Environmental Protection

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July 7, 2023

Edward Hampston, P.E.
Director, Bureau of Water Compliance
New York State Department of Environmental Conservation
625 Broadway, 4th Floor
Albany, New York 12233-3506

Re: Order on Consent ("CSO order''), DEC Case# C02-20110512-25
Modification to DEC Case# C02-20000107-8, Appendix A, XIII. Submit Approvable Citywide LTCP: **Supplemental Citywide & Open Waters Long Term Control Plan and Responses to DEC Comments**

Dear Mr. Hampston:

The New York City Department of Environmental Protection (DEP) hereby submits to the New York State Department of Environmental Conservation (DEC) responses to comments provided by DEC on March 9, 2021 and subsequent comments received on April 21, 2023 and June 21, 2023 via email. Attached please find the response to DEC comments and a redlined version of the Supplemental LTCP Documentation that reflects all updates made to the document.

If you require additional information, please do not hesitate to contact me at (718) 595-5972, or kmahoney@dep.nyc.gov.

Sincerely,

Keith Mahoney

Keith Mahoney, P.E
Acting LTCP Program Manager

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Capital Project No. WP-169
Long Term Control Planning III

Combined Sewer Overflow Long Term Control Plan for Citywide/Open Waters

Appendix D Supplemental Documentation

July 2023

Keith Mahoney, P.E.
NY License No. 074169

The City of New York
Department of Environmental Protection
Office of the Agency Chief Engineer

Prepared by: AECOM USA, Inc. with HAZEN AND SAWYER

Responses to DEC Comments

Responses to DEC Comments in Email from L. Allen Dated June 21, 2023

1. **Summary of Recommended Plan in Table 8.8-1**. For component ER-6, the selected alternative shown in Table 8.5-6 indicates for regulator TI-10B, there will be an increased orifice and new branch interceptor, but in Table 8.8-1, it indicates only an increased orifice, and for component NYB-1, Table 8.6-2 shows a weir modification, increased orifice size, and new branch interceptor for regulator RH-13, but Table 8.8-1 shows only increased orifice and new branch interceptor.

   Can you confirm the specific improvements that will be made at these regulators for ER-6 and NYB-1?

DEP Response: *DEP confirms the following:*

- *For Alternative ER-6, the Recommended Plan includes the branch interceptor modification downstream of Regulator TI-10B*
- *For Alternative NYB-1, the Recommended Plan includes the weir modification at Regulator RH-13*

It appears that those components were inadvertently left out of the descriptions of the alternatives inTable 8.8-1. A new revised version of Table 8.8-1 with edits in redline is presented below, and has been incorporated into a revised version of Section 8 in this Supplemental Documentation.

Table 8.8-1. Summary of Recommended Plan Components

Waterbody	Recommended Plan Description	Annual Net Untreated CSO Volume Reduction (MG)[1]	Probable Bid Cost ($M)[2]
Harlem River	No CSO project recommended[3]	0	$0
Hudson River	HUD-2: Enlargement of regulator orifice openings at Regulators NR-26A, 28, and 29A associated with Outfalls NR-040, 038, and 046, respectively.	7	$3
East River/Long Island Sound	ER-6: Enlargement of the regulator orifice opening on Regulator TI-10B (CSO TI-003), enlargement of the branch interceptor downstream of Regulator TI-10B, and installation of a bending weir at Regulator TI-13 (CSO TI-023).	86	$6

Table 8.8-1. Summary of Recommended Plan Components

Waterbody	Recommended Plan Description	Annual Net Untreated CSO Volume Reduction (MG)(1)	Probable Bid Cost ($M)(2)
New York Bay	NYB-1: Modifying the weir at Regulator RH-020A (CSO RH-005), increasing the regulator orifice opening, modifying the weir, and enlarging the branch interceptor connection at Regulator RH-13 (CSO RH-014). NYB-2: Installing a bypass connection on the Victory Boulevard combined sewer upstream of Regulator 17 (CSO PR-013). This connection would divert dry-weather flow and a portion of the wet-weather flow directly to the East Interceptor by gravity. NYB-3: Installing a control gate in Regulator 9C (CSO OH-015), to keep more wet-weather flow in the upper of the two combined sewer conduits entering the regulator.	132	$33
Kill Van Kull	No CSO project recommended(4)	0	$0
Totals		225	$42

Notes:
(1) Based on 2008 Typical Year.
(2) AACE International Level 5 cost estimates, in 2019 dollars.
(3) Tibbetts Brook Daylighting project is included under the Green Infrastructure Program as part of the LTCP Baseline Conditions. The project is estimated to reduce CSO volume to Harlem River by 228 MGY.
(4) No feasible optimization alternatives were identified for Kill Van Kull. Storage alternatives had high cost, and would not change the level of attainment with WQS.

Responses to DEC Comments in Email from L. Allen Dated April 21, 2023

1. **Early Tippers Analyses for CSO BMP Order**. DEC determined that the analyses of key regulators to identify options to reduce or eliminate early tipping events, completed as part of the Citywide LTCP, are sufficient to fulfill the CSO BMP Order obligations (Appendix B, para. 5.b and 5.c). DEC requested that the supp document include a summary of the analyses completed along with a statement that would serve as the basis for closing out the CSO BMP Order requirements. DEP has provided a summary of the analyses in the supp document along with the statement shown below to reflect the status of the key regulator analyses. However, the statement seems to leave open the possibility of future evaluations of early tippers if additional funding is provided or to support efforts to reduce

localized flooding for stormwater resiliency. Given the potential for future analyses, the statement does not provide the clarity needed to close-out the CSO BMP Order requirements. As such, DEC requests that the statement be revised to more clearly reflect that no further analyses are required to fulfill the CSO BMP Order requirements, even if DEP may envision evaluating these regulators for other reasons, such as to reduce localized flooding, which is unrelated to the BMP to maximize flow to the WRRFs. In the interest of expediency, DEC provides some suggested revised language as follows:

"In accordance with the requirements of the CSO BMP Order, DEP completed various analyses of key regulators to identify options to reduce CSO discharges outside of the period of a critical wet weather event, including a focused analysis of key regulators in the Tallman Island sewershed, and determined that no cost-effective alternatives existed to reduce these CSO discharges. Similar analyses of other sewersheds will very likely result in similar outcomes because DEP has already undertaken many cost-effective projects over the years to maximize wet weather flow to the WRRFs consistent with the BMP. Per the WRRF SPDES permits, DEP will continue to monitor key regulators. Based on the foregoing, DEP has completed sufficient analyses of key regulators at this time to fulfill the requirements of the CSO BMP Order for analyzing these regulators."

Excerpt from supp document, p. A-12.

