, DO concentrations were calculated to be in attainment with the WQS a high percent of the time. As noted in Table 6-5, annual DO attainment is between 85 and 96 percent depending on the area of the Creek.

Table 6-5. Model Calculated DO Attainment (2008)

Station	Annual Attainment (%)
OW-03	85
OW-04	88
OW-05	91
OW-06	96

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

Bacteria

The DEC is required to periodically review whether a waterbody can be reclassified to its next higher classification. This LTCP assessed the level of attainment for Flushing Creek if DEC were to reclassify it to Class SC (limited primary contact recreation) from the current Class I. This assessment also addresses the situation if the proposed DEC rulemaking to at the fecal coliform 200 cfu/100mL criteria to the Class I criteria is adopted.

Table 6-6 presents the calculated baseline compliance with the 200 cfu/100mL fecal coliform criterion for Class SC waters for sampling locations in Flushing Creek. As noted in the table, attainment is calculated to be less than 100 percent on an annual basis. Attainment is slightly better at the mouth of Flushing Creek at Station OW-06 than it is at the head end at Station OW-03, but none of the stations meet the DEC goal of 95 percent attainment.

In addition, Table 6-6 provides a summary of the calculated fecal coliform bacteria compliance with the SC criterion during the recreational season (May 1 through October 31). As shown in this table, higher levels of attainment are achieved during the recreational months but still not fully attain the criterion for the baseline conditions.

Simulations for 100 percent CSO control (Table 6-7) improve compliance during both the annual and the recreational season. Annual attainment improves but remains to be less than or equal to 95 percent (which is considered as full attainment with bacteria targets in accordance with guidance from DEC). During the recreational season, attainment increases to a point where 100 percent attainment is achieved in six of the ten recreation periods. However, four recreational months are out of attainment and as such Flushing Creek remains below the DEC desired 95 percent attainment even when examining only the recreational period. Thus, the gap between the water quality criteria for primary contact recreation cannot be fully attained even with 100 percent control of the CSOs that discharge into Flushing Creek. These results suggest that site-specific criteria could be considered for Flushing Creek as attainment values with Primary Contact WQ Criteria vary both spatially and temporally.

Table 6-6. Calculated 10-Year Baseline Fecal Coliform Maximum Monthly GM and Attainment of Class SC Criterion - Percent of Months in Attainment Baseline

Station	(a) Maximum Monthly Fecal Coliform Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
	November	June	April	December	January	December	February	December	March	August	
OW-03	1,135	1,354	834	1,346	1,600	2,184	2,319	4,259	1,275	2,265	1,857
OW-04	1,134	1,269	773	1,324	1,438	2,331	2,379	4,275	1,190	2,146	1,826
OW-05	1,026	1,196	682	1,176	1,264	2,093	2,115	3,808	1,121	1,920	1,640
OW-06	941	1,038	520	1,025	1,129	1,807	1,775	3,508	1,015	1,571	1,433
Station	(b) Fecal Coliform – Annual Attainment (Percent of Months)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	50	42	33	42	33	33	25	42	75	17	39
OW-04	58	42	42	42	33	33	42	42	75	25	43
OW-05	67	42	42	42	42	33	42	50	75	42	48
OW-06	75	50	42	50	42	50	50	58	75	42	53
Station	(c) Fecal Coliform – Recreational Season Attainment (Percent of Months)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	67	67	50	83	50	67	50	50	100	33	62
OW-04	83	67	67	83	50	67	67	50	100	50	68
OW-05	100	67	67	83	67	67	67	50	100	67	74
OW-06	100	83	67	83	67	83	83	50	100	67	78

Table 6-7. Calculated 10-Year Baseline Fecal Coliform Maximum Monthly GM and Attainment of Class SC Criterion - Percent of Months in Attainment with 100 Percent CSO Removal

Station	(a) Maximum Monthly Fecal Coliform Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
	November	December	December	December	January	December	February	December	March	March	
OW-03	303	365	230	442	482	522	457	1,114	453	459	483
OW-04	320	376	216	447	475	568	477	1,256	482	483	510
OW-05	392	426	260	493	535	680	565	1,529	557	540	598
OW-06	450	451	291	508	535	770	625	1,769	617	553	657
Station	(b) Fecal Coliform – Annual Attainment (Percent of Months)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	83	75	75	83	83	83	75	75	83	58	77
OW-04	83	75	83	83	83	83	83	75	83	67	80
OW-05	83	67	75	83	83	83	75	75	83	58	77
OW-06	83	67	92	67	83	83	75	75	83	75	78
Station	(c) Fecal Coliform – Recreational Season Attainment (Percent of Months)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	100	83	100	83	100	100	100	83	100	83	93
OW-04	100	83	100	83	100	100	100	83	100	83	93
OW-05	100	83	100	83	100	100	100	83	100	83	93
OW-06	100	83	100	83	100	100	100	83	100	83	93

Flushing Creek is a tidal water body that receives direct inflows from CSOs and stormwater, as well as receiving water on each flood tide from Flushing Bay, Flushing Creek attainment of the Class SC or proposed fecal coliform Class I criteria will therefore be affected by tidal inflows from the Bay and the water quality in the Bay. There are two large CSO outfalls that discharge large volumes of CSO to the Bay (BB-006 and BB-008). Based on the Flushing Bay WWFP, these two CSOs discharge about 1,800 MG/yr to the Bay even with the implementation of the WWFP recommendations. CSO discharges from Flushing Bay, and the exchange between the Bay and the Creek, therefore, has the potential to impact bacteria attainment within the Creek. Hence, a sensitivity analysis was conducted for the 2008 conditions to evaluate this influence of Flushing Bay CSOs on Flushing Creek bacteria levels. The analysis consisted of using the ERTM water quality model to calculate the bacteria concentrations in Flushing Bay and Creek under the assumption of 100 percent removal of both Creek and Bay CSO overflows. Results showed that complete removal of CSO discharges from both Flushing Creek and Flushing Bay improved compliance to 100 percent for Class SC criterion of 200 cfu/100mL for 2008 rainfall conditions. Similar results are expected for the10-year simulation period.

Dissolved Oxygen

Upgrading Flushing Creek to Class SC would require that it meet the DO criterion of a daily average DO concentration of greater than or equal to 4.8 mg/L, with some allowance for excursions based on the DO exposure-duration curve, as well as an acute criterion of never less than 3.0 mg/L. Table 6-8 presents the annual attainment with the Class SC DO criteria at Station OW-03 at the head end of the Creek, the location calculated to have the lowest DO concentrations. Attainment of the chronic criterion would be 78 percent measured over the year. Attainment of the acute criterion would be 92 percent over the year.

Table 6-8. Model Calculated DO Percent Compliance Results for Class SC Criteria – Baseline and 100 Percent CSO Control Conditions

Station	Chronic (4.8 mg/L)		Acute (3.0 mg/L)	
	Baseline	100% CSO Removal	Baseline	100% CSO Removal
OW-03	78	83	92	97
OW-04	80	87	95	98
OW-05	81	87	97	99
OW-06	90	91	99	100

The 100 percent CSO control scenario was evaluated to assess the impact of CSO discharges on non-attainment of the DO criteria, or the gap between attainment and non-attainment caused by CSO discharges. The attainment of the Class SC criteria for DO at Station OW-03 with 100 percent CSO control is also presented in Table 6-8. The annual attainment of the chronic criterion would increase from 78 percent to 83 percent. The annual attainment of the acute criterion would increase from 92 percent to 97 percent. This scenario suggests that complete control of the CSO input into Flushing Creek would not be sufficient for it to meet the Class SC criteria for DO.

This analysis indicated that the gap between the Class SC DO criterion and the baseline conditions could not be closed even with complete removal of the Flushing Creek CSOs. Since Flushing Creek is tidal and receives tidal flow from Flushing Bay, Flushing Creek attainment of the Class SC WQ Criteria is affected by CSO discharges from the Flushing Bay and the exchange between the Bay and the Creek. Hence, a sensitivity analysis was conducted for the 2008 conditions to evaluate this influence of Flushing Bay CSOs on Flushing Creek DO levels. Results indicated that complete removal of CSO discharges from both Flushing Creek and Flushing Bay slightly improved compliance with fecal coliform Primary Contact criterion but did not achieve the DEC goal of 95 percent compliance. Similar results are expected for the 10-year simulation period.

6.3.c 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 recreation use. The standards would include a rolling 30-day GM of either 30 cfu/100mL or 35 cfu/100mL, and a 90th percentile STV during the rolling 30-day period of either 110 cfu/100mL or 130 cfu/100mL. An analysis of the 10-year baseline and 100 percent CSO control conditions model simulation results was conducted using the 30 cfu/100mL GM and 110 cfu/100mL 90th percentile criteria, to assess attainment with these Future Primary Contact WQ Criteria. As noted earlier, DEC has recently advised DEP that it plans to adopt these criteria (30-day rolling GM for enterococci of 30 cfu/100mL, with a not-to-exceed the 90th percentile STV of 110 cfu/100mL), which are the more stringent of the recommendations presented in the 2012 EPA Recommended RWQC.

10-Year Long Term Simulation

Table 6-9 presents the 10-year recreational season attainment of the Future Primary Contact WQ Criteria of enterococci for the baseline. As shown in this table, maximum 30-day GM concentrations are calculated as being higher than the allowable maximum 30 cfu/100mL criterion and attainment is calculated to be lower than the 95 percent target for all locations for all periods. Comparison between the baseline and 100 percent CSO scenarios (Table 6-10) indicates some improvements in attainment, but all locations remain below the 95 percent attainment considered acceptable by the DEC. Attainment of the 90th percentile STV criteria were calculated to be very low at all locations (less than 10 percent), regardless of whether Flushing Creek CSOs are completely controlled or not.

This analysis indicated that the gap between the Future Primary Contact recreation criterion and the baseline conditions could not be closed even with complete removal of the Flushing Creek CSOs. Since Flushing Creek is tidal and receives tidal flow from Flushing Bay, Flushing Creek attainment of Future Primary Contact WQ Criteria is affected by CSO discharges from the Flushing Bay and the exchange between the Bay and the Creek. Hence, a sensitivity analysis was conducted for the 2008 conditions to evaluate this influence of Flushing Bay CSOs on Flushing Creek enterococci bacteria levels. Results indicated that complete removal of CSO discharges from both Flushing Creek and Flushing Bay improved compliance to 100 percent for the enterococci Future Primary Contact GM criterion of 30 cfu/100mL for 2008. Similar results are expected for the 10-year simulation period. The calculations also showed improvement in the STV values to around 40 percent.

Table 6-9. Recreational Season Maximum Rolling 30-day GM and Attainment with Future Primary Contact WQ Criteria with 2012 EPA RWQC for Enterococci for Baseline Simulation

Station	(a) Maximum Rolling 30 Day Enterococci Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	209	938	205	367	540	477	143	558	136	626	420
OW-04	205	863	183	318	504	447	146	526	126	577	390
OW-05	187	782	163	270	446	402	141	478	118	519	351
OW-06	173	703	129	217	392	350	126	456	105	436	309
Station	(b) Enterococci – Recreational Attainment with Future Primary Contact WQ Criteria with 30-Day GM of 30 cfu/100mL for Enterococci for Baseline Simulation (Percent)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	37	29	12	61	21	37	24	24	67	12	32
OW-04	43	41	29	70	26	47	34	28	68	19	41
OW-05	52	47	33	72	28	49	39	31	68	24	44
OW-06	59	51	42	78	32	52	46	37	70	33	50
Station	(c) Enterococci – Recreational Attainment with Future Primary Contact WQ Criteria with STV of 110 cfu/100mL for Enterococci for Baseline Simulation (Percent)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	3	0	0	17	0	0	0	0	1	0	2
OW-04	4	0	0	18	0	0	0	0	3	0	3
OW-05	4	0	0	18	0	0	0	0	6	0	3
OW-06	8	0	0	21	0	0	0	0	5	0	3

Table 6-10. Recreational Season Maximum Rolling 30-day GM and Attainment with Future Primary Contact WQ Criteria with 2012 EPA RWQC for Enterococci with 100 Percent CSO Removal

Station	(a) Maximum Rolling 30 Day Enterococci Geometric Mean (cfu/100mL)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	90	272	92	127	156	176	62	155	65	154	135
OW-04	85	272	80	116	154	173	57	149	61	154	130
OW-05	98	325	83	124	182	194	67	181	66	189	151
OW-06	103	365	76	129	206	205	75	214	66	219	166
Station	(b) Enterococci – Recreational Attainment with Future Primary Contact WQ Criteria with 30-Day GM of 30 cfu/100mL for Enterococci (Percent)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	65	61	51	87	45	59	70	44	75	51	61
OW-04	78	67	61	90	61	61	81	52	83	57	69
OW-05	75	65	57	90	57	61	76	45	83	56	67
OW-06	78	66	58	90	58	60	75	44	84	56	67
Station	(c) Enterococci – Recreational Attainment with Future Primary Contact WQ Criteria with STV of 110 cfu/100mL for Enterococci (Percent)										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
OW-03	12	2	0	36	1	10	5	9	19	6	10
OW-04	11	2	0	37	1	10	5	14	24	7	11
OW-05	11	2	0	36	1	9	4	4	12	4	8
OW-06	11	2	0	35	1	0	4	3	12	2	7

6.3.d CSO Volumes and Loadings Needed to Attain 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 fecal coliform and enterococci concentrations at key locations in Flushing Creek. A load source component analysis was conducted for the 2008 baseline condition to provide a better understanding of how each source type contributes to bacteria concentrations in Flushing Creek. The source types include the East River at the mouth of Flushing Bay, stormwater (including direct drainage), and CSOs discharging to Flushing Creek and CSOs discharging to Flushing Bay. The analysis was completed at Stations OW-03, OW-04, OW-05, and OW-06 using the ERTM model. The analysis included the calculation of fecal coliform and enterococci GMs in total and from each component. For fecal coliform, a maximum winter month was analyzed because the decay rate is lower in winter, resulting in generally higher fecal coliform concentrations, and a maximum summer month was selected in consideration of use impact during the recreational season (May 1 through October 31). Enterococci were evaluated on a recreational season basis. The calculated values can then be compared to applicable numeric criteria to determine the relative contribution of a component to non-attainment of those criteria.

In comparison with the Class SC fecal coliform concentration of 200 org/100mL, the maximum month GM concentrations exceed the criterion at all four stations during both the non-recreational season (November 1st through April 30th) and the recreation season (Table 6-6). As shown in Table 6-11, CSOs to the Creek contribute the largest amount of fecal coliform bacteria but CSOs that discharge to the Bay are the second largest source of bacteria. If DEP were to fully remove the CSOs in both the Creek and the Bay, attainment would be reached during both the recreation season and during the non-recreation season.

Table 6-11 also summarizes the enterococci component analysis. The 30-day GM concentrations are calculated to exceed the 30 cfu/100mL criterion at locations within the Creek during the recreational season. The 30-day GM maximum concentration attributable to CSO sources during the recreational season is calculated to be 120 cfu/100mL (80 cfu/100mL from the Creek and 40 cfu/100mL from the Bay) at Station OW-03, which is greater than 30 cfu/100mL, suggesting that CSOs by themselves have the potential to exceed the criterion. The components at other stations shift somewhat but are similar.

Table 6-11 also indicates that CSOs impact the entire portion of Flushing Creek, although the CSO contribution varies both spatially and temporally at those locations. There is a shift with CSO discharging to the Creek having the greatest impact on the inner portions at Stations OW-03, OW-04, OW-05 and CSOs discharging to the Bay having the largest impact on the outer portion of the Creek at Station OW-06.

6.3.e Time to Recover

An additional analysis that consisted of examining the calculated hourly fecal coliform and enterococci water quality model simulation results was performed to gain additional insight with respect to the impacts of CSO and non-CSO sources on Flushing Creek water quality. Analyses provided above examine the longer term impacts of wet weather sources, as required by existing and future primary contact bacteria criteria (monthly GM and 30-day GM). Shorter term impacts are not addressed using these regulatory measures. To gain insight to the shorter term impacts of wet weather sources of bacteria, DEP has reviewed the New York State Department of Health (NYSDOH) guidelines relative to single sample maximum bacteria concentrations that they believe “constitute a potential hazard to health if used for bathing". The presumption is that if the bacteria concentrations are lower than these levels, the waterbodies do not pose potential hazardous conditions if primary contact is practiced.

Table 6-11. Fecal Coliform and Enterococci GM Source Components

Source	Station	Fecal Coliform Contribution, cfu/100ML		Enterococcus Contribution, cfu/100mL
		Maximum Winter Month	Maximum Recreation Period Month	Worst 30-day Rolling-Geomean (Rec Season)
CSO Within Bay	OW-03	533	68	40
Stormwater and Direct Runoff Within Bay	OW-03	18	4	3
CSO Along Creek	OW-03	1,551	287	80
Stormwater and Direct Runoff Along Creek	OW-03	70	18	19
Meadow/Willow Lake	OW-03	31	13	5
East River Boundary	OW-03	15	3	1
Total	**OW-03**	**2,218**	**393**	**148**
CSO Within Bay	OW-04	577	82	47
Stormwater and Direct Runoff Within Bay	OW-04	21	3	3
CSO Along Creek	OW-04	1,552	294	81
Stormwater and Direct Runoff Along Creek	OW-04	71	16	15
Meadow/Willow Lake	OW-04	18	6	2
East River Boundary	OW-04	18	3	2
Total	**OW-04**	**2,257**	**404**	**150**
CSO Within Bay	OW-05	552	88	52
Stormwater and Direct Runoff Within Bay	OW-05	22	4	4
CSO Along Creek	OW-05	1,296	252	69
Stormwater and Direct Runoff Along Creek	OW-05	82	19	15
Meadow/Willow Lake	OW-05	9	3	1
East River Boundary	OW-05	23	4	2
Total	**OW-05**	**1,984**	**370**	**143**
CSO Within Bay	OW-06	511	93	61
Stormwater and Direct Runoff Within Bay	OW-06	27	6	5
CSO Along Creek	OW-06	927	175	50
Stormwater and Direct Runoff Along Creek	OW-06	66	14	11
Meadow/Willow Lake	OW-06	3	1	0
East River Boundary	OW-06	31	5	3
Total	**OW-06**	**1,565**	**294**	**130**

Fecal coliform concentrations that exceed 1,000 cfu/100mL and or enterococci concentrations exceeding 110 cfu/100mL are considered potential hazards by the NYSDOH. Water quality modeling analyses were conducted to assess the amount of time following the end of a rainfall required for Flushing Creek to recover and return to concentrations less than 1,000 cfu/100mL fecal coliform and 110 cfu/100mL enterococci. The value 110 was used instead of 104 as recent EPA guidance (2012 EPA RWQC) indicates that the 104 value will no longer be relevant.

From NYS DOH

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

Operation and Supervision

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

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

The water quality model calculation for Flushing Creek bacteria concentrations for recreation periods (May 1st through October 31st) were extracted from 10-years of model simulations. The time it takes for wet weather elevated bacteria concentrations to return to 1,000 or 110 was then calculated for each storm within the various size categories and used to calculate the median time for bacteria levels to return to below the concentration threshold after the end of rainfall was then calculated for each rainfall category.

The process began with an analysis of the nearby LaGuardia Airport rainfall data 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 of the 10-year period resulted in a 90th percentile rainfall event of 1.09 inches.

The rainfall event data was then compared against water quality model bacteria results for the ten recreational seasons to determine how long it took for the water column concentration to return to target threshold concentrations from the end of the rain event. Since the system is tidal, the change in concentration over time is not a constant decrease, so the last time the concentration returned to the target threshold after each rain event was considered (as opposed to the first, which might have been the result of tidal influences). To be conservative, the hour in which the concentration reached the target threshold concentration was included, so the minimum time to recover is one hour. The chosen target threshold concentrations were 1,000 cfu/100mL for fecal coliform, and 110 cfu/100mL for enterococci. The various rainfall events were then placed into rain event size “bins” ranging from less than 0.1 inch to greater than 1.5 inch, as shown in Table 6-12. Only rain events that reached the target threshold concentrations before the beginning of the next storm were included. The median time to recover for each bin at each water quality station was calculated.

The results for the baseline and 100 percent CSO control scenarios are shown in Table 6-12. As noted in Table 6-12, the time to recover is generally lengthy and greater than 48 hours for storm sizes that exceed about 0.4 inches and can be upwards of 72 hours for larger storms. With respect to time to recover to enterococci concentrations that are less than 110 cfu/100mL, even 100 percent CSO removal of Flushing Creek discharges does not have a major impact. With 100 percent removal of Flushing Creek CSO discharges, time to recover at locations OW5 and OW6 are not significantly changed from the baseline conditions. It should be noted that fecal coliform concentrations tend to remain below 1,000 cfu/100mL for locations toward the head end of Flushing Creek.

Table 6-12. Time to Recover

Rain Event Size (in)	Station	Time to Recover (hours)			
		Fecal Coliform Threshold (1000 cfu/100mL)		Enterococci Threshold (110 cfu/100mL)	
		Baseline	100% CSO Control	Baseline	100% CSO Control
<0.1	OW-03	-[1]	-	-	-
0.1-0.4	OW-03	8	-	18	3
0.4-0.8	OW-03	35	-	55	15
0.8-1.0	OW-03	50	-	66	64
1.0-1.5	OW-03	69	-	92	81
>1.5	OW-03	69[2]	-	92[2]	81[2]
<0.1	OW-04	-	-	-	-
0.1-0.4	OW-04	5	-	13	-
0.4-0.8	OW-04	40	-	55	14
0.8-1.0	OW-04	50	-	63	64
1.0-1.5	OW-04	68	-	90	81
>1.5	OW-04	68[2]	-	90[2]	81[2]
<0.1	OW-05	-	-	-	-
0.1-0.4	OW-05	-	-	8	-
0.4-0.8	OW-05	40	-	54	9
0.8-1.0	OW-05	50	-	63	62
1.0-1.5	OW-05	65	-	87	80
>1.5	OW-05	65[2]	46	87[2]	80[2]
<0.1	OW-06	-	-	-	-
0.1-0.4	OW-06	-	-	5	-
0.4-0.8	OW-06	38	-	53	8
0.8-1.0	OW-06	51	42	64	61
1.0-1.5	OW-06	64	46	85	78
>1.5	OW-06	64[2]	46	85[2]	78[2]

Notes:
(1) "-" indicates elevated bacteria concentrations return to the 1,000 cfu/100mL and 110 cfu/100mL threshold levels prior to the end of the rainfall events.
(2) In a few cases the time to recover was calculated to be less than the next smaller rain event bin. In those cases, both bins were set equal to the higher time to recover.

7.0 PUBLIC PARTICIPATION AND AGENCY COORDINATION

New York City Department of Environmental Protection (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 Long Term Control Plans (LTCPs). Public outreach and public participation are important aspects of plans designed to reduce combined sewer overflow (CSO)-related impacts to achieve waterbody-specific water quality standards (WQS), consistent with the federal CSO Policy and the Clean Water Act (CWA), and in accordance with U.S. Environmental Protection Agency (EPA) and New York State Department of Environmental Conservation (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 Flushing Creek LTCP by reaching out to the Queens Borough President's Office and Community Boards, to identify the stakeholders who would be instrumental to the development of this LTCP. Stakeholders identified included both citywide and regional groups, including: environmental organizations (Corona Park Conservancy, SWIM Coalition, World's Fair Marina, Empire Dragon Boat Team, Friends of Flushing Creek, The Holly Civic Association Inc., Precision Legal Video, Asian Americans For Equality, Riverkeeper, Natural Resources Defense Council, Metropolitan Waterfront Alliance, New York City Watertrail Association); community planning organizations; design and economic organizations; academic and research organizations (Pratt Institute); City government agencies (Queens Borough Office and Council members, NYC Department of Parks and Recreation) 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: Flushing Creek LTCP Kickoff Meeting (June 11, 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 Flushing Creek Waterbody. The two-hour event, held at P.S. 020 John Bowne in Queens, served to provide overview information about DEP's LTCP Program, present information on the Flushing Creek watershed characteristics and status of waterbody improvement projects, obtain public information on waterbody uses in Flushing Creek, and describe additional opportunities for public input and outreach. The presentation can be found at http://www.nyc.gov/dep/ltcp /. Twenty stakeholders from 14 different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event, and two reporters from local Queen's newspapers.

  The Flushing Creek 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 as part of the development of the LTCP:

  - CSO reductions and potential existing and future CSO-related projects in Flushing Creek;
  - Modeling baseline assumptions utilized during LTCP development;
  - Rainfall amounts and other assumptions utilized during LTCP development;
  - Water quality data collection;
  - Existing Flushing Creek 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: Flushing Creek LTCP Alternatives Review Meeting (October 23, 2014)

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

  On October 23, 2014, DEP hosted a second Public Meeting to continue discussion of the water quality planning process for long term control of CSOs in Flushing Creek. The purpose of the two-hour event, held in Queens, was to describe the alternatives identification and selection process, and receive public comment on the information. The presentation is on DEP's LTCP Program Website: http://www.nyc.gov/dep/ltcp. Approximately 15 stakeholders attended the event, from several different non-profit, community planning, environmental, economic development, and governmental organizations, as well as the general public.

  In response to stakeholder comments, DEP provided detailed information for each of the following as part of the development of the LTCP:

- 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 Flushing Creek;
- Green infrastructure and grey infrastructure potential alternatives;
- Opportunity to review and comment on the draft Flushing Creek 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

Objectives: Present LTCP after review by DEC

This meeting schedule will be announced. The purpose is 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

- Meeting with CB3 Environmental Committee at 7:30 pm (October 30th, 2014), 82-11 37th Avenue, Suite 606, Jackson Heights NY 11372

DEP held a meeting with Community Board 3 to explain the LTCP planning process and alternatives identified for Flushing Creek's Long Term Control Plan. Staff from DEP presented information on the LTCP Program, Flushing Creek water quality and waterbody characteristics. Approximately ten members from the public attended this meeting.

Public Comments Received

Following Public Meetings #1 and #2, DEP received four letters from environmental organizations:

1. SWIM Coalition. Comments on Flushing Creek Long Term Control Plan Public Meeting Presentation #2, November 17, 2014.
2. Friends of Flushing Creek. Friends of Flushing Creek Comments on Flushing Creek LTCP Options, November 17, 2014.
3. Water and Coastal Resources Engineering. NYCDEP Flushing Creek LTCP Retained Alternatives, November 17, 2014.
4. Empire Dragon Boat Team NYC. Received December 18, 2014.

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

7.3 Coordination with Highest Attainable Use

Comprehensive analysis of baseline conditions, along with the future anticipated conditions after implementing the recommended LTCP projects, show that Flushing Creek is not in attainment with its current Class I classification, and it is not feasible for the waterbody to meet the water quality criteria associated with the primary contact water quality criteria or Class SB classification. Furthermore, combinations of natural and manmade features prevent both the opportunity and feasibility of primary contact recreation in many parts of Flushing Creek. Primary contact recreation is prohibited by City law. The continued presence of non-CSO discharges, most notably stormwater from New York City outfalls, prevents attainment of Class SB standards, even when 100 percent CSO volume reduction is considered.

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 Flushing Creek LTCP public participation activities.

Table 7-1. Summary of Flushing Creek 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: June 11, 2014 • Meeting #2: October 23, 2014 • Meeting #3: TBD
	Stakeholder meetings and forums	• Community Board 3 – Environmental Committee, October 30th
	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

Table 7-1. Summary of Flushing Creek LTCP Public Participation Activities Performed

Category	Mechanisms Utilized	Dates (if applicable) and Comments
Communication Tools	Program Website or Dedicated Page	• LTCP Program website launched June 26, 2012 and frequently updated • Flushing Creek LTCP webpage launched June 2014 and frequently updated
	Social Media	• TBD
	Media Outreach	• Published advertisements in newspapers, Caribbean Life, Times Ledger Queens and Korea Times
	FAQs	• LTCP FAQs developed and disseminated beginning June 2014 via website, meetings and email
Communication Tools	Print Materials	• LTCP FAQs: June 11, 2014 • LTCP Goal Statement: June 26, 2012 • LTCP Public Participation Plan: June 26, 2012 • Flushing Creek Summary: June 11, 2014 • LTCP Program Brochure: June 11, 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

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. A LTCP feedback email account was also created to receive LTCP-related feedback, and stakeholders can sign up to receive LTCP Program announcements via email. In general, DEP's LTCP Program Website:

- Describes the LTCP process, CSO-related information and citywide water quality improvement programs to-date;
- Describes waterbody-specific information including historical and existing conditions;

- Provides the public and stakeholders with timely updates and relevant information during the LTCP process including meeting announcements;
- Broadens DEP's outreach campaign to further engage and educate the public on the LTCP process and related issues; and
- Provides an online portal for submission of comments, letters, suggestions, and other feedback.

A specific Flushing Creek LTCP webpage was created in June 2014, and includes the following information:

- Flushing Creek public participation and education materials
  - ➢ Flushing Creek Summary Paper
  - ➢ LTCP Public Participation Plan
- Flushing Creek LTCP Meeting Announcements
- Flushing Creek Kickoff Meeting Documents – June 11, 2014
  - ➢ Advertisement
  - ➢ Meeting Presentation
  - ➢ Meeting Summary and Response to Comments
- Queens Community Board presentation – October, 2014
- Flushing Creek Meeting #2 Meeting Documents – October 23, 2014
  - ➢ Meeting Advertisement
  - ➢ Meeting Presentation
- Meeting Summaries and Responses to Comments

8.0 EVALUATION OF ALTERNATIVES

This section of the Long Term Control Plan (LTCP) describes the development and evaluation of combined sewer overflow (CSO) control measures and watershed-wide alternatives. A CSO control measure is defined as a technology (e.g., treatment or storage) practice (e.g., Nine Minimum Control [NMC] or Best Management Practice [BMP]), or other method (e.g., source control or green infrastructure [GI]) capable 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 Flushing Creek.

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)

Assessment of water quality attainment of CSO control alternatives evaluated in this section considered the bacteria water quality (WQ) criteria presented in Section 6.0, Table 6.3. The preferred alternative is also evaluated in terms of attainment of the daily average chronic and acute DO criteria.

8.1 Considerations for LTCP Alternatives Under the Federal CSO Policy

This LTCP addresses the water quality objectives of the Federal Clean Water Act (CWA) and U.S. Environmental Protection Agency (EPA) CSO Control Policy and the New York State (NYS) Environmental Conservation Law. It builds upon the conclusions presented in New York City Department of Environmental Protection‘s (DEP) August 2011 Flushing Creek Waterbody/Watershed Facility Plan (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 Use Attainability Analysis (UAA) needs to be prepared. A UAA is the mechanism to examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State. If deemed necessary under these conditions, the UAA would assess the compliance of the next higher classification which the State would consider in adjusting water quality standards (WQS) and developing waterbody-specific criteria. In addition, when existing water quality criteria cannot be achieved even with 100 percent capture of CSO discharges, a Water Quality Based Effluent Limitation (WQBEL) variance to the State Pollutant Discharge Elimination System (SPDES) permit of the Flushing Bay CSO Retention Facility may be required.

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

8.1.a Performance

Section 6.0 presented evaluations of baseline LTCP conditions and concluded that there are no performance gaps because baseline conditions attain Existing WQ Criteria (Class I). Also determined from Section 6.0 is that Flushing Creek cannot attain the Primary Contact WQ Criteria (Class SC) even with 100 percent CSO control, due to limited tidal exchange and flushing, particularly at upstream locations, input from Flushing Bay and the East River, and the presence of remaining sources being discharged to the head of the Creek, such as lake outflows and direct drainage runoff. Discussion of performance for Flushing Creek alternatives will focus on bacteria criteria for Existing WQ Criteria (Class I), Primary Contact WQ Criteria (Class SC), and Future Primary Contact WQ Criteria (2012 EPA RWQC).

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

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

8.1.b Impact on Sensitive Areas

In development of LTCP alternatives, special consideration is made to minimize the impact of construction, to protect existing sensitive areas, and to enhance water quality in sensitive areas. As described in Section 2.0, however, there are no sensitive areas within Flushing Creek, so only construction impacts were considered for Flushing Creek.

8.1.c Cost

Cost estimates for the alternatives were computed using a costing tool based on parametric costing data. This approach provides an Association for the Advancement of Cost Engineering (AACE) Class 5 estimate (accuracy range of minus 20 to 50 percent to plus 30 to 100 percent), which is typical and appropriate for this type of planning evaluation. For the purpose of this LTCP, all costs are in October 2014 dollars.

For the LTCP alternatives, Probable Bid Cost (PBC) was used as the estimate of the capital cost. Annual operation and maintenance (O&M) costs are then used to calculate the total or net present worth (NPW) over the projected useful life of the project. For the purpose of this LTCP, a lifecycle of 20 years and an interest rate of 3 percent were used resulting in a Present Worth Factor of 14.877.

To quantify costs and benefits, alternatives are compared based on reductions of both CSO discharge volume and bacteria loading against the total cost of the alternative. These costs are then used to plot the performance and attainment curves. Should a pronounced inflection point appear in the resulting graphs, a so-called knee-of-the-curve (KOTC), it would designate 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 pollutant load. Reliability is an important operational consideration, and can have an impact on overall effectiveness of a control measure. Therefore, reliability and proven history were used to assess the technical feasibility and cost-effectiveness of a control measure.

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

8.1.e Cost-Effective Expansion

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

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

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

8.1.f Long Term Phased Implementation

The recommended implementation steps associated with the preferred alternative are structured in a way that makes it adaptable to change via expansion and modifications 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 have to be identified prior to selection of the alternative. These were identified along with permit schedules where appropriate. With the exception of GI, which is assumed to occur on both private and public property, most if not all of the CSO grey technologies are limited to City-owned property and right-of-way-acquisitions. DEP will work closely with other City agencies, and possibly NYS, to ensure proper coordination with these other agencies.

8.1.g Other Environmental Considerations

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

8.1.h Community Acceptance

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

8.1.i Methodology for Ranking Alternatives

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

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

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

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

4. Establishing three levels of intermediate CSO control that provide a range between baseline and 100 percent for which receiving water quality simulations were conducted.

5. Conducting a “brainstorming” workshop on October 2, 2014, to review the most promising control measures and to solicit additional options to explore.

6. Conducting a second LTCP workshop on October 27, 2014, to further review additional detail on the most promising control measures and to solicit additional options to explore.

7. Evaluating alternatives according to the previously described LTCP criteria and the predicted (modeled) water quality benefits of each alternative.

8. Conducting a third LTCP workshop on November 5, 2014, which evaluated the water quality benefits, costs, and fatal flaws of the alternatives under consideration.

The focal points of this process were the three workshops listed above. Prior to the first workshop, the universe of control measures that were evaluated in the 2009 WWFP was revisited from the perspective of the LTCP goal statement and in light of the implemented WWFP projects. The resultant control measures were introduced at the first workshop where DEP operational and engineering staff applied their expertise for further analysis. A preliminary evaluation of these control measures was then conducted including an initial estimation of costs. During the second workshop, promising alternatives were reviewed in more detail and additional control measures were identified. The third workshop included updated alternative assessments and a final fatal-flaw analysis.

The range of the control measures that were considered included a variety of storage, treatment and other control measures, including:

- High Level Sewer Separation
- Sewer Enhancements including Fixed Weirs, Inflatable Dams, Bending Weirs, Control Gates and Pump Station Expansion
- Interceptor Flow Regulation
- In-line Storage
- CSO Storage (In-System, Shaft, Tank and Tunnel)
- Outfall Disinfection
- CSO Tank Disinfection
- High Rate Clarification
- In-Stream Aeration
- Floatables Control
- Additional GI Build-out
- Tidal Wetland Restoration
- Dredging

All of the control measures except dredging and tidal wetland restoration advanced to the next level of evaluation. Dredging and tidal wetland restoration was eliminated from further consideration because a dredging and tidal wetland restoration program is already being implemented under a cooperative effort by DEP/U.S. Army Corps of Engineers (USACE) outside the LTCP framework.

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

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

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

Following the LTCP outline, these control measures are described under the following categories: Other Future Grey Infrastructure, Other Future Green Infrastructure and Hybrid Green/Grey Alternatives, and subsets thereof. Not all of the categories in the LTCP outline were applicable to Flushing Creek, as will become evident in the subsequent discussions.

8.2.a Other Future Grey Infrastructure

For the purpose of this LTCP, "Other Future Grey Infrastructure" refers to potential grey infrastructure beyond existing control measures implemented based on previous planning documents. "Grey infrastructure" refers to systems used to control, reduce or eliminate discharges from CSOs. These are the technologies that have been traditionally employed by DEP and other wastewater utilities in their CSO planning and implementation programs, 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 2011 WWFP, are described in Section 4.0 and include the Flushing Bay CSO Retention Facility. When completed, these projects, coupled with the planned GI implementation, are predicted to provide a significant (53 percent) reduction in CSO volume. Of the remaining CSO from outfalls TI-010, TI-011 and TI-022 discharging to Flushing Creek, 93 percent of the annual discharge comes from TI-010 and TI-011. Therefore the evaluation of control measures focused mainly on these two outfalls.

8.2.a.1 High Level Sewer Separation

High Level Sewer Separation, also referred to as High Level Storm Sewers (HLSS), is a form of partial separation that separates the combined sewers only in the streets or other public rights-of way, while leaving roof leaders or other building connections unaltered. In New York City (NYC), this is typically accomplished by constructing a new stormwater system and directing flow from street inlets and catch basins to the new storm sewers. Challenges associated with HLSS include constructing new sewers with minimal disruption to the neighborhoods along the proposed alignment and finding a viable location for necessary new stormwater outfalls. Separation of sewers minimizes the amount of CSO being discharged to receiving waters, but also results in increased separate stormwater discharges (which also carry pollutants) to receiving waters.

HLSS was considered in the WWFP. However, the additional and more frequent pollution loadings that would result from the new stormwater discharges resulted in elimination of the control measures from consideration. Typically, DEP implements HLSS projects to control localized flooding. DEP has conducted a number of sewer separation projects in the Tallman Island Wastewater Treatment Plant (WWTP) drainage area, with others to be constructed in the near future. Separation projects recently completed or planned for construction within the next 10-years which are shown in Figure 8-1 will result in 21 MG/yr of less CSO being discharged into Flushing Creek than the baseline. Additional HLSS was not evaluated further.

Figure 8-1. Sewer Separation Areas

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 control gate modifications, regulator or weir modifications, inflatable dams, real time control (RTC) and increasing the capacity of select conveyance system components including gravity lines, pump stations and/or force mains. Also, force main relocation or interceptor flow regulation 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.