With regard to conducting similar BMP evaluations in other sewersheds, any further evaluations would have to be done under a different planning contract, as the current LTCPIII contract does not have sufficient budget to support additional BMP evaluations. The experience with the Tallman Island evaluations indicates that future BMP evaluations would need to be closely coordinated with stormwater resiliency planning. The most practical path forward may be to tie the further investigations of BMP optimization opportunities to the parallel evaluations of options to address stormwater resiliency.

DEP Response: *DEP agrees with the suggested revision, and the text on page A-12 of Attachment A to the Supplemental Document has been revised to incorporate the suggested language in place of the existing text.*

2. **Model Updates to Reflect Changes to Approved LTCP Projects**. The supp document includes a discussion of the potential impacts on the open waters/East River water quality from proposed changes to some projects under other approved LTCPs, in particular the potential elimination of disinfection for Alley Creek, the substitution of a conduit in lieu of disinfection for Hutch River, and the potential elimination of the HP-007 relief sewer for Bronx River. Overall, these discussions are sufficient to support the conclusion that the proposed project changes will not adversely impact water quality for the waterbodies covered under the Citywide LTCP, in particular the East River. However, the discussion of the potential changes to the Alley Creek disinfection project requires some revisions or clarification. At this point in time, there is no certainty on what the alternative project might be or its associated water quality impacts (unlike the changes to the Bronx and Hutch River projects), there are only ongoing feasibility studies. There is a reference in Tables SD-13 and SD-14 that could be misinterpreted that the alternative project is known and its associated water quality attainment are comparable to the disinfection project, which is misleading. As such, the reference to the "Proposed Revised Plan for Alley Creek" in these tables needs to be removed. The analysis of impacts to the open waters/East River from possibly changing the Alley Creek disinfection project can stand on its own without identifying a specific alternative project. In other words, eliminating the disinfection project completely will have no impact on water quality in the East River because the CSOs to Alley Creek have always had a very localized impact. In addition, DEP makes no mention of the possible use of the restored wetlands as an alternative to disinfection, even though evaluation of the wetlands is also being included under the Alley Creek mini-mod. As such, the general discussion of alternatives for Alley Creek is incomplete and should be revised to reflect all the options being considered. Lastly, please confirm that the reference point for analysis of the potential elimination of the Bronx River HP-

AECOM with Hazen

007 relief sewer is correct. Table SD-20 and associated narrative indicates the reference point in the East River is EA6, but it seems like it should be E14 based on the HSM map and past DEP presentations; also confirm whether reference point E14 or EA6 point coincides with reference point BR9 and the annual attainment level in Table SD-20 is correct, as it differs slightly from the BR9 in Table SD-19.

Excerpt from supp document, p. SD-31.

Tributaries Model (ERTM) with an enhanced grid for Alley Creek and Little Neck Bay.

Table SD-13. Fecal Coliform Attainment in Little Neck Bay Stations for Alley Creek LTCP Baseline and Recommended Plan, and for the Proposed Revised Plan for Alley Creek

Station	% Attainment – Fecal Coliform Monthly GM ≤ 200 cfu/100mL			
	Original Baseline(1)		Original LTCP Recommended Plan(1)	
	Annual	Rec. Season(2)	Annual	Rec. Season(2)
OW2	98%	N/A(3)	97%	100%
DMA	100%	100%	100%	100%
LN1	99%	N/A(3)	99%	100%
E11	100%	100%	100%	100%

Notes:
(1) Values from Table 4-2 in the Citywide/Open Waters LTCP.
(2) The recreational season is from May 1st through October 31st.
(3) Recreational season fecal coliform attainment was not developed at these stations for this LTCP.

DEP Response: *DEP's response is organized into the following parts corresponding to the specific requests in DEC's comment:*

A. … the reference to the "Proposed Revised Plan for Alley Creek" in these tables [SD-13 and SD-14] needs to be removed. The analysis of impacts to the open waters/East River from possibly changing the Alley Creek disinfection project can stand on its own without identifying a specific alternative project.
B. … DEP makes no mention of the possible use of the restored wetlands as an alternative to disinfection, even though evaluation of the wetlands is also being included under the Alley Creek mini-mod. As such, the general discussion of alternatives for Alley Creek is incomplete and should be revised to reflect all the options being considered.
C. Please confirm that the reference point for analysis of the potential elimination of the Bronx River HP-007 relief sewer is correct. Table SD-20 and associated narrative indicates the reference point in the East River is EA6, but it seems like it should be E14 based on the HSM map and past DEP presentations.
D. Confirm whether reference point E14 or EA6 point coincides with reference point BR9 and the annual attainment level in Table SD-20 is correct, as it differs slightly from the BR9 in Table SD-19.

Responses to each of these items are provided below.

A. the reference to the "Proposed Revised Plan for Alley Creek" in these tables [SD-13 and SD-14] needs to be removed

The Response to Comments document has been edited below in redline/strikeout to reflect DEC's comment (see response to Additional Information Requested by DEC in March 9, 2021 Letter Comment No. 6 starting on page SD-34 below.) The reference to the "Proposed Revised Plan for Alley Creek" in Tables SD-13 and SD-14 has been deleted, and the text on page SD-34 has been revised to clarify that the final revised plan for Alley Creek has not yet been determined.

B. DEP makes no mention of the possible use of the restored wetlands as an alternative to disinfection

The Response to Comments document has been edited below in redline/strikeout to reflect DEC's comment (see response to Additional Information Requested by DEC in March 9, 2021 Letter Comment No. 6 starting on page SD-34 below.) The text on page SD-35 has been revised to include a reference to the restored wetlands.

C. Please confirm that the reference point for analysis of the potential elimination of the Bronx River HP-007 relief sewer is correct.

Bronx River LTCP Sampling Station BR-09, Citywide/Waters Sampling Station EA6, and Harbor Survey Monitoring Station E14 are all in the same location. Tables SD-19 and SD-20 have been revised to clarify.

D. Confirm whether reference point E14 or EA6 point coincides with reference point BR9 and the annual attainment level in Table SD-20 is correct, as it differs slightly from the BR9 in Table SD-19.

See response to Comment 2.C above. The results shown in Table SD-19 were based on the East River Tributaries Water Quality Model used for the Bronx River LTCP, while the results shown in Table SD-20 were based on the LTCP Regional Model used for the Citywide/Open Waters. The different water quality models produced slightly different results for the annual fecal coliform attainment at Station BR-09/EA6. Footnotes were added to the two tables to clarify the model used for each.

3. **Technical Memo on % CSO Capture.** Based on past discussions with DEP, it seems that the compilation of information on % CSO capture aggregated to different scales or levels (e.g., citywide, sewershed, waterbody) has been more challenging than originally envisioned when requested by DEC. At this point in time, DEC would prefer that DEP not expend any additional resources to compile information on % capture and simply provide whatever information it has gathered to date in a tech memo, which should be submitted separate from the LTCP.

   DEP Response: *Comment is noted and DEP will be submitting a separate memo with methodology and projected % wet weather capture per WRRF drainage area.*

4. **Tibbetts Brook Daylighting Description**. The revised the description of Tibbetts Brook project now includes the term "greenway" but it is DEC 's understanding that DEP wanted to remove this term because the greenway portion of the project might not be done by the proposed project completion milestones. The inclusion of the term greenway has no bearing on the scope or function of the daylighting component of the project, which is the key component because it comprises the green infrastructure characteristics and results in CSO reduction. DEP should confirm if inclusion of the term greenway is still desirable if it has the potential to adversely impact compliance with proposed project completion milestones. DEC has no preference either way on whether or not to include the term.

   Excerpt from supp document, p. 21 of Executive Summary.

Tibbetts Brook Daylighting and Greenway

Daylighting would restore the historical connection of Tibbetts Brook from Hester and Pierro's Mill Pond in Van Cortlandt Park to the Harlem River via new water conveyance system consisting of an open channel stream in Van Cortlandt Park and the former railroad right-of-way (CSX) and a closed conduit through the Metro North property, reducing flows to the combined sewer system.

DEP Response: *The description of the Tibbetts Brook project has been revised to differentiate between the daylighting and the greenway.*

<u>Responses to DEC Comment Letter Dated March 9, 2021</u>

Additional Analyses:

1. **Early Tippers.** Under the 2014 CSO BMP Order, the City was required to evaluate alternatives to reduce or eliminate early tipping flows at about 100 regulators, and if the projects identified by the analysis required more than 2 years to implement, they were to be incorporated into the LTCP process. The Department and City subsequently agreed that the early tipper projects would be incorporated into the Citywide LTCP. During development of this LTCP, the City conducted an extensive analysis of alternatives for the early tippers using an innovative multi-objective optimizer software, Optimatics, which was supplemented by a conventional trial and error analysis using the InfoWorks model. Notwithstanding the large number of alternatives evaluated for the early tippers, the Citywide LTCP includes only a few low-cost optimization projects to reduce early tipping flows. The Department believes that proposed early tipper projects do not fulfill the obligations under the CSO BMP Order and as was discussed between the City and Department in February 2020, further analysis of the early tippers needs to be completed.

   Although the specific approach to be used for the additional early tipper analysis is subject to further discussions, in general, the Department envisions an approach that analyzes alternatives more systematically, starting with the early tippers in upstream sewershed and moving downstream in a stepwise manner. In other words, the analysis would examine options to reduce or eliminate early tipping flows for the uppermost early tippers first, and then the associated hydraulic impacts would be taken into consideration for the downstream early tippers, which are subsequently analyzed for reduction or elimination of early tipping flows. This additional analysis of early tippers would initially focus on one or two sewersheds, which would allow the Department and City to fine tune this analytical approach before it is applied to the remaining sewersheds. The Department supports the continued use of the Optimatics software in conjunction with the InfoWorks model, but the penalties assigned to different performance conditions for the Optimatics analyses should be revised from the earlier analysis and agreed upon in advance with the Department. The outcome of the analysis should be a series of knee of the curves for alternatives evaluated to facilitate election of possible early tipper projects.

   The Department envisions a couple of approaches for completing the additional analyses of the early tipping regulators. One approach would be for the City to complete the early tipper analyses and submit the results as part of a supplemental document to the Citywide LTCP. The supplemental document would include responses to all comments provided in this letter, consistent with past practice for other LTCPs. This approach would allow the early tipper analyses and any associated projects selected to reduce or eliminate the early tipping flows to be incorporated directly into the selected alternative for the LTCP, as was anticipated under the CSO BMP Order. A second approach the Department may consider would consist of the City establishing specific milestones within the LTCP to complete the analyses and submit a separate report with recommended projects to reduce or eliminate the early tippers at a future date. However, this approach is not consistent with the requirements of the CSO BMP Order.

The Department is open to suggestions from the City on other possible approaches to complete the early tipper analyses within a timely manner to ensure that its obligations under the CSO BMP Order are fulfilled and would like to discuss timing of various approaches. As such, the Department requests that the City prepare a couple of possible scenarios with tentative schedules for completing the early tipper analyses taking into consideration the comments provided above. The Department and City will discuss these scenarios at future technical meetings before the City proceeds with any early tipper analyses.

DEP Response: *See Attachment A for response and a summary of further investigation of BMP regulators in the Tallman Island system and DEP has modified BMP language in accordance with DEC's recommended language in the April 21, 2023 email.*

2. **Non-Attainment with *Enterococcus* STV Standard in NY Harbor/Bay.** Overall, the waterbodies covered under the Citywide LTCP are projected to have high levels of attainment with existing water quality standards. The main exceptions are the Arthur Kill and Kill van Kull for the fecal coliform geomean standard and the NY Harbor/Bay for the enterococcus STV standard. The non-attainment in the Arthur Kill and Kill van Kull is due to non-CSO sources, and as such, no further action is required for these waterbodies under the Citywide LTCP. The non-attainment with the enterococcus STV standard in the Harbor/Bay (along the Brooklyn-side shoreline), however, appears to be due to CSO discharges from the Red Hook and Owls Head sewersheds. In the LTCP, the City evaluated numerous alternatives for reducing CSOs from the Red Hook, Owls Head, and Port Richmond sewersheds to the Harbor/Bay, including sewer system optimization projects and large CSO storage tunnels. Several cost-effective optimization projects for the Harbor/Bay waters are included as part of the LTCP selected alternative but their impact on improving attainment appears to be minimal at best. The larger CSO storage tunnel projects, by contrast, measurably improve attainment with the water quality standards, but they are quite costly. The Department requests that further analyses be conducted for the Harbor/Bay waters to determine if there are other alternatives beyond those already considered that would have a measurable impact on attainment with the enterococcus STV standard in these waters but that would be more cost-effective than large tunnels.