System optimization alternatives that were reviewed included regulator improvements consisting of weir modifications, dry weather flow line size increases, dry weather pumping capacity increases and interceptor flow regulation. All of the system optimization alternatives were eliminated due to a number of considerations including limited hydraulic capacity (fixed weirs), reliability concerns (inflatable dams), and minimal mitigation of CSO impacts (interceptor flow regulation, bending weirs, control gates, pump station expansion).

8.2.a.3 Retention/Treatment Alternatives

There were a number of the control measures considered for Flushing Creek that fall under this category. For the purposes of this LTCP, the term storage is used in lieu of retention. This includes in-line storage and deep tunnel storage. Storage using Vertical Treatment Shafts (VTS) was initially considered but rejected early in the process as both deep tunnels and in-line storage encompassed the levels of volumetric control that the less proven shaft technology could achieve. Each is described below.

Retention Alternatives – In-line Storage

In-line storage is typically used when existing conveyance elements can be retrofitted to provide cost-effective storage and resultant CSO volume reduction. Modifications to the existing system need to be made in order to realize the additional storage capacity in the form of bending weirs, inflatable dams or fixed weirs. For Flushing Creek, evaluations revealed that the TI-010 and TI-011 outfall sewers were the most conducive sites for in-line storage. These outfalls are long and have a significant grade change along the alignments where storage capacity is available. To realize the available storage capacity, multiple control structures would be required along each outfall alignment; two along the TI-010 outfall alignment and four along the TI-011 outfall alignment. These control structures would need to include either bending weirs or actuated weir gates to provide for storage along the alignment, while allowing higher flows to pass to minimize impacts to the upstream hydraulic gradient line (HGL).

Outfall storage would need to have suitable access locations in order to periodically wash down and remove settled solids and debris that would accumulate. Provisions for dewatering back to the collection system would be required at each control structure. Pumping would be required at some of the control locations depending on the selection of control equipment and the configuration of the existing collection system at that location. Finally, an odor control system may also be needed to prevent unwanted odors emanating from the outfall sewers when in storage mode.

There are a number of challenges presented by these outfall storage concepts. The most significant challenge is that there is already existing residential and street flooding occurring under certain conditions in the Kissena Corridor along the TI-010 outfall sewer. Attempting to induce additional storage within an existing system that already has limited hydraulic capacity would increase flooding risks in the tributary area. Similarly, another operational challenge is dewatering additional storage to the Tallman Island WWTP, which already receives flow from the Alley Creek and Flushing Creek Retention Facilities. Modeling indicates that dewatering of the Flushing Creek Retention Facility and upstream sewers currently takes two days on average after a storm event. Adding additional outfall storage upstream of the retention facility will increase that dewatering time to four days, on average. Other significant challenges include siting of the control structures, access hatches, dewatering pump stations and odor control facilities along the proposed outfall route.

Figure 8-2 shows the locations of the two control structures along the TI-010 outfall route. The downstream facility (Site 1) would need to be sited on private land adjacent to the outfall. The upstream facility (Site 2) would be within or adjacent to the right-of-way along Fresh Meadow Lane within the Kissena Corridor Park.

Figure 8-2. Locations of Control Structures for Outfall Storage Along Outfall TI-010

Figure 8-3 shows the locations of the four control structures along the TI-011 outfall. Each of the facilities would be within the right-of-way along 32nd Avenue.

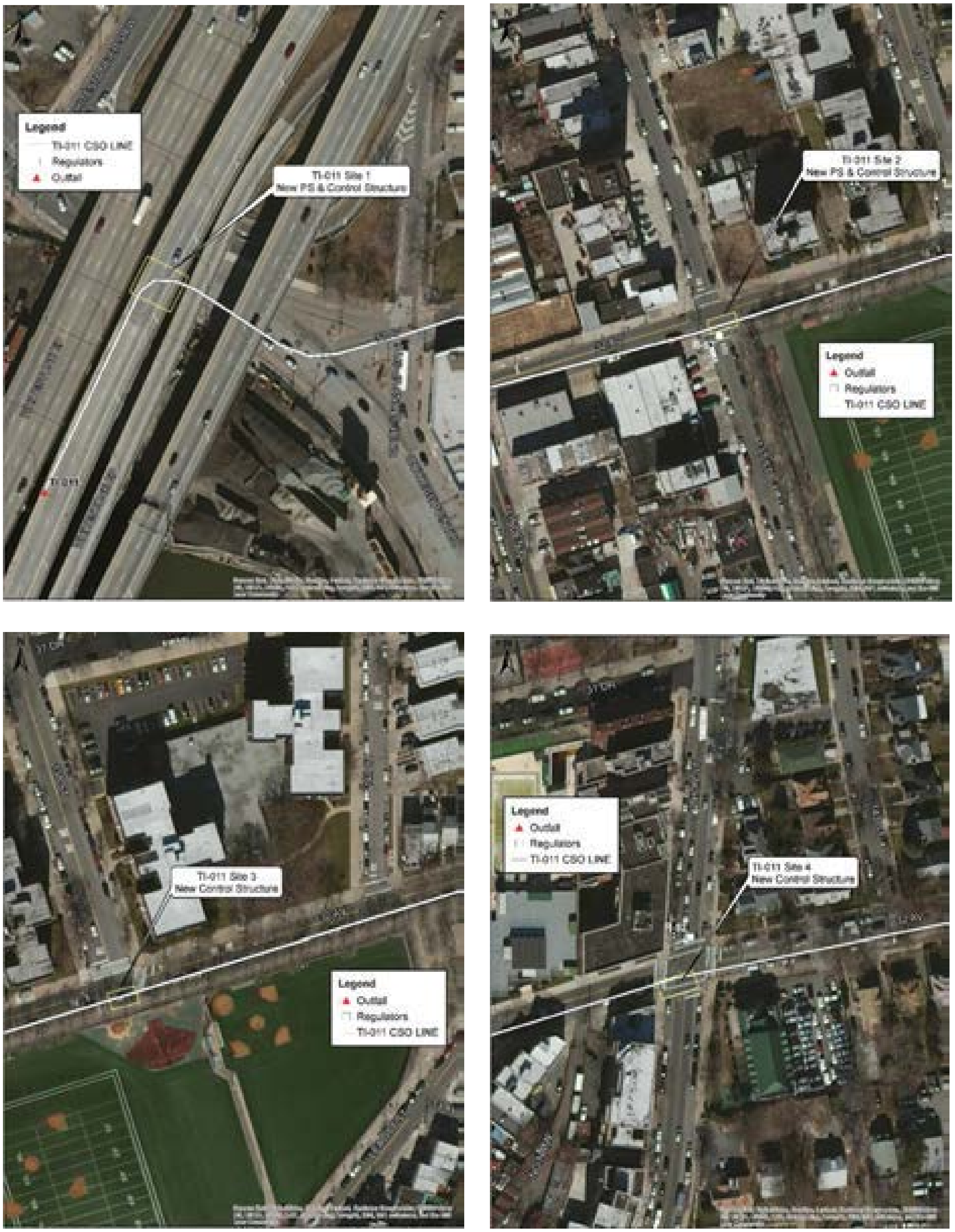

Figure 8-3. Locations of Control Structures for Outfall Storage Along Outfall TI-011

A summary of the benefits, costs and challenges associated with outfall storage include:

Benefits

There are two primary benefits associated with this control measure. The first is that the outfall storage projects would reduce CSO volume. Together these projects would reduce annual CSO volume discharged to Flushing Creek by 41 percent. Secondly, the projects would maximize the use of existing grey infrastructure.

Cost

The estimated NPW for this control measure could be as high as $65M.

Challenges

As noted above, there are numerous challenges related to implementing outfall storage, both to initial implementation and to continued successful operation. Challenges include O&M of multiple control structures, including mechanical, electrical, instrumentation and communication systems, and increased risk of flooding. Also, the physical condition of the outfall sewers would need to be evaluated to determine if priority pipeline rehabilitation would be necessary.

Retention Alternatives – Deep Tunnels

Due to the limited availability of sites within the Flushing Creek watershed, deep storage tunnels were selected as the most viable type of off-line storage control measure for increased levels of service. Unlike traditional tank storage or VTS, tunnel storage requires less permanent above-ground property per equivalent unit storage volume. Due to limited siting availability in the watershed, storage tanks and VTS are not viable. Tunnel construction involves the boring of linear storage conduits deep in the ground, typically in bedrock. Shafts are required in both the initial construction, as well as during its operation. A dewatering pump station and odor control systems are also included with such facilities.

For the purpose of the Flushing Creek LTCP, tunnel storage was evaluated to accomplish a range of CSO volume controls including 25, 50, 75 and 100 percent, proportioned across the three Flushing Creek outfalls. Technical details of these tunnel concepts are summarized in Table 8-1. Figure 8-4 shows the layout of the 100 percent control tunnel concept. A single drop shaft is proposed to collect CSO from TI-010 and TI-022. A second shaft is proposed near TI-011. For the 25 percent control option the tunnel would only need to run from near TI-010 to near TI-011. For higher levels of service (50, 75 and 100 percent), the tunnel must be extended to provide adequate storage requiring a third shaft near Northern Boulevard and Grand Central Parkway to retrieve the tunnel boring machine.

Table 8-1. Deep Tunnel Characteristics

Tunnel Options	Level of Service (% CSO Capture)			
	25%	50%	75%	100%
Tunnel Volume (MG)	5	19	45	130
Tunnel Length (lf)	4,530	5,710	7,530	13,840
Tunnel Diameter (ft)	13	24	32	40
Cost (Millions)	$447	$850	$1,085	$1,765

Figure 8-4. Proposed Route of 100 Percent CSO Volume Tunnel

A summary of the benefits, costs and challenges associated with tunnel storage include:

Benefits

The major benefit of tunnel storage is the high range of CSO volume reduction. In this case, the range of reduction for the alternatives developed was a low of 25 percent to a high of 100 percent CSO capture. A secondary benefit is in siting: tunnels (permanent shafts) require a smaller site footprint than would be needed for traditional storage tanks or storage shafts of equivalent volume.

Cost

The estimated NPW cost ranges from a low of $447M for the 25 percent control concept to a high of $1,767M for the 100 percent control concept.

Challenges

Even with the reduced footprint over traditional storage tanks and storage shafts, tunnels present a number of siting and operational challenges. In addition to the downstream shaft, each outfall under consideration would also require a feed shaft and its own odor control system. The dewatering pump station would need to be sited, typically at the downstream end of the tunnel. For Flushing Creek, the pump stations would be near TI-011. As discussed in the Flushing Creek WWFP, dewatering an additional storage facility would put significant stress on the Tallman Island WWTP and might necessitate extensive upgrades. For the LTCP, the 50, 75 and 100 percent CSO capture tunnels will not dewater to Tallman Island and instead are proposed to include a high rate clarification facility to process tunnel dewatering flows prior to discharging to Flushing Creek. The 25 percent CSO capture tunnel is proposed to have a dewatering pump station and force main to dewater to the Tallman Island WWTP. Another alternative considered in the WWFP is a combined tunnel to collect combined sewage from both the Flushing Creek and Flushing Bay CSOs and dewatering to the Bowery Bay WWTP. This would need to be evaluated as part of the Flushing Bay LTCP, which is scheduled to be completed in June of 2017. On a more general basis, tunnels are subject to major disruptions during the actual construction with both the tunneling operation and trucking and disposal of the spoils. Land acquisition and easements may be required along the tunnel route. Periodic O&M of the tunnel components would pose a challenge due to their relative inaccessibility and depth. As this would be the first CSO tunnel in NYC, specific health and safety measures would need to be developed.

Treatment Alternative – Disinfection

DEP examined the requirements for seasonal disinfection facilities at TI-010 and TI-011. Disinfection would be accomplished by dosing chlorine, in the form of sodium hypochlorite, upstream of a contact chamber. Because of the concerns about potential toxicity from high chlorine residuals at CSO facilities, DEP would seek to optimize the sodium hypochlorite dose to achieve a two-log kill (99 percent bacteria reduction) in order to minimize residuals to near non-detect, and avoid the need for dechlorination. Towards this end, DEP has proposed to conduct chlorination studies as part of the Alley Creek LTCP implementation. The information collected in that study would be used to supplement operations at Flushing Creek disinfection facilities. Sodium hypochlorite would be dosed at the disinfection facility during the recreational season (May 1st through October 31st). A chlorination facility will require equipment and piping for chemical delivery, storage, and feed. Ancillary electrical, controls and heating, ventilation and air conditioning (HVAC) systems would also be included. The facilities would be sited as close to the dosing point as is practical, but it is likely that a long chemical feed force main will be required, possibly requiring a carrier water system to convey the chemical to the dosing point within a reasonable time. As discussed later in this section, should dechlorination be required in the future, such addition has been considered in the conceptual layouts.

TI-010 Disinfection

The existing Flushing Bay CSO Retention Facility is just upstream of TI-010 and provides a significant opportunity to maximize the benefit of this existing infrastructure by using it not only for storage but also for disinfection as it would provide contact time in excess of 14 minutes for all flows anticipated in the typical year. This is longer than what is considered necessary for high rate disinfection of CSO flows (5 to 10 minutes). The initial concept for disinfecting at the Flushing Bay CSO Retention Facility is to dose chlorine just downstream of the influent screens. However, modeling indicates that just under half of the CSO discharged from TI-010 in the recreational season (May 1st through October 31st) bypasses the Flushing Bay CSO Retention Facility due to the configuration of the tributary sewers. The bypassing occurs at a number of regulators and diversion chambers just upstream of the tank depending on the upstream hydraulic gradeline. The majority of the bypass occurs through Diversion Chamber No. 5 (DC-5), but additional bypasses can occur at DC-2, DC-4 and Regulator 31 (See Figure 8-5).

Figure 8-5. Combined Sewer Configuration near the Flushing Bay CSO Retention Facility

Due to the high percentage of flow bypassing the tank, additional dosing locations were evaluated to determine the optimum dosing location that would provide disinfection for the largest proportion of TI-010 CSO discharges in the recreational season (May 1st through October 31st). Table 8-2 compares the possible dosing locations. Options A, B and D only add disinfection and do not otherwise alter the existing system configuration of the tank or gate operation. Option C considers other system configuration changes, including raising the effluent weir of the retention facility from +2.0 to +2.5 and modifying the DC-5 gate protocols. Option D would entail dosing at two locations. The system changes accompanying Option C would alter the operation of the tank, which currently operates in flow through mode when it fills above elevation +2.0. By raising the weir and changing the DC-5 gate operation, excess flow would instead bypass the tank through DC-5, where chlorine dosing would occur. Above elevation +2.5 the tank would again operate in flow through mode.

Table 8-2. Optional Disinfection Dosing Locations for TI-010

Dosing Location(s)	Proportion of TI-010 Rec Season CSO Volume Disinfected (%)	Waterbody-wide Rec Season Fecal Reduction (%)	Waterbody-wide Rec Season Enterococcus Reduction (%)	NPW ($ Millions)
A. Downstream of Tank Screens	49	14.4	23.8	5.5
B. Upstream of DC-3	71	21.6	35.9	6.4
C. Upstream of DC-5	85	25.1	42.0	6.2
D. Tank Screens + U/S of DC-5	88	25.6	43.0	7.2

Dosing for each of the TI-010 disinfection options is relatively close in proximity to the existing retention facility. The existing facility is equipped with a chemical facility for odor control consisting of separate tanks, pumps, piping, fill stations and containment for sodium hypochlorite and sodium hydroxide. These facilities were commissioned when the facility was brought on-line, but have never been operated. To provide for CSO disinfection, a portion of the odor control sodium hypochlorite system would be converted to CSO disinfection facilities. Costs for converting the existing facilities, as well as for keeping the odor control system operational, are included in the costs in Table 8-2. For some of the alternatives, with dosing locations upstream of the tank screens, it may also be necessary to include some flow control structures to increase detention time in the outfall pipe upstream of TI-010. The structures would add between $6M to $7M to the cost of either facility plus any land acquisition costs.

TI-011 Disinfection

Siting a new chlorine contact tank near TI-011 would be very challenging because the area around TI-011 is densely developed. To avoid the significant land acquisition challenges associated with siting a contact tank, using the existing outfall to provide contact time was evaluated. It was determined that dosing just downstream of Regulator TI-R09 would provide contact time in excess of 6 minutes for all flows anticipated in the typical year recreational season (May 1st through October 31st). This minimum contact time is adequate for high rate disinfection and would occur for only minutes during the recreational season (May 1st through October 31st) at the very peak flow. Much longer contact times will be available during lower flows, which occur the majority of the time. Siting options for the chlorination building were evaluated and three possible sites were identified, including a DEP maintenance garage site and two Consolidated Edison sites. Figure 8-6 shows one possible location for the chlorination facilities within an existing DEP garage at Downing Street and 32nd Avenue.

Figure 8-6. Example TI-011 Disinfection Facility Location and NaOCl Solution Pipe Routing

Disinfection of TI-011 would result in a waterbody-wide recreational season (May 1st through October 31st) fecal coliform reduction of 63.3 percent and enterococcus reduction of 42.9 percent. Comparing this to Table 8-2, disinfection of TI-011 would provide a greater reduction in fecal coliform than all of the TI-010 disinfection options and a similar reduction in enterococcus to that of TI-010 Option D. This is partially due to the efficiency of the dosing locations for each alternative. While nearly 80 percent more CSO discharges from TI-010 than from TI-011, only a portion of the CSO at TI-010 would get disinfected. Additionally, water quality sampling at both locations shows that average fecal concentrations at TI-011 are five times greater than at TI-010 (1,355,000 compared to 268,500 cfu/100mL) and enterococcus concentrations are nearly twice as high (151,737 compared to 77,802 cfu/100mL). The drainage area tributary to TI-010 includes the Flushing Bay CSO Retention Facility, which provides some bacteria reduction through solids settling and a sizeable area of parkland increasing the proportion of stormwater to sanitary sewage in the flow reaching TI-010 creating a dilution effect.

Disinfection Options B, C and D for TI-010 and the disinfection alternative for TI-011 would all rely, at least in part, on contact time provided in the existing outfalls. Minimum contact times have been evaluated based on modeled 5-minute peak flows and are considered to be adequate for high rate disinfection. However, the design flow rate, as well as the target minimum contact time for any disinfection facilities, will be confirmed during design. If it is decided to target a longer contact time, control structures may be required at the end of the outfalls to increase contact volumes throughout each event. Alternatively, control structures would also likely be necessary if dechlorination is required in the future to provide for improved process control. These structures would need to be located within the easement above the outfalls or on private property adjacent to the outfalls. The control structures and dechlorination facilities would add between $6M to $7M to each of the disinfection alternatives costs identified below, plus any additional land acquisition costs. All siting considerations for the chlorination facilities and any potential future dechlorination facilities would require further evaluation.

Benefits

The chief benefit of disinfection is the significant reduction in recreational season (May 1st through October 31st) bacteria along with maximizing the use of existing infrastructure, which leads to significantly lower costs than for any of the other alternatives evaluated. The cost savings are generated from using existing DEP facilities to house the chemical feed and storage equipment and using existing outfall piping to provide contact. Construction duration for these projects will also be much shorter than other alternatives leading to much less community disruption. Additionally, DEP will likely not need to acquire additional lands.

Cost

The estimated NPW cost for the seasonal disinfection alternatives are:

- TI-010 Option A, Downstream of the Retention Facility Screens: $5.5 Million
- TI-010 Option B, Upstream of Diversion Chamber 3: $6.4 Million
- TI-010 Option C, Upstream of Diversion Chamber 5: $6.2 Million
- TI-010 Option D, Downstream of the Screens and Upstream of DC-5: $7.2 Million
- TI-011, Downstream of Regulator TI-R09: $9.5 Million

It is important to note that each of these disinfection alternatives will require significant ongoing O&M. Annual O&M costs are estimated to be between $310,000 and $350,000 and are included in the NPW values shown above.

Challenges

Challenges generally associated with seasonal disinfection facilities include:

- Not consistent with current DEP operations, as DEP does not currently operate a remote or satellite wet weather disinfection facility.
- O&M required for disinfection.
- Process control requirements for disinfection system.
- Although targeting low effluent total residual chlorine (TRC), acute chlorine toxicity is still a potential concern.
- The New York State Department of Environmental Conservation (DEC) has indicated that it will not impose numerical effluent limits for TRC or pathogens at this time. However, there is the potential for future effluent limits and enhanced monitoring requirements that could require additional capital outlays and additional O&M costs. Chemical handling, storage and feed facilities required, as well as regular chemical deliveries.
- Effluent pumping with its associated cost and operational and maintenance complexity may be necessary, if control structures are required.
- Odor control may be required.
- Post event dewatering (pumped) and clean-up may be required.

Site-specific challenges for the TI-010 and TI-011 seasonal disinfection facilities include:

- Adding chlorination facilities to an existing active site, or alternatively, site acquisition for the TI-011 chlorination facility.
- Potential for siting control structures and future dechlorination facilities near each outfall.
- Coordination with New York City Department of Transportation (DOT) operations for chlorination line crossing College Point Boulevard (TI-010) along 32nd Avenue (TI-011).
- Potential for encountering contaminated soil at selected sites.
- Unforeseen geotechnical conditions.

Treatment Alternative – High Rate Clarification

High rate clarification (also referred to as ballasted flocculation or ballasted sedimentation) is a traditional gravity settling process enhanced with both flocculation using settling aids and a ballast material to significantly increase surface loading rates and improve total suspended solids (TSS) removal performance. To reduce bacteria, the targeted pollutant, disinfection of the effluent would still be required. Thus high rate clarification would require additional mechanical equipment and chemical storage and feed processes in addition to those required for the disinfection facilities. High rate clarification would also require an additional contact tank for disinfection or a more energy intensive ultraviolet (UV) process. When used in conjunction with high rate clarification, UV is viable as an alternative to chlorination since additional treatment (clarification) is added upstream of disinfection. Given that this technology would provide similar levels of bacteria reduction to stand-alone disinfection facilities but require increased capital, operations and maintenance costs, high rate clarification was not evaluated further as a stand-alone control measure. However, it will be considered to treat tunnel effluent for some of the tunnel alternatives.

In-Stream Aeration

In-Stream Aeration would improve the DO content of Flushing Creek by adding air directly to the water column either by diffusers placed directly within the waterbody or by aeration of a side-stream of water that is reintroduced into the waterbody. Aeration does not reduce CSO volume or pollutant loads that impact oxygen in Flushing Creek. Other control measures under consideration, such as storage and some treatment alternatives, will directly reduce the biochemical oxygen demand (BOD) entering Flushing Creek from CSOs, thus improving dissolved oxygen (DO). For example, studies completed as far back as the 1920s also show that disinfection will reduce BOD (Susag, 1968).

In addition to control measures implemented as part of the Flushing Creek LTCP, several other DEP programs are expected to increase DO within Flushing Creek. As stated earlier in this section, a dredging and tidal wetland restoration program is being implemented under a cooperative effort by DEP/USACE outside the LTCP framework. Research has shown that wetlands remove BOD from surface water through decomposition of organic matter or oxidation of inorganics and that BOD removal by wetlands may approach 100 percent (Hemond and Benoit, 1988). Further, should DEP be able to restore the upper reaches of the Creek into a healthy wetland ecosystem, improvements in DO would be expected to occur through direct addition of DO to the waterbody from wetland plantings. Additionally, analyses presented earlier, in Section 6.0, indicate that Flushing Bay CSOs have an impact on Flushing Creek. Development of the Flushing Bay LTCP is scheduled to be completed by June 2017. As such, CSO control measures recommended for implementation in Flushing Bay are expected to positively impact Flushing Creek.

Therefore, in-stream aeration was not evaluated further as part of this LTCP. Aeration may be considered in the future if post-construction compliance monitoring (PCM) performed after implementation of the Flushing Creek and Flushing Bay LTCPs indicate a need. An aeration evaluation would require consideration of facility siting, oxygen demand evaluations, determination of aeration zones, and evaluation of dredging needs. Alternatively, DEP has identified approximately 2 to 4 acres of additional wetland restoration that may be possible outside of USACE/DEP restoration/dredging coordination effort if further DO improvements are necessary. These locations are shown in Figure 8-7.

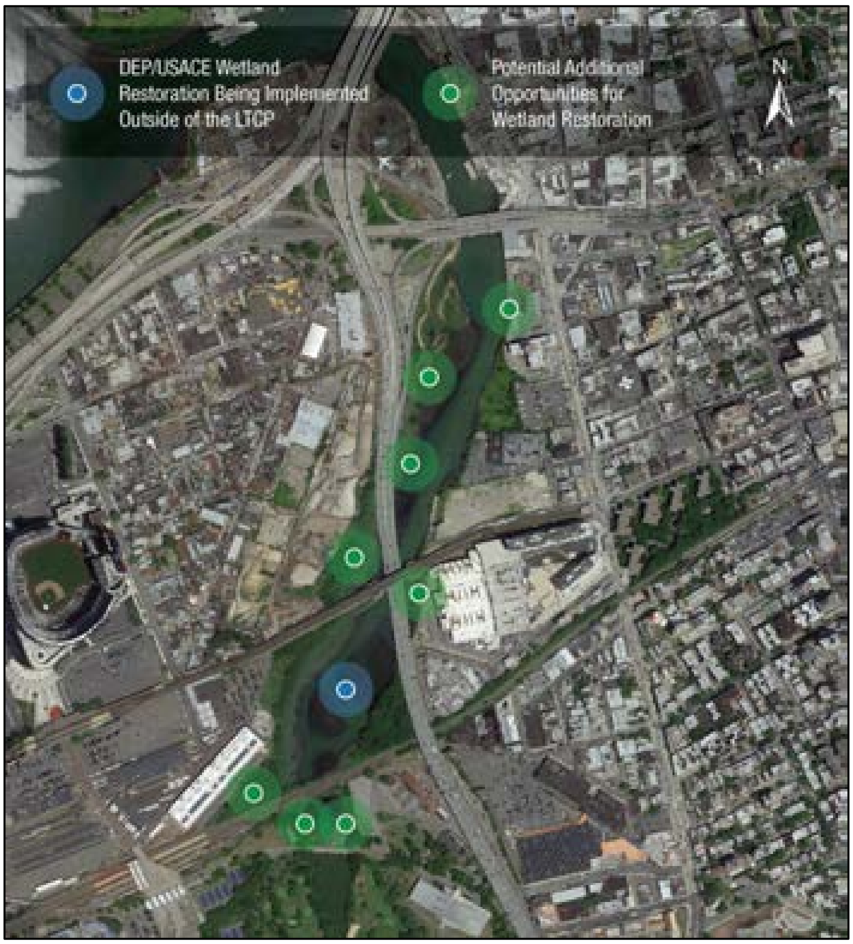

Figure 8-7. Potential Wetland Restoration Opportunities

Floatables Control

Floatables control technologies or control measures are designed to reduce or eliminate aesthetically objectionable items from CSOs, such as plastic, paper, polystyrene and sanitary “toilet litter” matter, etc. However, because they do not reduce the volume or frequency of overflows, these control measures are not evaluated on a cost-performance or cost-attainment bases as with the other control measures.

Floatables control technologies were evaluated in detail in the 2011 Flushing Creek WWFP, including ongoing institutional programs such as catch basin hooding and other CSO BMPs. As discussed in the WWFP, there is already an Interim Floatables Containment Program in place for Flushing Creek which includes a boom downstream of TI-010 and TI-022 and a net at the end of TI-011. Further, nearly 50 percent of the typical year overflow from TI-010 is screened and settled at the Flushing Bay CSO Retention Facility and any discharge from TI-010 is again skimmed at the boom. Given that there are numerous floatables controls already installed to address each of the Flushing Bay CSO outfalls, there is insufficient opportunity available to provide additional control. Therefore, floatables control was not evaluated further. In addition, as stated in the WWFP, that if PCM shows that the floatables boom is no longer necessary, it will be removed. PCM is ongoing at the TI-011 net, the Flushing Creek boom, and at the Flushing Bay CSO Retention Tank. The most recent recoveries from the booms and nets are reported in the 2013 Best Management Practices Annual Report. The recoveries from the tank screens are reported in the Post-Construction Compliance Monitoring and CSO Retention Facility Overflow Summary for Calendar Year 2013.

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 8 percent of the impervious surfaces within the Flushing Creek/Bay portion of the Tallman Island combined sewer service area and 13 percent of the impervious surfaces in the Flushing Creek/Bay portion of the Bowery Bay WWTP combined sewer service area. This GI has been included as part of the baseline model projections, and is thus not categorized as an LTCP alternative.

For the purpose of this LTCP, "Other Future Green Infrastructure" is defined as GI alternatives that are in addition to those implemented under previous facility plans and those included in the baseline conditions. Because DEP is working on the implementation of GI area-wide contracts in the tributary drainage areas of TI-010, TI-011, and TI-022, additional GI beyond the baseline is not being considered for this LTCP at this time. DEP intends to saturate each target tributary drainage areas with as much GI as feasible, as discussed in Section 5.0. Should conditions show favorable feasibility for penetration rates above the current targets, then DEP would take advantage of those opportunities as they become known.

8.2.c Hybrid Green/Grey Alternatives

Hybrid green/grey alternatives are those that combine traditional grey control measures with GI control measures, to achieve the benefits of both. However, as noted above, the 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 Flushing Creek LTCP.

8.2.d Retained Alternatives

A summary of the evaluation of the control measures discussed in detail above is presented in Table 8-3. The table indicates which of the control measures were retained for further evaluation as basin-wide alternatives. The reasons for dropping the non-retained controls from further consideration are also noted in the table.

Table 8-3. Summary of Preliminary Evaluations

Control Measure	Retained for Further Analysis?	Remarks
High Level Sewer Separation	NO	HLSS projects planned in watershed are incorporated in baseline. No additional opportunities identified.
Sewer Enhancements	NO	Sewer enhancements will provide minimal CSO impact mitigation and present other challenges such as reliability concerns and possible sewer back-ups.
Outfall Storage at TI-010 and TI-011	NO	Existing outfall pipes are located beneath 32nd Avenue (TI-011) and within the Kissena Corridor Park (TI-010), resulting in difficult construction and limited O&M access. Implementation would require complex control structures and dewatering pumping. The Kissena Corridor experiences frequent flooding under existing conditions. Dewatering times for storage would exceed 48 hours.
Off-line Storage (Tunnels)	YES	See Table 8-4 below.
Disinfection Upstream of TI-010	YES	See Table 8-4 below.
Disinfection Upstream of TI-011	YES	See Table 8-4 below.
High Rate Clarification	NO	TSS has not been identified as a source of non-attainment. Other control measures provide similar levels of bacteria reduction at a lower cost.
In-Stream Aeration	NO	In-stream treatment. Not a CSO loading mitigation measure. Other control measures directly reduce BOD.
Floatables Control	NO	Already implemented for Flushing Creek. Insufficient opportunity available for additional control.
Additional GI Build-out	NO	Planned GI build-out in the watershed (included in the baseline) is in development; additional sites unlikely to be identified.

As shown, the retained control measures include disinfection upstream of TI-010 and TI-011 and several deep tunnels to provide a range of CSO control up to 100 percent. Further details of the retained measures are presented in Table 8-4, along with their new sequential numbering system, as basin-wide alternatives.

Table 8-4. Summary of Retained Alternatives with Sequential Numbering

Alternative	Description
1A. TI-010 Tank Disinfection	Chlorinate influent to the Flushing Bay CSO Retention Facility during the recreational season just downstream of the influent screens. Contact time would be provided in the tank and downstream outfall sewers.
1B. TI-010 Outfall Disinfection at Diversion Chamber 3	Chlorinate flows entering Diversion Chamber No. 3 during the recreational season. Contact time would be provided in the tank and various sewers upstream, downstream and bypassing the tank.
1C. TI-010 Outfall Disinfection at Diversion Chamber 5	Raise the tank effluent weir and modify Diversion Chamber No. 5 gate control protocols. Chlorinate flows entering Diversion Chamber No. 5 during the recreational season. Tank would operate as an off-line tank when the upstream HGL is between +2.0 and +2.5. Contact time would be provided in the outfall sewers that bypass the tank.
1D. TI-010 Outfall Disinfection at Tank and Diversion Chamber 5	Chlorinate influent flows to the Flushing Bay CSO Retention Facility just downstream of the influent screens and flows entering Diversion Chamber No. 5 during the recreational season. Contact time would be provided in the tank and outfall sewers that bypass the tank.
2. TI-011 Outfall Disinfection	Chlorinate flows in the TI-011 outfall just downstream of Regulator TI-R09 during the recreational season. Contact time would be provided in the TI-011 outfall.
3. TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection	Implement both Alternative 1D and 2 to maximize the proportion of recreational season overflow to Flushing Creek that is disinfected.
4. 25% Control Tunnel	13-ft. dia., 4,530 LF tunnel to capture 25% of overflow from all three Flushing Creek CSO outfalls. Includes a dewatering pump station and FM to the Tallman Island WWTP.
5. 50% Control Tunnel	24-ft. dia., 5,710 LF tunnel to capture 50% of overflow from all three Flushing Creek CSO outfalls. Includes dewatering pump station and high rate classification (HRC) facility to process dewatering prior to discharging to Flushing Creek.
6. 75% Control Tunnel	32-ft. dia., 7,530 LF tunnel to capture 75% of overflow from all three Flushing Creek CSO outfalls. Includes dewatering pump station and HRC facility to process dewatering prior to discharging to Flushing Creek.
7. 100% Control Tunnel	40-ft. dia., 13,840 LF tunnel to capture 100% of overflow from all three Flushing Creek CSO outfalls. Includes dewatering pump station and HRC facility to process dewatering prior to discharging to Flushing Creek.

The retained alternatives for Flushing Creek (Alternatives 1 through 7) were then analyzed further for their ability to reduce pollutants and improve water quality, as described in Sections 8.3 through 8.5, including the critically-important cost-performance and cost-attainment evaluations.

8.3 CSO Reductions and Water Quality Impact of Retained Alternatives

To evaluate their effects on the pollutant loadings and water quality impacts, the retained alternatives listed in Table 8-4 were analyzed using both the Flushing Creek watershed (IW) and receiving water/waterbody or water quality (ERTM) models. Evaluations of levels of CSO control for each alternative are presented below. In all cases, the reductions shown are relative to the baseline conditions using 2008 JFK rainfall as described in Section 6.0. The baseline assumptions were described in detail in Section 6.0 and assume that the grey infrastructure projects from the WWFP have been implemented, along with the 8 percent GI penetration.

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

Table 8-5 summarizes the projected CSO volume reductions and bacteria for the retained alternatives. These data are plotted on Figure 8-8. It should be noted that the bacteria loading reductions shown were computed on an annual basis. Later in the section both annual and recreational season (May 1st through October 31st) reductions are evaluated.

Table 8-5. Flushing Creek Retained Alternatives Summary (2008 Rainfall)

Alternative	Untreated CSO Volume (MGY)	Untreated CSO Volume Reduction (%)	Fecal Coliform Reduction(1) (%)	Enterococci Reduction (%)(1)
Baseline Conditions(2)	1,201	-	-	-
1A. TI-010 Tank Disinfection	991	18	8	14
1B. TI-010 Outfall Disinfection at Diversion Chamber 3	899	25	13	21
1C. TI-010 Outfall Disinfection at Diversion Chamber 5	841	30	15	25
1D. TI-010 Outfall Disinfection at Tank and Diversion Chamber 5	823	32	15	25
2. TI-011 Outfall Disinfection	996	17	36	25
3. TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection	617	49	51	49
4. 25% Control Tunnel	901	25	25	25
5. 50% Control Tunnel	601	50	50	50
6. 75% Control Tunnel	300	75	75	75
7. 100% Control Tunnel	0	100	100	100

Notes:
(1) Bacteria reduction computed on an annual basis.
(2) Differs from results reported in Section 6.0, which were based on 10 year simulations.

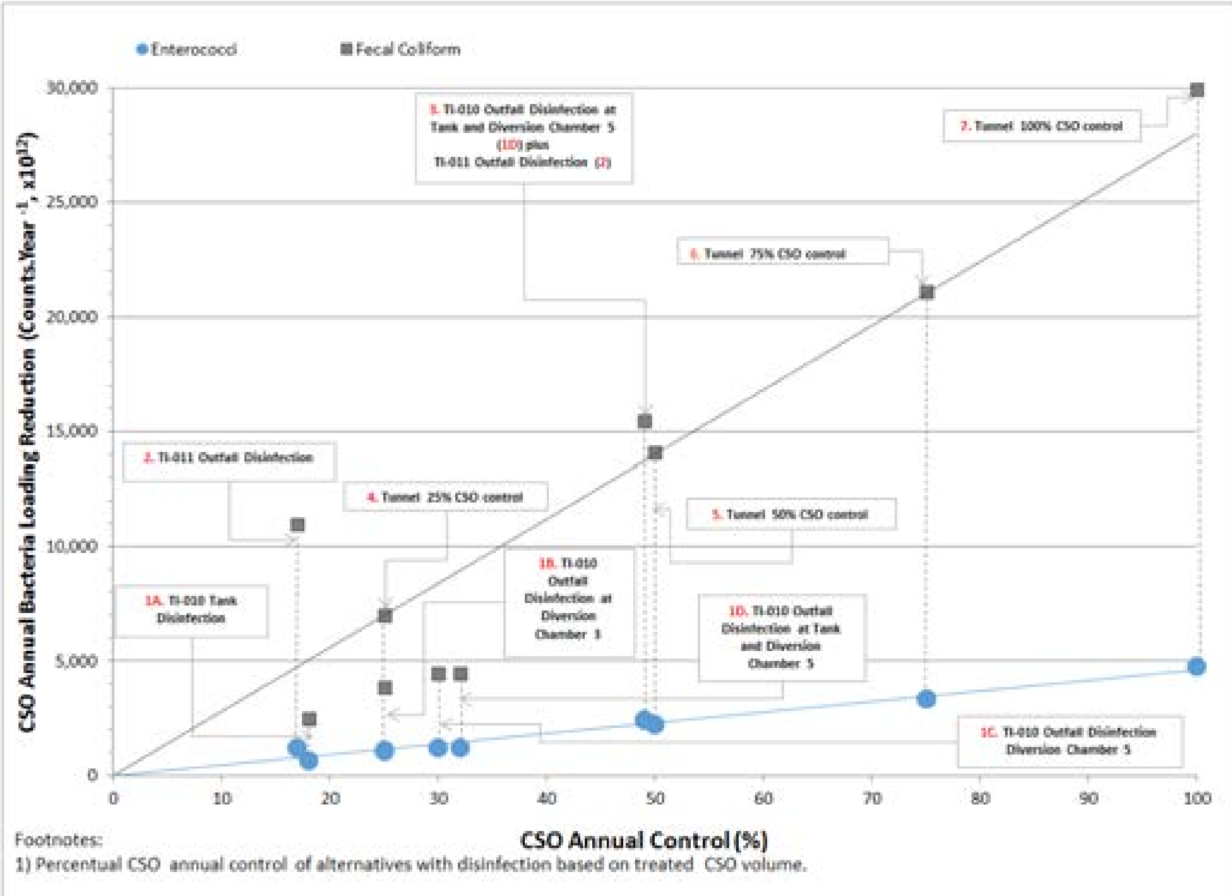

Figure 8-8. CSO Volume Reductions vs. Annual Total Bacteria Loading Reduction (2008 Rainfall)

Because the Flushing Creek alternatives serve outfalls in predominantly combined areas, the bacteria loading reductions of the alternatives are aligned with their projected CSO volume reductions.