   In general, the Department envisions that these additional analyses could consist of 2 parts. The first part is a more detailed component analysis. As background, Figures 6-13 and 6-34 (baseline and 100% CSO capture scenarios) indicate that CSOs are definitely impacting the Harbor/Bay waters along the Brooklyn shoreline and Figures 8.6-14 and 8.6-16 further indicate that CSO outfalls OH-015 and OH-017 are significant contributors to this water quality impairment, because the 50% storage tunnel alternative with capture only from these 2 outfalls results in high levels of attainment (100% attainment) at stations NB-4 and NB-9. However, the LTCP does not provide a detailed component analysis that identifies the relative contributions of individual CSO outfalls to the impairment at specific geographic locations in the Harbor/Bay, which could be used to further focus abatement efforts. Table 6-18 provides one type of component analysis, but it only shows the fecal coliform and enterococcus concentrations from different sources for some monitoring stations under certain worse case scenarios for the waterbodies. Appendix A also provides the total fecal coliform and enterococcus loads from different sources, including CSO outfalls, to the waterbodies but it does not indicate the geospatial impacts of each outfall. Both component analyses are useful for understanding the general sources of pollutants to the Harbor/Bay waters, but a more detailed component analysis could be used to better target abatement efforts for these waters.

For the additional component analysis, the Department requests the total annual loads for fecal coliform and enterococcus be provided for stations NB-1, NB-3, NB-4, NB-7, and NB-9 (along the Brooklyn shoreline), broken down first by major source (e.g. CSO, MS4), and then for the CSO component only, the fecal coliform and enterococcus loads from each contributing CSO outfall at each of the aforementioned stations. Taking into consideration this more detailed component analysis, the second part of the analyses would consist of an evaluation of additional alternatives for mitigating discharges from CSO outfalls that contribute most to the Harbor/Bay impairment. For example, if outfall OH-015 is determined to be the most significant source of impairment to the waters along the Brooklyn shoreline, then the City should evaluate other alternatives to mitigate impacts of just that outfall. The specific new alternatives to be considered are subject to further discussions between the City and Department and the City should provide the detailed component analysis before proceeding with the evaluation of new alternatives.

In addition to the additional analyses outlined above, the Department requests cost vs. attainment curves, similar to Figure 8.6-14, for the alternatives already evaluated for the Harbor/Bay for stations NB-1, NB-3, and NB-7 as well as heat maps of the attainment levels for the 25%, 50%, and 75% CSO storage tunnel alternatives. Lastly, cost vs. attainment curves that include the newly considered alternatives should also be provided for the same suite of stations and associated attainment heat maps.

DEP Response:

DEP's response is organized into the following parts corresponding to the specific requests in DEC's comment:

A. Provide a component analysis for stations NB-1, NB-3, NB-4, NB-7, and NB-9, broken down first by major source.
B. Provide evaluation of additional alternatives for mitigating discharges from CSO outfalls that contribute most to the Harbor/Bay impairment based on the component analysis.
C. Provide cost vs. attainment curves, similar to Figure 8.6-14, for the alternatives already evaluated for the Harbor/Bay for stations NB-1, NB-3, and NB-7 as well as heat maps of the attainment levels for the 25%, 50%, and 75% CSO storage tunnel alternatives.
D. Provide cost vs. attainment curves that include the newly considered alternatives for the same suite of stations and associated attainment heat maps.

Responses to each of these items are provided below.

A. ***Provide a component analysis for stations NB-1, NB-3, NB-4, NB-7, and NB-9, broken down first by major source.***

Table SD-1 presents a component analysis for water quality stations NB-1, NB-3, NB-4, NB-7 and NB-9, for the components of the maximum 30-day Enterococcus STV during the 2008 recreational season. The values presented for each station include the maximum STV value for the Citywide/Open Waters LTCP Baseline Conditions, the maximum STV value for conditions with CSO loadings eliminated, the component of the maximum STV value under Baseline Conditions contributed by all CSO, and the components contributed by the individual outfalls OH-003, OH-002, OH-017 and OH-015. Collectively, these four outfalls contribute over 75 percent of the total annual CSO volume to New York Bay for 2008 Baseline Conditions.

Figure SD-1 presents a mosaic of the 10-year, Recreational Season 30-day Rolling 90th Percentile Enterococcus STV attainment for New York Bay, along with the location of the water quality stations in New York Bay. The attainment mosaic is from Figure 8.6-18 from the Citywide/Open Waters LTCP.

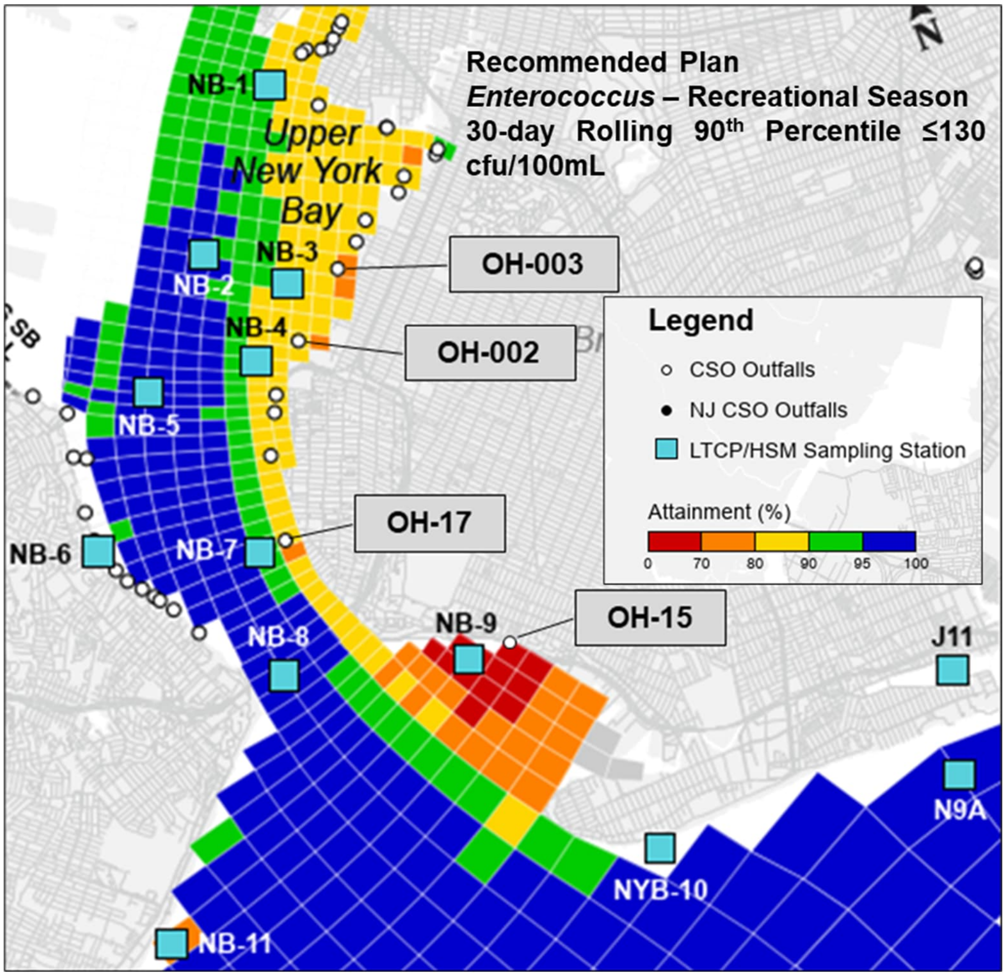


Figure SD-1. Recommended Plan *Enterococcus* STV Attainment and Location of WQ Stations in New York Bay