8.3.b Water Quality Impacts

This section describes the levels of attainment with applicable current and possible future bacteria criteria within Flushing Creek that would be achieved through implementation of the retained CSO control alternatives listed in Table 8-5. The previous discussion focused on the level of volumetric or bacteria pollution reductions.

Flushing Creek is a Class I waterbody. Based on the analysis presented in Section 6 supported by the 10 year ERTM runs, historic and recent water quality monitoring, along with baseline condition modeling, revealed all locations along Flushing Creek are currently in attainment with the Class I fecal coliform criterion. When the attainment is assessed using the Primary Contact WQ Criteria of Class SC, none of the alternatives would result in full attainment. As explained in the gap analysis presented in Section 6.3, bacteria loadings from other sources, particularly the tidal exchange with Flushing Bay, influence the fecal and enterococci concentrations to the extent that even the removal or control of 100 percent of the CSO discharges to Flushing Creek would not result in full attainment of the Class SC criteria. These relationships of levels of CSO control through implementation of the retained alternatives, including 100 percent, and predicted levels of water quality standard attainment is discussed in greater detail in Section 8.5. Unlike the previously described analyses based on the 10 year ERTM runs, these latter analyses are based on 2008 typical year ERTM runs.

8.4 Cost Estimates for Retained Alternatives

Evaluation of the retained alternatives requires an appropriate level of cost estimating. The methodology for developing these costs is dependent on the type of technology and its O&M requirements. As noted previously, the capital costs were developed as PBC and the total net present worth costs were determined using the PBC estimated plus the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 20-year life cycle. All costs are in October 2014 dollars.

8.4.a Alternative 1A - TI-010 Tank Disinfection

Costs for Alternative 1A include all of the facilities and support systems required to implement tank disinfection at the Flushing Bay CSO Retention Facility downstream of the screens as described in detail in Section 8.2. The total cost, expressed as NPW, for Alternative 1A is $5.46M as shown in Table 8-6.

Table 8-6. Costs for Alternative 1A - TI-010 Tank Disinfection

Item	October 2014 Cost ($ Million)
Capital Costs	0.72
Annual O&M	0.32
Total Present Worth	5.46

8.4.b Alternative 1B - TI-010 Outfall Disinfection at Diversion Chamber 3

Costs for Alternative 1B include all of the facilities and support systems required to implement disinfection at outfall TI-010 upstream of Diversion Chamber No. 3 as described in detail in Section 8.2. The total cost for Alternative 1B is $6.39M as shown in Table 8-7.

Table 8-7. Costs for Alternative 1B –TI-010 Outfall Disinfection at Chamber 3

Item	October 2014 Cost ($ Million)
Capital Costs	1.62
Annual O&M	0.32
Total Present Worth	6.39

8.4.c Alternative 1C - TI-010 Outfall Disinfection at Diversion Chamber 5

Costs for Alternative 1C include all of the facilities and support systems required to implement disinfection at outfall TI-010 upstream of Diversion Chamber No. 5 as described in detail in Section 8.2. The total cost for Alternative 1C is $6.20M as shown in Table 8-8.

**Table 8-8. Costs for Alternative 1C –
TI-010 Outfall Disinfection at Chamber 5**

Item	October 2014 Cost ($ Million)
Capital Costs	1.46
Annual O&M	0.32
Total Present Worth	6.20

8.4.d Alternative 1D - TI-010 Outfall Disinfection at Tank and Diversion Structure 5

Costs for Alternative 1D include all of the facilities and support systems required to implement disinfection at outfall TI-010 at both the tank screens and at Diversion Chamber No. 5 as described in detail in Section 8.2. The total cost for Alternative 1D is $7.17M as shown in Table 8-9.

**Table 8-9. Costs for Alternative 1D –
TI-010 Outfall Disinfection at Tank and Chamber 5**

Item	October 2014 Cost ($ Million)
Capital Costs	1.97
Annual O&M	0.35
Total Present Worth	7.17

8.4.e Alternative 2 – TI-011 Outfall Disinfection

Costs for Alternative 2 include all of the facilities and support systems required to implement disinfection at outfall TI-011 just downstream of Regulator TI-R09 as described in detail in Section 8.2. The total cost for Alternative 2 is $9.53M as shown in Table 8-10.

**Table 8-10. Costs for Alternative 2 –
TI-011 Outfall Disinfection**

Item	October 2014 Cost ($ Million)
Capital Costs	4.92
Annual O&M	0.31
Total Present Worth	9.53

8.4.f Alternative 3 - TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection

Costs for Alternative 3 include all of the facilities and support systems required to implement tank disinfection at outfall TI-010 plus disinfection at the TI-011 outfall as described in detail in Section 8.2. The total cost for Alternative 2 is $16.70M as shown in Table 8-11.

Table 8-11. Costs for Alternative 3 – TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection

Item	October 2014 Cost ($ Million)
Capital Costs	6.89
Annual O&M	0.66
Total Present Worth	16.70

8.4.g Alternatives 4, 5, 6 and 7 – 25%, 50%, 75% and 100% Control Tunnels

Cost estimates for the four tunnels, Alternatives 4 through 7, are summarized in Table 8-12. The estimated total NPW ranges between $446.5M to $1,765.4M 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 8-12. Tunnel Alternatives Costs

Tunnel Control Level	25% Tunnel (Alternative 4)	50% Tunnel (Alternative 5)	75% Tunnel (Alternative 6)	100% Tunnel (Alternative 7)
October 2014 PBC ($ Million)	435.64	833.81	1,053.31	1,685.59
Annual O&M Cost ($ Million)	0.77	1.10	2.22	5.46
Total Present Worth ($ Million)	447.08	850.19	1,086.37	1,766.89

The cost estimates of these retained alternatives are summarized below in Table 8-13 and are then used in the development of the cost-performance and cost- attainment plots presented in Section 8.5.

Table 8-13. Cost of Retained Alternatives

Alternative	PBC ($Million)	Annual O&M Cost ($Million)	Total Present Worth ($Million)
1A. TI-010 Tank Disinfection	0.72	0.32	5.46
1B. TI-010 Outfall Disinfection at Diversion Chamber 3	1.62	0.31	6.39
1C. TI-010 Outfall Disinfection at Diversion Chamber 5	1.46	0.32	6.20
1D. TI-010 Outfall Disinfection at Tank and Diversion Chamber 5	1.96	0.35	7.17
2. TI-011 Outfall Disinfection	4.92	0.31	9.53
3. TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection	6.89	0.66	16.70
4. 25% Control Tunnel	435.64	0.77	447.08
5. 50% Control Tunnel	833.81	1.10	850.19
6. 75% Control Tunnel	1,053.31	2.22	1,086.37
7. 100% Control Tunnel	1,685.59	5.46	1,766.89

8.5 Cost-Attainment Curves for Retained Alternatives

The final step of the analysis is the evaluation of the cost-effectiveness of the alternatives based on their NPW and projected impact in attainment of applicable WQS.

8.5.a Cost-Performance Curves

Cost-performance curves were developed by plotting the costs of the retained alternatives against their predicted level of CSO control. For the purposes of this section, CSO control is defined as the degree or rate of bacteria reduction through volumetric capture, disinfection or combinations of the two. As mentioned in Section 8.1.a, the following cost-performance and subsequent cost-attainment analyses focus on bacteria loadings and bacteria WQ criteria.

Because of the wide range of project costs, two figures were developed, one showing the entire range of costs (slightly greater than $5M to over $1.7B), shown as Figure 8-9, with the second plot, Figure 8-10, focusing on the lower cost alternatives, Alternatives 1A through 1D, 2 and 3, all costing under $20M. This more focused plot is also shown as an insert to Figure 8-9. A linear best-fit cost curve was developed based on those alternatives that were judged more cost-effective for a defined level of CSO control as estimated by IW for the typical year rainfall (2008). Because the retained alternatives included some with recreational season (May 1st through October 31st) disinfection and some with year-round storage, the best-fit lines were based on annual levels of control for the latter and annual equivalent levels of control for the former.

As clearly shown on Figure 8-9, which includes all of the retained alternatives, a defined KOTC is visible for Alternative 3, TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection. Alternative 3 is a combination of Alternatives 1D and 2 and results in greater than a 50 percent level of control for bacteria on an annual basis and a nearly 90 percent level of control during the disinfection season at a NPW of slightly less than $17M. Alternative 3 is shown in bold in the plots presented herein.

The cost-performance curves also revealed which of the retained alternatives were the least cost-effective. This was the case of the two smaller tunnels (25 percent control and 50 percent control) which plotted well below the best-fit line, and other, less costly alternatives could provide a nearly equal level of control. A similar finding resulted for Alternative 1B - TI-010 Outfall Disinfection at Chamber 3. Because of these findings, these three retained alternatives were not considered in the cost-attainment analysis described in Section 8.5b.

The goal of the LTCP is to reduce CSO bacteria loadings to the waterbody to the extent that such loadings are responsible for non-attainment of applicable WQS. Bacteria reduction plots were also developed as presented as Figures 8-11 through 8-14. These 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 percent CSO bacteria loading reductions and the secondary vertical axis shows the corresponding total bacteria loading reductions, as a percentage, when loadings from other sources of bacteria are included.

Enterococci CSO reduction ranges from a low of 13 percent for Alternative 1A – TI-010 Tank Disinfection to a high of 100 percent for the Alternative 7 – 100% Control Tunnel. Fecal coliform CSO reduction ranges from a low of 8 percent for Alternative 1A – TI-010 Tank Disinfection to a high of 100 percent for the Alternative 7 – 100% Control Tunnel. When total loadings are considered, including other non-CSO sources of bacteria, these reductions span from 5 percent to 98 percent for fecal coliform and from 10 percent to 97 percent for enterococci, as shown in Figures 8-11 through 8-14.

8.5.b Cost-Attainment Curves

In summary, the cost-performance plots shown in Figures 8-9 through 8-14 indicate that most of the retained alternatives represent incremental gains in marginal performance. The retained alternatives that do not show incremental gains in marginal performance, shown in red in the figures, include Alternatives 1B, 4 and 5.

This section evaluates the relationship of the costs of the retained alternatives versus their expected level of attainment of Existing WQ Criteria (Class I), Primary Contact WQ Contact (Class SC) and Future Primary Contact WQ Criteria and their associated bacteria criteria as modeled using ERTM with 2008 rainfall. Those retained alternatives that did not show incremental gains in marginal performance on the cost-performance curves are not included in the cost-attainment curves as they were deemed to be not cost-effective relative to other alternatives.

In addition to the current Class I water quality standard, the cost-attainment analysis considered other standards and bacteria criteria, including: Class SC which represents the existing Primary Contact WQ Criteria and Future Primary Contact WQ Criteria. As was noted in Section 2.0, under the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, enterococci criteria do not apply to tributaries, such as Flushing Creek. The Class SC evaluations thus only considered the fecal coliform (FC) criterion, specifically the monthly geometric mean (GM) of 200 cfu/100mL both on an annual and

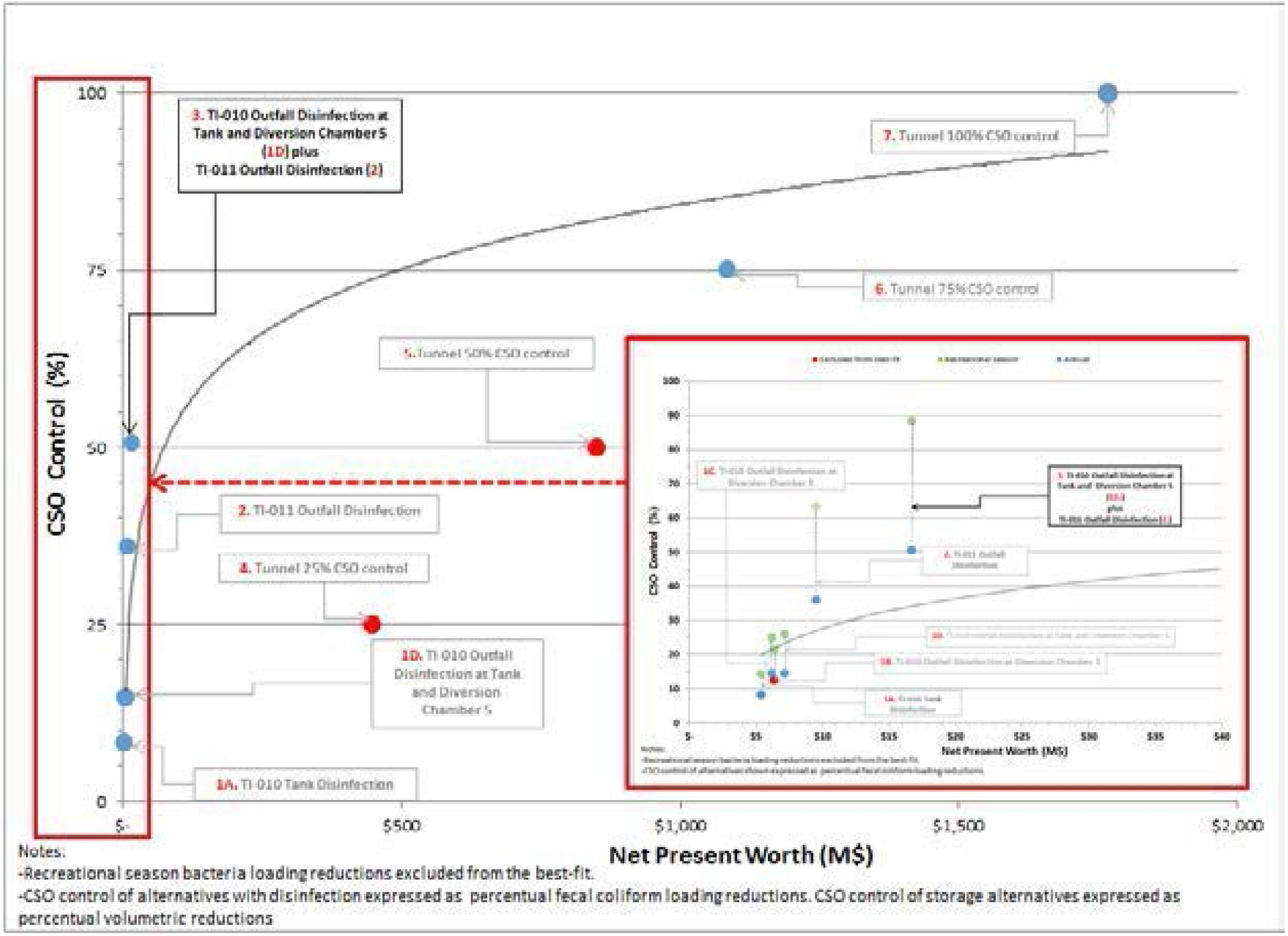

Figure 8-9. Cost vs. CSO Control (2008 Rainfall) – Full Cost Range

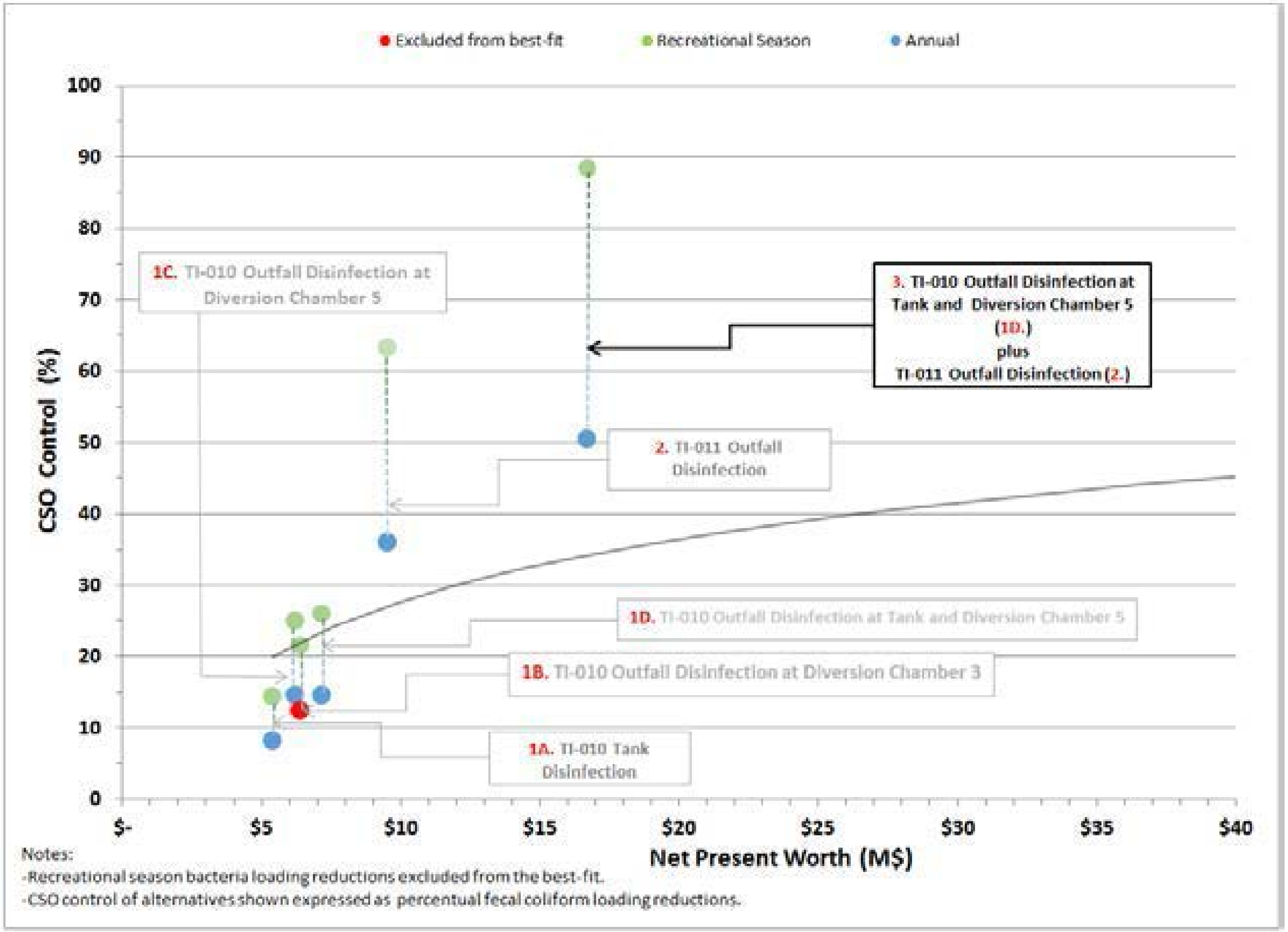

Figure 8-10. Cost vs. CSO Control (2008 Rainfall) – Lower Cost Range

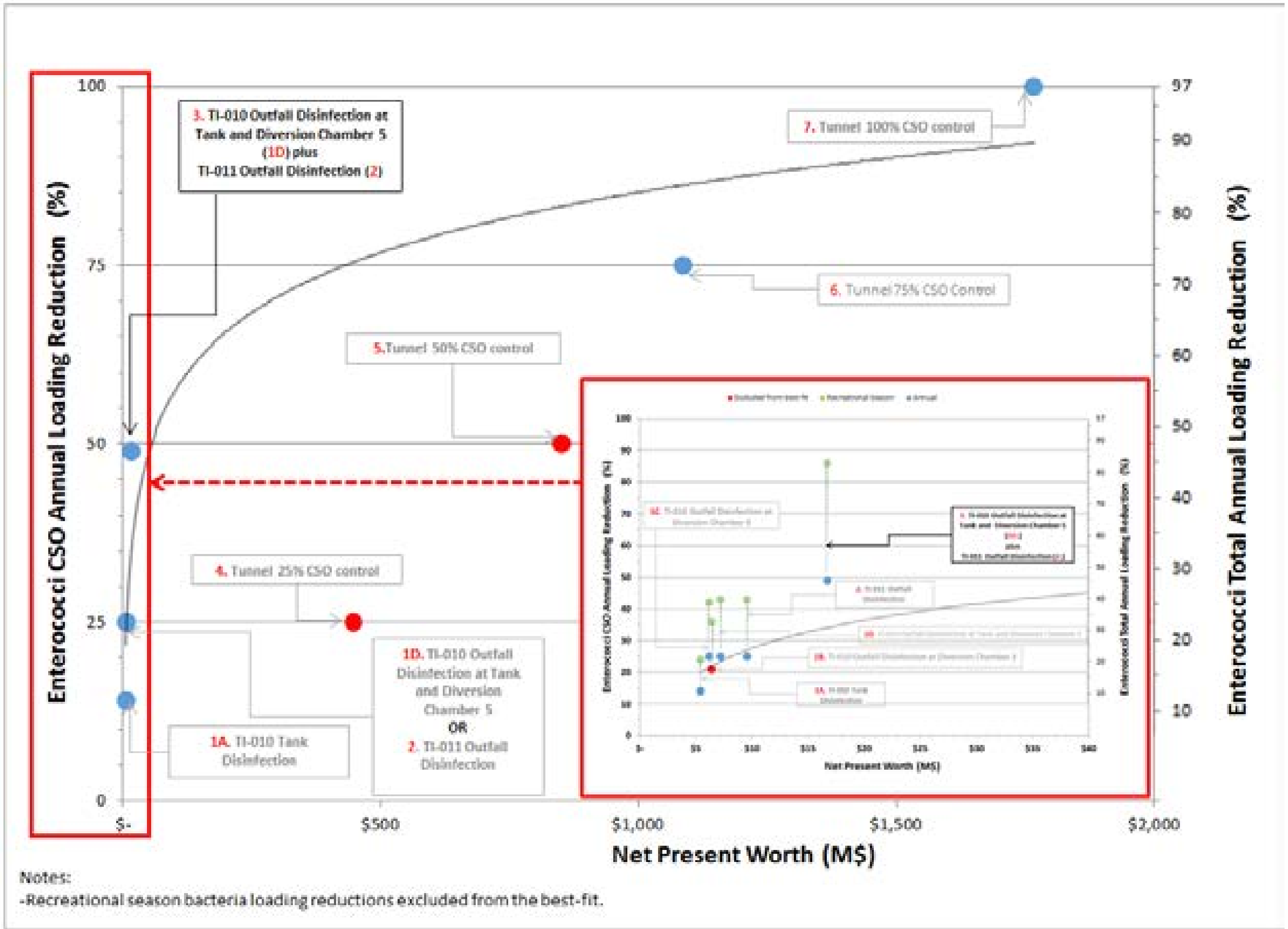

Figure 8-11. Cost vs. Enterococci Loading Reduction (2008 Rainfall) - Full Cost Range

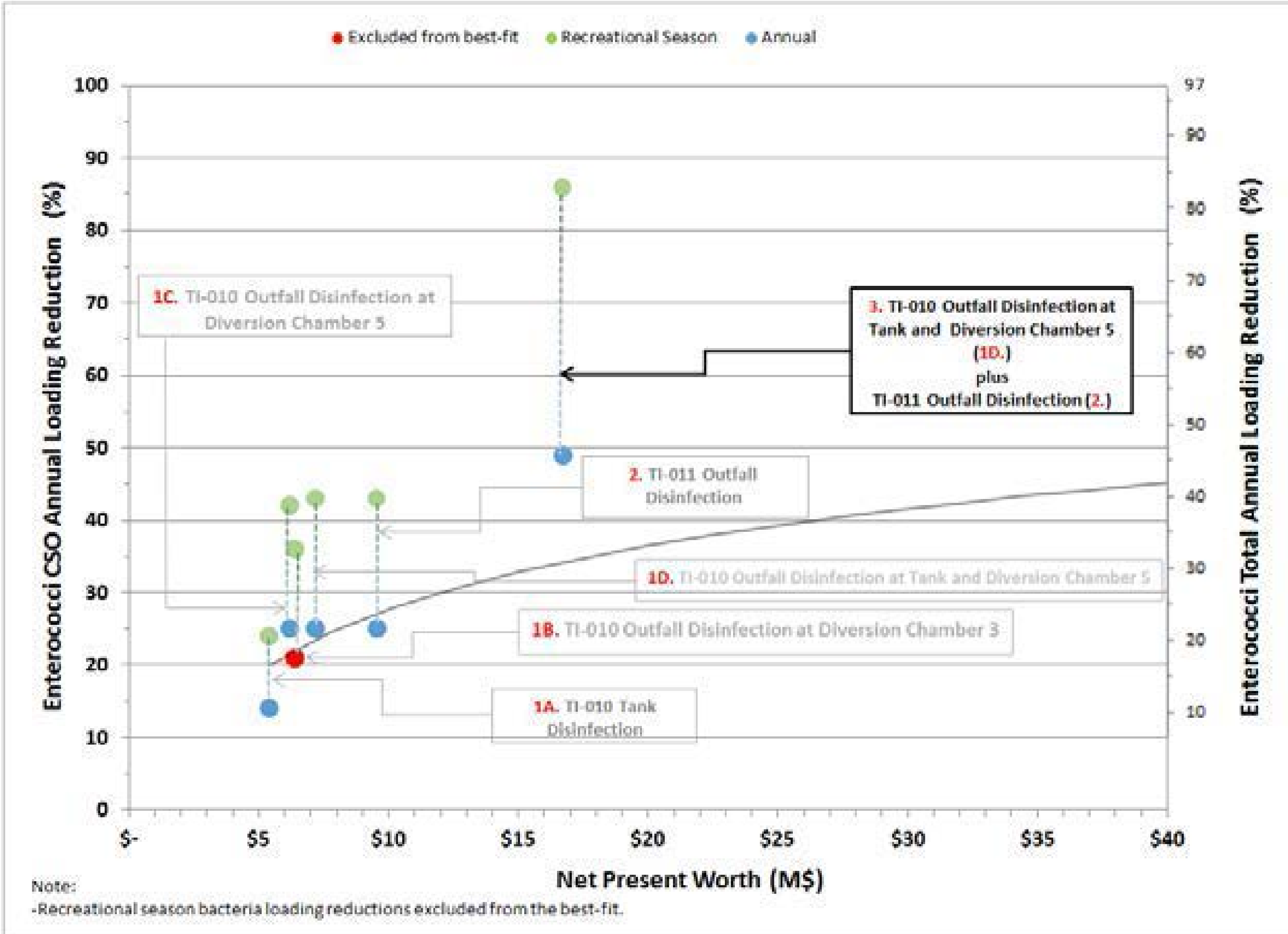

Figure 8-12. Cost vs. Enterococci Loading Reduction (2008 Rainfall) - Lower Cost Range

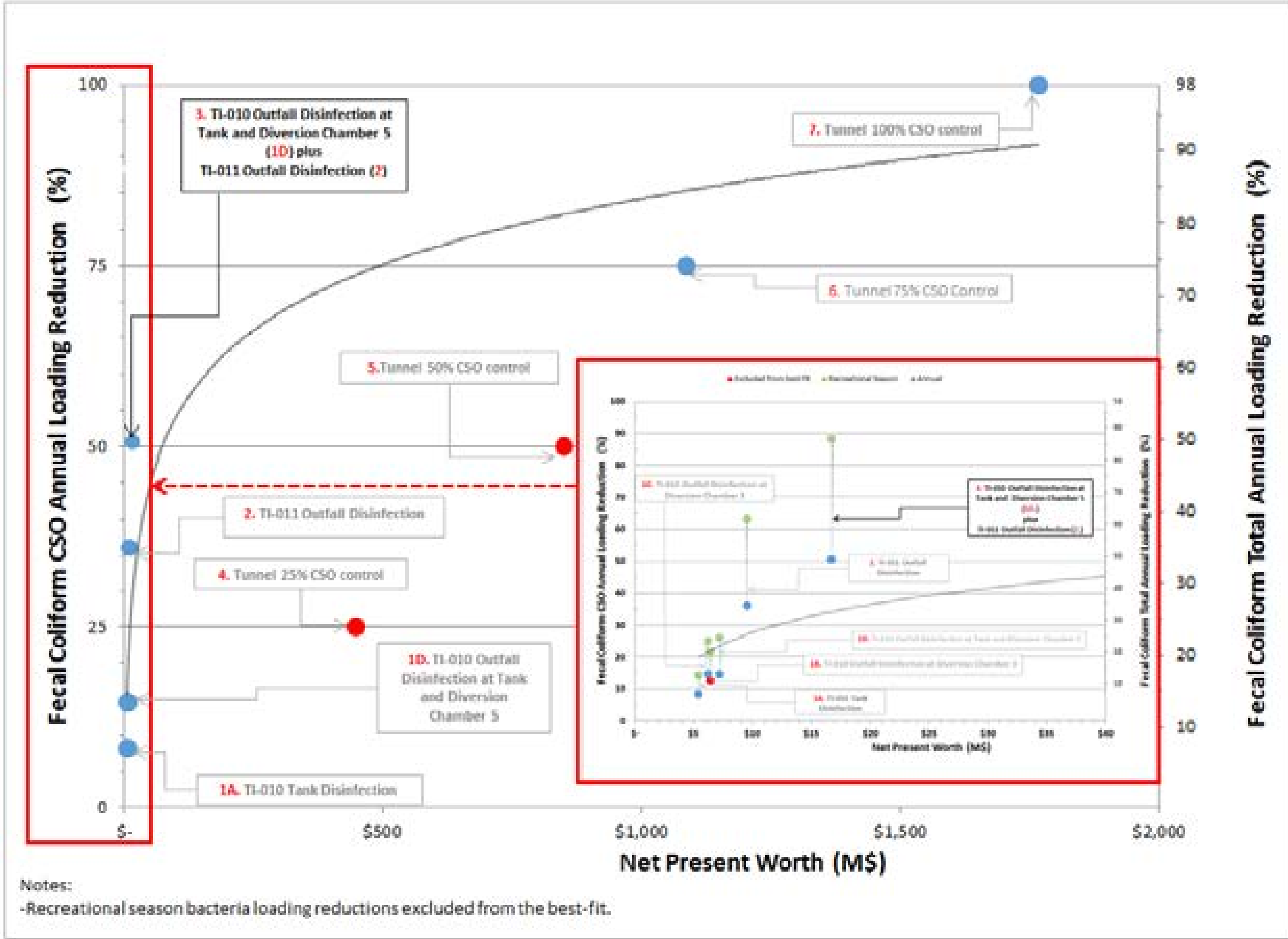

Figure 8-13. Cost vs. Fecal Coliform Loading Reduction (2008 Rainfall) - Full Cost Range

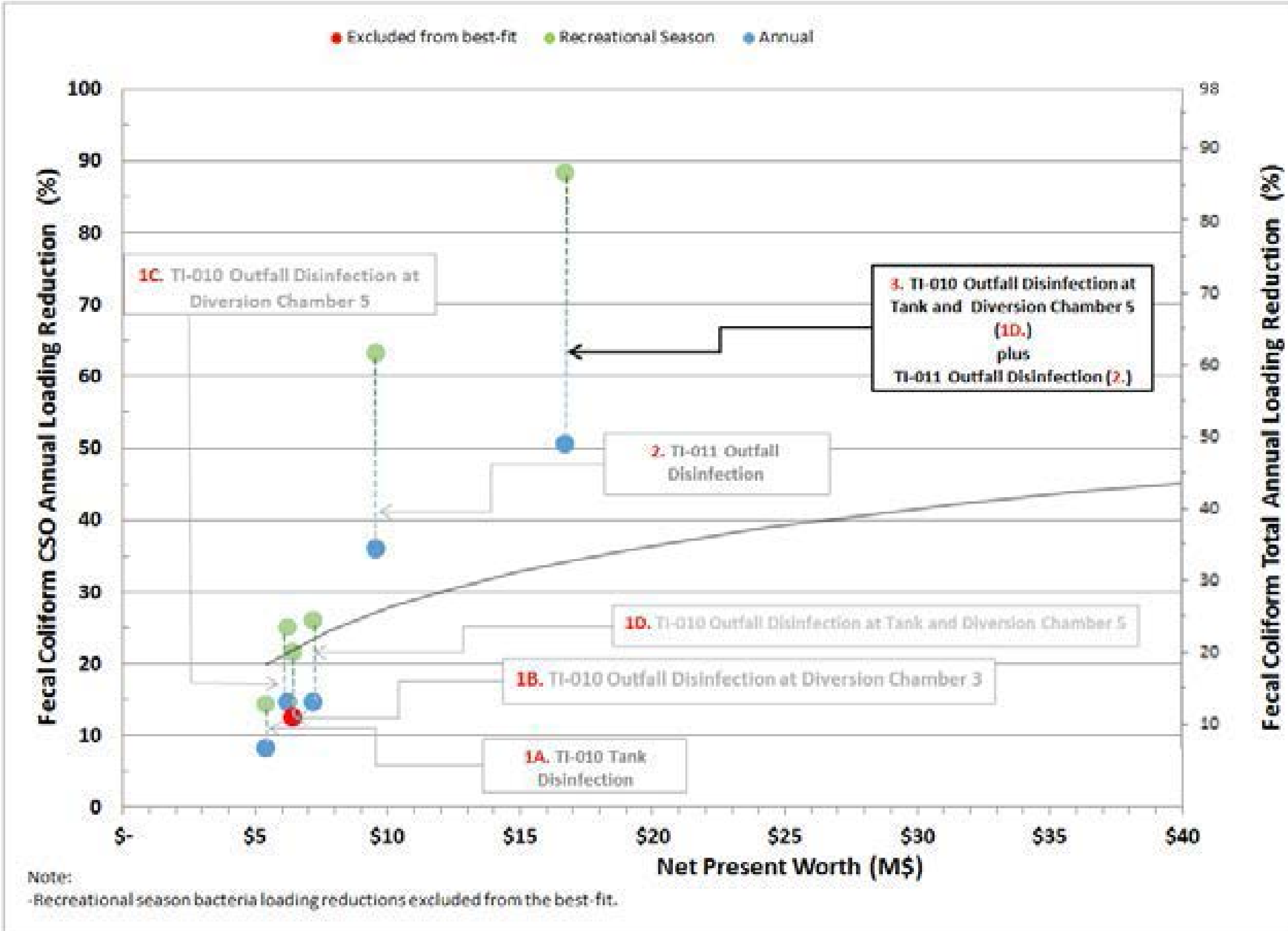

Figure 8-14. Cost vs. Fecal Coliform Loading Reduction (2008 Rainfall) - Lower Cost Range

recreational season (May 1st through October 31st) basis. The resultant curves for all of the applicable standards and relevant criteria are presented as Figures 8-15 through 8-18 for four locations along Flushing Creek: Stations OW-3 through OW-6.

As noted earlier, attainment of the Existing WQ Criterion (Class I) for fecal coliform is met for a high percentage of the time (greater than 95 percent) and thus Flushing Creek is in compliance. The baseline condition values on the above referenced cost-attainment plots, however, show slightly lower attainment due to the fact that typical year (2008) rainfall was used for these alternative evaluations in lieu of the 10-years of ERTM runs from Section 6.0.

Based on the 2008 typical year WQ runs, attainment of the Primary Contact WQ Criteria (Class SC) under baseline conditions are somewhat lower than with Class I, with the highest levels of attainment being roughly 83 percent of the recreational season (May 1st through October 31st) time and 50 percent of the year, occurring at Station OW-6 near the confluence with Flushing Bay. As shown on Figures 8-15 through 8-18, while 100 percent CSO control raises the level of seasonal Primary Contact WQ Criteria (Class SC) attainment to 100 percent throughout the Creek, this occurs at a very high cost running into billions of dollars. However, a significant jump in seasonal Primary Contact WQ Criteria (Class SC) attainment does result with the lower cost non-tunnel alternatives. An example would be Alternative 3 - TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection that, for under $17M, increases the attainment level from roughly 50 percent at baseline conditions to 83 percent at Station OW-3 and from 83 percent to 100 percent at Station OW-6.

The most restrictive bacteria criteria are associated with the Future Primary Contact WQ Criteria with 2012 EPA RWQC modification. Plots based on 2008 typical year WQ runs are included for both the proposed GM and statistical threshold value (STV) criteria. As shown, for the GM enterococci criteria of 30 cfu/100mL, baseline levels of attainment range from a low of 32 percent in the upper reach to a high of around 50 percent near the mouth of the Creek. With 100 percent CSO control, attainment improves to between 70 percent in the upper reach at Station OW-3, to a high of 75 percent in the lower reach, at Stations OW-5 and OW-6. However, these increases in attainment come at a very high cost, in the billions of dollars.

A similar review of the 2008 cost-attainment plots for the STV enterococci criteria of 110 cfu/100mL reveals there is no noticeable gain in attainment level between baseline conditions and 100 percent CSO control with attainment never exceeding 5 percent at any station, even at Station OW-6 near Flushing Bay.

The results of the cost-attainment analysis demonstrate that the retained alternatives will result in a 17 percent gain in annual attainment for the Primary Contact WQ Criteria (Class SC) and negligible gains for the Future Primary Contact WQ Criteria with 2012 EPA RWQC, both GM and STV. However, the seasonal attainment gains of most retained disinfection alternatives are significant. Further, most of the gains would be realized through implementation of these lower cost alternatives that include disinfection at outfalls TI-010 and TI-011 versus the vastly more expensive tunnel alternatives. Again, while this comparison is based on volumetric control versus bacteria inactivation, the benefit to the waterbody is similar with respect to compliance with WQS. Coupled with the results of the cost-performance analysis, it appears that Alternative 3 - TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection, would provide DEP with the most efficient means of controlling a high percent of baseline CSO loadings and striving towards meeting Primary Contact WQ Criteria (Class SC), particularly during the recreational season (May 1st through October 31st).