Table SD-1. Component Analysis for New York Bay WQ Stations

	Maximum 30-day *Enterococcus* STV, 2008 Recreational Season, #/100mL						
Station	CW/OW LTCP Baseline	No CSO	Contribu-tion by All CSOs	Contributions by Individual Outfalls			
				OH003 57 act.* 374 MG*	OH002 41 act.* 407 MG*	OH017 39 act.* 449 MG*	OH015 64 act.* 1,105 MG*
NB-1	136	96.7	39.3	14.5	0.4	3.7	2.4
NB-3	183	31.8	151	44.6	18.5	46.7	45.4
NB-4	143	40.6	102	44.0	11.6	38.7	33.6
NB-7	226	31.2	195	28.4	4.6	85.3	60.5
NB-9	497	16.3	481	10.1	1.1	36.9	332

Notes: *Activations and volumes for 2008 Typical Year

From review of Table SD-1 and Figure SD-1, the following observations are noted:

- *Station NB-01 is minimally affected by outfalls OH-002, OH-003, OH-015 or OH-017, and has the largest relative component from non-CSO sources.*
- *At Station NB-3, the contributions from OH-003, OH-017 and OH-015 are about equal.*
- *At Station NB-4, the predominant contribution comes from OH-003, followed by OH-017 and OH-015.*
- *At Station NB-7, the predominant source is OH-017, followed by OH-015.*
- *Station NB-9, located adjacent to outfall OH-015, had the highest maximum STV value under Baseline Conditions, and had the lowest maximum STV under conditions of no CSO. This station also had the highest component contribution from all CSOs, and the highest contribution from a single CSO (OH-015).*

These observations suggest that targeting outfall OH-015 would have the greatest impact on STV attainment in New York Bay. This observation is not surprising given that OH-015 has the largest average annual CSO discharge volume, and discharges into the relatively shallower waters of Gravesend Bay.

B. ***Provide evaluation of additional alternatives for mitigating discharges from CSO outfalls that contribute most to the Harbor/Bay impairment based on the component analysis.***

The component analysis shown in Table SD-1 was presented to DEC in a meeting on October 7, 2021. In discussions with DEC during and following that meeting, DEP agreed to evaluate the following additional alternatives focused on outfall OH-015:

- *Interceptor relief*
- *Localized storage tank*
- *Extension of the OH-015 outfall away from the shoreline and further into Gravesend Bay*

These evaluations are presented below.

Interceptor Relief

Three alternatives to relieve flow from the OH-015 system were evaluated:

- *Relocate the 48-in. force main from the Avenue V Pump Station*
- *Relieve the Bath Avenue Sewer from Regulater 9A*
- *Relieve the 60th Street Sewer from Regulator 9C*

These three alternatives are presented schematically in Figure SD-2.

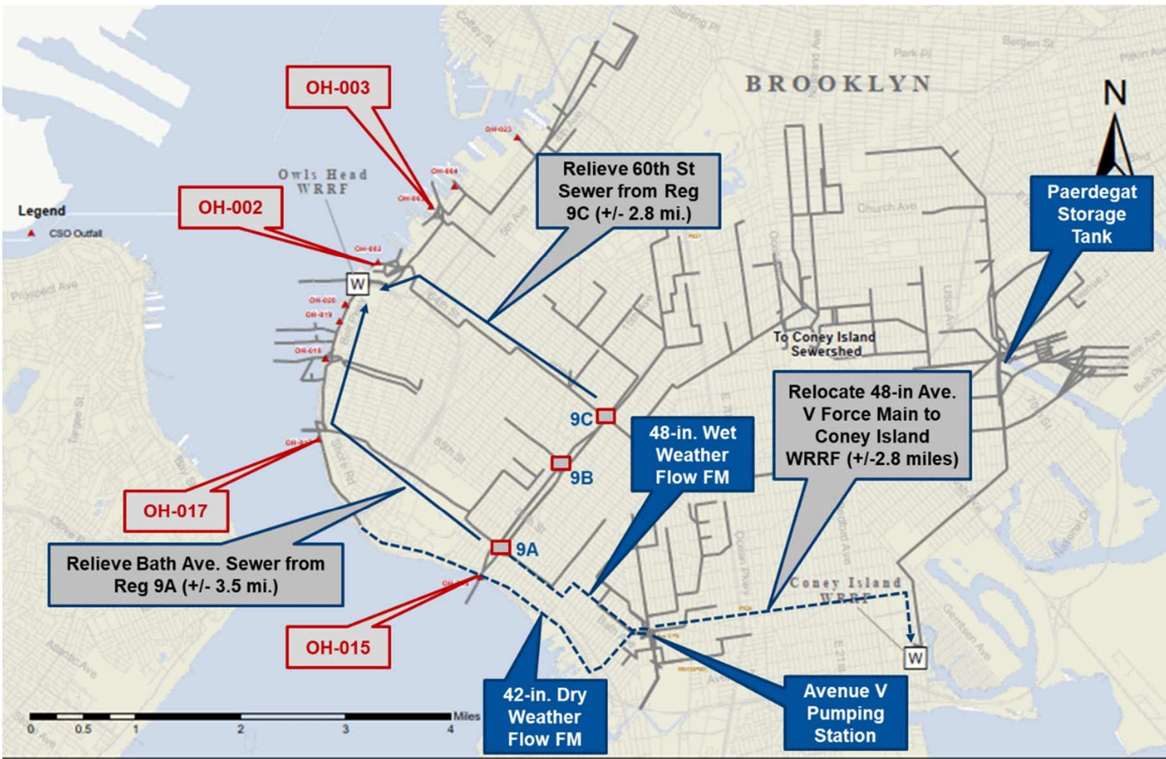


Figure SD-2. Location of Conveyance Relief Alternatives for OH-015

The first alternative would involve abandoning the existing 48-inch wet weather force main that runs between the Avenue V Pump Station and regulator 9A and constructing a new 48-inch force main from the Avenue V Pump Station directly to the Coney Island WRRF. The new force main would be approximately 2.8 miles long. This alternative would reduce the wet weather flow tributary to Regulator 9A but would increase the wet weather flow tributary to the Coney Island WRRF.