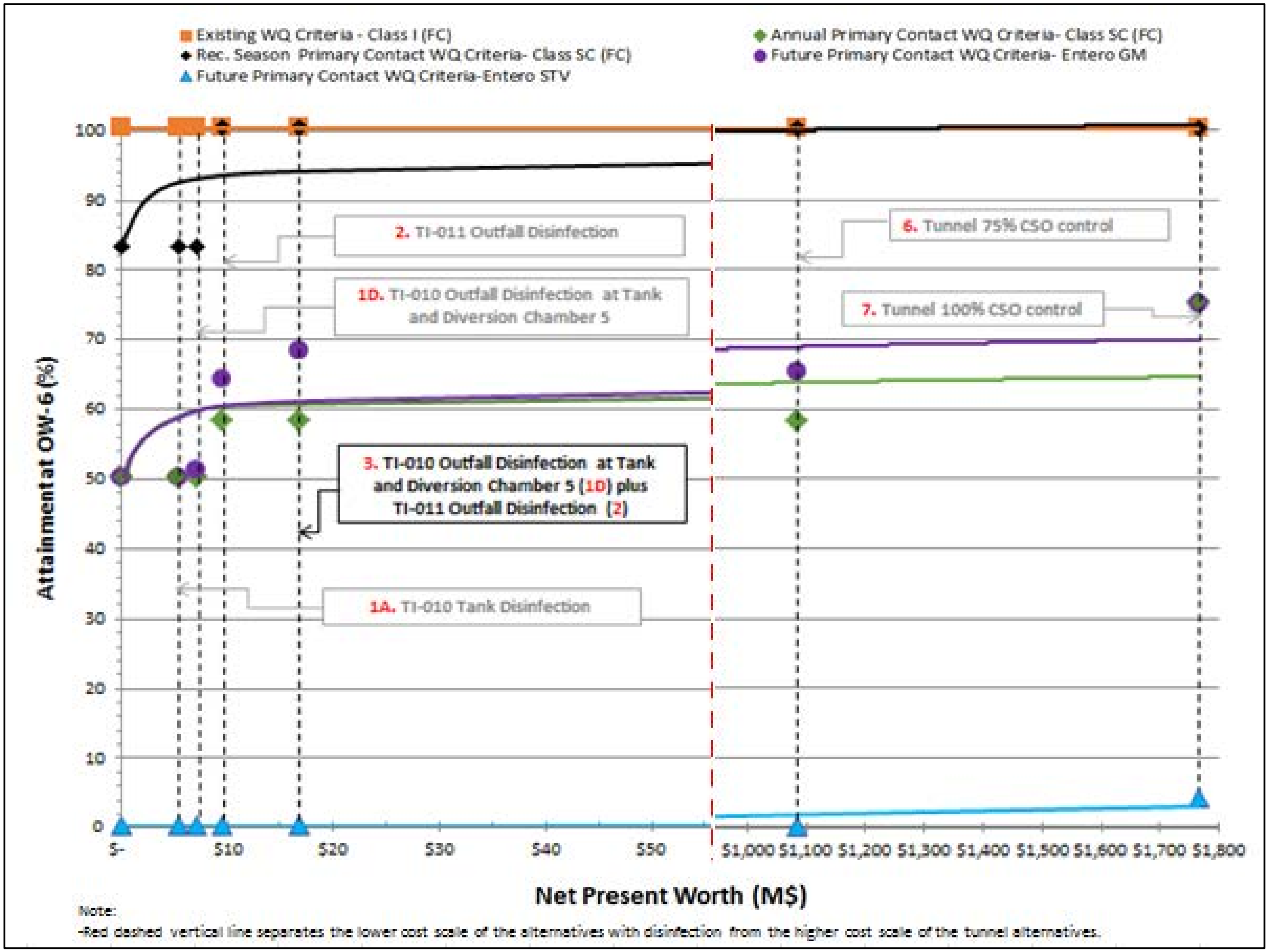

Figure 8-15. Cost vs. Bacteria Attainment at Station OW-6 (2008 Rainfall)

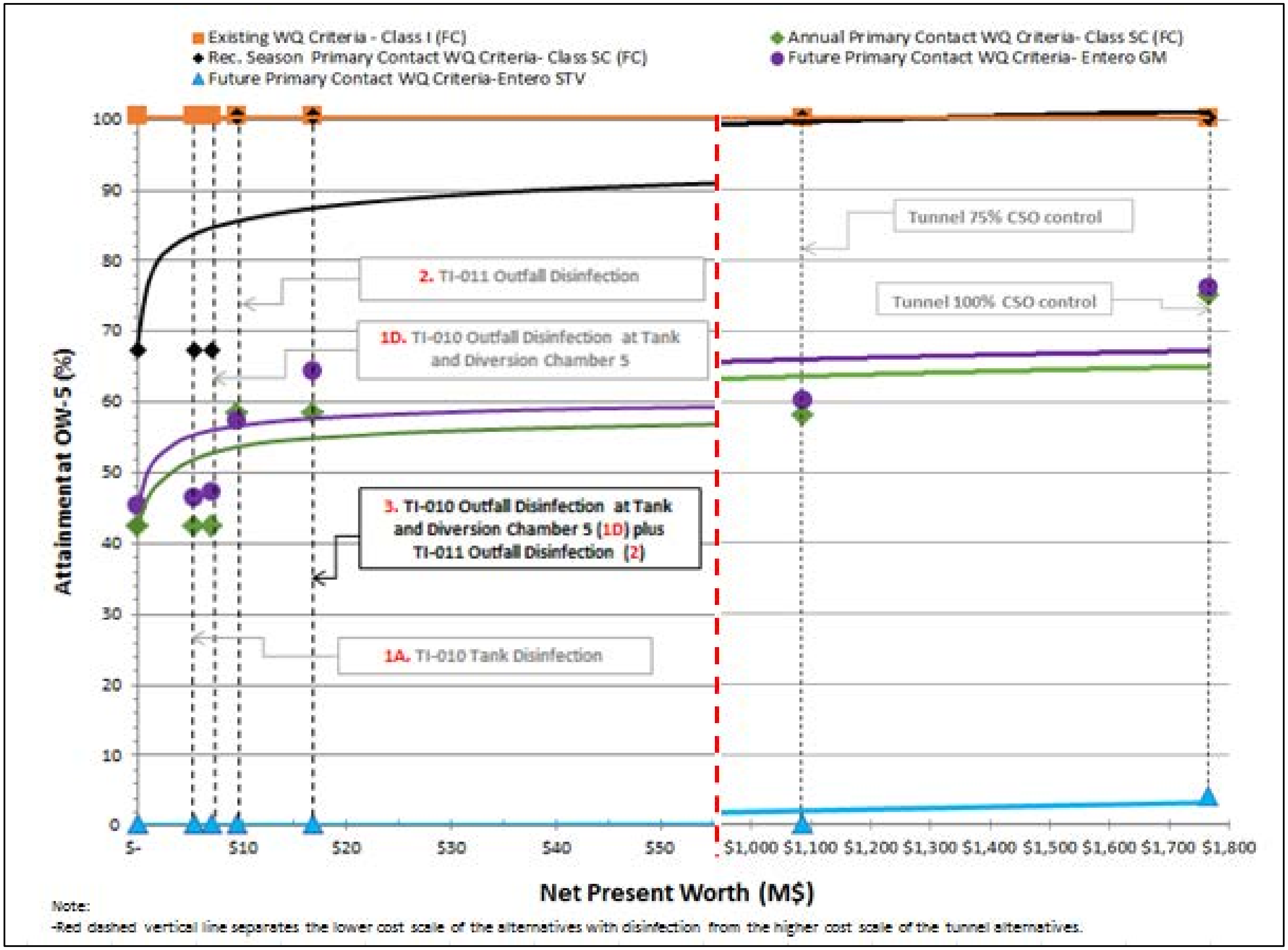

Figure 8-16. Cost vs. Bacteria Attainment at Station OW-5 (2008 Rainfall)

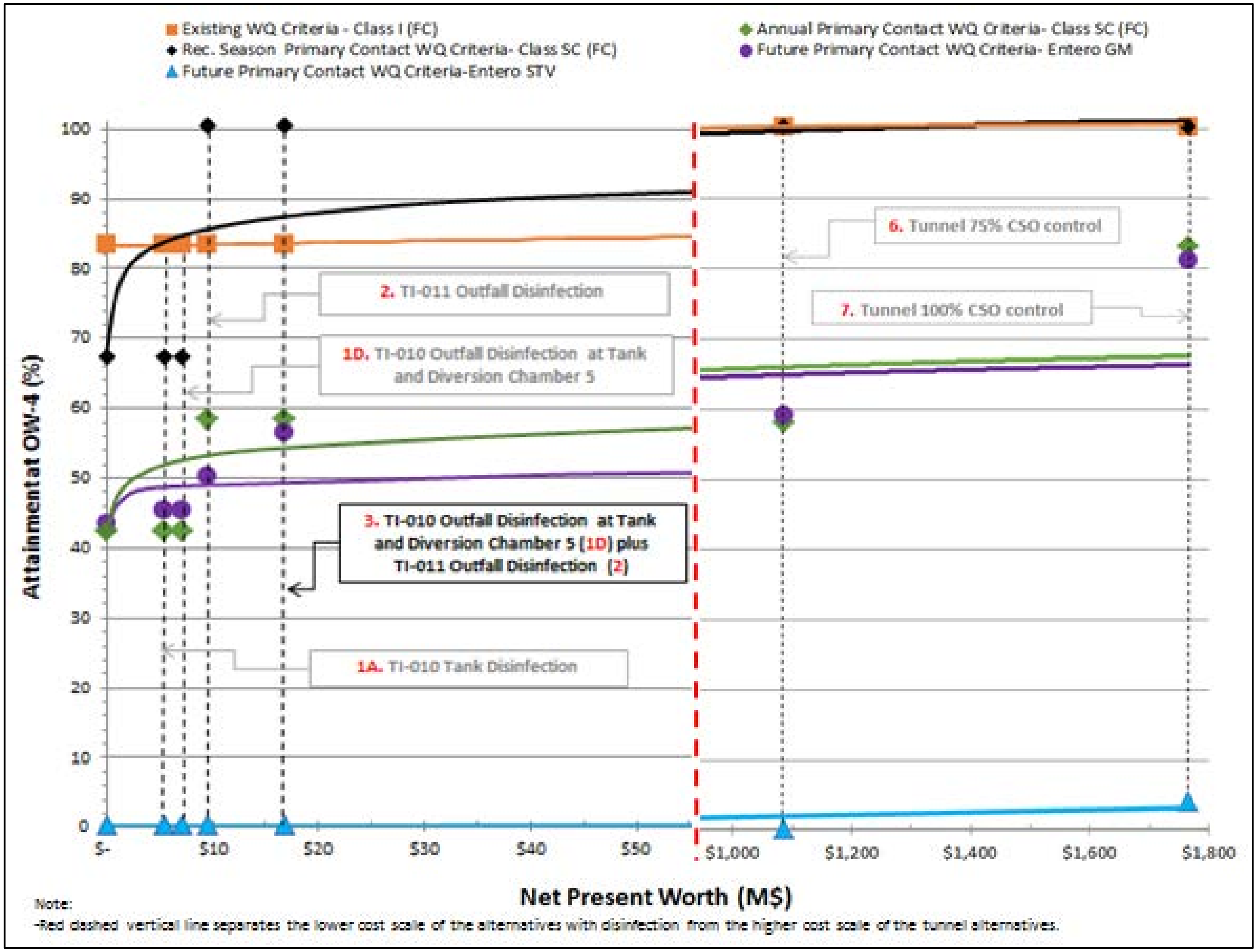

Figure 8-17. Cost vs. Bacteria Attainment at Station OW-4 (2008 Rainfall)

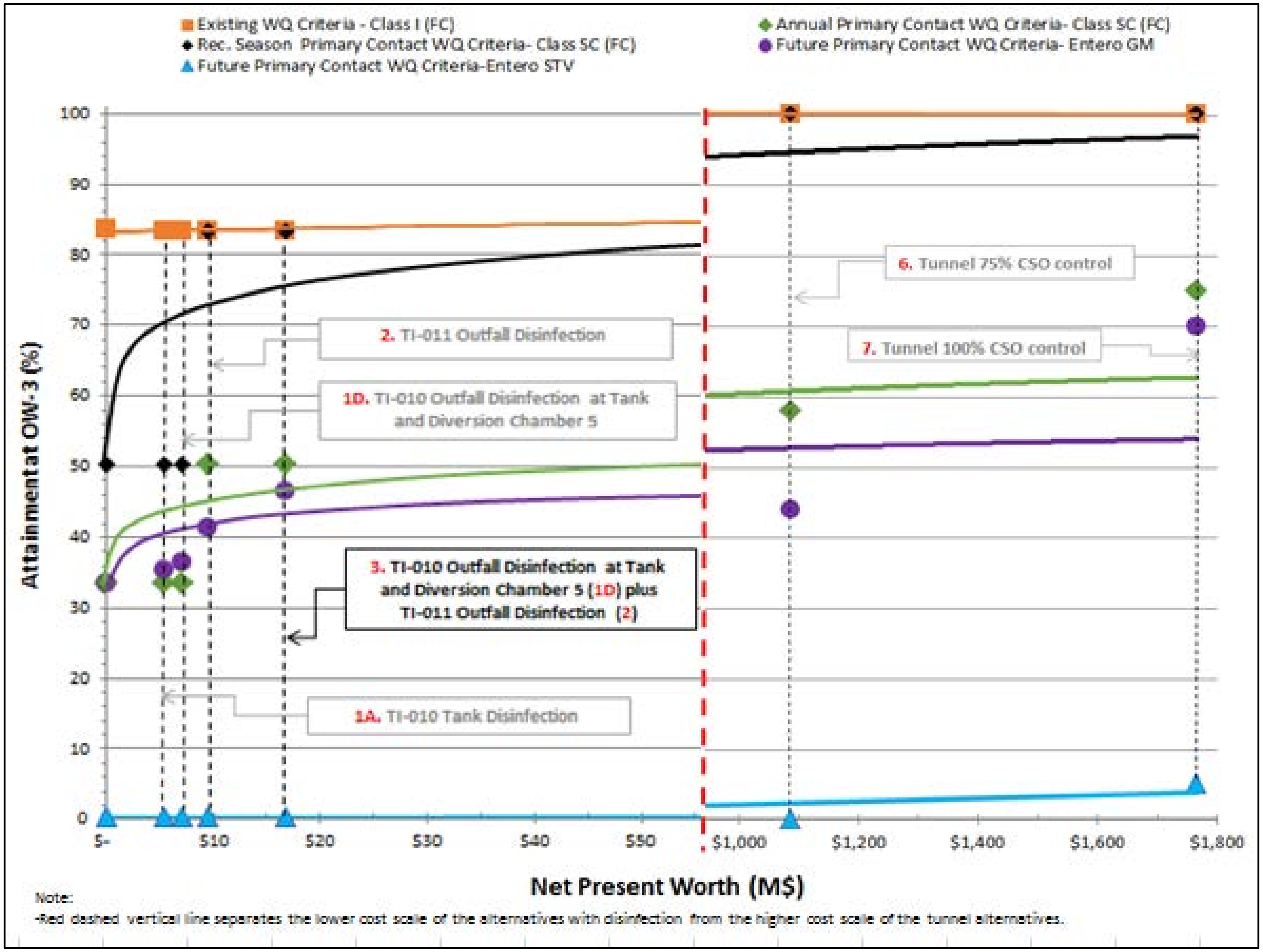

Figure 8-18. Cost vs. Bacteria Attainment at Station OW-3 (2008 Rainfall)

8.5.c Conclusion on Preferred Alternative

Based upon the findings from the series of cost-performance (Figures 8-9 through 8-14) and cost-attainment (Figures 8-15 through 8-18) plots, it is concluded that Alternative 3 - TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection - is the most cost-effective alternative from the series of retained alternatives resulting from Section 8.2. Alternative 3, with a total cost of $16.7M, would provide 88 percent level of fecal coliform loading reduction at outfalls TI-010 and TI-011 during the recreational season (May 1st through October 31st) and result in measurable gains in attainment for the Primary Contact WQ Criteria (Class SC) during the recreational season (May 1st through October 31st) throughout Flushing Creek.

Based on the findings and observations noted above, DEP is proposing to move forward with the construction of the grey infrastructure controls proposed as Alternative 3 - TI-010 Outfall Disinfection at the Tank and Diversion Chamber No. 5 (Figure 8-19) plus TI-011 Outfall Disinfection downstream of Regulator TI-R09 (Figure 8-20), and the GI as described in Section 5.0, collectively constituting the preferred alternative for this Flushing Creek LTCP.

Figure 8-19. Alternative 3 – TI-010 Disinfection at the Tank and Diversion Chamber No. 5

Figure 8-20. Alternative 3 – TI-011 Outfall Disinfection Downstream of Regulator TI-R09

As discussed earlier in this section, the ability of a CSO control technology to be retrofitted to handle process improvements was considered as part of the alternatives evaluation. For the preferred grey alternative, future expansion to improve process control may be necessary to increase chlorine contact times or to provide for dechlorination prior to discharge. For the preferred alternative, improved process control may entail some combination of a dechlorination building and a control structure located near the end of each outfall. Figure 8-21 and Figure 8-22 each show an example general arrangement of these facilities. The need for these facilities would be identified during design or through PCM and sites would need to be identified.

Figure 8-21. Possible Future Process Control Upgrades for Disinfection at TI-010

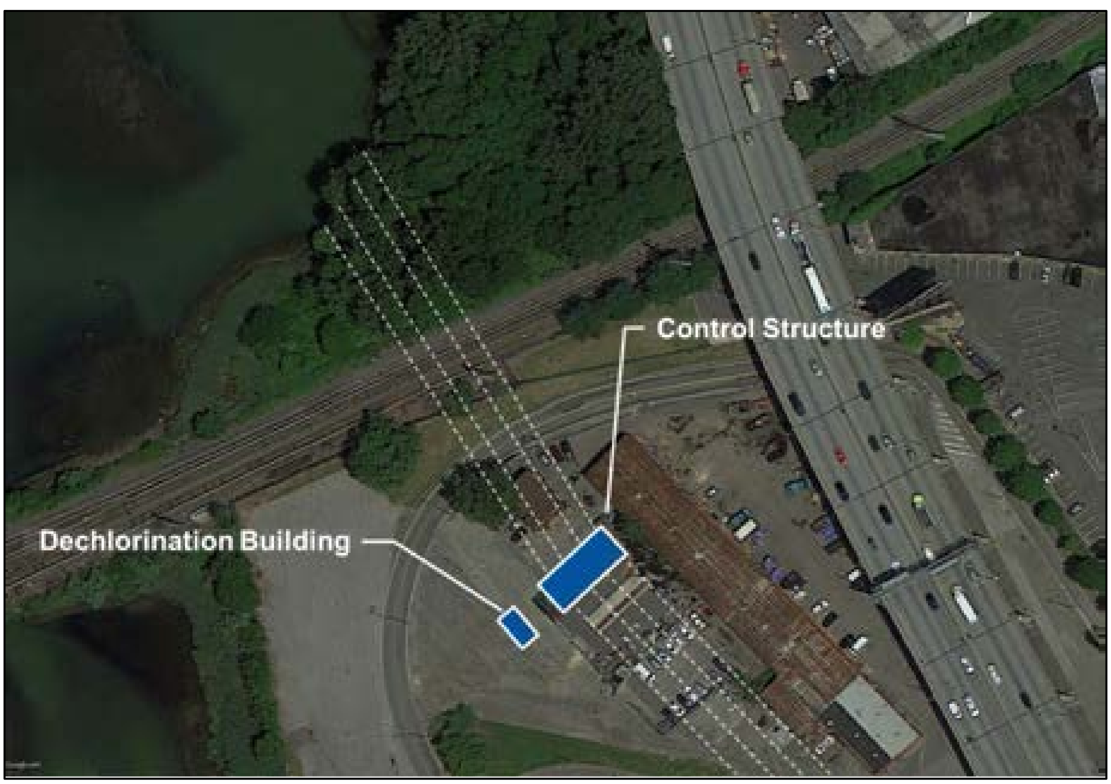

Figure 8-22. Possible Future Process Control Upgrades for Disinfection at TI-011

A 10-year continuous simulation was performed with the ERTM WQ model to characterize WQS attainment for this preferred alternative. The results of these runs are summarized in Tables 8-14 (annual attainment) and 8-15 (recreational season [May 1st through October 31st] attainment).

Table 8-14. Calculated 10-year Bacteria Attainment for Preferred Plan – Annual Period

Station	Existing WQ Criteria (Class I)		Primary Contact WQ Criteria (Class SC)	
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
OW-3	Fecal ≤2,000	100	Fecal ≤200	67
OW-4	Fecal ≤2,000	100	Fecal ≤200	67
OW-5	Fecal ≤2,000	100	Fecal ≤200	75
OW-6	Fecal ≤2,000	100	Fecal ≤200	75

Table 8-15. Calculated 10-year Bacteria Attainment for Preferred Plan – Recreational Season (May 1st – October 31st)

Station	Existing WQ Criteria (Class I)		Primary Contact WQ Criteria (Class SC)		Future Primary Contact WQ Criteria	
	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)	Criterion (cfu/100mL)	Attainment (%)
OW-3	Fecal ≤2,000	100	Fecal ≤200	78	Enterococci ≤30	45
					STV≤130	3
OW-4	Fecal ≤2,000	100	Fecal ≤200	82	Enterococci ≤30	55
					STV≤130	3
OW-5	Fecal ≤2,000	100	Fecal ≤200	90	Enterococci ≤30	59
					STV≤130	5
OW-6	Fecal ≤2,000	100	Fecal ≤200	92	Enterococci ≤30	62
					STV≤130	6

Examination of Table 8-14 and Table 8-15 shows that attainment of the Primary Contact WQ Criteria (Class SC) for fecal coliform improves above the 10-year simulated baseline conditions that were presented earlier (see Table 6-6). As shown, the 200 cfu/100mL criterion is attained a high percent of the time for the recreational season (May 1st through October 31st). During this period, attainment is lowest (78 percent) for the upstream portions of the Creek at Station OW-3. That is likely the result of the relatively poor flushing that occurs at the head end of tidal tributaries, such as Flushing Creek, combined with the remaining sources being discharged to the head end of the Creek (lake outflows, CSOs, etc.). However, unlike the Primary Contact WQ Criteria (Class SC), the Future Primary Contact WQ Criteria for enterococci are not attained at a high level during the recreational season (May 1st through October 31st) for any location for the GM criterion of 30 cfu/100mL and even less so for the STV value of 110 cfu/100mL.

Table 8-16 provides a summary of the calculated annual attainment (vertically averaged) of Flushing Creek for dissolved oxygen for the preferred alternative. As noted in the table, there is a high level of DO attainment for the never-less-than 3 mg/L component of the water quality criterion. The daily average 4.8 mg/L component of the criterion is not fully attained.

Table 8-16. Model Calculated DO Percent Compliance Results for Class SC Criteria – Preferred Alternative

Station	Class SC Dissolved Oxygen Attainment (Percent)	
	Chronic (4.8 mg/L)	Acute (3.0 mg/L)
OW-03	78	92
OW-04	80	95
OW-05	81	97
OW-06	90	99

8.5.d Time to Recover Analysis

Analyses were conducted with the ERTM model to evaluate the length of time fecal coliform concentrations and enterococci concentrations would exceed target values of 1,000 and 110 cfu/100mL, respectively. These target values are discussed further in Section 8.7.a, and represent concentrations above which bathing would be unadvisable. These analyses were performed for the baseline conditions of upstream freshwater bacteria concentrations unchanged from present levels, with the exception that suspected illicit dry weather discharges are currently being investigated and will be removed when located. The analysis was conducted for a rainfall event sequence that occurred August 14, 2008 (0.96 inches) and August 15, 2008 (1.02 inches) which fell over approximately 4 hour periods each day, which is a rainfall event that represents about a 90th percentile event.

The results of this analysis are shown in Figure 8-23 for both fecal coliform bacteria and enterococci. The results represent the amount of time it takes after the end of the August 14-15 rainfall for the bacteria concentrations to return to the target levels at Station OW-3, closest to outfall TI-010 associated with the preferred alternative, or Alternative 3. This rate of reduction is then followed by Alternative 6 – Tunnel 75 percent CSO control. The explanation for this is as follows: for a given wet weather event during the recreational season (May 1st through October 31st), the preferred alternative provides nearly 100 percent bacteria loading reduction at outfalls TI-010 and TI-011, beyond the 75 percent bacteria loading reduction provided by the Alternative 6 tunnel. As also shown, for the enterococci time to recover, the larger tunnel from Alternative 7 (100% vs. 75% CSO control) does not provide a significant improvement over the smaller Alternative 6 tunnel. There is no time to recover to the fecal coliform target of 1,000 cfu/100mL for the larger Alternative 7 tunnel because the loading reduction provided prevents the fecal coliform levels at Station OW-3 from reaching this threshold value for this event.

Alternative 3 realizes times to recover of 33 and 62 hours, for the fecal coliform and enterococci targets, respectively.

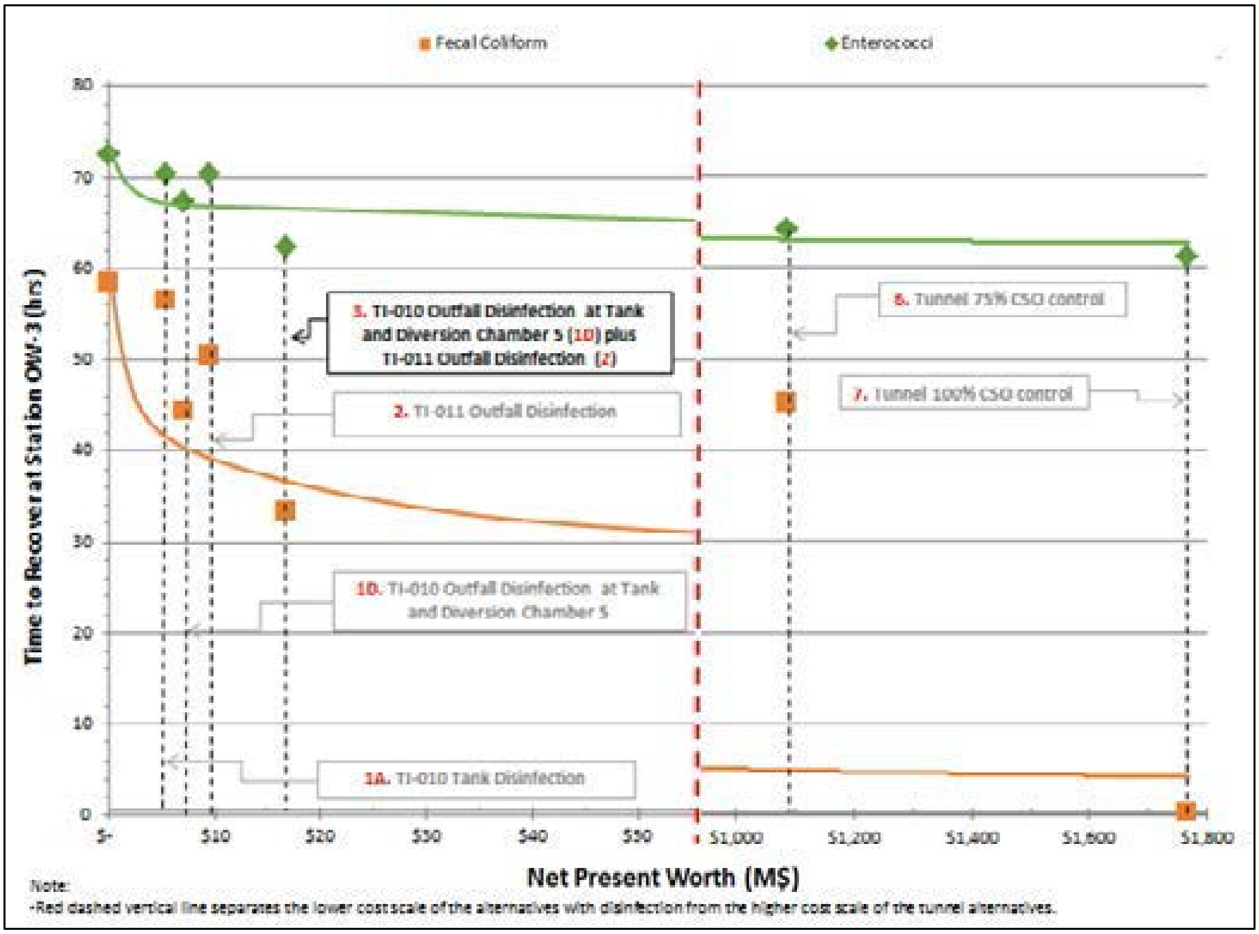

Figure 8-23. Time to Recover at Station OW-3

8.6 Use Attainability Analysis

The 2012 CSO Order on Consent requires a UAA to be included in the LTCPs "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 Section101(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. Because Flushing Creek is not expected to meet Primary Contact (Class SC) bacteria standards with the implementation of the preferred alternative, a UAA is attached hereto in Appendix E.

8.6.a Use Attainability Analysis Elements

Cost-effectively maximizing the water quality benefits associated with CSO reduction 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 Flushing Creek will not fully attain primary contact water quality standards. For this LTCP, 100 percent elimination of Flushing Creek CSO sources does not result in full attainment. However, as noted in Section 6.0, CSOs discharged into Flushing Bay are responsible for a portion of the remaining non-attainment. A full understanding of attainment with the bacteria standards will not be possible until the Flushing Bay LTCP is completed in June 2017. This means that as of now, human caused conditions (Flushing Bay CSO, direct drainage and urban stormwater) prevent the attainment of the use and it is possible that fully correcting them would cause environmental damage and modifications to the shoreline prevent access to the Creek. As such, UAA Factors 3 and 4 provide a justification for the UAA until such time as the Flushing Bay LTCP is completed and the full impacts of remedying the Flushing Bay CSOs and the cost of remedying them is known. At such time, the Flushing Creek UAA, appended as Appendix E, would be retracted or amended.

8.6.b Fishable/Swimmable Waters

As discussed in Sections 2.0 and 6.0, municipal stormwater and direct drainage introduced through the urbanization of the Flushing Creek watershed contribute to bacteria levels in Flushing Creek to some extent based on model predictions. However, other sources such as CSOs discharged to Flushing Bay are also identified as a contributor to the non-attainment of bacteria criteria.

As noted in Section 8.1, and in other previous sections, 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. SA, SB, and SC classifications are fully supportive of the CWA Section 101(a)(2) fishable/swimmable goals.

Water quality modeling analyses, conducted for Flushing Creek and summarized in Table 8-14, shows that upon implementation of the preferred alternative summarized in Section 8.5, Flushing Creek is predicted to comply with both the Existing WQ Criteria (Class I) 100 percent of the time and the Primary Contact WQ Criteria (Class SC) monthly fecal coliform criterion of 200 cfu/100mL between 67 and 75 percent of the time throughout the waterbody for the 10-year simulation period. Compliance with the Future Primary Contact WQ Criteria for the enterococci 30-day GM recreational season (May 1st through October 31st) criterion of 30 cfu/100mL is predicted (Table 8-15) to be lower 45 percent of the time at the head end, and 62 percent of the time at Station OW-6 following implementation of the preferred plan. Attainment of the associated STV values is much less. As such, Flushing Creek would not comply with the Class SC Primary Contact WQ Criteria under the preferred plan, and compliance with all Future Primary Contact WQ Criteria is also predicted to be below the DEC target of 95 percent attainment.

These results indicate that no portions of Flushing Creek could potentially support Class SC Primary Contact WQ Criteria.

8.6.c Assessment of Highest Attainable Use

The analyses contained herein, as noted above in Section 8.5.c and summarized in Table 8-14, indicate that the Primary Contact WQ Criteria (Class SC), is not projected to be attained 100 percent of the time annually within most of Flushing Creek with the preferred alternative. For the purpose of this LTCP, attainment of the standards was calculated using a mathematical water quality model. For this LTCP, a calculation of 95 percent attainment or higher is taken as fully attaining the criteria. A more accurate assessment of attainment will be performed once the preferred alternative is constructed. However, the preferred alternative is not projected to attain the 95 percent attainment goal.

The modeling analysis assessed whether the preferred plan would improve water quality to allow for the Primary Contact WQ Criteria (Class SC), both annually and during the recreational season (May 1st through October 31st). As shown in Tables 8-14 and 8-15, fecal coliform bacteria levels approach the Class SC criterion but still do not attain the criterion in the Creek, although attainment is higher during the recreational season (May 1st through October 31st). With construction of the WWFP recommendations and planned GI, Flushing Creek cannot fully attain a higher classification than the existing Class I through CSO controls put in place for Flushing Creek alone.

As noted in Section 6.0, however, CSOs discharged into Flushing Bay are responsible for a portion of the remaining non-attainment and if fully abated (100 percent removal) Primary Contact WQ Criteria could be attained. A full understanding of attainment with the bacteria standards and the associated costs will not be possible until the Flushing Bay LTCP is completed in June 2017. This means that the UAA provided herein will require updating in 2017 when the Flushing Bay LTCP is completed.

Table 8-17 summarizes the compliance for the preferred plan.

Table 8-17. Preferred Plan Compliance with Bacteria Water Quality Criteria

Meets Existing WQ Criteria(1,2) (Class I)	Meets Primary Contact WQ Criteria(1) (Class SC)	Meets Future Primary Contact WQ Criteria(2)
YES	NO	NO

Notes:
YES indicates attainment is calculated to occur ≥ 95 percent of time.
NO indicates attainment is calculated to be less ≤ 95 percent of time.
(1) Annual attainment
(2) Recreational season attainment (rolling 30-day GM Enterococci and STV value)

8.7 Water Quality Goals

Based on the analyses of Flushing Creek, and the WQS associated with the designated uses, the following conclusions can be drawn on both existing and further water quality goals:

8.7.a Existing Goals

Flushing Creek remains a highly productive Class I waterbody that can fully support existing uses: kayaking and wildlife propagation. Flushing Creek is in attainment with its current Class I classification. Furthermore, manmade features, shoreline access and industrial uses prevent the opportunity and feasibility of primary contact recreation in Flushing Creek.

This LTCP conducted assessments for attainment with the primary recreation water quality standard spatially and temporally and identified site-specific targets that will allow DEP to continue to improve water quality over time. As such, the Primary Contact WQ Criteria of Class SC and Future Primary Contact WQ Criteria could be considered for the recreational period with site-specific targets, as further described below.

8.7.b Future Water Quality

DEP is committed to improving water quality in Westchester Creek. Toward that end, DEP has identified site-specific water quality targets for Westchester Creek that will allow DEP to continue to improve water quality in the system over time. Site-specific targets are recommended for consideration to advance towards the numerical limits established, or under consideration by DEC, including Primary Contact WQ Criteria (Class SC) or proposed Class I fecal coliform criterion of 200 cfu/100mL and enterococci Future Primary Contact WQ Criteria consistent with the 2012 EPA RWQC. It is clear from this LTCP that full attainment with primary contact standards cannot be readily achieved. These targets were developed using the 10-year water quality modeling simulations and assessing bacteria concentrations that provide for 95 percent attainment of the fecal coliform criteria of a monthly GM of 200 cfu/100mL and an enterococci criteria of a rolling 30-day GM of 30 cfu/100mL. DEP notes that these targets are based on projections and may require adjustment based upon PCM results. These targets are shown below.

- Recreational Season Site-Specific Targets: Uses of Flushing Creek generally oriented around the recreational season (May 1st through October 31st). DEP proposes that the following numerical site-specific targets be established for Flushing Creek for the recreational season (May 1st through October 31st) against which continual water quality improvements be measured:

- o Maximum rolling 30-day GM enterococci value of 180 cfu/00mL
- o Monthly fecal coliform GM concentration of 700 cfu/100mL

- Non-Recreational Season Site-Specific Targets: DEP proposes that the following numerical site-specific targets be established for Flushing Creek for the non-recreational season against which continual water quality improvements be measured:

  - o Monthly fecal coliform GM concentration of 2,000 cfu/100mL

These water quality targets are summarized in Table 8-18 in comparison to the existing and primary contact pathogen WQ criteria. This table also provides a summary of the calculated pathogen criteria attainment. As noted in the table, the preferred plan results in a high level of attainment with these identified site-specific pathogen targets. DEP recommends that these site-specific targets be re-evaluated when the Flushing Bay LTCP is conducted in 2017.

Table 8-18. Summary of Recommended Flushing Creek Bacteria Water Quality Targets

Location	Existing WQ Criteria (Class I)	Primary Contact WQ Criteria (Class SC)	Site-specific Targets (cfu/100mL)	Attainment(3) with Site-specific Targets (%)
Recreational Season	Fecal Coliform(1) ≤ 2000	Fecal Coliform(1) ≤ 200	Fecal Coliform ≤ 700	95
			Enterococci ≤ 180(2)	95
Non-Recreational Season	Fecal Coliform(1) ≤ 2000	Fecal Coliform(1) ≤ 200	Fecal Coliform ≤ 2,000	95

Notes:
(1) Monthly GM.
(2) 30-day rolling average GM during the recreational season (May 1st through October 31st).
(3) At location OW-3. Attainment at all other locations is higher.

Also, as noted above, DEP does not believe that adoption of the STV portions of the proposed 2012 EPA RWQC is warranted at this time. Analyses presented herein (Table 8-15) clearly show that attaining the STV value of 110 cfu/100mL is not achievable. Alternatively, DEP believes that if a STV value is required, it should be derived specifically for individual portions of Flushing Creek based on measured enterococci concentrations and their variability.

If Flushing Creek were upgraded to Primary Contact WQ Criteria (limited primary contact – Class SC), it would not be capable of supporting primary contact 100 percent of the time. Even with anticipated reductions in CSO loadings resulting from the preferred plan and GI, the waterbody could possibly be protective of primary contact should it occur, as long as it did not occur during and following rainfall events. Toward that end, DEP has performed an analysis to assess the amount of time following the end of a rainfall required for Flushing Creek to recover and return to concentrations less than 1,000 cfu/100mL fecal coliform and 110 cfu/100mL enterococci. The value 110 was used instead of 104, as recent EPA guidance indicates that the 104 value will no longer be relevant.

The analyses consisted of examining the water quality model calculations for Flushing Creek bacteria concentrations for the recreational season (May 1st through October 31st), abstracted from 10-years of model simulations. The time to return to 1,000 or 110 was then calculated for each storm with the various size categories and the median time after the end of rainfall was then calculated for each rainfall category.

The results of these analyses for the preferred plan are summarized in Table 8-19 for Flushing Creek. As noted, the duration of time within which pathogen concentrations are expected to be higher than New York State Department of Health (NYSDOH) considers safe for primary contact varies with location and with rainfall event size. Generally, a value of 72 hours would be typical for Flushing Creek for storms with rainfall volumes of less than 1 inch.