The second alternative would involve providing a relief sewer between Regulator 9A and the Owls Head WRRF, running approximately parallel to the existing Bath Avenue sewer. The third alternative would involve providing a relief sewer between Regulator 9C and the Owls Head WRRF, running approximately parallel to the existing 60th Street sewer.

Table SD-2 summarizes the performance in terms of annual CSO activations and volume of the alternative to reroute the Avenue V force main compared to the Citywide/Open Waters LTCP Recommended Plan. Table SD-3 provides a similar comparison for the relief alternative at Regulator 9A, and Table SD-4 presents the performance of the relief alternative at Regulator 9C.

Table SD-5 provides an overall summary comparison of the performance of the three alternatives. As indicated in Table SD-5, the alternative to reroute the Avenue V force main would result in a 16 MG reduction at outfall OH-015, and a total reduction of 46 MG from the Owls Head WRRF system. This reduction would be partially offset by an increase of 18 MG in Paerdegat Basin, resulting in a net total reduction of 28 MG.

Table SD-2. Performance of Alternative to Reroute Avenue V Force Main

			Recommended Plan(1)		Re-rout 48-inch Ave V Force Main(1)	
System	**Waterbody**	**Outfall**	**Volume (MG)**	**Frequency**	**Volume (MG)**	**Frequency**
Coney Island	Paerdegat Basin	Tank Bypass	31.6	5	32.8	5
	Paedergat Basin	Tank Overflow	480	12	497	12
	Total – Paerdegat Basin		**512**		**530**	
Owls Head	New York Bay	OH-002	367	41	367	41
	New York Bay	OH-003	374	57	375	57
	New York Bay	OH-015	994	64	978	64
	New York Bay	OH-017	508	40	478	40
	New York Bay	OH-018	123	33	123	33
	New York Bay	OH-019	22.8	27	22.8	27
	New York Bay	OH-020	1.2	25	1.2	24
	Total - Owls Head		**2,584**		**2,538**	
Combined Total – Paerdegat Basin + Owls Head			**3,096**		**3,068**	

Notes:
(1) Performance based on 2008 Typical Year

Table SD-3. Performance of Parallel Conduit from Regulator 9A

			Recommended Plan(1)		5-ft dia. Parallel Conduit from Reg 9A to Reg R-1 (OH-017) (1)	
System	**Waterbody**	**Outfall**	**Volume (MG)**	**Frequency**	**Volume (MG)**	**Frequency**
Coney Island	Paerdegat Basin	Tank Bypass	31.6	5	31.6	5
	Paedergat Basin	Tank Overflow	480	12	480	12
	Total – Paerdegat Basin		**512**		**512**	
Owls Head	New York Bay	OH-002	367	41	370	41
	New York Bay	OH-003	374	57	374	57
	New York Bay	OH-015	994	64	935	64
	New York Bay	OH-017	508	40	589	40
	New York Bay	OH-018	123	33	128	33
	New York Bay	OH-019	22.8	27	24.1	27
	New York Bay	OH-020	1.2	25	1.4	26
	Total - Owls Head		**2,584**		**2,615**	
Combined Total – Paerdegat Basin + Owls Head			**3,096**		**3,127**	

Notes:
(1) Performance based on 2008 Typical Year

Table SD-4. Performance of Parallel Conduit from Regulator 9C

			Recommended Plan(1)		5-ft dia. Parallel Conduit from Reg 9C to Reg R-6c (OH-002) (1)	
System	**Waterbody**	**Outfall**	**Volume (MG)**	**Frequency**	**Volume (MG)**	**Frequency**
Coney Island	Paerdegat Basin	Tank Bypass	31.6	5	31.3	5
	Paedergat Basin	Tank Overflow	480	12	479	12
	Total – Paerdegat Basin		**512**		**511**	
Owls Head	New York Bay	OH-002	367	41	520	43
	New York Bay	OH-003	374	57	398	55
	New York Bay	OH-015	994	64	685	57
	New York Bay	OH-017	508	40	534	41
	New York Bay	OH-018	123	33	129	36
	New York Bay	OH-019	22.8	27	24.2	29
	New York Bay	OH-020	1.2	25	1.5	30
	Total - Owls Head		**2,584**		**2,485**	
Combined Total – Paerdegat Basin + Owls Head			**3,096**		**2,996**	

Notes:
(1) Performance based on 2008 Typical Year

Table SD-5. Summary of Performance of Interceptor Relief Alternatives for OH-015

	Recommended Plan(1)	Change in Annual Volume from Recommended Plan		
		Re-rout 48-inch Ave V Force Main(1)	5-ft dia. Parallel Conduit from Reg 9A to Reg R-1 (OH-017)(1)	5-ft dia. Parallel Conduit from Reg 9C to Reg R-6c (OH-002)(1)
Location	**Volume (MG)**	**Change in Volume (MG)**	**Change in Volume (MG)**	**Change in Volume (MG)**
Paerdegat Basin	512	+18	0	-1
New York Bay – OH-015	994	-16	-59	-305
New York Bay – All other outfalls	1,590	-30	+90	+206
Total New York Bay	2,584	-46	+31	-99
Total New York Bay + Paerdegat Basin	3,096	-28	+31	-100

Notes:
(1) Performance based on 2008 Typical Year

The alternative to relieve flow at Regulator 9A would reduce the volume at outfall OH-015 by 59 MG, but would increase the overflow volume at other outfalls to New York Bay by 90 MG, resulting in a net increase in discharge to New York Bay of 31 MG. The alternative to relieve flow at Regulator 9C would have the greatest impact on volume at outfall OH-015, reducing the volume by 305 MG. However, discharge at other New York Bay outfalls would increase by 206 MG, resulting in a net reduction in volume to New York Bay of 99 MG.

None of these alternatives was recommended for further evaluation. For the Avenue V force main relocation alternative, increasing the CSO volume in Paerdegat Basin was not considered to be an appropriate trade off for the modest reduction achieved at outfall OH-015. For the Regulator 9A relief alternative, the net increase in CSO volume to New York Bay counteracted the reduction at outfall OH-015. For the Regulator 9C alternative the significant (>200MG) increase at the other New York Bay outfalls would have substantially offset the benefit of the approximately 300 MG reduction at outfall OH-015. All three alternatives would have had substantial construction impacts along the routes of the new piping, with extensive utility conflicts and relocations likely required. In general, the relatively modest benefits at outfall OH-015 or net benefits to discharges to New York Bay would not justify the anticipated costs and construction impacts of these alternatives.