Table 8-19. Time to Recover (Hours) at Flushing Creek

Interval	OW-03		OW-04		OW-05		OW-06	
	Fecal(1)	Entero(2)	Fecal(1)	Entero(2)	Fecal(1)	Entero(2)	Fecal	Entero(2)
<0.1	-	-	-	-	-	-	-	-
0.1 – 0.4	8	17	5	11	-	5	-	-
0.4 – 0.8	21	45	17	48	13	49	3	49
0.8 – 1.0	42	65	44	63	45	62	44	62
1.0 – 1.5	56	84	55	85	56	80	54	78
>1.5	56(3)	84(3)	55(3)	85(3)	56(3)	80(3)	54(3)	78(3)

Notes:

"-" indicates median elevated bacteria concentrations return to the 1,000 cfu/100mL and 110 cfu/100mL threshold levels prior to the end of the rainfall events.

(1) Threshold for Fecal coliform is 1000 cfu/100mL.

(2) Threshold for Enterococci is 110 cfu/100mL

(3) In a few cases the time to recover was calculated to be less than the next smaller rain event bin. In those cases, both bins were set equal to the higher time to recover.

8.8 Recommended LTCP Elements to Meet Water Quality Goals

Water quality in Flushing Creek will be improved with the preferred alternative and the implementation of the planned GI projects and recommendations made herein. The Flushing Creek LTCP identified the following actions:

1. The LTCP includes feasible site-specific WQ targets based on the projected performance of the selected CSO controls. A PCM program will be initiated after the LTCP improvements are operational. Based upon the results of such monitoring, the site-specific WQ targets may need to be reviewed.

2. DEP will issue a wet weather advisory during the recreational season (May 1st through October 31st), alerting the public that the water may be unsafe for recreational uses.

3. DEP will continue to operate the Flushing Bay CSO Retention Facility in accordance with its Wet Weather Operating Plan.

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

5. DEP will implement the design and construction of seasonal disinfection of the TI-010 Outfall Disinfection at the Flushing Bay CSO Retention Facility and Diversion Chamber 5 plus Outfall TI-011 Outfall Disinfection, which will provide DEP with the most efficient means of controlling a high percent of baseline CSO loadings and striving towards meeting Class SC Primary Contact WQ Criteria, particularly during the recreational season (May 1st through October 31st). The Capital Cost is estimated to be $6.89M, annual O&M is $0.66M, and the Total Present Worth is $16.70M.

6. A UAA is provided with site-specific targets for Flushing Creek. This UAA should be revisited upon completion of the Flushing Bay LTCP.

7. A SPDES variance is included in Appendix C.

Section 9.0 presents the implementation schedule of these actions.

9.0 LONG-TERM CSO CONTROL PLAN IMPLEMENTATION

The evaluations performed for this Flushing Creek Long Term Control Plan (LTCP) concluded that with the recommendations from previous planning work that have been implemented, Flushing Creek meets its current water quality classification of Class I for bacteria approximately 97 percent of the time. This level of attainment exceeds the 95 percent attainment level that, in accordance with guidance from New York State Department of Environmental Conservation (DEC), has been accepted as being equivalent to full attainment. Analyses also indicated that additional expenditures in grey infrastructure would not result in full attainment with the Primary Contact WQ Criteria (Class SC or the recently proposed fecal coliform Class I criteria[1]). However, the cost performance and cost attainment analyses presented in Section 8.5 showed that Alternative 3 - TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection would provide a high level of attainment with the Primary Contact WQ Criteria (Class SC or the recently proposed fecal coliform Class I criteria[1]) during the recreational season (May 1st through October 31st), and the significantly more costly alternatives would only result in marginal improvements over that predicted for Alternative 3. As demonstrated in Sections 6.0 and 8.0, due to the influence of other wet weather sources to the river, full attainment of Primary Contact WQ Criteria cannot be achieved through the control of the combined sewer overflow (CSO) discharges in Flushing Creek alone, but the recommended Alternative 3A (TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection) will significantly improve water quality and achieve highest attainable use.

9.1 Adaptive Management (Phased Implementation)

Adaptive management, as defined by U.S. Environmental Protection Agency (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, New York City Department of Environmental Protection (DEP) will continue to apply the principles of adaptive management based on its annual evaluation of monitoring data, which will be collected to optimize the operation and effectiveness once the actions identified in this LTCP are constructed.

Another aspect of the LTCP's phased adaptive management relates to interim or incremental water quality. Because of the inability to meet the Primary Contact WQ Criteria (Class SC or the recently proposed fecal coliform Class I criteria[1]) and Future Primary Contact WQ Criteria (2012 EPA RWQC), the concept of "Site-Specific Targets" is discussed for Flushing Creek in Section 8.7 and Appendix D. The water quality of the river will be monitored and compared with these targets as part of Post-Construction Compliance Monitoring (PCM).

New York City (NYC) will also develop a program to further address stormwater discharges as part of the upcoming MS4 permit. This program, along with the actions identified in this LTCP, may further improve water quality in Flushing Creek.

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[1] *DEC has publicly noticed a proposed rulemaking which, if promulgated, would amend 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 (Proposed Rulemaking). If promulgated, the Class I standard for fecal coliform would be the same as that for current Class SB waterbodies. As such, the term Class SC criteria used in this LTCP is interchangeable with the proposed Class I numerical criteria when used in the context of bacteria WQ limits.*

DEP will also continue to monitor water quality of the river through its ongoing monitoring programs. When evidence of dry weather sources of pollution is found, track downs will be initiated. Such activities will be reported to DEC on a quarterly basis as is currently required under the wastewater treatment plant (WWTP) State Pollutant Discharge Elimination System (SPDES) permit.

In addition to control measures implemented as part of the Flushing Creek LTCP, other DEP programs are expected to increase dissolved oxygen (DO) within Flushing Creek. As described in Section 8, a dredging and tidal wetland restoration program is being planned under a cooperative effort by DEP/U.S. Army Corps of Engineers (USACE) outside the LTCP framework. The DEP/USACE wetland restoration program is described in a letter from USACE to DEP dated November 24, 2014, attached in Appendix D. Research has shown that wetlands remove biochemical oxygen demand (BOD) from surface water through decomposition of organic matter or oxidation of inorganics. Through the PCM, DEP will evaluate DO improvements from this tidal wetlands restoration program. If further DO improvements are necessary, DEP has identified approximately two to four acres downstream of the DEP/USACE restoration/dredging project area as potential additional wetland restoration areas.

Finally, the findings from the Flushing Bay LTCP, scheduled for a June 2017 submittal to DEC, could have a bearing on the water quality and water quality standards (WQS) attainment in Flushing Creek. As noted in Section 6, reduction in CSO discharges to Flushing Bay could improve the level of WQS attainment in Flushing Creek. These issues will be evaluated as part of the Flushing Bay LTCP.

9.2 Implementation Schedule

The implementation schedule to construct the facilities associated with the TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection is presented in Figure 9-1. The disinfection facilities will be operated from May 1st through October 31st (recreational season). The schedule presents the duration of time needed to perform the engineering design, advertise and bid the construction contracts and complete the construction of the actions identified in this LTCP.

During the design phase, selection of design flows and dosage rates of chlorine for each location will be determined. Additional permitting and environmental review will occur during the design phase including a Uniform Land Use Review Procedure (ULURP) application for the disinfection facility at outfall TI-011.

9.3 Operational Plan/O&M

DEP is committed to effectively operating the Flushing Creek LTCP components as they are built-out during the implementation period. To the extent DEP has information from other seasonal CSO disinfection facilities, DEP will apply lessons-learned to maximize efficient operations and water quality benefits.

9.4 Projected Water Quality Improvements

As described in Section 8.4, Alternative 3 will result in improved water quality in Flushing Creek including a high degree of reduction of the human or CSO-derived bacteria during the recreational season (May 1st through October 31st). Improvements in water quality will also be realized as green infrastructure (GI) projects are built-out.

Other improvements in water quality are expected to continue as the result of implementation of NYC's MS4 program.

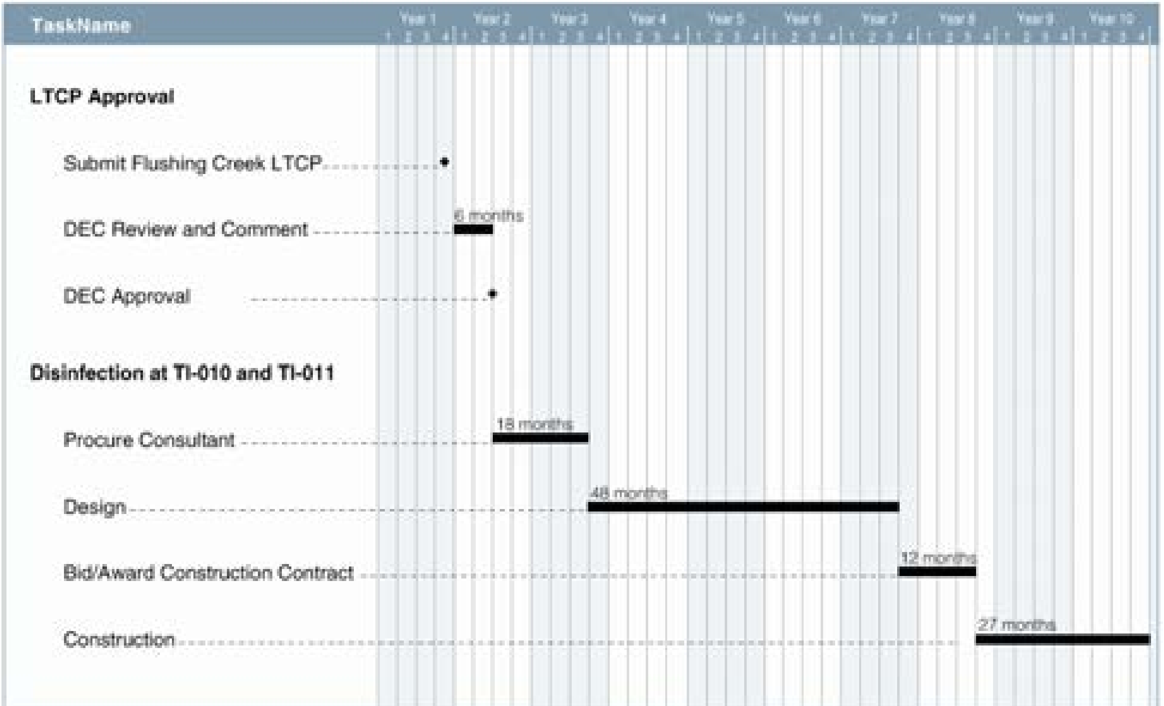


Figure 9-1. Implementation Schedule

9.5 Post Construction Monitoring Plan and Program Reassessment

Ongoing DEP monitoring programs will continue, including the PCM associated with the Flushing Bay CSO Retention Facility, the Harbor Survey Monitoring Program (HSM), and Sentinel Monitoring program. Harbor Survey data collected from Stations FLC1, FLC2, E15 and E6 will be used to periodically review and assess the water quality trends in the Flushing Creek and Bay. Depending on the findings, the data from these programs could form the basis of additional recommendations for inclusion in, as appropriate, the 2017 Citywide LTCP.

9.6 Consistency with Federal CSO Policy

The Flushing Creek LTCP was developed to comply with the requirements of the EPA CSO Control Policy and associated guidance documents, and the Clean Water Act (CWA). Development of the LTCP revealed that Flushing Creek currently attains the Class I fecal coliform criterion but cannot support the Primary Contact WQ Criteria classification (Class SC or the recently proposed fecal coliform Class I criteria[1]), even with 100 percent CSO control. However, a full understanding of attainment with the bacteria standards will not be possible until the Flushing Bay LTCP is completed in June 2017. A Use Attainability Analysis (UAA) for Flushing Creek is included with this LTCP. It is recognized that the UAA may need to be updated in June 2017 with the conclusion of the Flushing Bay LTCP; due to Flushing Creek's overall water quality attainment being impacted by Flushing Bay. DEP is proposing to submit a comprehensive UAA for both Flushing Bay and Flushing Creek, if required, when the Flushing Bay LTCP is completed in June 2017. A SPDES Permit Variance is also provided for the Flushing Bay CSO Retention Facility as requested by the DEC.

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). EPA, in conversation with communities, the U.S. Conference of Mayors, and the National Association of Clean Water Agencies, is also preparing a Financial Capability Framework which clarifies and explains 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. 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-City WWTP. In wet weather, the system can treat up to 3.5 billion gallons per day of combined storm and sanitary flow. In addition to the WWTPs, DEP has four CSO storage facilities. DEP recently launched a $2.4B GI program, of which $1.5B will be funded by DEP, and the remainder will be funded through private partnerships.

9.6.a.2 Currently Budgeted and Recent Completed Mandated Programs

As shown in Figure 9-2, from Fiscal Year (FY) 2002 through FY 2013, 62 percent of DEP's capital spending was for wastewater and water mandates. Figure 9-3 identifies associated historical wastewater and water operating expenses from FY 2003 through FY 2014, which have generally increased over time reflecting the additional operational costs associated with the City's investments. Many projects have been important investments that safe-guard our water supply and improve the water quality of our receiving waters in the Harbor and its estuaries. These mandates and associated programs are described below.

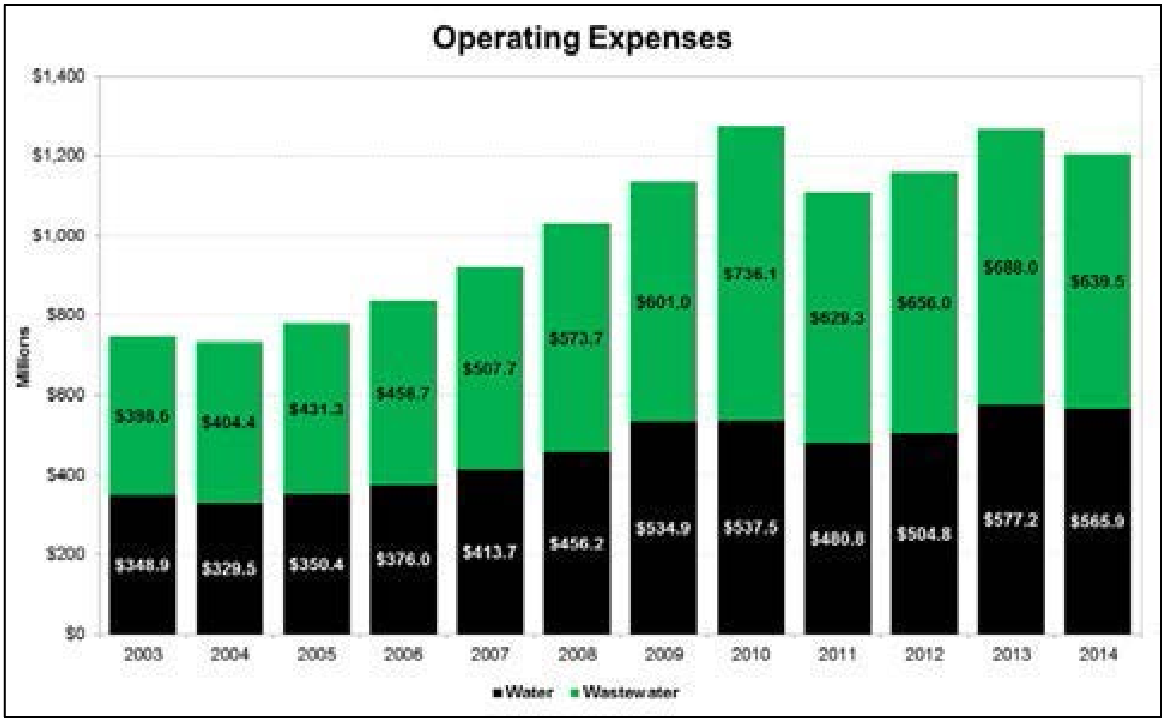


Figure 9-2. Historical and Projected Capital Commitments

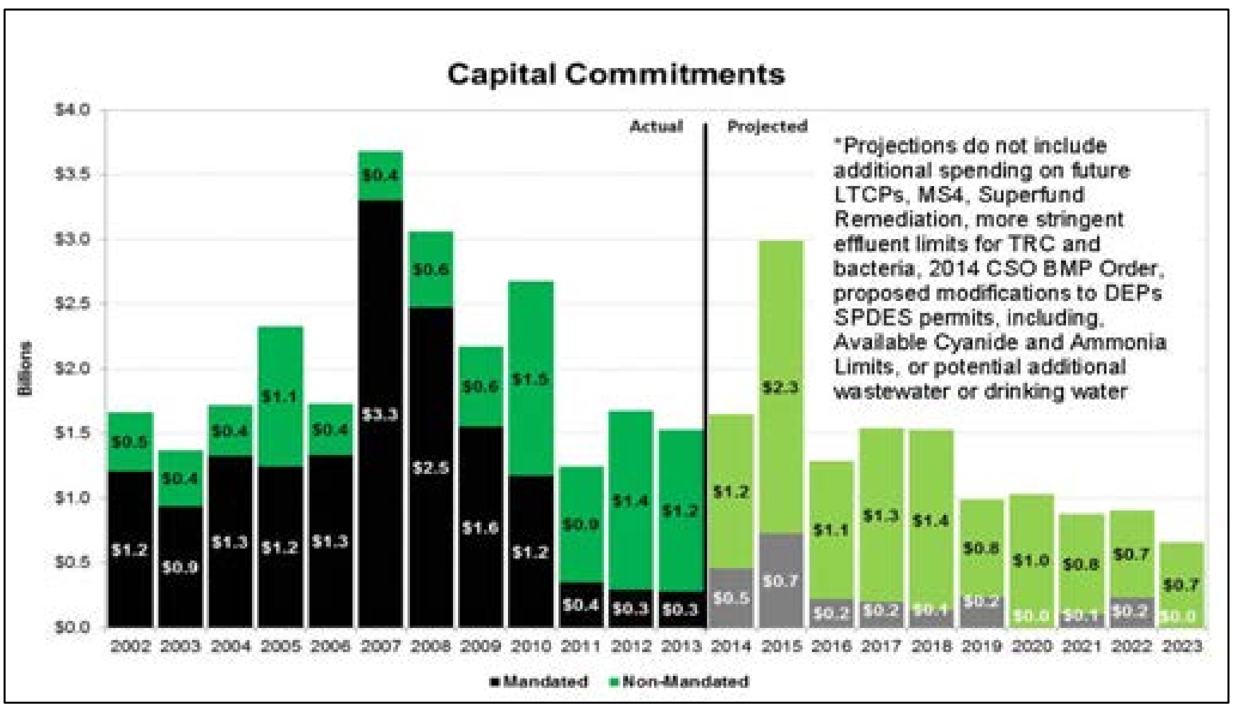


Figure 9-3. Historical Operating Expenses

Wastewater Mandated Programs

The following wastewater programs and projects have been initiated to comply with federal and state laws and permits:

- CSO abatement and stormwater management programs

  DEP has initiated a number of projects to reduce CSOs and eliminate excess infiltration and inflow of groundwater and stormwater into the wastewater system. These projects include: construction of CSO abatement facilities, optimization of the wastewater system to reduce the volume of CSO discharge, controls to prevent debris that enters the combined wastewater system from being discharged, dredging of CSO sediments that contribute to low DO and poor aesthetic conditions, and other water quality based enhancements to enable attainment of the WQS. These initiatives impact both the capital investments that must be made by DEP, as well as operations and maintenance (O&M) expenses. Historical commitments and those currently in DEP's ten year capital plan for CSOs are estimated to be about $3.3B. FY13 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 City 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 FY14 amounted to $3.2M per year, and by FY17 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 FY15, 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 New York State Department of Health (NYSDOH) 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. FY13 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-City 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 City agencies. Under the proposed MS4 permit, the permittee will be NYC.

  DEP is delegated to coordinate efforts with other City 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 Total Maximum Daily Loads (TMDLs). In FY2014, 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 Total Maximum Daily Load (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 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 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-$35,000 per impervious area 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 WWTP, potentially interfere with the chlorination process, particularly at 26th Ward and Jamaica.

  - Monitor for available cyanide and ultimately comply with a final effluent limit for available cyanide. Available cyanide can be a byproduct of the chlorination process.

  - DEC has also advised DEP that fecal coliform, the parameter that has been historically used to evaluate pathogen kills and chlorination performance/control, will be changing to enterococcus. This change will likely be incorporated in the next round of SPDES permits scheduled in the next five years. Enterococcus has been shown to be harder to kill with chlorine and may require process changes to disinfection that would eliminate the option of adding de-chlorination after the existing chlorination process.

  The potential future costs for these programs have yet to be determined. Preliminary compliance costs for TRC control and ammonia control are estimated to be up to $560M and $840M, respectively.

- CSO Best Management Practices Order

  On May 8, 2014, DEC and DEP entered into an agreement for the monitoring of CSO compliance, reporting requirements for bypasses, and notification of equipment out-of-service at the WWTP during rain events. The 2014 CSO BMP Order on Consent incorporates, expands, and supersedes the 2010 CSO BMP Order by requiring DEP to install new monitoring equipment at identified key regulators and outfalls and to assess compliance with requirements to "Maximize Flow to the WWTP". The costs for compliance for this Order have not yet been determined, but DEP expects this program to have significant capital costs as well as expense costs.

- Superfund Remediation

  There are currently three Superfund sites in NYC, 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, and the Former Wolff-Alport Chemical Corporation has only recently been listed as a Superfund site.

  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. While the EPA estimated cost is $78M, the DEP estimate based on actual construction experience in NYC is $380-760M for construction, with an additional $40-80M for design. Potential alternatives to the EPA selected remedy will be evaluated during the Gowanus LTCP process. Similar Superfund mandated CSO controls at Newtown Creek could add costs of $1-2B.

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 NYSDOH 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 high level storm sewers 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 order to meet the PlaNYC goal, DEP is working to reduce energy consumption and GHG emissions through: reduction of fugitive methane emissions, investment in cost-effective, clean energy projects, and energy efficiency improvements.

Fugitive methane emissions from WWTPs currently account for approximately 170,000 metric tons (MT) of carbon emissions per year and 30 percent of DEP's overall emissions. To reduce GHG emissions and to increase on-site, clean energy generation, DEP has set a target of 60 percent beneficial use of the biogas produced by 2017. Recent investments by DEP to repair leaks and upgrade emissions control equipment have already resulted in a 30 percent reduction of methane emissions since a peak in 2009. Going forward, DEP has approximately $500M allocated in its CIP to make additional system repairs to flares, digester domes, and digester gas piping, in order to maximize capture of fugitive emissions for beneficial use or flaring.

A 12 megawatt cogeneration system is currently in design for the North River WWTP and estimated to be in operation in Spring 2019. This project will replace ten direct-drive combustion engines, which are over 25 years old and use fuel oil, with five new gas engines enhancing the WWTP's operational flexibility, reliability, and resiliency. The cogeneration system will produce enough energy to meet the WWTP's base electrical demand and the thermal demand from the treatment process and building heat, in addition to meeting all of the WWTPs emergency power requirements. The project is taking a holistic approach and includes: (1) improvements to the solids handling process to increase biogas production and reduce treatment, transportation and disposal costs; (2) optimization of biogas usage through treatment and balancing improvements; and (3) flood proofing the facility to the latest FEMA 100-year flood elevations plus 30 inches to account for sea level rise. The cogeneration system will double the use of anaerobic digester gas produced on-site, eliminate fuel oil use, and off-set utility electricity use, which will reduce carbon emissions by over 10,000 MT per year, the equivalent of removing ~2,000 vehicles from the road. The total project cost is estimated at $212M. DEP is also initiating an investment-grade feasibility study to evaluate the installation of cogeneration at the Wards Island WWTP, NYC's second largest treatment WWTP.

To reduce energy use and increase energy efficiency, DEP has completed energy audits at all 14 in-City WWTPs. Close to 150 energy conservation measures (ECMs) relating to operational and equipment improvements to aeration, boilers, dewatering, digesters, HVAC, electrical, thickening and main sewage pumping systems have been identified and accepted for implementation. Energy reductions from these ECMs have the potential to reduce greenhouse gas emissions by over 160,000 MT of carbon emissions at an approximate cost of $140M. DEP is developing implementation plans for these measures.

Water Projects

- Water for the Future

  In 2011, DEP unveiled Water for the Future: a comprehensive program to permanently repair the leaks in the Delaware Aqueduct, which supplies half of New York's drinking water. Based on a 10-year investigation and more than $200M of preparatory construction work, DEP is currently designing a bypass for a section of the Delaware Aqueduct in Roseton and internal repairs for a tunnel section in Wawarsing. Since DEP must shut down the Aqueduct when it is ready to connect the bypass tunnel, DEP is working on projects that will supplement NYC's drinking water supply during the shutdown, such as developing the groundwater aquifers in Jamaica, Queens, and implementing demand reduction initiatives, such as offering a toilet replacement program. Construction of the shafts for the bypass tunnel is underway, and the project will culminate with the connection of the bypass tunnel in 2021. The cost for this project is estimated to be about $1.5B.

- Gilboa Dam

  DEP is currently investing in a major rehabilitation project at Gilboa Dam at Schoharie Reservoir. Reconstruction of the dam is the largest public works project in Schoharie County, and one of the largest in the entire Catskills. This project is estimated to cost roughly $440M.

As shown in Figure 9-4, increases in capital expenditures have resulted in increased debt. While confirmed expenditures may be on the decline over the next few years, debt service continues to be on the rise in future years, occupying a large percentage of DEP's operating budget (approximately 45 percent in FY15).

9.6.b Background on History of DEP Water and Sewer Rates

The NYC Water Board is responsible for setting water and wastewater rates sufficient to cover the costs of operating NYC's water supply and wastewater systems (the "System"). Water supply costs include those associated with water treatment, transmission, distribution, and maintaining a state of good repair. Wastewater service costs include those associated with wastewater conveyance and treatment, as well as stormwater service, and maintaining a state of good repair. The NYC Municipal Water Finance Authority (MWFA) issues revenue bonds to finance NYC's water and wastewater capital programs, and the costs associated with debt service consume a significant portion of the system revenues.

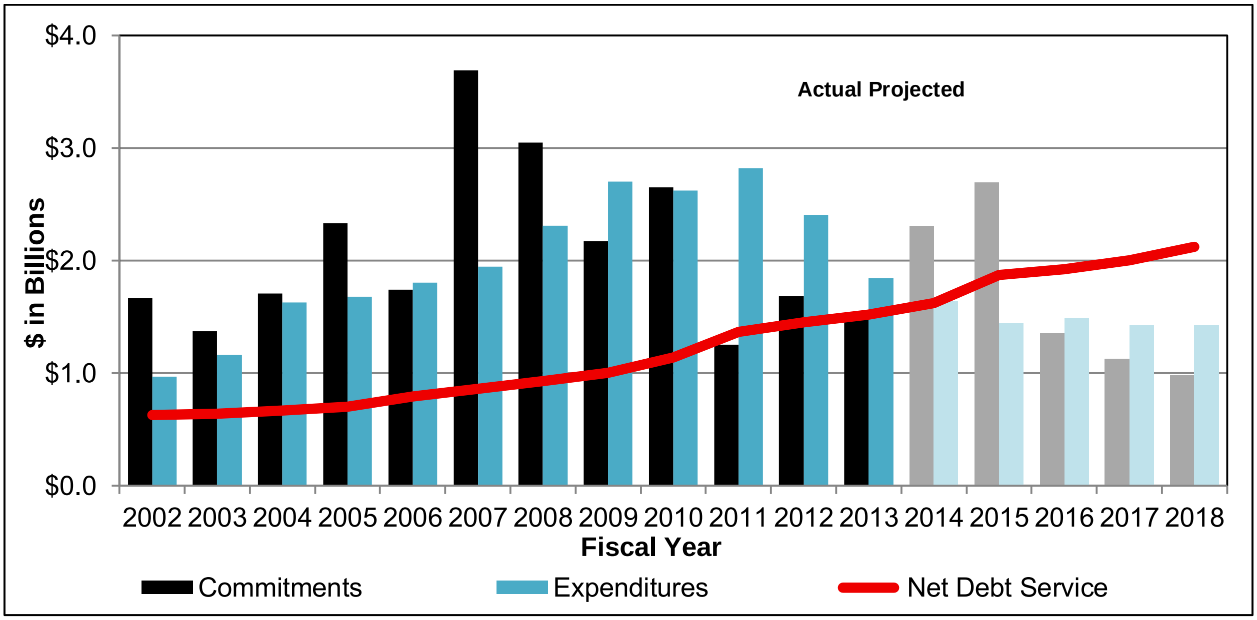


Figure 9-4. Past Costs and Debt Service

For FY15, most customers will be charged a uniform water rate of $0.49 per 100 gallons of water. Wastewater charges are levied at 159 percent of water charges ($0.79 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 an annual credit on their DEP bill.

Figure 9-5 shows how water and sewer rates have increased over time and how that compares with system demand and population. Despite a modest rise in population, water consumption rates have been falling since the 1990s due to metering and increases in water efficiency measures. At the same time, rates have been rising to meet the cost of service associated with DEP's capital commitments. DEP operations are funded almost entirely through rates paid by our customers with less than two percent of spending supported by federal and state assistance over the past ten years. From FY 2002 to FY 2015, water and sewer rates have risen 173 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; to-date initiatives have been implemented that result in a recurring annual benefit of $80M.

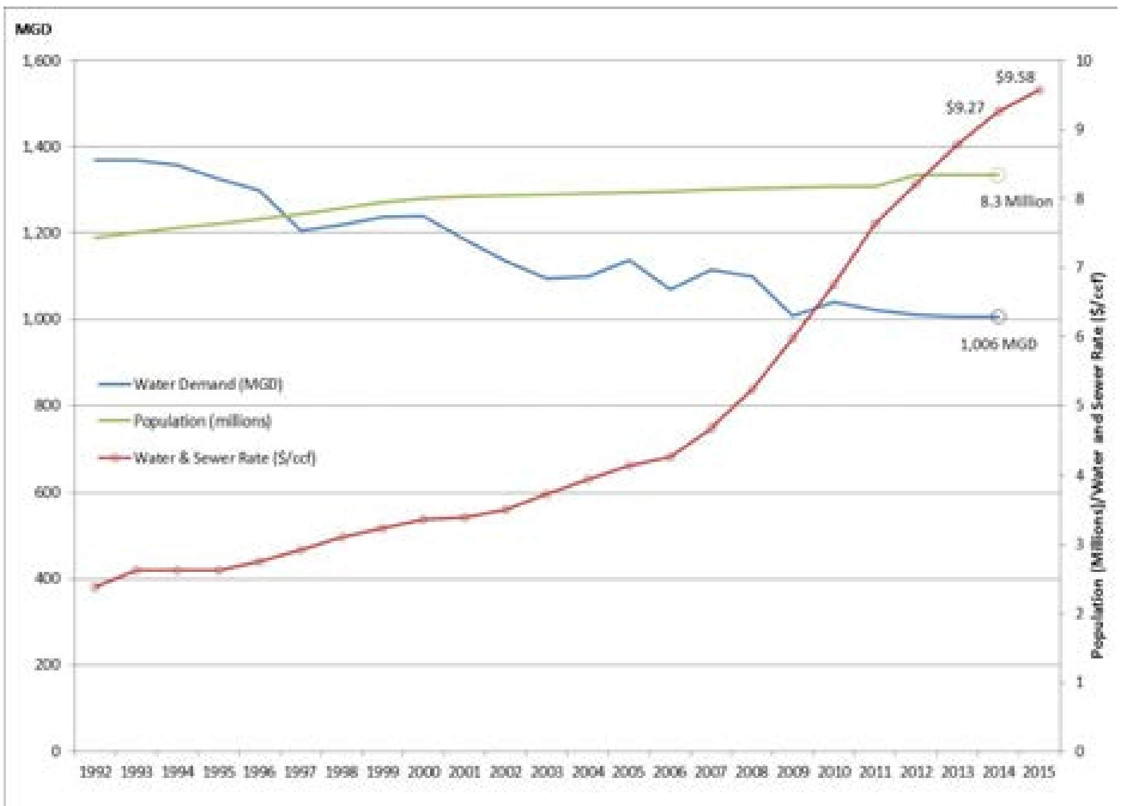


Figure 9-5. Population, Consumption Demand, and Water and Sewer Rates Over Time

9.6.c Residential Indicator

As discussed above, the first economic test as part of EPA's 1997 CSO guidance is the residential indicator (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 Median Household Income (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]	629	**1.11**	1,025	**1.81**
Multi-family[3]	409	**0.72**	666	**1.17**
Average Household Consumption[4]	534	**0.94**	870	**1.53**
MCP	599	**1.06**	976	**1.72**

Notes:
(1) Latest MHI data is $52,223 based on 2013 ACS data, estimated MHI adjusted to present is $56,751.
(2) Based on 80,000 gallons/year consumption and FY 2015 Rates.
(3) Based on 52,000 gallons/year consumption and FY 2015 Rates.
(4) Based on average consumption across all metered residential units of 67,890 gallons/year and FY 2015 Rates.

As shown in Table 9-1, the RI for wastewater costs varies between 0.72 percent of MHI to 1.11 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 1.17 percent to 1.81 percent of MHI.

Based on this initial screen, current wastewater costs pose a low to mid-range economic impact according to the 1997 CSO guidance. However, there are several limitations to using MHI in the context of a City like New York. NYC has a large population and more than three million households. Even if a relatively small percentage of households were facing unaffordable water and wastewater bills, there would still be a significant number of households experiencing this hardship. For example, more than 685,000 households in NYC (about 22 percent of NYC's total) earn less than $20,000 per year and have estimated wastewater costs well above 2 percent of their household income. Therefore, there are several other socioeconomic indicators to consider in assessing residential affordability, as described below.

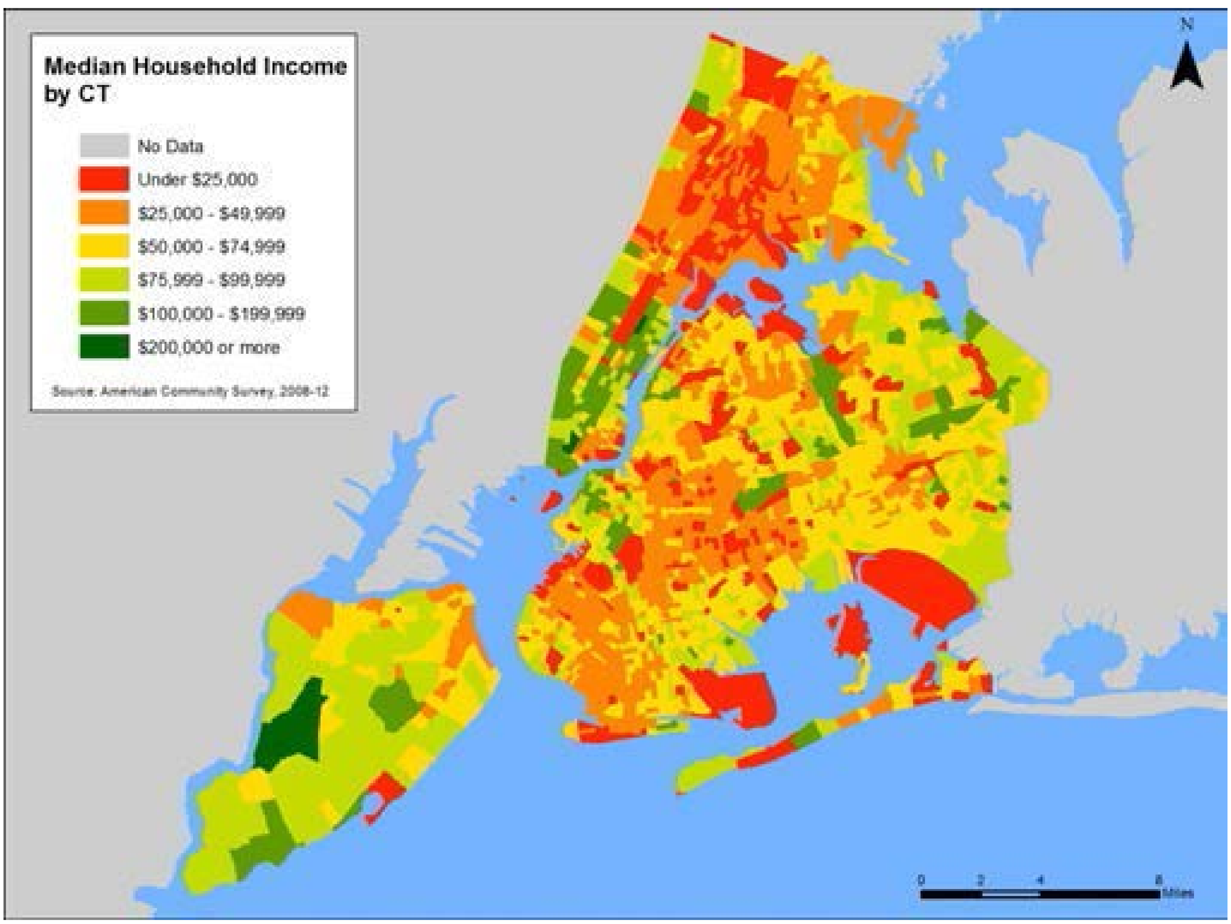
9.6.c.1 Income Levels

In 2013, the latest year for which Census data is available, the MHI in NYC was $52,223. As shown in Table 9-2, across the NYC boroughs, MHI ranged from $32,009 in the Bronx to $72,190 in Manhattan. Figure 9-6 shows that income levels also vary considerably across NYC neighborhoods, and there are several areas in NYC with high concentrations of low-income households.

Table 9-2. Median Household Income

Location	2013 (MHI)
United States	$52,250
New York City	$52,223
Bronx	$32,009
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 2008-2012 ACS 5-Year Estimates.

Figure 9-6. Median Household Income by Census Tract

As shown in Figure 9-7, after 2008, MHI in NYC actually decreased for several years, and it has just begun to recover to the 2008 level. At this same time, the cost of living continued to increase.

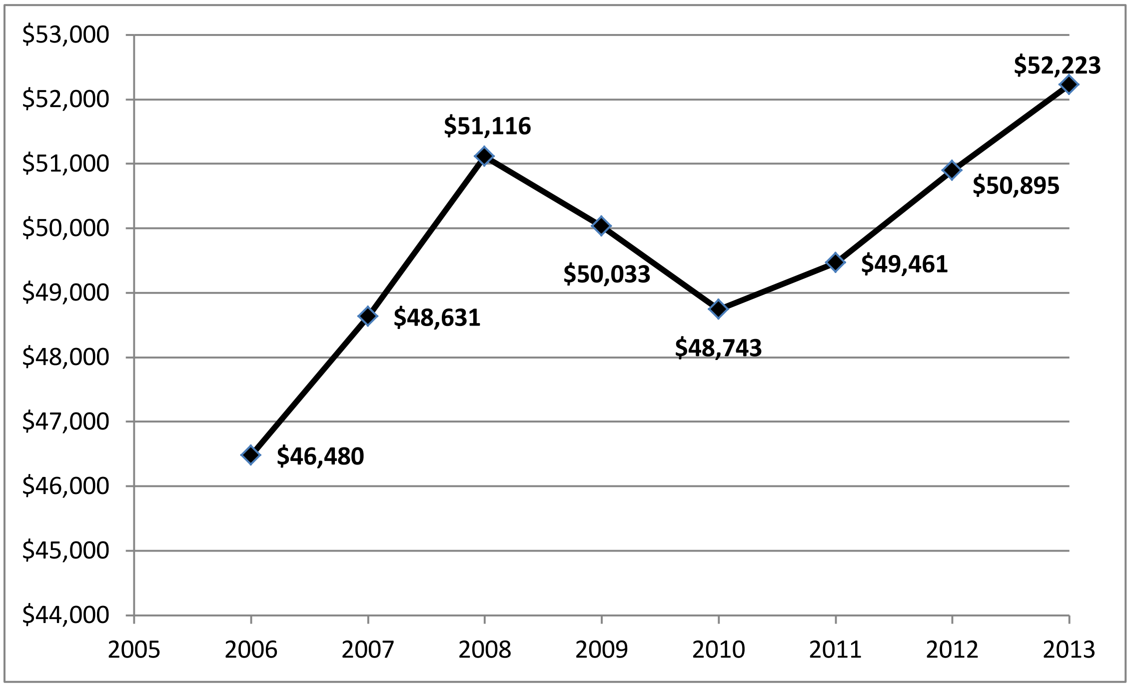


Figure 9-7. NYC Median Household Income Over Time

9.6.c.2 Income Distribution

NYC currently ranks as one of the most unequal cities in the United States (U.S.) in terms of income distribution. NYC's income distribution highlights the need to focus on metrics other than citywide MHI in order to capture the disproportionate impact on households in the lowest income brackets. It is clear that MHI does not represent "the typical household" in NYC. As shown in Figure 9-8, incomes in NYC are not clustered around the median, but rather there are greater percentages of households at both ends of the economic spectrum. Also, the percentage of the population with middle-class incomes between $20,000 and $100,000 is 7.4 percent less in NYC than in the U.S. generally.

Source: U.S. Census Bureau 2013 ACS 1-Year Estimates.

Figure 9-8. Income Distribution for NYC and U.S.

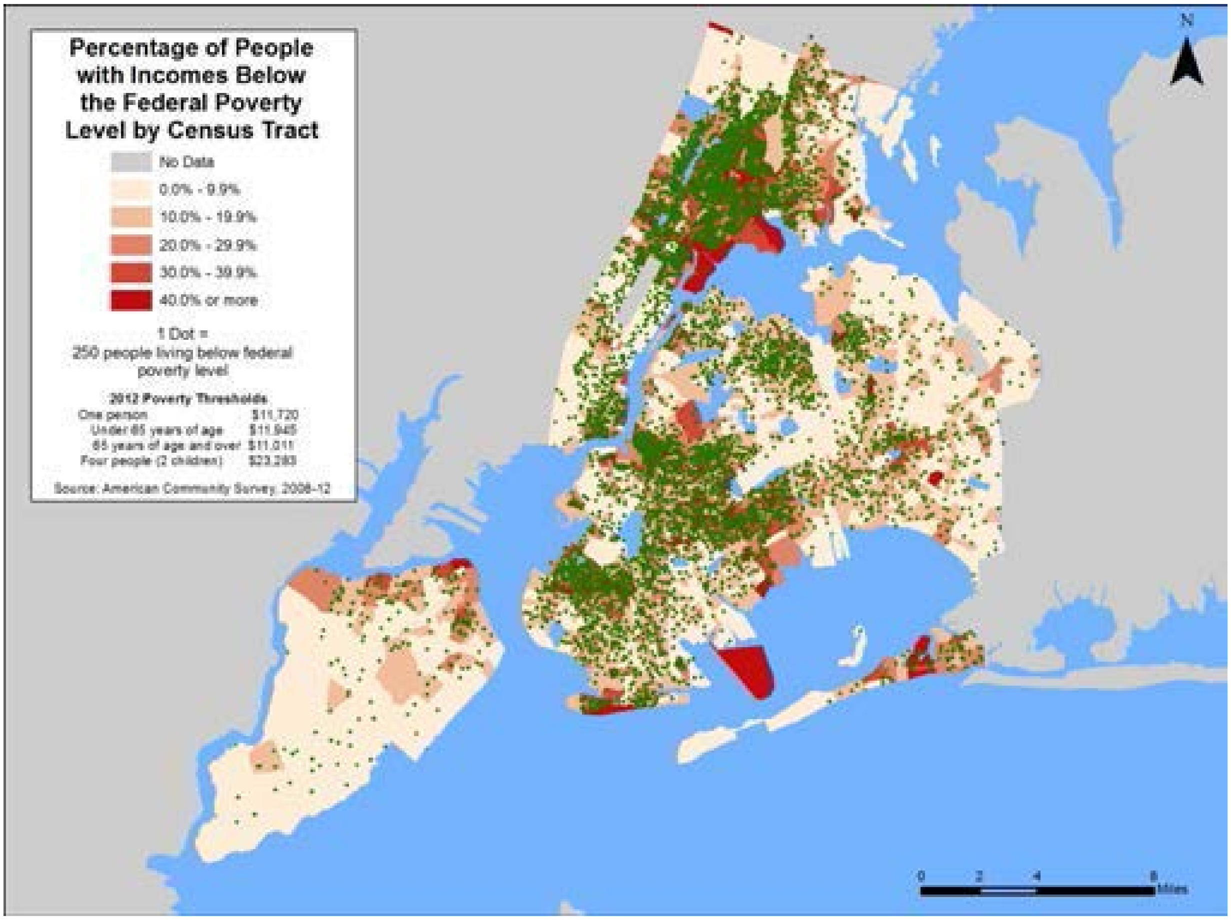
9.6.c.3 Poverty Rates

Based on the latest available Census data, 20.9 percent of NYC residents are living below the federal poverty level (more than 1.7 million people, which is greater than the entire population of Philadelphia). This compares to a national poverty rate of 15.8 percent despite the similar MHI levels for NYC and the U.S. as a whole. As shown in Table 9-3, across the NYC boroughs, poverty rates vary from 12.8 percent in Staten Island to 30.9 percent in the Bronx.

Table 9-3. NYC Poverty Rates

Location	Percentage of Residents Living Below the Federal Poverty Level (%) (ACS 2013)
United States	15.8
New York City	20.9
Bronx	30.9
Brooklyn	23.3
Manhattan	18.9
Queens	15.3
Staten Island	12.8

Figure 9-9 shows that poverty rates also vary across neighborhoods, with several areas in NYC having a relatively high concentration of people living below the federal poverty level. Each green dot represents 250 people living in poverty. While poverty levels are concentrated in some areas, there are pockets of poverty throughout NYC. An RI that relies on MHI alone fails to capture these other indicators of economic distress. Two cities with similar MHI could have varying levels of poverty.



Source: U.S. Census Bureau 2008-2012 ACS 5-Year Estimates.

Figure 9-9. Poverty Clusters and Rates in NYC

The New York City Center for Economic Opportunity (CEO) has argued that the official (federal) poverty rate does not provide an accurate measure of the number of households truly living in poverty conditions (CEO, 2011). This is especially relevant in NYC, where the cost of living is among the highest in the nation. According to CEO, federal poverty thresholds do not reflect current spending patterns, differences in the cost of living across the nation, or changes in the American standard of living (CEO, 2011). To provide a more accurate accounting of the percentage of NYC's population living in poverty, CEO developed an alternative poverty measure based on methodology developed by the National Academy of Sciences (NAS).

The NAS-based poverty threshold reflects the need for clothing, shelter, and utilities, as well as food (which is the sole basis for the official poverty threshold). The threshold is established by choosing a point in the distribution of expenditures for these items, plus a small multiplier to account for miscellaneous expenses such as personal care, household supplies, and non-work-related transportation. CEO adjusted the NAS-based threshold to account for the high cost of living in NYC.

In addition, the NAS-based income measure uses a more inclusive definition of resources available to households compared to the federal measure, which is based on pre-tax income. Along with cash income after taxes, it accounts for the cash-equivalent value of nutritional assistance and housing programs (i.e., food stamps and Section 8 housing vouchers). It also recognizes that many families face the costs of commuting to work, child care, and medical out-of-pocket expenses that reduce the income available to meet other needs. This spending is accounted for as deductions from income. Taken together, these adjustments create a level of disposable income that, for some low-income households, can be greater than pre-tax cash income.

CEO's methodology shows that in NYC, poverty level incomes are actually much higher than those defined at the federal level, which results in a higher percentage of NYC residents living in poverty than is portrayed by national measures. As an example, in 2008, CEO's poverty threshold for a two-adult, two-child household was $30,419. The federal poverty threshold for the same type of household was $21,834. In that year, 22.0 percent of NYC residents (about 1.8 million people) were living below the CEO poverty threshold income; 18.7 percent were living below the federal poverty threshold.

More recently, the U.S. Census Bureau developed a Supplemental Poverty Measure (SPM), reflecting the same general approach as that of CEO. The federal SPM factors in some of the financial and other support offered to low-income households (e.g., housing subsidies, low-income home energy assistance) and also recognizes some nondiscretionary expenses that such households bear (e.g., taxes, out-of-pocket medical expenses, and geographic adjustments for differences in housing costs) (U.S. Census Bureau, 2012).

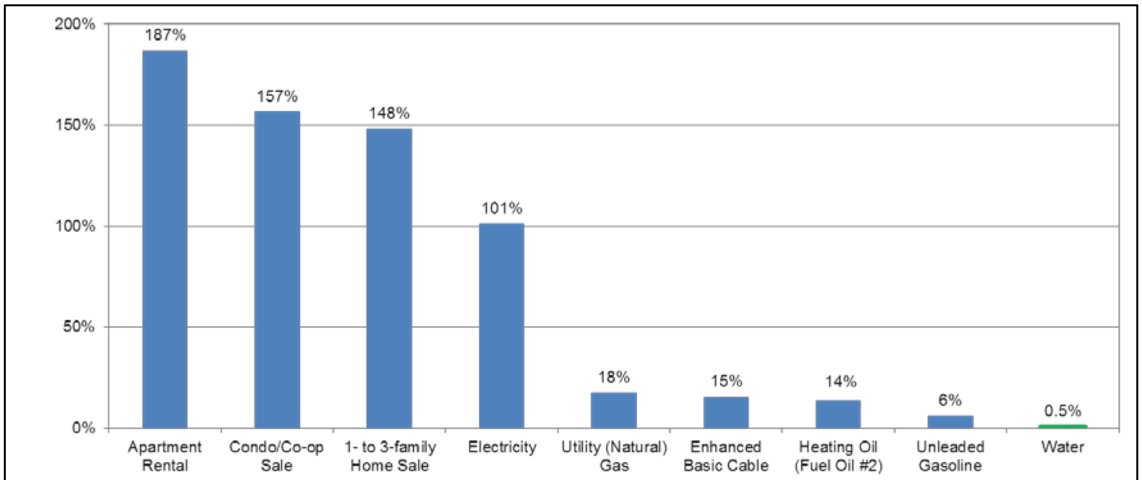
Nationwide, the SPM indicates that there are 5.35 percent more people in poverty than the official poverty threshold would indicate. The SPM also indicates that inside Metropolitan Statistical Areas the difference is 11.2 percent more people in poverty, and within "principal cities," the SPM-implied number of people in poverty is 5.94 percent higher than the official poverty measure indicates.

9.6.c.4 Unemployment Rates

In 2013 the annual average unemployment rate for NYC was 8.7 percent according to the U.S. Bureau of Labor Statistics, compared to a national average of 7.4 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 significantly, moving closer to that of NYC.

9.6.c.5 Cost of Living and Housing Burden

NYC residents face relatively high costs for nondiscretionary items (e.g., housing, utilities) compared to individuals living almost anywhere else in the nation as shown in Figure 9-10. While water costs are comparable to other average U.S. cities, the housing burden is substantially higher.



	Apartment Rental	Condo/Co-op Sale	1- to 3-family Home Sale	Electricity	Utility (Natural) Gas	Enhanced Basic Cable	Heating Oil (Fuel Oil #2)	Unleaded Gasoline	Water
	(average monthly rent)	*(median per sale)*	*(median per sale)*	*(average per year; 6,000 kwh)*	*(average per therm)*	*(average per year)*	*(average per gallon)*	*(average per gallon)*	*(average per year; 80,000 gallons)*
NYC	$3,105	$500,000	$490,000	$1,556	$1.222	$854	$4.437	$3.524	$992
U.S. Cities	$1,083	$194,900	$197,400	$774	$1.040	$740	$3.904	$3.320	$987

Source: Wall Street Journal (Apartment Rental); The Real Estate Board of New York and National Association of Realtors (condo/coop and home sales); New York State Energy Research and Development Authority and Bureau of Labor Statistics (electricity and fuel oil #2); U.S. Bureau of Labor Statistics (natural gas and unleaded gasoline); FCC and company websites (enhanced basic cable); NYC FY 2014 Water and Wastewater Rate Survey (water)

Figure 9-10. Comparison of Costs Between NYC and other U.S. Cities

Approximately 67 percent of all households in NYC are renter-occupied, compared to about 35 percent of households nationally. For most renter households in NYC, water and wastewater bills are included in the total rent payment. Rate increases may be passed on to the tenant in the form of a rental increase, or born by the landlord. In recent years, affordability concerns have been compounded by the fact that gross median rents have increased, while median renter income has declined as shown in Figure 9-11 (NYC Housing, 2014).

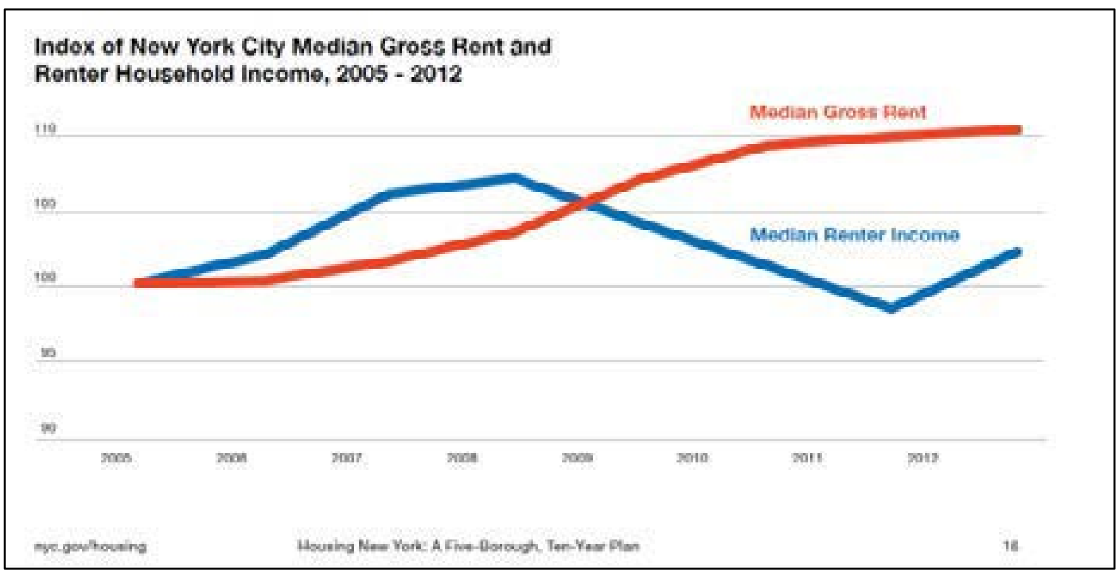


Figure 9-11. Median Gross Rent vs. Median Renter Income

Most government agencies consider housing costs of between 30 percent and 50 percent of household income to be a moderate burden in terms of affordability; costs greater than 50 percent of household income are considered a severe burden.

A review of Census data shows approximately 21 percent of NYC households (close to 645,000 households) spent between 30 percent and 50 percent of their income on housing, while about 25 percent (748,000 households) spent more than 50 percent. This compares to 20 percent of households nationally that spent between 30 percent and 50 percent of their income on housing and 16.2 percent of households nationally that spent more than 50 percent. This means that 46 percent of households in NYC versus 36.2 percent of households nationally spent more than 30 percent of their income on housing.

The NYC Housing Authority (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 FY15. 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%

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) Aaa-A (Moody's)	
Overall net debt as percentage of FMPV	4.5%	Mid-range/2
G.O.		
Debt	$41.2B	
Market value	$914.7B	
Socioeconomic indicators		
Unemployment rate (2013 annual average)	1.3 percentage point above the national average	Weak/1
NYC unemployment rate	8.7%	
United States unemployment rate	7.4%	
MHI as percentage of national average	99.9%	Mid-range/2
Financial management indicators		
Property tax revenues as percentage of FMPV	2.3%	Mid-range/2
Property tax revenue collection rate	98.5%	Strong/3
Permittee Indicators Score		2.2

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 $914.7B. This results in a ratio of outstanding debt to FMPV of 4.5 percent and a "mid-range" rating for this indicator. If $30.6B of MWFA revenue bonds that support the system are included, net debt as a percentage of FMPV increases to 7.8 percent, which results in a "weak" rating for this indicator. Furthermore, if NYC's $37.5M of additional debt that is related to other services and infrastructure is included, the resulting ratio is 8.6 percent net debt as a percentage of FMPV.

9.6.d.3 Unemployment Rate

For the unemployment benchmark, the 2013 annual average unemployment rates for NYC were compared to those for the U.S. NYC's 2013 unemployment rate of 8.7 percent is 1.3 percent higher than the national average of 7.4 percent. Based on EPA guidance, NYC's unemployment benchmark would be classified as "weak". 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 in FY14, NYC had collected $21.0B in real property taxes against a $914.7B FMPV, which amounts to 2.3 percent of FMPV. For this benchmark, NYC received a "mid-range" score. Also, this figure does not include water and wastewater revenues. Including $3.5B of FY13 system revenues increases the ratio to 2.6 percent 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". This NYC Property Tax Annual report issued in FY14 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 New York City Department of Finance (DOF), for example, can sell real property tax liens on all types of non-exempt properties to third parties, who can then take action against the delinquent property owners. DEP, in contrast, can sell liens on multi-family residential and commercial buildings whose owners have been delinquent on water bills for more than one year, but it cannot sell liens on single-family homes. The real property tax collection rate thus may not accurately reflect the local agency's ability to collect the revenues used to support water supply and wastewater capital spending.

9.6.e Future Household Costs

For illustration purposes, Figure 9-12 shows the average estimated household cost for wastewater services compared to household income, versus the percentage of households in various income brackets for the years 2015 and 2022. As shown, 48 percent of households are estimated to pay more than one percent of their income on wastewater service in 2015. Roughly 27 percent of households are estimated to pay two percent or more of their income on wastewater service alone in 2015. Estimating modest future rate and income increases (based on costs in the CIP and historic Consumer Price Index data, respectively), up to 36 percent of households could be paying more than two percent of their income on wastewater services by 2022. These projections are preliminary and do not include additional future wastewater spending associated with the programs outlined in Section 9.6.a.3 - Future System Investment. When accounting for these additional costs, it is likely that an even greater percentage of households could be paying well above two percent of their income on wastewater services in the future.

DEP, like many utilities in the nation, provides both water and wastewater service, and its rate payers see one bill. Currently the average combined water and sewer bill is around 1.6 percent of MHI, but 22 percent of households are estimated to be currently paying more than 4.5 percent of their income, and that could increase to about 28 percent of households in future years as shown in Figure 9-13. Again, this estimate does not include additional spending for the additional water and wastewater programs outlined in Section 9.6.a.3 - Future System Investment.

9.6.f Potential Impacts of CSO LTCPs to Future Household Costs

As previously discussed, DEP is facing significant future wastewater spending commitments associated with several regulatory compliance programs. This section presents the potential range of CSO LTCP implementation costs for NYC and describes the potential resulting impacts to future household costs for wastewater service. The information in this section reflects a simplified household impact analysis that will be refined in future LTCP waterbody submittals. All referenced Waterbody/Watershed Facility Plan (WWFP) costs presented in this section have been escalated to June 2014 dollars using the Engineering News-Record City Cost Index (ENRCCI) for New York for comparison purposes.

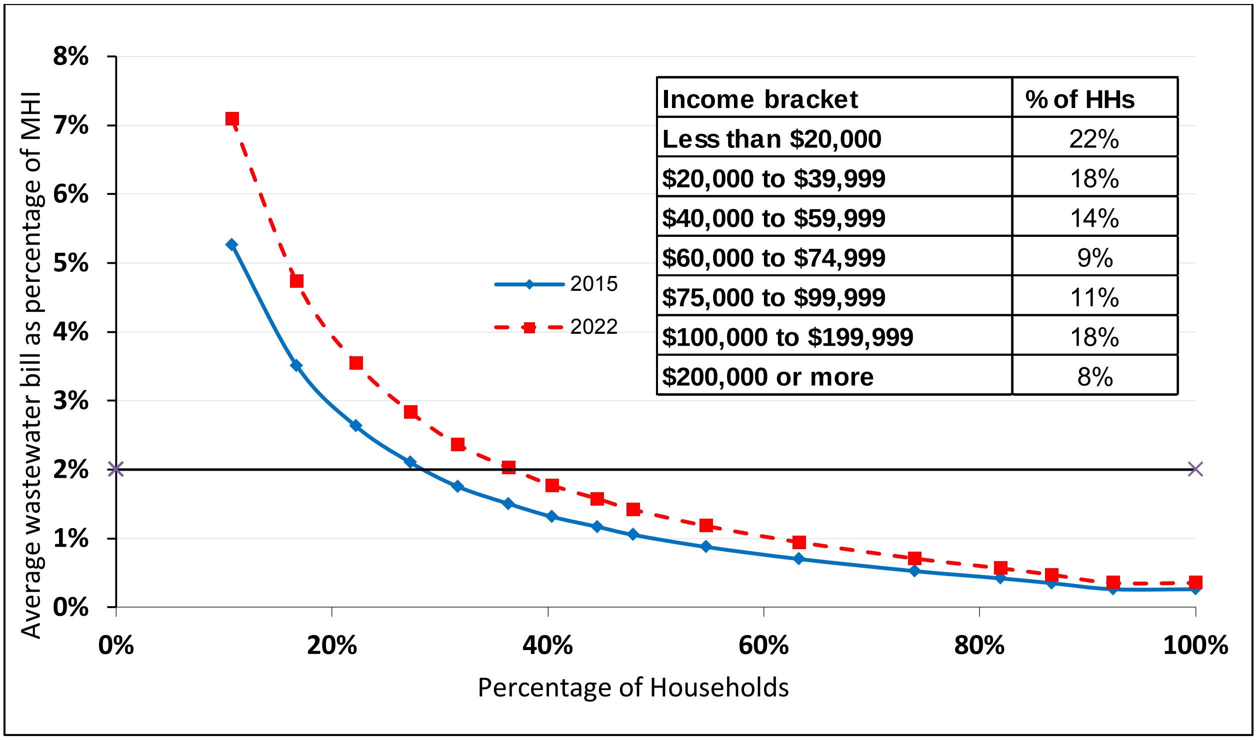


Figure 9-12. Estimated Average Wastewater Household Cost Compared to Household Income (FY15 & FY22)

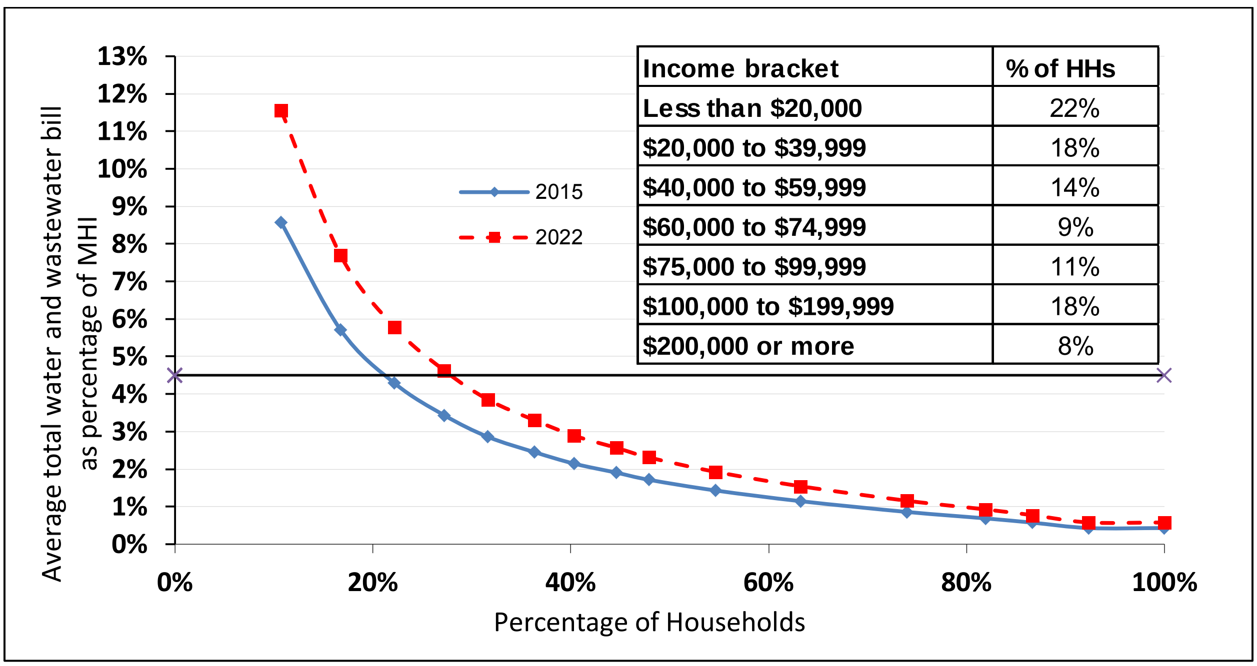


Figure 9-13. Estimated Average Total Water and Wastewater Cost as a Percentage of Household Income (FY15 and FY22)

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

As discussed in Section 8.8, the preferred LTCP alternative for Flushing Creek is TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection to reduce the human pathogens discharged during the recreational season (May 1st through October 31st). DEP is also committed to working with the USACE on dredging and wetland restoration and to identify opportunities for additional wetland restoration projects. DEP will also continue to conduct PCM to determine DO benefits from LTCP and wetland restoration/dredging programs. The preferred LTCP alternative also includes management of 8 percent of the combined sewer impervious area by implementing GI in the Flushing Creek watershed by 2030. To-date, approximately $406.6M has been committed to grey CSO control infrastructure.

The total present worth cost for the grey component of the LTCP alternative, which reflects capital costs and O&M costs over the projected useful life of the project, is approximately $16.7M.

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 Consent Order schedule. Overall anticipated CSO program costs for NYC will not be known until all of the LTCPs have been developed and approved. However, DEP did develop CSO control costs as part of a previous WWFP effort. These costs are presented in Table 9-6, and they will be supplemented by LTCP preferred alternative costs in future waterbody LTCP affordability sections as new costs become available.

Capital costs for the preferred alternatives as well as 25 percent, 50 percent, and 100 percent CSO control are included in Table 9-6 to provide a possible range of future CSO control costs. Also, GI is a major component of the CSO Consent Order. 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 control costs and are therefore presented as a separate line item. As shown in Table 9-6, overall future CSO control capital costs could range from $4.3B to $80.6B.

Table 9-6 also presents CSO control costs that have been committed from FY 2002 through FY 2013 and in DEP's FY 2014-2024 CIP. When excluding these committed costs, the range of possible future CSO control capital costs is $1.4B to $77.7B.

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 9-6. Range of Potential Future CSO Control Costs(1)

Waterbody / Watershed(2)	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs: Committed FY 2002-FY 2013	Baseline Committed Grey Infrastructure Costs: Committed in 2014-2024 CIP	Baseline Committed Grey Infrastructure Costs: Total Existing Committed	Additional LTCP Recommended Alternative	LTCP Recommended Alternative Cost(3)	25% CSO Control Cost(3)	50% CSO Control Cost(3)	100% CSO Control Cost(3)
Alley Creek and Little Neck Bay	CSO Abatement Facilities and East River CSO	$141,916,025	($3,085,000)(4)	$138,831,025	Disinfection in Existing CSO Retention Facility	$7,600,000	$83,000,000	$145,000,000	$535,000,000
Westchester Creek	Hunts Point WWTP Headworks	$7,800,000	$88,425,000	$96,225,000	Green Infrastructure Implementation and Post-Construction Compliance Monitoring	TBD	$200,000,000	$507,300,000	$728,900,000
Hutchinson River	Hunts Point WWTP Headworks	$3,000,000	$0	$3,000,000	Alternative 12 - 50 MGD Seasonal Disinfection in New Outfall HP-024	$108,000,000	$242,000,000	$620,000,000	$809,000,000
Flushing Creek	Flushing Bay Corona Avenue Vortex Facility, Flushing Bay CSO Retention, Flushing Bay CSO Storage	$360,348,471	$46,334,000	$406,682,471	Alternative 3 - TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection	$6,890,000	$435,640,000	$833,810,000	$1,685,590,000
Bronx River	*Installation of Floatable Control Facilities, Hunts Point Headworks*	*$46,989,901*	*$106,000*	*$47,095,901*	*TBD*	*TBD*	*$36,165,246*	*$90,413,115*	*$1,218,286,583*
Gowanus Canal	*Gowanus Flushing Tunnel Reactivation, Gowanus Facilities Upgrade*	*$174,828,480*	*$3,139,000*	*$177,967,480*	*TBD*	*TBD*	*$249,182,401*	*$529,512,603*	*$1,148,481,688*
Coney Island Creek	*Avenue V Pumping Station, Force Main Upgrade*	*$199,749,241*	*$2,485,000*	*$202,234,241*	*TBD*	*TBD*	*$59,646,395*	*$119,292,789*	*$1,163,462,575*

Table 9-6. Range of Potential Future CSO Control Costs[1]

Waterbody / Watershed[2]	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs			Additional LTCP Recommended Alternative	LTCP Recommended Alternative Cost[3]	25% CSO Control Cost[3]	50% CSO Control Cost[3]	100% CSO Control Cost[3]
		Committed FY 2002-FY 2013	Committed in 2014-2024 CIP	Total Existing Committed					
Jamaica Bay	*Improvements of Flow Capacity to Fresh Creek-26th Ward Drainage Area, Hendrix Creek Canal Dredging, Shellbank Destratification, Spring Creek AWPCP Upgrade*	*$141,135,131*	*$323,733,000*	*$464,868,131*	*TBD*	*TBD*	*$180,881,883*	*$367,416,325*	*$4,142,534,281*
Flushing Bay[5]	*See Flushing Creek*	*$0*	*$0*	*$0*	*TBD*	*TBD*	*$222,270,368*	*$791,802,838*	*$4,787,918,645*
Newtown Creek	*English Kills Aeration, Newtown Creek Water Quality Facility, Newtown Creek Headworks*	*$160,099,445*	*$91,312,000*	*$251,411,445*	*TBD*	*TBD*	*$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*	*$43,131,000*	*$196,276,476*	*TBD*	*TBD*	*$534,921,268*	*$7,016,829,726*	*$59,488,594,159*
Bergen and Thurston Basins[6]	*Pumping Station and Force Main Warnerville*	*$41,876,325*	($180,000)[3]	*$41,696,325*	NA	NA	NA	NA	NA
Paerdegat Basin[6]	*Retention Tanks, Paerdegat Basin Water Quality Facility*	*$397,605,260*	($4,609,000)[3]	*$392,996,260*	NA	NA	NA	NA	NA

Table 9-6. Range of Potential Future CSO Control Costs(1)

Waterbody / Watershed(2)	Historical and Current CIP Commitments	Baseline Committed Grey Infrastructure Costs			Additional LTCP Recommended Alternative	LTCP Recommended Alternative Cost(3)	25% CSO Control Cost(3))	50% CSO Control Cost(3)	100% CSO Control Cost(3)
		Committed FY 2002-FY 2013	Committed in 2014-2024 CIP	Total Existing Committed					
Green Infrastructure Program(7)	*Miscellaneous Projects Associated with City-wide Green Infrastructure Program*	$24,200,000	$907,005,000	$931,205,000	Full Implementation of Green Infrastructure Program	$1,500,000,000	$1,500,000,000	$1,500,000,000	$1,500,000,000
TOTAL		*$1,852,693,755*	*$1,497,796,000*	*$3,350,489,755*		*$1,622,490,000*	*$4,310,277,013*	*$14,107,771,863*	*$80,629,280,854*

Notes:
(1) All costs reported in this table reflect estimated capital costs only. Projected O&M costs are not included.
(2) The shaded waterbody rows include current LTCP alternative and cost information. Other waterbody rows are presented in italics and will be updated in future waterbody LTCP affordability chapters as new alternatives and costs become available.
(3) 25%, 50%, and 100% CSO costs are estimated using knee-of-the-curve / cost vs. CSO control plots from WWFPs and LTCPs 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) Negative values for Alley Creek and Little Neck Bay, Bergen and Thurston Basins, and Paerdegat Basin reflect a de-registration of committed funds.
(5) Committed costs for Flushing Bay are captured in the committed costs reported for Flushing Creek.
(6) Bergen and Thurston Basins and Paerdegat Basin are not part of the current LTCP effort; thus, no LTCP detail is provided for them.
(7) DEP's green infrastructure program costs are assumed to be the same regardless of the CSO control level. The green infrastructure program costs presented in this table reflect anticipated capital costs only and do not include O&M projections.

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 2015 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 25 percent CSO control scenario would result in a two percent rate increase, the 50 percent CSO control scenario would result in a double-digit rate increase of 19 percent, and the 100 percent CSO control scenario would result in a substantial 135 percent rate increase. These rate increases translate into additional annual household costs of up to $1,385. Both the 50 percent and 100 percent 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 9-7. 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 2015 Rates	Additional Annual Household Cost	
					Single-family Home	Multi-family Unit
Current CIP	$13,664	*TBD*	$839	24	$245	$159
Future Potential Mandated Program Costs for MS4, TRC, Ammonia, Superfund, and Hillview Cover(4)	$6,500	*TBD*	$399	11	$117	$76
100% CSO Control	$77,279	*TBD*	$4,746	135	$1,385	$901
50% CSO Control	$10,758	*TBD*	$661	19	$193	$125
25% CSO Control	$960	*TBD*	$59	2	$17	$11
Citywide LTCP CSO Control Alternatives(5)	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*

Notes:

(1) CSO Capital costs have been reduced to reflect historic and currently committed costs for CSO control projects (see Table 9-6).

(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) 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 2015 Rates	$1,025	$666	1.9	1.2	1.1	0.74
Current CIP(4)	$1,270	$825	2.0	1.3	1.2	0.81
Other Future Potential Mandated Program Costs for MS4, TRC, Ammonia, Superfund, and Hillview Cover(5)	$1,387	$901	2.2	1.4	1.4	0.89
100% CSO Control +CIP +Other	$2,772	$1,802	4.4	2.9	2.7	1.77
50% CSO Control+CIP+Other	$1,580	$1,026	2.5	1.6	1.6	1.01
25% CSO Control+CIP+Other	$1,404	$912	2.2	1.5	1.4	0.90
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 2020 MHI projection ($62,511).
(4) A new CIP for FY 15-25 will be released in January 2015. Future LTCP submittals will be updated accordingly.
(5) 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),

Table 9-8 presented above 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-City 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 Flushing Creek resulting from implementation of the preferred alternative.

9.6.g.1 Citywide Water Quality Benefits from Previous and Ongoing Programs and Anticipated Flushing Creek 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. 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 Flushing Creek 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 Consent Order 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 Flushing Creek is included in Section 8.0, and a UAA is included in Appendix D.

9.6.h Conclusions

As part of the LTCP process, DEP will continue to develop and refine the affordability and financial capability assessments for each individual waterbody as it works toward an expanded analysis for the citywide LTCP. In addition to what is outlined in the federal CSO guidance on financial capability, DEP has presented in this section a number of additional socioeconomic factors for consideration in the context of affordability and assessing potential impacts to our ratepayers. Furthermore, it is important to include a fuller range of future spending obligations and DEP has sought to present an initial picture of that here. Ultimately the environmental, social, and financial benefits of all water-related obligations should be considered when priorities for spending are developed and implementation of mandates are scheduled, so that resources can be focused where the community will get the most environmental benefit.

9.7 Compliance with Water Quality Goals

As noted above, Flushing Creek is currently attaining the Class I bacteria criterion. The assessment of the waterbody indicates that Flushing Creek cannot support Primary Contact WQ Criteria (Class SC or the recently proposed fecal coliform Class I criteria), nor is it suitable for such uses. A UAA for Flushing Creek is included with this LTCP. It is recognized that the UAA may need to be updated in June 2017 with the conclusion of the Flushing Bay LTCP; due to Flushing Creek's overall water quality attainment being impacted by Flushing Bay. DEP is proposing to submit a comprehensive UAA for both Flushing Bay and Flushing Creek, if required, when the Flushing Bay LTCP is completed in June 2017. A SPDES Permit Variance is also provided for the Flushing Bay CSO Retention Facility as requested by the DEC.

DEP proposes "Site-Specific Targets" to provide a feasible compliance target and also allow DEP to continue to improve water quality in Flushing Creek. These site-specified targets are presented in Table 8-20 with the preferred alternative, Alternative 3. They are based on 10-year water quality model simulations that account for CSO and stormwater sources and TI-010 Outfall Disinfection at Tank and Diversion Chamber 5 plus TI-011 Outfall Disinfection. They represent a reasonable range of targets that can be met the majority of the time through implementation of the actions identified in the LTCP. DEP anticipates that DEC will review and comment on the site-specific targets as part of LTCP review process.