Localized Storage Tank

The vast majority of New York Bay fully attains bacterial standards for geometric means but there is some projected non-attainment with the enterococcus STV criteria and the largest contributor to this non-attainment is CSO Outfall OH-15. This additional analysis is to look at viability of constructing a localized CSO Storage Tank near OH-015 and based on the component analysis it would take greater than a 75% CSO reduction to bring NB-9 into attainment with applicable enterococcus STV. Criteria. The approximate interior dimensions of storage tanks sized to provide a range of levels of control at outfall OH-015 are summarized in Table SD-6. Additional footprint space would be needed for influent/effluent channels, influent screens and dewatering pumps. No open sites were identified along the route of the OH-015 outfall downstream of Regulator 9C that were of sufficient size for even the 25% control tank. For this reason, localized storage tanks were not evaluated further. Figure SD-3 shows the location of outfall OH-015 and the congested development along either side of the outfall upstream and downstream of regulator 9A, which is the downstream-most regulator along the outfall.

Table SD-6. Approximate Interior Dimensions for Storage Tanks at Outfall OH-015

CSO Control	Tank Volume (MG)	Length (ft)	Width (ft)	Side Water Depth (ft)
25%	7	315	150	20
50%	17	379	200	30
75%	38	564	300	30
100%	94	838	500	30

Figure SD-3. Location of Outfall OH-015

Extension of the OH-015 Outfall into Gravesend Bay

Based on the water quality modeling, the lowest Enterococcus STV attainment levels and the highest Enterococcus concentrations were located along or close to the shoreline adjacent to outfall OH-015 (see Figure SD-1, above). The alternative to extend the OH-015 outfall further into Gravesend Bay was identified as a potential means to relocate the discharge away from the shoreline and into deeper water, where greater dilution and dispersion could potentially mitigate the impacts of the discharge.

The approximate length of the outfall extension was initially developed from review of bathymetry available from navigational charts. The length was then refined so as to avoid an Army Corps of Engineers (ACOE) designated anchorage area with specified minimum clearance depth. Figure SD-4 presents a location plan for the OH-015 outfall extension concept.

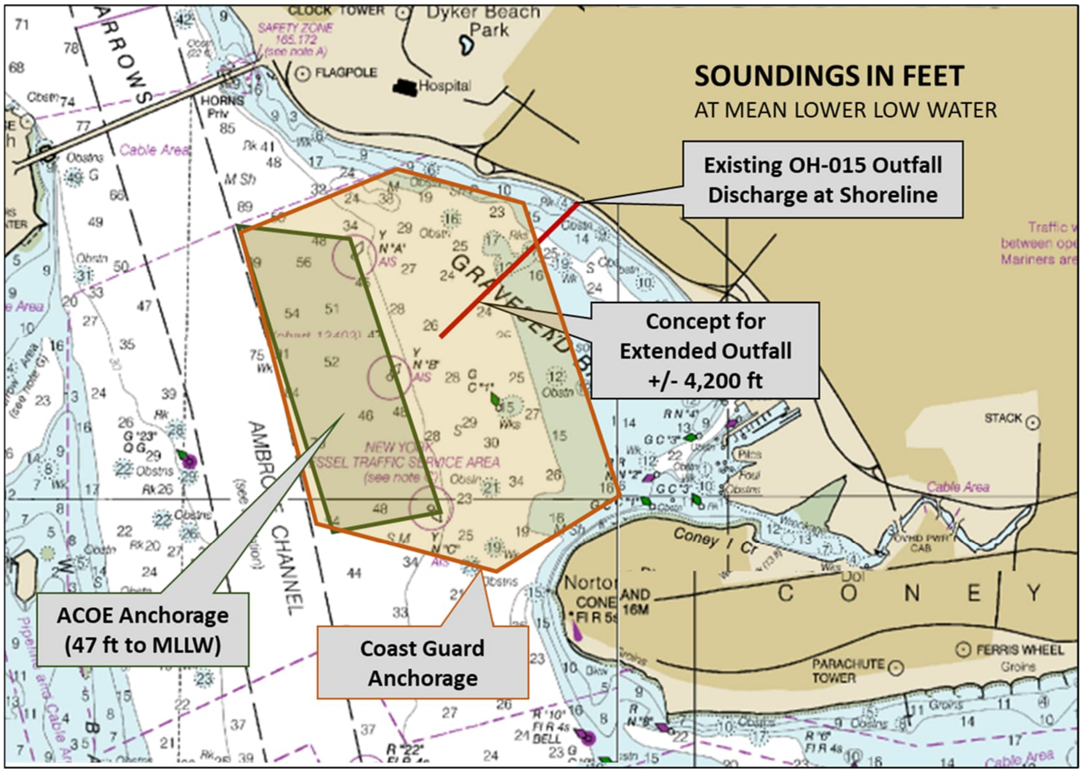


Figure compiled from www.charts.noaa.gov/BookletChart/12327_BookletChart.pdf

Figure SD-4. OH-015 Outfall Extension Concept Location Plan

As indicated in Figure SD-4, the outfall would extend approximately 4,200 feet into Gravesend Bay from the end of the existing outfall at the shoreline. The preliminary diameter of the outfall was established through an iterative assessment of peak flow, velocity, and impact on the upstream peak hydraulic grade line. Figure SD-5 presents the distribution of 15-minute timestep flows from the model for the Typical Year at outfall OH-015. As indicated in Figure SD-5, while the peak flow was 841 MGD, the 99th percentile flow was 331 MGD and the 95th percentile flow was 166 MGD. Sizing the outfall for the peak flow in the Typical Year would have resulted in very low flow velocities in the outfall during most storm events. Friction losses along the outfall extension were also predicted to potentially affect the peak hydraulic grade line along the land-side portion of the outfall. To offset those losses, a near-shore relief weir would be provided to relieve the flow during larger storm events, thus mitigating the impacts on the upstream hydraulic grade line.