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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
AAOV:	Annual Average Overflow Volumes
ACS:	American Community Survey
AWPCP:	Auxiliary Water Pollution Control Plant
BB:	Bowery Bay
BEACH:	Beaches Environmental Assessment and Coastal Health
BEPA	Bureau of Environmental Planning and Analysis
BGY:	Billon Gallons Per Year
BMP:	Best Management Practice
BNR:	Biological Nutrient Removal
BOD:	Biochemical Oxygen Demand
BODR:	Basis of Design Report
BWSO:	Bureau of Water and Sewer Operations
CAC:	Citizens Advisory Committee
$CBOD_5$:	Carbonaceous Biochemical Oxygen Demand
CEG:	Cost Effective Grey
CEO:	New York City Center for Economic Opportunity
CFR:	Code of Federal Regulation
CFS:	Cubic Feet Per Second
CFU:	Colony-Forming Unit
CIP:	Capital Improvement Plan
CMMS:	Computerized Maintenance and Management Systems

CPK:	Central Park
CSO:	Combined Sewer Overflow
CSS:	Combined Sewer System
CWA:	Clean Water Act
DCIA:	Directly Connected Impervious Areas
DCP:	New York City Department of City Planning
DDC:	New York City Department of Design and Construction
DDWF:	Design Dry Weather Flow
DEC:	New York State Department of Environmental Conservation
DEP:	New York City Department of Environmental Protection
DO:	Dissolved Oxygen
DOB:	New York City Department of Buildings
DOE:	New York City Department of Education
DOF:	New York City Department of Finance
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
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
EIS:	Environmental Impact Statement
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
FC:	Fecal Coliform
FCI:	Financial Capability Indicators
FEMA:	Federal Emergency Management Agency
FM:	Force Main
FMPV:	Full Market Property Value
FSAP:	Field Sampling Analysis Program
FT:	Abbreviation for “Feet”
FY:	Fiscal Year
GHG:	Greenhouse Gases
GI:	Green Infrastructure
GIS:	Geographical Information System
GM:	Geometric Mean
G.O.:	General Obligation
GRTA:	NYC Green Roof Tax Abatement
HEAP:	Home Energy Assistance Program
HGL:	Hydraulic Grade Line
HLSS:	High Level Storm Sewers
HRA:	New York City Human Resources Administration
HRC:	High Rate Classification
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
LGA:	LaGuardia Airport
LIRR:	Long Island Railroad
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
MHI:	Median Household Income
MOU:	Memorandum of Understanding
MPN:	Most probable number
MS4:	Municipal separate storm sewer systems
MSS:	Marine Sciences Section
MST:	Marine Source Tracking
MT:	Metric Ton
MWFA:	New York City Municipal Water Finance Authority
NaOCI:	Sodium hypochlorite

NAS:	National Academy of Sciences
NEIWPCC:	New England Interstate Water Pollution Control Commission
NMC:	Nine Minimum Control
NMFS:	National Marine Fisheries Service
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&G:	Oil and Grease
O&M:	Operation and Maintenance
OGI:	Office of Green Infrastructure
OLTPS:	Mayor's Office of Long Term Planning and Sustainability
OMB:	Office of Management and Budget
ONRW:	Outstanding National Resource Waters
OpX:	Operational Excellence
PBC:	Probable Bid Cost
PCM:	Post-Construction Compliance Monitoring
POTW:	Publicly Owned Treatment Plant
ppt:	Parts per thousand

PS:	Pump Station or Pumping Station
Q:	Symbol for Flow (designation when used in equations)
RI:	Residential Indicator
RI/FS:	Remedial Investigation/Feasibility Study
ROW:	Right-of-Way
ROWB:	Right-of-way bioswales
ROWRG:	Right-of-way rain gardens
RTC:	Real-Time Control
RWQC:	Recreational Water Quality Criteria
S&P:	Standard and Poor
SBU:	Sewer back-up
SCA:	NYC School Construction Authority
SCADA:	Supervisory Control and Data Acquisition
SGS:	Stormwater Greenstreets
SIU:	Significant Industrial User
SNWA:	Significant Natural Waterfront Area
SPDES:	State Pollutant Discharge Elimination System
SPM:	Supplemental Poverty Measure
SSS:	Sanitary Sewer Systems
STV:	Statistical Threshold Value
SWIM:	Stormwater Infrastructure Matters Coalition
TAZ:	Transportation Analysis Zone
TBD:	To Be Determined
TDA:	Tributary Drainage Areas
TI:	Tallman Island
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
UER-WLIS:	Upper East River – Western Long Island Sound
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
USGS:	United States Geological Survey
USTA:	United States Tennis Association
UV:	Ultraviolet Light
VTS:	Vertical Treatment Shaft
WDAP:	Water Debt Assistance Program
WQ:	Water Quality
WQBEL:	Water Quality Based Effluent Limitations
WQS:	Water Quality Standards
WWFP:	Waterbody/Watershed Facility Plan
WWOP:	Wet Weather Operating Plan
WWTP:	Wastewater Treatment Plant

Supplemental Tables

Annual CSO, Stormwater, Direct Drainage,
Local Source Baseline Volumes (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Discharge (MG/Yr)**
Flushing Creek	TI-010	Multiple	713.2
Flushing Creek	TI-011	R-54	404.5
Flushing Creek	TI-022	R-55,-56,-57	83.6
		Total CSO	**1,201.3**

Stormwater Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Discharge, (MG/Yr)**
Flushing Creek	TI-546	NA	14.4
Flushing Creek	TI-548	NA	2.2
Flushing Creek	TI-601	NA	21.8
Flushing Creek	TI-605	NA	320.7
Flushing Creek	TI-631	NA	78.2
		Total Stormwater	**437.4**

Direct Runoff Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Discharge, (MG/Yr)**
Flushing Creek	BB—50	NA	18.4
Flushing Creek	BB—51	NA	35.4
Flushing Creek	BB—52	NA	18.9
Flushing Creek	BB—53	NA	12.7
Flushing Creek	TI—74	NA	52.8
Flushing Creek	TI—76	NA	7.6
Flushing Creek	TI—85	NA	9.2
		Total Direct Runoff	**187.1**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Discharge (MG/Yr)**
Flushing Creek	Meadow Lake	NA	456.4
Flushing Creek	Groundwater	NA	1,179.7
		Total Dry Weather	**1,636.1**

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Discharge (MG/Yr)**
Flushing Creek	CSO	35	1,202.3
	Stormwater	13	437.4
	Direct Runoff	5	187.1
	Local Sources	47	1,636.1
		Total	**3,462.9**

**Annual CSO, Stormwater, Direct Drainage,
Local Sources Enterococci Loads (2008 Rainfall)**

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Flushing Creek	TI-010	Multiple	220.8
Flushing Creek	TI-011	R-54	226.8
Flushing Creek	TI-022	R-55,-56,-57	30.0
		Total CSO	**477.6**

Stormwater Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Flushing Creek	TI-546	NA	0.8
Flushing Creek	TI-548	NA	0.1
Flushing Creek	TI-601	NA	1.2
Flushing Creek	TI-605	NA	18.2
Flushing Creek	TI-631	NA	4.4
		Total Stormwater	**24.8**

Direct Runoff Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Flushing Creek	BB—50	NA	0.1
Flushing Creek	BB—51	NA	0.2
Flushing Creek	BB—52	NA	0.1
Flushing Creek	BB—53	NA	0.1
Flushing Creek	TI—74	NA	2.2
Flushing Creek	TI—76	NA	1.4
Flushing Creek	TI—85	NA	0.3
		Total Direct Runoff	**4.3**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Flushing Creek	Meadow Lake	NA	0.8
Flushing Creek	Groundwater	NA	0
		Total Dry Weather	**0.8**

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Org.x10^{13}**
Flushing Creek	CSO	94	477.6
	Stormwater	5	24.8
	Direct Runoff	<1	4.3
	Local Sources	<1	0.8
		Total	**507.5**

Annual CSO, Stormwater, Direct Drainage,
Local Sources Fecal Coliform Loads (2008 Rainfall)

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Flushing Creek	TI-010	Multiple	781.0
Flushing Creek	TI-011	R-54	2,030.6
Flushing Creek	TI-022	R-55,-56,-57	182.5
		Total CSO	**2,993.7**

Stormwater Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Flushing Creek	TI-546	NA	1.9
Flushing Creek	TI-548	NA	0.3
Flushing Creek	TI-601	NA	2.9
Flushing Creek	TI-605	NA	42.5
Flushing Creek	TI-631	NA	10.4
		Total Stormwater	**57.9**

Direct Runoff Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Flushing Creek	BB—50	NA	<0.1
Flushing Creek	BB—51	NA	0.1
Flushing Creek	BB—52	NA	<0.1
Flushing Creek	BB—53	NA	<0.1
Flushing Creek	TI—74	NA	1.5
Flushing Creek	TI—76	NA	0.9
Flushing Creek	TI—85	NA	0.2
		Total Direct Runoff	**2.8**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Org.x10^{13}**
Flushing Creek	Meadow Lake	NA	2.4
Flushing Creek	Groundwater	NA	0
		Total Dry Weather	**2.4**

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Org.x10^{13}**
Flushing Creek	CSO	98	2,993.7
	Stormwater	2	57.9
	Direct Runoff	<1	2.8
	Local Sources	<1	2.4
		Total	**3,056.8**

**Annual CSO, Stormwater, Direct Drainage,
Local Sources BOD_5 Loads (2008 Rainfall)**

Combined Sewer Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Flushing Creek	TI-010	Multiple	116,157
Flushing Creek	TI-011	R-54	98,900
Flushing Creek	TI-022	R-55,-56,-57	19,475
		Total CSO	**234,532**

Stormwater Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Flushing Creek	TI-546	NA	1,798
Flushing Creek	TI-548	NA	280
Flushing Creek	TI-601	NA	2,720
Flushing Creek	TI-605	NA	40,062
Flushing Creek	TI-631	NA	9,772
		Total Stormwater	**54,632**

Direct Runoff Outfalls			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Flushing Creek	BB—50	NA	518
Flushing Creek	BB—51	NA	890
Flushing Creek	BB—52	NA	357
Flushing Creek	BB—53	NA	521
Flushing Creek	TI—74	NA	12,054
Flushing Creek	TI—76	NA	7,424
Flushing Creek	TI—85	NA	1,609
		Total Direct Runoff	**23,373**

Local Sources			
Waterbody	**Outfall**	**Regulator**	**Total Lbs**
Flushing Creek	Meadow Lake	NA	57,010
Flushing Creek	Groundwater	NA	0
		Total Dry Weather	**57,010**

Totals by Source by Waterbody			
Waterbody	**Outfall**	**Percent**	**Total Lbs**
Flushing Creek	CSO	63	234,532
	Stormwater	15	54,632
	Direct Runoff	6	23,373
	Local Sources	16	57,010
		Total	**369,550**

Long Term Control Plan (LTCP) Flushing Creek Meeting #1 – Summary of Meeting and Public Comments Received

On June 11th, 2014 DEP hosted a Public Kickoff Meeting to initiate the water quality planning process for long term control of combined sewer overflows in the Flushing Creek waterbody. The two-hour event, held at P.S. 020 John Bowne in Queens served to provide overview information about DEP's Long Term Control Plan (LTCP) Program, present information on the Flushing Creek watershed characteristics and status of waterbody improvement projects, obtain public information on waterbody uses in Flushing Creek, and describe additional opportunities for public input and outreach. The presentation can be found at http://www.nyc.gov/dep/ltcp. Twenty stakeholders from 14 different non-profit, community, planning, environmental, economic development, governmental organizations and the broader public attended the event and two reporters from local Queens's papers.

The Flushing Creek LTCP Kickoff Public Meeting was the first opportunity for public participation in the LTCP for the Flushing Creek Waterbody. As part of DEP's LTCP Public Participation Plan, Flushing Creek's 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 Flushing Creek's waterbody-specific LTCP. Specific questions asked during the Flushing Creek LTCP Public Kickoff Meeting are summarized below with DEP's responses for each.

- Is Class I (the water quality standard for Flushing Creek) the lowest and what does it protect?
    - *Class I waterbodies such as Flushing Creek are classified for secondary contact recreation and fishing and includes limits for dissolved oxygen and bacteria. Class SD does not have a bacteria standard and has a lower dissolved oxygen standard than Class I.*
- What is DEP planning to do to for the three CSO outfalls that discharge into Flushing Creek?
    - *The long term control planning process for Flushing Creek has just recently begun. Additional water quality sampling and flow monitoring has recently been completed and the results are being reviewed. The next steps include evaluating grey alternatives for reducing CSO discharges into the creek. In addition, a number of green infrastructure projects have been completed as presented, and DEP will soon be developing designs for additional right-of-way and public property retrofits.*
- What are plans to identify available land to build another CSO storage tank?
    - *As planning continues, a number of different alternatives will be evaluated, including additional storage.*
- Modeling done in 2008 shows different projections for CSOs after implementation of the Waterbody Watershed Facility Plan than current projections, why?
    - *The models are continuously refined and updated with new information. In addition, DEP recently began using 2008 for the base year, which is a wetter year than the previous base year of 1998.*

- Is DEP going to dredge Flushing Creek?
  - *DEP is currently working with the Army Corps of Engineers planning for ecological restoration within Flushing Creek.*
- How are population increases due to development being considered?
  - *The modeling that is used in developing the LTCP incorporates population projections to the year 2040. DEP evaluates requests for new development, which sometimes lead to sewer system improvements. Additionally, a new stormwater rule was implemented in 2012 for any new or substantial redevelopment, which requires the developer to substantially reduce stormwater runoff from the site. DEP shares enforcement responsibilities with other departments.*
- Does the planning include the effects of climate change?
  - *The City has been evaluating resiliency over the last three years and released a report in 2013 (http://www.nyc.gov/html/sirr/html/report/report.shtml). For the LTCP development, climate change is reflected in the selection of a new wetter base model year (2008), which includes larger more frequent rainfall events than the previous base year. The evaluation will also look at performance over a longer rainfall record covering the last 10 years (2002-2011) to assess pathogen compliance for meeting the appropriate water quality standards.*
- During the City-wide Kickoff meeting, it was noted that twelve of 16 waterbodies are anticipated to meet existing water quality standards, but the four that will not include Flushing Creek. What is DEP going to do about that?
  - *The LTCP process evaluates how the water quality is in relation to the standards. DEP must first complete the LTCP process.*
- What is DEP doing about people dumping oil in drains?
  - *If someone witnesses illegal dumping, they should call 311 and DEP will send out a response crew.*
- Is the water quality sampling over and what are the plans for sharing with the public in an understandable way?
  - *The recently completed sampling summarized during the meeting was done for the purposes of updating the models and the data is still under review. The DEP will present more details of the data in the next meeting. In addition, information from the ongoing Harbor Survey (http://www.nyc.gov/html/dep/html/harborwater/index.shtml) is available online. Additional sampling and monitoring will also occur after the plan is implemented.*
- Will the LTCP meet water quality standards all of the time? Will the waterbody be upgraded and will the goal be for the creek to be fishable and swimmable?
  - *The ability to improve the water quality in Flushing Creek to meet the Clean Water Act goal that waters of the U.S. should be fishable and swimmable where attainable will be evaluated as part of the long term control planning process. This process will consider*

the feasibility and cost of various levels of water quality improvement. This is a long term process and it is anticipated that water quality will continue to incrementally move towards that goal.

- Is Con Edison contributing to PCB cleanup on the east side of the creek?
  - *An attendee, who is a representative of the Friends of Flushing Creek, indicated that the DEC is currently reviewing the Con Edison remediation plan.*
- How will DEP incorporate the input it receives from stakeholders into the LTCP?
  - *The planning process will identify alternatives that can be implemented and the associated costs of the various implementation scenarios. Input from stakeholders on how they would like to use the creek, as well as the willingness to pay for the improvements that would be required to provide those uses, will be considered when selecting what is to be implemented under the LTCP.*
- What is the green infrastructure plan for Citi Field?
  - *The parking lot at Citi Field already has some porous pavement. At this time, DEP is focusing green infrastructure development efforts on right-of-way and public property, but the field may present a partnering opportunity. Additionally, DEP maintains a grant program for funding green infrastructure development on private property.*
- Why does the creek smell and can the odors be addressed?
  - *The smell occurs during low tide when sediment is exposed. DEP is working with the Army Corps of Engineers in developing a wetlands mitigation project that will include removal of some sediment exposed at low tide.*
- Is DEP moving to provide more information on CSO volumes and activations as they occur?
  - *The DEP is currently evaluating alternatives for providing more detailed information on CSOs when they occur. The predictive models are being improved regularly and the DEP is currently piloting some new outfall flow monitoring.*

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

On October 23, 2014 DEP hosted the second of three public meetings for the water quality planning process for long term control of combined sewer overflows (CSOs) in Flushing Creek. The two-hour event, was held at the Al Oerter Recreation Center on Fowler Avenue in Queens, and was preceded by a tour of the Flushing Creek CSO Retention Facility. The meeting provided information about DEP's Long Term Control Plan (LTCP) development for Flushing Creek. DEP presented information on the LTCP process, Flushing Creek 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 fifteen people from the public attended the event as well as representatives from the Department of Environmental Protection and the New York State Department of Environmental Conservation. The following summarizes the questions and comments from attendees as well as responses given.

- An attendee asked if the new Whitestone Interceptor would allow for the CSO retention tank to dewater faster than it currently does.
    - *DEP replied that Whitestone Interceptor projects are intended to reduce CSOs to the East River and Flushing Bay. The tank dewatering time is a function of the size of the tank, its dewatering pump station capacity, the capacity of the conveyance system to the Tallman Island WWTP and the capacity of the WWTP itself, which are not materially impacted by the Whitestone projects. Therefore, the dewatering time will not be improved by that work.*
- A resident asked about the capacity of the Tallman Island WWTP.
    - *DEP replied that the design flow was approximately 110 million gallons per day (mgd). As a point of clarification, DEP would like to correct the statement: the design flow is 80 mgd.*
- An attendee asked if changing the hydrology of the drainage area, such as daylighting creeks, was considered.
    - *DEP indicated that projects similar to the Staten Island Blue Belt were not considered under the LTCP, but that green infrastructure projects, which modify the hydrologic characteristics of the drainage area, are being planned and designed in the drainage areas tributary to CSO outfalls TI-011 and TI-022.*
- An attendee observed that the water quality appears to improve as one progresses towards the mouth of the river but recalled that DEP stated that even complete elimination of CSO does not achieve water quality goals and asked why this might be the case.
    - *DEP concurred with the premise of the question, and stated that this has to do with the physical characteristics of the river and tidal influence from the larger waterbody of the East River. DEP also noted that there is a balance that must be established between water quality goals and capital commitments in an era of tight budgets.*
- An attendee asked for a clarification on the operation of the existing CSO retention tank. Specifically, does the tank bypass when it is full.

  - *DEP stated that the tank does bypass when it is full. Referencing the schematic in the presentation, DEP indicated that there are weirs at the end of the tank and just upstream of the screens that allow bypassing to protect the tank and upstream sewer system from flooding. If the water level continues to rise once bypassing has begun, the sluice gates upstream of the screens will close to protect the facility.*

- In reference to DEP noting high residual chlorine levels in disinfected CSO and its potential toxicity to aquatic species, an attendee commented that ultraviolet light (UV) disinfection would not have a residual.
  - *DEP agreed that UV disinfection does not have the same toxicity concerns as chlorine. However, UV disinfection requires relatively clean water to be effective. Disinfecting lower quality water, such as a CSO requires much higher doses and energy consumption. Further, DEP uses sodium hypochlorite (chlorine solution similar to household bleach) for disinfection at its WWTPs, which means DEP's operations staff is already familiar with safety protocols, operation, and maintenance of sodium hyphochlorite systems.*

- An attendee asked why disinfection is only proposed to occur during the recreation season and if year-round disinfection is something that will be considered.
  - *DEP explained DEC has provided guidance that disinfection will only be provided during the recreation season (May 1 to October 30). Additionally, disinfection is intended to reduce pathogen levels to make it safe for primary contact (immersion) recreation and primary contact generally only occurs in the recreation season. Disinfecting for the entire year would not improve recreation season water quality and would result in discharging more chlorine to the environment.*

- Noting that DEP indicated that Flushing Creek does not meet water quality standards all of the time, an attendee asked if there was a specific time of the year that it does not meet water quality standards.
  - *DEP explained there are a number of factors impacting water quality, including CSOs, and that reduced quality may occur at any time of the year. For example, CSOs can occur due to heavy rains in the spring or snow melt in the winter.*

- While DEP was describing additional water quality sampling that was completed as part of the development of the Flushing Creek LTCP, a representative of the DEC recalled that during a meeting on the Hutchinson River, the DEP indicated that the wettest time of the year is from April and October.
  - *DEP noted that the sampling completed under the LTCP was done from November 2013 to May 2014, including both historically wetter and dryer months. The timing of sampling for a particular waterbody is based on project schedules and available resources. Additionally, wet weather sampling requires sampling during and just after rainfall events and thus sampling events can only occur when certain weather dependent conditions occur.*

- A representative from the DEC requested clarification regarding the City's position on the impact to water quality from dredging and wetland restoration.
  - *DEP referenced the presentation slides on the dredging and wetland restoration project currently being coordinated with the Army Corps of Engineers (COE). The DEP noted several environmental and water quality benefits from dredging and wetland restoration and the DEP is currently moving forward with the planning and design of a joint dredging and restoration project with the COE within Flushing Creek.*
- A representative of the Friends of Flushing Creek indicated that they have had conversations with the COE confirming that they are indeed moving forward with a project in conjunction with the DEP, but also noting a concern that CSOs will continue to discharge into Flushing Creek after the project is completed.
  - *The DEP responded that alternatives to reduce CSO volumes discharged to Flushing Creek have been evaluated. The DEP is implementing green infrastructure projects which will manage approximately 8% of the first inch of rain that falls on impervious surfaces within the drainage area. The costs and benefits of other grey projects, aimed at providing additional CSO storage, were evaluated against the shortlisted alternatives but were eliminated because the benefits were small relative to costs and because of concerns over increased risk of upstream flooding.*
- An attendee commented that City-wide, the City has more CSO than it can afford to eliminate.
  - *DEP agreed.*
- An attendee asked if the DEP had quantified the reduction in CSOs anticipated from the implementation of green infrastructure in the drainage area.
  - *DEP stated that the green infrastructure projects are currently being planned and designed and that the anticipated reduction in CSO volume will be determined as the projects move into implementation. Referencing a bioswale on an information board, the DEP indicated that a single bioswale can prevent approximately 2,900 gallons from entering the combined system. The number of projects in the two targeted drainage areas tributary to Flushing Creek has not yet been determined.*
- A representative of the Friends of Flushing Creek noted that the LTCP for Alley Creek was initially rejected because it was not robust enough.
  - *DEP responded that the Alley Creek LTCP was rejected in part because the DEP had not proposed disinfection at the existing tank. The shortlisted alternatives for Flushing Creek include a number of disinfection options.*
- As a follow up question, a representative from the DEC asked that if the DEC did not find the shortlisted alternatives acceptable, which of the previously screened alternatives would DEP most likely consider as their next option.
  - *DEP indicated that system optimization would be given a second look even thought it was eliminated over concerns of increased flooding risk.*

- An attendee asked if an alternative did not achieve the forecasted goals, would DEP restart the process and identify a new alternative.
    - *DEP stated that the process would not revert to the beginning, but design modifications would be considered that satisfy the requirements from DEC regarding CSO mitigation and address whatever problem was causing DEP to question the continuation of that alternative. DEP noted that anything they construct is going to be an improvement and because of the environmental review process would not be a detriment.*
- An attendee inquired about the schedule for submittal of the Flushing Creek LTCP.
    - *The LTCP will be submitted in December 2014.*
- An attendee asked if dredging or wetland restoration can be completed separate from the other.
    - *The DEP indicated that dredging is usually necessary as part of wetland restoration to remove exposed sediment and that it is more cost effective to install the wetland as part of the dredging project so the contractor does not have to re-mobilize to the site.*
- A representative of the DEC commented that floating wetlands are being considered elsewhere in the City and could be considered in Flushing Creek to extent the penetration of green infrastructure.
- An attendee asked if the minutes of the meeting would be available before the end of the comment period.
    - *DEP indicated that the minutes will be up by then.*

S.W.I.M. Coalition
Stormwater Infrastructure Matters: utilizing stormwater as a resource, not a waste!

November 17, 2014

Honorable Emily Lloyd
Commissioner
NYC DEP
59-17 Junction Blvd
Flushing, NY 11373

via email: ELloyd@dep.nyc.gov and ltcp@dep.nyc.gov

Re: Comments on Flushing Creek Long Term Control Plan Public Meeting Presentation #2

Dear Commissioner Lloyd,

The Stormwater Infrastructure Matters (SWIM) Coalition submits this letter in response to the New York City Department of Environmental Protection's (DEP) invitation for public comments concerning the development of the Flushing Creek Long Term Control Plan (LTCP). We repeat some of the comments submitted to LTCPs for other waterbodies (e.g., Hutchinson River) because we see problems that are beyond any specific waterbody but are common threads in the general LTCP process. We also incorporate by reference those portions of our Hutchinson River comment letter (date 9/9/14) that were not limited to that water body but, rather, spoke to the city's LTCP process as a whole.[1]

Based on our experience with the Flushing Creek LTCP public meetings, we maintain our opinion that the current LTCP development process is deeply flawed, both in process and in substance.

The SWIM Coalition represents over 70 organizations dedicated to ensuring swimmable and fishable waters around New York City through natural, sustainable stormwater management practices. Our members are a diverse group of community-based, citywide, regional and national organizations, water recreation user groups, institutions of higher education, and businesses. SWIM was instrumental in crafting and passing the Local Law 5, which required development of the city's first Sustainable Stormwater Management Plan, and negotiating with the State and City to incorporate green infrastructure in the CSO Consent Order. We helped to pass the NYS Green Roof Tax Abatement legislation in Albany. Since our formation in 2007, we have testified at numerous public hearings on stormwater management related topics and have represented our members' interests with DEP, the Mayor's Office of Long Term Planning and Sustainability, City Council, the State Legislature, the state Departement of Environmental Conservation (DEC), U.S. Environmental Protection Agency (EPA), and others. Several members of the Coalition currently serve on the DEP's Water Infrastructure Steering Committee (formerly known as the Green Infrastructure Steering Committee).

[1] See http://swimmablenyc.info/wp-content/uploads/2014/10/LTCP-comment-09-19-14-FINAL1.pdf

In regard to the invitation for comments on the development of the Flushing Creek LTCP, we cannot emphasize strongly enough that it is impossible at this time for us or any member of the public to evaluate DEP's proposal or its underlying analysis, as the public is merely provided a PowerPoint presentation, instead of the actual draft plan. A PowerPoint presentation, almost by definition, lacks the substance or details vital to public review of the City's decision-making. Particularly for those who are unable to attend the meeting, simply accessing a Power Point presentation is woefully inadequate as compared to a robust, well-written, thoroughly cited, and comprehensive document on which to solicit meaningful feedback. Specifically for Flushing Creek, the PowerPoint presentation was missing essential information on the following:

- How the Waterbody/Watershed Facility Plan (WWFP) interfaces with the LTCP,
- CSO volume reductions and water quality improvements,
- How we determine whether a Use Attainment Analysis is warranted,
- How green infrastructure fits in, and
- Comprehensive analysis of alternatives proposed.

Before submitting any draft LTCPs to the State, the City should publish – for public comment – the actual plans, not just PowerPoint summaries of DEP's progress on development of the plans.

We again refer DEP to SWIM's recommendations for a meaningful public participation process that would meet the requirements of the CSO Policy. (Our July 2010 letter to DEP presenting our recommendations is posted here: http://swimmablenyc.info/wp-content/uploads/2010/07/SWIM_pubpart.pdf.)

Notwithstanding the limited available information, we offer the following questions and concerns about what DEP has presented to date. These must be addressed both in the public participation phase of LTCP development and in the technical review by DEC. We also sincerely hope that DEP will propose a LTCP that accounts for all of these concerns. We cannot help but note, however, that the final Hutchinson River LTCP submitted in September 2014 failed even to acknowledge the comment letter we submitted, at DEP's invitation, following the last public meeting on that plan.

First, DEP has not clearly explained the interaction between projects to which DEP has already committed and the obligations that DEP has in regard to the LTCP. From the Flushing Creek LTCP PowerPoint, it is not clear where the WWFP left off and the LTCP picks up. The distinction is important in understanding what the public should expect, how far along we are in the process, and determining where public comments are meaningful. Moreover, the public can be easily confused as to the *legal* requirements of each Plan, absent clear explanations of the City's roles and responsibilities (which have thus far been missing from LTCP presentations).

Among the key distinctions between LTCPs and WWFPs are 1) inclusion of GI as per the 2012 CSO Consent Order; and 2) the requirement to meet the water-quality based requirements of the Clean Water Act (CWA) and the 2012 CSO Consent Order.

Given the current legal disputes between the city and the state about the scope of these responsibilities, it is critical that DEP present unbiased explanations of the differing viewpoints and not merely DEP's view. (In this regard, we strongly recommend that DEC contribute to this portion of the PowerPoint presentations.)

Second, we have questions about DEP's implementation of the Nine Minimum Controls (NMC) required under the EPA CSO Policy. Are we correct in assuming that these are not all included in the presentation because some of them are included in the Flushing Creek WWFP? It would be useful for the public to know what is being implemented or planned for each of the NMCs. In particular we would like to know how the DEP is addressing floatables and public notification of CSO events since floatables control was eliminated as an alternative (even though it is required by EPA) and there is no mention of public notification of CSO discharge events in the presentation (likewise required by EPA).

Third, we strongly support the use of green infrastructure to reduce CSOs wherever feasible and are very concerned that not enough preliminary work is being conducted prior to inclusion of GI in the LTCPs, including the Flushing Creek LTCP. It is not clear whether the "potential area-wide GI contract" is part of the WWFP or the LTCP. This lack of details also makes it difficult to understand whether the "potential area-wide GI contract" is factored into the volume reduction shown on slide 20, whether it will be included in the LTCP, or to what extent it would be potentially included. Furthermore, will this be additional reduction beyond the stated WWFP targets? How and when does the DEP decide whether to implement an area-wide GI contract? What kinds of GI practices will be included in the contract? How will the feasibility of an area-wide contract be determined, and by when? Why is this listed under "current improvement projects (slide 17)" but not explained further on the "status of current improvements" (slide 19)? Based on what specific analysis is "Additional GI" eliminated as an alternative (slide 24)? As presented, the DEP gave the public absolutely no information as to their green infrastructure plans for this watershed; leaving us with the assumption that the City has no plan to implement GI for Flushing Creek beyond the few projects that are already underway, and that DEP has performed no detailed quantitative analysis (field-based or modeling-based) of the extent of opportunities for additional GI or the CSO reductions that such GI could achieve. We incorporate by reference the comments on green infrastructure that we included in our letter on the Hutchinson River LTCP; they apply equally to Flushing Creek.

We further emphasize that it is critical to assess not only GI opportunities on public land, but also on private property. In regard to private property, DEP must assess both opportunities for retrofits of existing developed space (through incentives and/or direct subsidy of capital costs, including under existing City programs and potential new programs and policies, such as those in place in other cities); and opportunities to improve stormwater regulations applicable to redevelopment projects. In regard to regulatory standards for redevelopment projects, we incorporate by reference point 1.b. of NRDC's Nov. 3, 2013 comments on the city's draft SPDES permits, which proposed strengthening DEP's existing rules with a revised standard that would result in the construction of more green infrastructure, without cost to the city.[2] SWIM

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[2] See http://switchboard.nrdc.org/blogs/llevine/NRDC%20comments%20on%20NYC%20SPDES%20permits%20%2810-3-13%29.pdf.

made similar recommendations in 2011, when DEP last proposed updates to its storwater rules.[3] At the time, DEP rejected that approach. DEP must reevaluate that decision now, as part of the LTCP development process, in order to evaluate the additional green infrastructure penetration rates, and resulting CSO reductions and water quality improvements that could be achieved by such a rule.

Fourth, much more information is needed on CSO volume reductions and water quality improvements that would result from each of the technically feasible options. DEP's public meeting presentation reported that current improvement projects, to which DEP already committed in the 2012 Consent Order, would reduce CSOs from 2,531 MGY to 1,200 MGY. These numbers do not match those reported when the Consent Order was signed; at that time, DEP reported a higher baseline of 2,395 MGY, and a higher post-project discharge of 1,394 MGY. What accounts for the new estimates? Has there been a change in calculation methodology? Or a change in the plans? Further, DEP did not present the breakdown of the projected volume reductions attributed to grey vs. green infrastructure.

Nor did DEP explain how the projected volume reductions translate to water quality improvements. What reductions in bacterial loads are expected? Is the dissolved oxygen level expected to increase? If so, by how much? Additionally we do not understand the justification for "recreational season" as the duration in which the City needs to improve water quality. Is this based on feedback from the recreational water users – that there are no uses off-season that require protection? Moreover, shouldn't any such temporal restrictions on meeting water quality standards be determined through the use attainment analysis process?

Fifth, at the second public meeting, the DEP engineer said that the main reason most grey infrastructure options were discounted was "flooding" – without elaboration. This rationale, without more to back it up, seems dubious. Since grey infrastructure is designed to increase the amount of stormwater that can be captured below-ground and conveyed to treatment facilities, how could it *increase* surface flooding?

Sixth, we understand that it will take more than eliminating CSO discharges to allow the Flushing Creek and Flushing Bay – and other waterbodies – to meet the Clean Water Act's 40-year-old fishable/swimmable goals. DEP needs to ensure all water quality programs are implemented in a coordinated fashion to not only maximize public resources but to achieve the greatest outcome. For this reason, DEP, in partnership with other state and federal agencies, needs to ensure effective coordination among units of the government responsible for CSO abatement, stormwater management via the city's MS4 permit, the city's broader green infrastructure initiatives, Superfund cleanups, and other related programs and initiatives.

Finally, we are left without any credible evidence as to why the DEP is recommending disinfection as the preferred alternatives. For instance, "additional GI" was eliminated based on "insufficient opportunity available," yet, there are no data to substantiate this claim. It is also unclear how this assessment relates to the "potential area-wide GI contract" presented under the "current improvement projects." Floatables control is also eliminated for the same reason without supporting evidence or explanation of how it can be simply eliminated from further

[3] See http://swimmablenyc.info/wp-content/uploads/2011/11/SWIM_rule_comments_final.pdf.

consideration given that it is one of the NMCs. In fact, none of the alternatives are analyzed in terms of advantages, disadvantages and costs, with the exception of proposed disinfection alternatives. How is the public to evaluate the relative differences between grey infrastructure options without a comparative analysis between them?

By solely presenting the issue as a choice between disinfection options, the DEP is egregiously skewing the outcome of the LTCP process before providing any meaningful opportunity for public input. The entire purpose of the public participation requirement in the EPA CSO Policy (codified in section 402(q) of the Clean Water Act) is that the members of the public can engage in the LTCP decision-making process. In DEP's own Long Term Control Plan Public Participation Plan, the agency states:

> "The overall goal of the LTCP public participation program is to raise awareness about, foster understanding of and encourage *input on the development* of waterbody-specific and citywide LTCPs. [emphasis added]"

The plan further lists objectives that include:

> "Encourage public input on the preferred options for addressing CSOs and establish a process to maintain two-way communication with interested stakeholders."

We share with the DEP again some of SWIM's recommendations on improving public participation, as submitted to former Commissioner Holloway on July 7, 2010, and emphatically call on DEP to overhaul its public participation process to incorporate our public participation recommendations:

- Establish a feedback-loop communication model (information traveling to and from the public; a clear route through which the public and the agency can share information and experiences).
- Dedicate appropriate personnel to maintain regular communication with stakeholders, and provide timely responses to requests for information.
- Establish a Citizens Advisory Committee, or equivalent stakeholder body(ies), and schedule to meet on a regular basis *throughout* the development of the LTCP.
- Provide an ongoing forum for local stakeholders and agency personnel to share plan updates and gather feedback. Presentations by all parties should clearly explain technical jargon and quantitative data.
- Institute a complete feedback loop for public participation by soliciting input from CAC members regarding the local impacts and feasibility of plan elements, defining the water quality and use goals for specific waterbodies, and clearly indicating how this feedback is incorporated into the resulting plans.
- Establish a Citywide LTCP CAC and hold technical work group sessions (as was done for the Open Water Citizens Advisory Committee [from 2005-07, as part of the WWFP process) to educate key stakeholders and interested members of the public on technical aspects of CSO abatement, such as modeling, public notification, source control, and water quality standards.

- DEP should seek public input specifically related to GI projects pursued by NYC residents on their own.

* * * * *

We appreciate DEP's efforts over the last several years to improve its openness about its CSO planning process and its willingness to receive constructive feedback from SWIM and other members of the public. In many respects, DEP has come a long way in that regard since the S.W.I.M. Coalition was formed in 2007. However, our recent experience, summarized above, demonstrates that DEP still has a long way to go.

We would welcome the opportunity to meet with you to discuss these matters further, and we will continue our efforts to improve both the process and the results. Please contact me at 718-399-4323 or jstein9@pratt.edu with any questions.

Sincerely,

Jaime Stein, Chair

On behalf of the SWIM Coalition Steering Committee:
Sean Dixon, Riverkeeper
Robin Kriesberg, Bronx River Alliance
Lawrence Levine, Natural Resources Defense Council
Paul Mankiewicz, Gaia Institute
Tatiana Morin, New York City Soil & Water Conservation District
Nina Sander, Rocking the Boat
Shino Tanikawa, New York City Soil & Water Conservation District

cc: Council Member Donovan Richards, Chair, New York City Council, Committee on Environmental Protection
Judith Enck, Regional Administrator, US EPA Region 2
Angela Licata, Deputy Commissioner, NYC DEP
Jim Tierney, Assistant Commissioner for Water Resources, NYS DEC
Venetia Lannon, Regional Director, Regional Director, NYS DEC Region 2

Friends of Flushing Creek

136-20 38th Avenue, Flushing NY 11354

November 17, 2014

Commissioner Emily Lloyd
New York City Department of Environmental Protection
9605 Horace Harding Expressway
Corona, New York 11368

Dear Commissioner Lloyd,

Re: Friends of Flushing Creek Comments on Flushing Creek LTCP Options

I am writing on behalf of Friends of Flushing a Creek, a nonprofit organization comprised of stakeholders, environmentalists and community representatives who are dedicated to ensuring the clean up of Flushing Creek. Our goal is to ensure that the creek will be a healthy waterbody that can serve as a recreational resource. As you know, the creek does not meet water quality standards and is the subject of a consent order with New York State that requires the development of a long term control plan to reduce combined sewer overflows.

I write today to offer comments on the long term control plan options for Flushing Creek now under consideration by DEP as presented at its October 23rd, 2014 public meeting. As a general and underlying statement, Friends of Flushing Creek fundamentally disagrees with the department's failure to retain options that would result in much-needed CSO volume reduction. Indeed, none of the retained options for future projects provide for increased sewage treatment capacity at Tallman Island or additional retention tanks needed to handle needs beyond its capacity.

Historic stressors, including industrial legacy impacts and reduced tidal flow, have combined with the continual release of CSOs to create an oxygen starved waterbody with pathogen laden sediments that cause community-wide foul odors at low tide. Flushing Creek receives more than 1 million gallons of raw sewage and storm water runoff annually during increasingly common heavy rain events. Remarkably, just one of the creek's outfalls releases more CSO volume than will be released in the entire Bronx River, Alley Creek, Bergen & Thurston Basin, Coney Island Creek, Gowanus Canal, Hutchinson Creek, Jamaica Bay and CSO Tributaries, Paedegat Basin or the Westchester Creek after implementation of the city's green infrastructure program. As a result, a substantial portion of the creek fails to meet minimally acceptable levels of fecal coliform during wet weather events and is a community detriment.

Rising sea levels, increasing population and plans for future development along Flushing Creek require a robust and aggressive plan to bring the creek into compliance with water quality standards and to sustain that compliance.

Today, the New York City Planning Commission announced plans to launch a study of the 60 acres adjoining Flushing Creek as part of the Flushing-Willets Point-Corona Local Development Corporation's Brownfield Opportunity Area grant funded program. The study will culminate in rezoning proposals geared to help spur the development of a new Flushing West community, including much-needed affordable housing-a central goal of the Mayor's administration. Current plans envision accessible open space along Flushing Creek including a kayak launch, waterfront park, wetland cove, a riverfront terrace and open space-all geared to providing residents and visitors a positive connection to Flushing Creek. The success of Flushing West's open space plans requires the clean-up of Flushing Creek. Bluntly stated, no one wants to live next to an open sewer with foul odors every low tide.

Comments on Disinfection: The retained options for the LTCP focus on disinfection and do not address the need to reduce CSO volumes. The use of chlorine and it's residual release into the creek poses significant concerns. We share concerns of environmental experts regarding its reported health effects impacts, including breast and bladder cancer. Additionally, chlorine is toxic to shellfish and other beneficial organisms that are needed to restore oxygen levels to water quality standards.

Comments on Wetland Restoration: Friends of Flushing Creek has been an active advocate for dredging the creek in order to remove existing sediments that cause foul odors at low tide and continue to serve as a toxic presence that destroys nutrient potential within the creek.

DEP has presented four potential wetland restoration sites in addition to the Army Corps of a engineers project currently in the planning process. Approximately 2 to 4 acres of additional wetland restoration are possible outside of USACE/DEP restoration/ dredging coordination effort now underway. We support efforts to restore the wetlands within the creek and acknowledge the beneficial impact of such projects on the restoration and sustainability of healthy waterbodies.

However, while we support and advocate for such projects they must be part of a comprehensive plan to dredge existing sediment and to materially affect CSO released volumes. Without CSO reduction, the potential of generating a productive ecosystem is greatly diminished, representing a short sighted plan that does not maximize the use of funding or potential of such efforts.

Current projects included in the LTCP reference the $41 million capacity increase at Tallamn Island at the Whitestone interceptor. We note that DEP has previously acknowledged that the positive effects for this project will primarily effect Flushing Bay and the East River. As a result they were not included in the DEP Waterbody/ Watershed Plan of current projects underway for Flushing Creek.

An emphasis on Green Infrastructure to control storm-water runoff has been included in the DEP consent order with NYC DEC. While bios whales, green and blue roofs, rain gardens, and permeable paving are positive components of a comprehensive CSO storm-water source reduction plan, a clearly articulated, project specific, funded green infrastructure plan for the Flushing Creek CSO impact area has not been developed. Therefore, we cannot consider green infrastructure goals as a reliable component in the Flushing Creek LTCP

Finally, we remain concerned that the approved Waterbody/Watershed Plan for Flushing Creek included references of the following " If water quality criteria are demonstrated to be unrealistic, DEP would request reclassification of portions of Flushing Creek." and possible development of a "UAA to assess and determine the waterbody's highest attainable use, which the State will consider in adjusting water quality standards, classifications, or criteria and developing waterbody-specific criteria. Possible outcomes include: Recommending partial use standards or seasonal uses for certain waterbodies". The goals of the Federal Clean Water Act are fishable and swimmable waters. Friends of Flushing Creek look to upgrade its secondary contact classification-not to step backwards.

We thank you for your consideration and look forward to a continued dialogue about how to improve Flushing Creek.

Sincerely,

ALEXANDRA ROSA

November 17, 2014

New York City Department of Environmental Protection
Customer Service Center
59-17 Junction Boulevard, 13th Floor
Flushing, NY 11373

Re: NYCDEP Flushing Creek LTCP Retained Alternatives, November 17, 2014

Dear NYCDEP,

Thank you for your continued efforts to maintain and improve the health of Flushing Creek through the reduction of combined sewage discharges. These efforts will continue to improve the water quality of the Creek, enhancing ecosystems and allowing increased recreational opportunities for the benefit of the community. At a recent NYCDEP hosted public meeting, the LTCP retained alternatives were discussed which included recreation season treatment of combined sewage discharges to the Creek with chlorine, and the implementation of tidal wetland restoration or enhancement. Please find my comments below for consideration:

Permitting Residual Chlorine Discharges and Mixing in a Narrow, Shallow Tidal Creek

In response to the retained alternative to treat combined sewage discharges to Flushing Creek with chlorine during the recreation season, the residual chlorine that will be discharged to the Creek as part of the treated combined sewage effluent will likely be a challenge to permit. Because of the narrowness and shallowness of the Creek, the mixing zone is likely to be large and acute levels of chlorine exposure to existing tidal ecosystem components (phytoplankton, Spartina, bivalves, etc.) may be significant.

Because of the potential challenges and complexity with permitting and implementation, will the permitting process be explored sooner than normal in the planning process, before the LTCP is finalized, to verify that this option will be feasible to meet water quality standards without sacrificing the health of existing or future aquatic ecosystem components in the Creek?

Fecal Coliform Reduction Benefits Provided By Tidal Ecosystems

In response to NYCDEP's plan to include tidal wetland restoration in the LTCP efforts, are the benefits of existing or planned tidal ecosystem components (i.e. Spartina Alterniflora fringe marsh, ribbed mussels, mud flat, other bivalves such as clams or oysters) on fecal coliform reduction in the Creek being included in the receiving water model? It is understood that the receiving water hydrodynamic and water quality model is very coarse grid, but it may be beneficial to lump the ecosystem service benefits into the coarse grid hydrodynamic model, if not already?

The literature indicates that tidal wetland vegetation such as Spartina Alterniflora will trap and remove suspended sediments, and bivalves (such as ribbed mussels, clams, and oysters) will remove suspended sediments and chlorophyll a. Fecal coliform, which is typically bound to suspended sediments (especially fine sediments) will then be stored on the platform of the wetland and filtered by bivalves, removing them from the water column. Additionally, the shallow water depths of the mud flats and tidal wetland combined with the bivalve filtration of the water column allow for increased sunlight penetration through the water column, which is the ultimate source of fecal coliform die off.

Developing quantitative fecal coliform benefits created by the existing and proposed tidal ecosystems may increase the justification of their benefit for LTCP planning in combination with other upstream "grey infrastructure" treatments. It is expected that as the upstream treatments begin to reduce loadings to the receiving waters, the ecosystem components and their associated benefits will begin to increase as well. With the benefits of both the grey infrastructure and the natural ecosystems beginning to work in tandem, the receiving waters will likely move to a more natural, healthy state faster than using grey infrastructure alone.

Thank you for your time and consideration of these items,

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Honorable Emily Lloyd
Commissioner
NYC DEP
59-17 Junction Blvd
Flushing, NY 11373

Dear Commissioner Lloyd:

We are writing on behalf of the Empire Dragon Boat Team as part of our "Green Team." Our team is the only breast cancer and all cancer dragon boat team in the New York City area and we have forty members from all over the tri-state area. As cancer survivors, we are very concerned about the overall environment in New York City. As paddlers who practice in Flushing Bay three to four times per week, we are routinely reminded of the direct correlation between the waterways' health and our own. Team members have contracted eye infections and several cases of diarrhea from exposure to contaminated water.

Firsthand experience of the effects of water quality issues, have made us keenly aware and, as such, deeply invested in the outcome of the Flushing Creek Long Term Control Plan (LTCP) process.

Our team has made it part of our mission to advocate and promote cleaner waters in and around New York City and to this end, we are dedicated to seeing an overall reduction in CSO outflows. We have been monitoring water quality in the Bay with the Citizens Water Quality Testing Project through the Water Trail Association, and we have also been active in oyster gardening projects in the Bay in conjunction with the Billion Oyster Project at the Harbor School. In addition, team members have been attending DEP meetings on the Flushing Creek LTCP. We are writing now because we are very concerned about this LTCP proposal, as well as the DEP's process overall.

Although we have attended the meetings about the LTCP held thus far, we continue to have questions about the plan. What are anticipated CSO volume reductions and water quality improvements as a result of the plan? How does the Waterbody Watershed Facility Plan interface with the LTCP? What is the role of green infrastructure? We have found the presentations to be somewhat confusing and incomplete.

Further, we are especially concerned about disinfection as a preferred alternative for cleaning the water – especially as we have no clear understanding of whether there will be meaningful reduction in CSO outflow and how this will be accomplished.

More broadly, we are concerned that the community is being asked to provide meaningful feedback on a powerpoint presentation, as opposed to a thorough, well documented actual Plan. In other waterbodies, the LTCPs ultimately submitted to the State have, on average, consisted of over 200 pages of information. Here, the public was presented with scant evidence. Having a more complete analysis to review is vital to the public process.

As far as we can tell, DEP is presenting no plans for green infrastructure, no plans for actual CSO reduction beyond pre-existing commitments (which would leave 1.2 billion gallons of CSO discharges annually to the creek, according to DEP's public meeting presentation), and no plans for year-round improvement of pathogen pollution. Based on what we have seen, we simply do not believe that a minimalist plan, along the lines DEP seems to be suggesting, would protect the health of recreational users like our team.

Our team represents a fraction of the recreational human powered boat enthusiasts who use Flushing Bay. The Bay is ideal for the sport of dragon boat – it is large and protected. There are no really good alternatives for this sport around New York City. But it seems that the DEP has abandoned Flushing Bay and Flushing Creek – we would like to see both the Bay and Creek some day be elevated to "swimmable".

We are active members of the SWIM coalition and would like to endorse their recommendations on improving public participation in DEP meetings. Further, we would like to thank Mikelle Adgate for her work in green infrastructure and for helping us to better understand the issues around this that are unique to Queens.

Thank you for your attention to this. We look forward to your response. Please reply to empiredragonsinfo@gmail.com.

The Empire Dragon Boat "Green" Team

Alexandra Herzan
Carmel Fromson
Carmen Melian
Akila Simon
Elaine Greenstein
Karen Craddock
Kim Greenspun
Chryse Glackin
Barbara Brown

Cc: Council Member Donovan Richards, Chair, New York City Council, Committee on Environmental Protection
Judith Enck, Regional Administrator, US EPA Region 2
Angela Licata, Deputy Commissioner, DEP
Jim Tierney, Assistant Commissioner for Water Resources, NYS DEC
Venetia Lannon, Regional Director, NYS DEC Region 2

State Pollution Discharge Elimination System (SPDES) Variance

By submitting this variance application, the New York City Department of Environmental Protection (DEP) is not waiving its right to seek other regulatory options for addressing applicable water quality standards (WQS), including a request for water quality standards revisions based upon a Use Attainability Analysis (UAA).

APPLICATION FOR VARIANCE

TO WATER QUALITY BASED EFFLUENT LIMITATION

Tallman Island Water Pollution Control Plant

SPDES Permit No NY-0026239

Outfall TI-010

The DEP seeks a variance from the anticipated Water Quality Based Effluent Limitation ("WQBEL") for the Flushing Bay CSO Retention Facility permitted under the Tallman Island SPDES Permit as Outfall TI-010 and TI-011. This variance application is based on information set forth in the *Flushing Creek Long-Term CSO Control Plan Report* (the "Report") submitted December 2014.

This variance request is based on the anticipation of occasional exceedances of the WQS for: (a) Suspended, colloidal and settleable solids; (b) Oil and floating substances; and (c) Dissolved oxygen (DO). Modeling and engineering estimations indicate that complete elimination of periodic excursions from those WQS would require a WQBEL of 100% combined sewer overflows (CSO) capture. Accordingly, for the reasons set forth below, we hereby request a variance from the presumed WQBEL of 100 percent CSO capture.

Specifically, DEP requests that the permit will specify "operational conditions" based limits for the facility as an "alternative effluent control strategy" defined under Section 302(a) of the Clean Water Act (CWA). Based on New York State Department of Environmental Conservation's (DEC) April 12, 2006 letter regarding the Paerdegat Basin CSO facility, DEP understands that the enforceable conditions for the operation of the Flushing Bay CSO Retention Facility would be based on its design specifications, its Wet Weather Operating Plan (WWOP), and the 14 Best Management Practices (BMP) for CSOs for the duration of the variance. DEP further understands that numerical effluent limits are not appropriate for CSO-based discharges such as those that will occasionally occur from the Flushing Bay CSO Retention Facility due to episodic heavy or intense rainfall events.

Flushing Bay CSO Retention Facility

The Flushing Bay CSO Retention Facility provides 43 million gallons (MG) of storage of combined sewage (28 MG in the tank and 15 MG in the upstream sewers). The facility became operational in May 2007 and was accepted by DEC in January 2011. The facility has been in continuous operation since that time and remains so presently. In 2013 (the most recent annual report) the Flushing Bay CSO Retention Facility captured over 85 percent of the CSO that would have otherwise discharged from TI-010. The resulting water quality benefits are projected to meet the existing WQS for pathogens in Flushing Creek nearly 97 percent of the time, thus exceeding the DEC goal of 95 percent attainment and therefore, considered in full attainment of the criterion. Dissolved oxygen standard is met at least 85 percent of the time during a typical rainfall year.

Because of its flow-through configuration, CSO which discharges through the facility receive solids and floatables removal. However, the New York State standard for suspended, colloidal and settleable solids is “None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.” Similarly, for oil and floating substances the limit is “No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease” (6 NYCRR Part 702.17). There is therefore a practical limitation to the facility being able to attain these WQBELs. Further, minimum DO requirements in Flushing Creek (4.0 mg/L) cannot be attained even with 100 percent CSO removal.

Environmental Benefits

The Flushing Bay CSO Retention Facility significantly improves the water quality and environmental conditions in Flushing Creek and Flushing Bay. As demonstrated in the Flushing Creek[1] Long Term Control Plan (LTCP) Baseline scenario (which includes the facility), bacteriological conditions are projected to attain the existing Class I criteria for fecal coliform 116 of the 120 months during this 10-year simulation period (96.7 percent), thus exceeding the DEC goal of 95 percent attainment and therefore, in full attainment of the criterion. DO will also significantly attain the Class I criterion, with attainment 85 percent of the year at Station OW-03 and as high as 96 percent further downstream. Odors will be reduced by the high level capture of settleable material, and the benthic habitat and diversity of aquatic life in Flushing Creek is expected to improve accordingly.

Regulatory Assessment

As described in the Flushing Creek LTCP, complete attainment of numerical and narrative water quality criteria applicable to Flushing Creek would not be achieved even with 100 percent capture of CSO discharges, which would require an additional 130 MG storage facility with an estimated cost of $1.7B. The addition of disinfection facilities for TI-010 and TI-011 in conjunction with the existing Flushing Bay CSO Retention Facility was selected based on the "knee-of-the-curve” analysis consistent with U.S. Environmental Protection Agency’s (USEPA) CSO Control Policy.

USEPA guidance as contained in *Coordinating CSO Long-Term Planning with WQS Reviews* provides for regulatory reviews and revision, as appropriate, of water quality standards when considering CSO control plans to reflect the site-specific wet weather impact of CSOs and to reconcile designated uses with what is attainable cost-effectively. However, NYSDEC has stated that it prefers that DEP apply for a variance to the presumed WQBELs rather than seek WQS revisions.

[1] The CSO retention facility is named Flushing Bay but outfall TI-010 discharges to Flushing Creek. Therefore the facility has been evaluated under the Flushing Creek LTCP.

Application for Variance to WQBELs

As noted, the requirements for variances to effluent limitations are based on standards and guidance values and contained in 6 NYCRR Part 702.17. Complete elimination of periodic excursions from the following WQS applicable to Flushing Creek would require a WQBEL of 100 percent CSO capture.

In order to meet the above-referenced standards, DEP would be required to attain 100 percent CSO capture. As this level of CSO capture is neither cost-effective nor consistent with CSO Control Policy specifications, we request a variance to the presumed WQBEL of 100 percent CSO capture.

Water Quality Standards for Class I Waters(1)

Parameter	Standard
Suspended, colloidal and settleable solids	None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.
Oil and floating debris	No residue attributable to sewage, industrial wastes or other wastes, nor visible oil film nor globules of grease.
Dissolved Oxygen	Not less than 4.0 mg/L at any time.

Notes:
(1) Compiled from 6 NYCRR Part 703.

The following narrative presents the information or the source of information to support this application under 6 NYCRR Part 702.17. Responses are provided to those subsections of Section 702.17 which are applicable to DEP and to the Flushing Bay CSO Retention Facility.

Sec. 702.17(a) [DEC] may grant, to a SPDES permittee, a variance to a water quality-based effluent limitation included in a SPDES permit.

As the SPDES permittee, DEP seeks a variance to the presumed WQBEL of 100 percent CSO retention for the Flushing Bay CSO Retention Facility. The variance should be incorporated into the Tallman Island WPCP SPDES Permit, NY-0026239.

Sec. 702.17(a)(1) A variance applies only to the permittee identified in such variance and only to the pollutant specified in the variance, A variance does not affect or require the department to modify a corresponding standard or guidance value.

The variance is requested for the following effluent constituents in the periodic overflows from the Flushing Bay CSO Retention Facility.

- Suspended, colloidal and settleable solids;
- Oil and floating substances;
- BOD and other oxygen demanding substances (for DO).

It is understood that this variance is only applicable to the Tallman Island WWTP SPDES permit governing the Flushing Bay Facility and would not modify any water quality standard or guidance value.

Sec. 702.17(a)(3) A variance shall not be granted that would likely jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of such species critical habitat.

The LTCP notes that there are no endangered or threatened species in Flushing Creek. Therefore, the variance would not jeopardize the continued existence or result in the destruction or adverse modification of the critical habitat for endangered or threatened species.

Sec. 702.17(a)(4)) A variance shall not be granted if standards or guidance values will be attained by implementing effluent limits required under Section 750-1.11(a) of this Title and by the permittee implementing cost-effective and reasonable best management practices for nonpoint source control.

The requirements applicable to CSO outfalls and CSO retention facilities are set forth in DEC's Technical and Operational Guidance (TOGS) 1.6.3, which requires that all technology based effluent limits for CSOs must be developed using Best Professional Judgment (BPJ). BPJ has been used to develop the Flushing Creek LTCP and some excursions from WQS are expected after implementation. BMPs applied for nonpoint source control will also not achieve attainment.

Sec. 702.17(a)(5) A variance term shall not exceed the term of the SPDES permit. Where the term of the variance is the same as the permit, the variance shall stay in effect until the permit is reissued, modified or revoked.

DEP acknowledges that the variance will not exceed the term of the Tallman Island WPCP SPDES Permit; however, in the absence of a UAA, it is likely that the variance will need to be renewed. As appropriate, DEP may timely file an application for such renewal.

Sec. 702.17(b)(1), (2), (3) (4) and (5) A variance may be granted if the requestor demonstrates that achieving the effluent limitation is not feasible because:

(1) Naturally occurring pollutant concentrations prevent attainment of the standard or guidance value,

(2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent attainment, unless these conditions may be compensated for by the discharge of sufficient volume of effluent to enable the standard or guidance value to be met without violating water conservation requirements,

(3) Human-caused conditions or sources of pollution prevent attainment of the standard or guidance value and cannot be remedied or would cause more environmental damage to correct them to leave in place,

(4) Dams, diversions or other types of hydrologic modifications preclude attainment of the standard or guidance value, 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 such attainment,

(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 chemical water quality, preclude attainment of the standard or guidance value; or

(6) Controls more stringent than those required by Section 750-1.11(a) would result in substantial and widespread economic and social impact.

This subsection requires the applicant to demonstrate that achieving the WQBEL is not feasible due to a number of site-specific factors. These factors established by New York State Environmental Conservation Law are the same as those in 40 CFR 131.10(g) which indicate Federal requirements for a UAA. In the framework DEP and DEC have agreed to for UAAs, at least one of these six criteria must be met, and it is expected that this agreement would also be applicable to a SPDES Variance request. Because 100 percent CSO removal does not enable attainment, factors #3 (human-caused conditions) and #4 (hydrologic modifications) at a minimum would provide justification.

Sec. 702.17(c) In addition to the requirements of subdivision (b) of this section, the requestor shall also characterize, using adequate and sufficient data and principles, any increased risk to human health and the environment associated with granting the variance compared with attainment of the standard or guidance value absent the variance, and demonstrate to the satisfaction of the department that the risk will not adversely affect the public health, safety and welfare.

This subsection requires the applicant to demonstrate to DEC any increased risk to human health associated with granting of the variance compared with attainment of the WQS absent the granting of the variance. As noted above under Sec. 702.17(a)(1), this variance application is for suspended, colloidal and settleable solids, and oil and floating substances in the periodic overflows from the Flushing Bay CSO Retention Facility. These substances pose no significant risk to human health. In addition, pathogen criteria are expected to be fully attained and therefore no variance is requested for these parameters. Very limited risk to the environment is expected absent attainment of the standard.

Sec. 702.17(d), The requestor shall submit a written application for a variance to the department. The application shall include:

(I) All relevant information demonstrating that achieving the effluent limitation is not feasible based on subdivision (b) of this section; and

(2) All relevant information demonstrating compliance with the conditions in subdivision (c) of this section.

This application and the Flushing Creek LTCP satisfy the requirements of this subsection.

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

24 November, 2014

Programs and Project Management Division

Mr. John McLaughlin
Director, Office Ecological Services
Bureau of Environmental Planning and Analysis
New York City Department of Environmental Protection
59-17 Junction Blvd - 13th Floor
New York, NY 11373

Dear Mr. McLaughlin:

The U.S. Army Corps of Engineers (USACE), New York District (District) has valued New York City Department of Environmental Protection's (DEP's) continued partnership as the non-federal sponsor for ecosystem restoration feasibility study activities within Flushing Creek and Bay. The District acknowledges that a significant amount of in-kind work has been provided by DEP over the last several years to better align the restoration plans with DEP's Long Term Control Plan including environmental dredging activities and Combined Sewer Overflow (CSO) Abatement Program. It is critical that the restoration planning and dredging actions within the creek be closely planned and coordinated through implementation. As you are aware, the restoration planning within Flushing Creek has been formally incorporated into the Hudson Raritan Estuary (HRE) Ecosystem Restoration Feasibility Study in order to ensure the Study's completion.

As a result of this integration, the District plans to recommend the restoration of Flushing Creek as part of the HRE Feasibility Report. The plan being evaluated within the Draft HRE Feasibility Report includes the restoration of low and high salt marsh, salt scrub, and upland forest between Roosevelt Avenue and the Long Island Rail Road which will improve sediment and water quality in this reach. Preliminary designs and costs of potential recommended alternatives are currently being developed with DEP's Consultant team, which will then be followed by a Cost Effectiveness/Incremental Cost Analysis (CE/ICA) to determine the specific "best buy plan" that will be recommended for construction.

The Draft HRE Feasibility Report is scheduled to be completed in late 2015. Following concurrence with USACE Headquarters, the Draft Feasibility Report will be released to the public for review. Based on comments received, a Tentatively Selected Plan (TSP) will be further developed (with feasibility level designs and detailed cost estimates) for the Final Feasibility Report and Chief's Report which will ultimately recommend authorization for construction of the Flushing Creek restoration project in late 2016. Upon the Chief's Report approval, the restoration would be potentially authorized in a future Water Resource Development Act (as early as 2017) followed by appropriations for construction (cost shared 65% Federal/35% non-federal). Preconstruction Engineering Design (PED) could then be initiated while seeking construction authority and could optimistically be advanced in 2017.

The District is committed to working with DEP to finalize the restoration planning and advance construction of Flushing Creek pending Congressional authorization and appropriations. Flushing Creek restoration is an important component to our overall HRE Feasibility Study and advancement of the goals set forth in the 2014 HRE Comprehensive Restoration Plan. Please contact me at 917-790-8306 if you have any questions or need further assistance.

Sincerely,

Lisa A. Baron

Lisa A. Baron
Project Manager
U.S. Army Corps of Engineers
NY District

Use Attainability Analysis

EXECUTIVE SUMMARY

The New York City Department of Environmental Protection (DEP) has performed a Use Attainability Analysis (UAA) for Flushing Creek in accordance with the 2012 CSO Order on Consent. Flushing Creek is a tributary of the Upper East River, currently designated as a Class I waterbody along its tidal or marine reach downstream of the Tide Gate Bridge in Flushing Meadow Park (Porpoise Bridge). The Creek is designated as Class B along the upstream freshwater reach, from the Porpoise Bridge up to Willow Lake, which is considered for purposes of this Long Term Control Plan (LTCP) to be the upstream limit of the study area. Flushing Creek flows in a northerly direction towards Flushing Bay. Flushing Bay opens to the Upper East River (Figure 1). The Willow and Meadow lakes outflow, the combined sewer overflows (CSOs) and stormwater constitute the sources of freshwater flows into Flushing Creek. The tidal interchange with Flushing Bay waters, the various sources of pollutant loadings, as well as their impacts on the water quality (WQ) conditions of the tidal portions of the Creek, were analyzed within the LTCP framework. This analysis concluded that a draft UAA is to be appended to the LTCP report, and that such UAA is pending a revision of its content and factors supporting it, to be conducted post-Flushing Bay LTCP submittal.

The Flushing Creek watershed is located within Queens County in its entirety. According to Title 6 NYCRR, Chapter X, Part 935, the Flushing Creek saltwater front is at the Tide Gate Bridge in Flushing Meadow Park, also known as Porpoise Bridge, in northern Queens County. Per design, the tide gates at the Porpoise Bridge impede the saline CSO impacted waters from migrating into the freshwater section of the Creek. Therefore, this UAA considers the marine section of the Flushing Creek exclusively, as defined above.

Detailed analyses performed during the Flushing Creek LTCP concluded that the Existing WQ Criteria for the designated Class I secondary contact uses in the tidal section of Flushing Creek are attained for the corresponding fecal coliform criterion under baseline conditions. It is noted that, based on New York State Department of Environmental Conservation's (DEC) interpretation of the enterococci criterion proposed in the BEACH ACT of 2000, the criterion is not applicable to Flushing Creek as this waterbody is a tributary of the Upper East River.

However, as discussed in the supporting information in the Flushing Creek LTCP report, the waterbody is not expected to attain the next higher classification, i.e. Class SC, with the implementation of the LTCP preferred alternative or even with 100 percent Flushing Creek CSO control conditions. Based on a technical assessment, the non-attainment is due, in part, to the bacteria loadings originating in Flushing Bay and carried upstream to the tidal reach of Flushing Creek. The inability to meet the primary contact standard is also due to direct drainage and urban runoff impacts to Flushing Bay, as well as physical and hydrological characteristics of the Creek. Based upon modeling, DEP projects that with the completion of the projects listed in this LTCP for the Flushing Creek watershed, there will be a significant improvement in WQ in Flushing Creek. However, full attainment of the next higher classification (i.e., Class SC), is only feasible when further mitigation of CSO and potentially stormwater discharges to Flushing Bay is considered. On the basis of these findings, DEP is requesting, through the UAA process, that the DEC consider site-specific WQ targets for the tidal section of Flushing Creek.

Figure 1. Aerial View of Flushing Creek

INTRODUCTION

Regulatory Considerations

DEC has designated the tidal or marine portion of Flushing Creek as a Class I waterbody. The best usages of Class I waters are “secondary contact recreation and fishing” (6 NYCRR 701.13). The next higher classification is Class SC. The best usages of Class SC waters are “limited primary and secondary contact recreation and fishing” (6 NYCRR 701.11). The SC classification is presumed by DEC to be equivalent to attaining the fishable and swimmable goals of the Clean Water Act (CWA). In addition, DEC has proposed new total and fecal coliform criteria for Class I waters.

Federal policy recognizes that the uses designated for a waterbody may not be attainable, and the UAA has been established as the mechanism to modify the water quality standards (WQS) in such a case. Here, Flushing Creek meets the existing designated use classification (existing Class I). Furthermore, complete elimination of CSO discharges to the Creek will not result in attainment of the classification of SC or the proposed fecal coliform Class I criteria.

This UAA identifies the attainable and existing uses of Flushing Creek and compares them to those designated by DEC, in order to provide data to establish appropriate WQ targets for this waterway. An examination of several factors related to the physical condition of the waterbody and the actual and possible uses suggests that the uses listed in the SC classification may not be attainable.

Under federal regulations (40 CFR 131.10), six factors may be considered in conducting a UAA:

1. Naturally occurring pollutant concentrations prevent the attainment of the use; or

2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or

3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or

4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original conditions or to operate such modification in a way that would result in the attainment of the use; or

5. Physical conditions related to the natural features of the waterbody, such as the lack of proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to WQ, preclude attainment of aquatic life protection uses; or

6. Controls more stringent than those required by Sections 301(b) and 306 of the Act [CWA] would result in substantial and widespread economic and social impact.

Identification of Existing Uses

The waterfront area surrounding tidal Flushing Creek is dominated by industry and is intensely developed. No formal waterfront access facilities exist along Flushing Creek. There are no known informal access areas to Flushing Creek. Limited access to the waters of tidal Flushing Creek preclude access for bathing or canoe/kayak launching due to rip-rap or bulkheads along the shoreline, as illustrated in Figures 2a and 2b. Figure 3 shows the uses identified by the public. As shown, identified uses within Flushing Creek are limited to kayaking in Meadow Lake.

Figure 2a. Shoreline View of Flushing Creek from Whitestone Expressway (Looking South)

Flushing Creek is not suitable for bathing and as such there are no New York City Department of Health and Mental Hygiene (DOHMH) certified bathing beaches anywhere within the waterbody. There are no areas known to be frequented by the public for full body immersion. As such, the bulk of the waterbody is not conducive to primary contact uses.

Figure 2b. Flushing Creek Shoreline (Looking Northeast from Van Wyck Expressway)

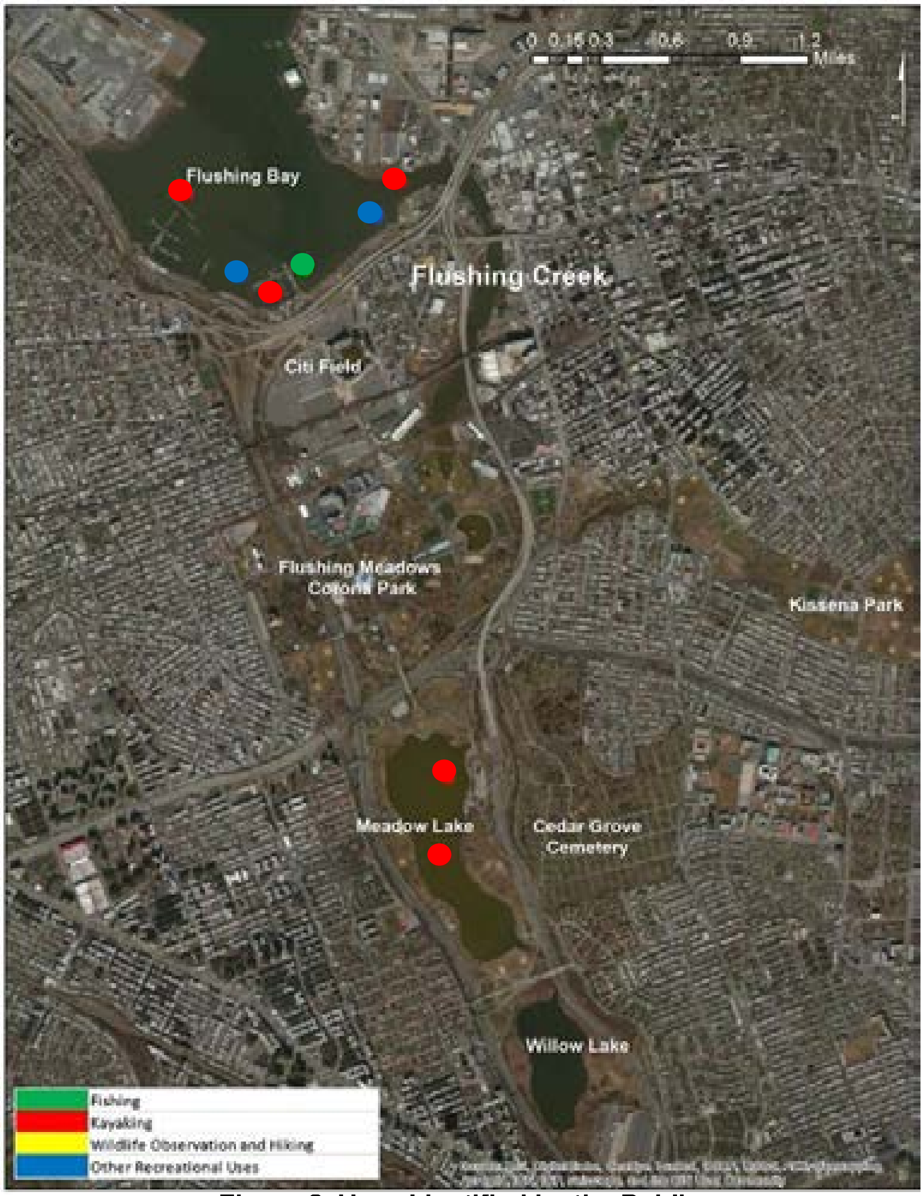

Figure 3. Uses Identified by the Public

ATTAINMENT OF DESIGNATED USES

The tidal or marine portion of Flushing Creek is a Class I waterbody. This classification is suitable for secondary contact recreation and aquatic life propagation and survival. As noted previously, Flushing Creek is not suitable for primary contact recreation. At the public meetings there were no reports of full body immersion occurrences and this is not a common or supported use.

WQ modeling and observed data indicate that the existing Class I (secondary contact) bacteria criterion is being achieved. With respect to the Class SC WQS, or the proposed fecal coliform Class I criteria, the attainment of the fecal coliform numeric criteria throughout the entirety of Flushing Creek is not possible 100 percent of the time primarily due to CSOs discharged to the Creek and Flushing Bay, as well as additional pollutant sources other than CSO (namely, direct drainage and urban stormwater). With complete removal of Flushing Creek CSOs, attainment is still not possible.

Furthermore, an analysis was conducted during the development of the LTCP using ten years of WQ model projections from 2002 through 2011 to predict the time to recover in Flushing Creek following a rain event, an approach consistent with DEC direction. As primary contact uses during the recreational season (May 1st through October 31st) require attainment a high percent of the time, DEP used a primary contact fecal coliform target of 1,000 counts/100mL from the New York State Department of Health (DOH) guidelines and an enterococcus target of 110 counts/100mL based on the 2012 U.S. Environmental Protection Agency (EPA) Recreational Water Quality Criteria (RWQC) recommendations in this analysis. The result of the analysis is summarized in Section 8 of the Flushing Creek LTCP. As noted, the duration of time after a rainfall event within which bacteria concentrations are expected to be higher than DOH considers safe for primary contact varies based on the size of the rainfall event. Generally, a value of around 72 hours for storms with rainfall volumes of less than 1 inch appears to be the length of time for the Flushing Creek waterbody to recover from the influence of these wet weather events.

DEP has been using model projections in various waterbodies and near beaches to assist with advisories that are typically issued twice a day. The recovery time is essentially the timeframe during which the waterbody will not support primary contact. It is intended to advise the water users of the potential health risk associated with this use during the recovery period.

CONCLUSIONS

Flushing Creek attains the existing Class I WQS but cannot fully achieve the primary contact WQ criteria of Class SC, based on fecal coliform on an annual basis. However, the analyses show that primary contact WQ criteria can be attained throughout the recreational season (May 1st through October 31st) a high percent (>78 percent of the time) of the time with the caveat that during and after rain events, bacteria levels will be elevated. Flushing Creek is not used for primary contact recreation, so the non-attainment of fishable/swimmable standards during and after rainfall or during the non-recreational season would not impact existing waterbody uses. Non-attainment of primary contact WQ criteria is attributable to the following UAA factors:

- Human caused conditions or sources of pollution (CSO, direct drainage and urban runoff), create high bacteria levels after storms that prevent the attainment of the use and cannot fully be remedied through correction of Flushing Creek CSOs (UAA factor #3).

- Changes to the shoreline to channelize it and protect it, created bulkheads and steep rip-rap lined banks limiting access to Flushing Creek along the majority of the eastern shoreline (UAA factor #4).

RECOMMENDATIONS

Flushing Creek attains the existing Class I criterion for fecal coliform bacteria. Protecting primary contact WQ criteria in Flushing Creek is possible on a limited basis; hence, DEP has identified seasonal site-specific WQ targets as set forth below.

DEP believes DEC should adopt site-specific bacteria targets for the Creek during the recreational season (May 1st through October 31st) to advance the Creek towards the numerical limits established, or under consideration by DEC, including SC bacteria standards, the proposed Class I coliform criteria, and Future Primary Contact WQ Criteria consistent with the 2012 EPA RWQC. DEP notes that these targets are based on WQ modeling projections and may require adjustment based upon submittal of the Flushing Bay LTCP and post-construction compliance monitoring results. Targets were developed by calculating the 95^{th} percentile recreation period and non-recreation period monthly geometric means (GMs) for fecal coliform, and the 95^{th} percentile 30-day rolling GM concentration for enterococci during the recreation period during the projection years 2002-2011 at Station OW-3.

During the Recreational Season Site-Specific Targets (May 1^{st} through October 31^{st}), DEP has identified that the following numerical site-specific targets be established for the Creek against which continual WQ improvements can be measured:

During the Recreational Season, DEP has identified the following numerical site-specific targets:

Maximum rolling 30-day GM enterococci value of 180 cfu/100mL

Monthly fecal coliform GM concentration of 700 cfu/100mL

During the Non-Recreational Season, DEP has identified the following numerical site-specific targets:

Monthly fecal coliform GM concentration of 2000 cfu/100mL

With anticipated reductions in CSO overflows resulting from grey and green infrastructure, the Flushing Creek could be protective of infrequent primary contact during the recreational season (May 1^{st} through October 31^{st}), should it occur, as long as it did not occur during or following rainfall events. Toward that end, DEP believes that a wet weather advisory would be appropriate for the waterbody:

- 72 hours for rainfall up to 1 inch; and
- 90 hours for rainfall greater than 1 inch.

Further, DEP has indicated that through the control of CSOs that discharge to Flushing Bay, it would be possible to further reduce fecal coliform bacteria levels in Flushing Creek. What is not known at this time is the level of Flushing Bay CSO controls needed to fully attain Class SC standards (or the proposed Class I coliform criteria) in Flushing Creek, the cost for those controls and the physical alterations and environmental impacts resulting from such levels of control. This additional information will be developed in June 2017 with the completion of the Flushing Bay LTCP. At such time, the Flushing Creek UAA would be retracted or amended.