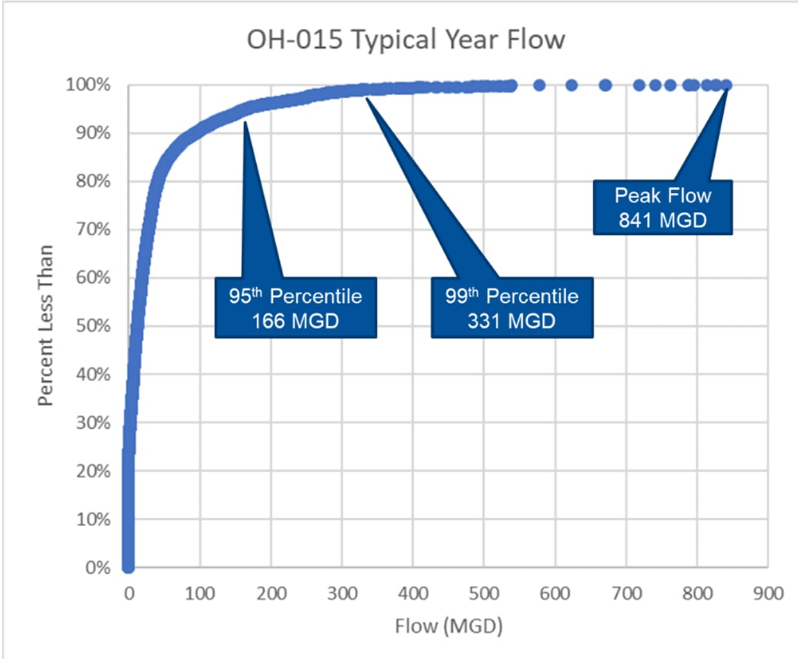


Figure SD-5. Distribution of 15-minute Flows at OH-015 for Typical Year

Through trial and error using the hydraulic model, a configuration was developed that featured a 12-foot diameter outfall extension, with a 75-foot long relief weir in a shoreline structure, with the weir elevation set at el. +2.0. This configuration was predicted to result in minimal impact to the upstream peak hydraulic grade line in the 5-year design storm. The relief weir was predicted to activate during the Typical Year. Table SD-7 presents the predicted performance of the OH-015 outfall extension for the Typical Year, in comparison to Baseline Conditions. As indicated in Table SD-7, 20 activations and 134 MG of discharge would remain at the shoreline relief structure where the existing OH-015 outfall currently discharges, while 854 MG would be relocated to the end of the new outfall.

Table SD-7. Predicted Performance of OH-015 Outfall Extension

CW/OW Recommended Plan			
	Annual Volume (MG)	Annual Activation Frequency	Typical Year Peak Flow (MGD)
Existing OH-015 Outfall	994	64	841
Outfall Extension Alternative – 12-ft Diameter Outfall, 75-ft long Relief Weir at El. +2.0			
Extended OH-015 Outfall	854	64	372
Near-shore Relief Weir	134	20	486

Figure SD-6 presents a comparison of the percent attainment with the 2008 Recreational Season Enterococcus 30-day 90th percentile STV criterion for the CW/OW Recommended Plan vs. the OH-015 outfall extension alternative. As indicated inFigure SD-6, the outfall extension alternative

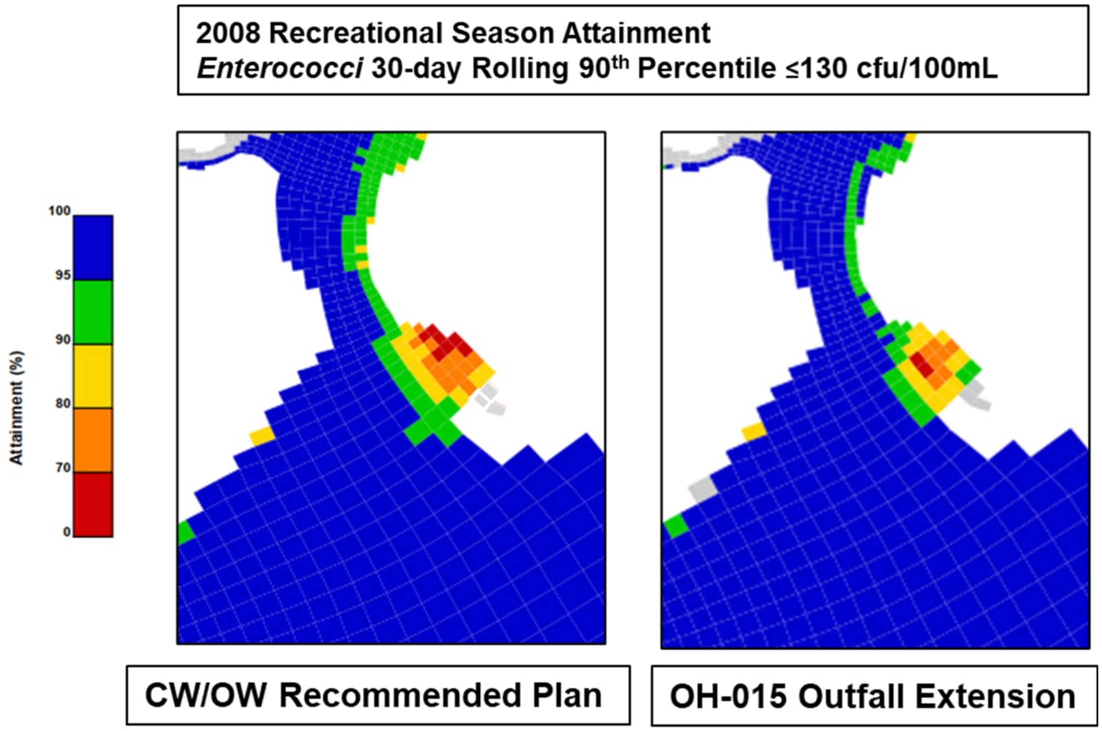


Figure SD-6. 2008 Recreational Season *Enterococcus* STV Attainment, CW/OW Recommended Plan vs. OH-015 Outfall Extension

improve the level of attainment along the shoreline in the vicinity of the existing OH-015 outfall, but the attainment would still be in the 70 to 90 percent range. Attainment at two model cells offshore in the vicinity of the end of the extended outfall would drop below 70 percent. Since most of Gravesend Bay would remain well below the 95 percent attainment target for the Enterococcus STV criterion following implementation of the OH-015 outfall alternative, this alternative was not recommended for implementation.

C. ***Provide cost vs. attainment curves, similar to Figure 8.6-14, for the alternatives already evaluated for the Harbor/Bay for stations NB-1, NB-3, and NB-7 as well as heat maps of the attainment levels for the 25%, 50%, and 75% CSO storage tunnel alternatives.***

Figure SD-7 to Figure SD-9 below present the cost/attainment curves for Stations NB-1, NB-3 and NB-7. Figure SD-10 presents a mosaic of the percent attainment with the Enterococcus 90th percentile STV criteria for the New York Bay 25-percent capture alternative from the Citywide/Open Waters LTCP, for the 2008 Recreational Season, and Figure SD-11 presents a mosaic of the percent attainment with the Enterococcus 90th percentile STV criteria for the New York Bay 50-percent capture alternative from the Citywide/Open Waters LTCP. The mosaic for the 75-percent control alternative looks identical to the mosaic for the 50-percent capture alternative, as the percent attainment within New York Bay is greater than 95 percent for both cases.

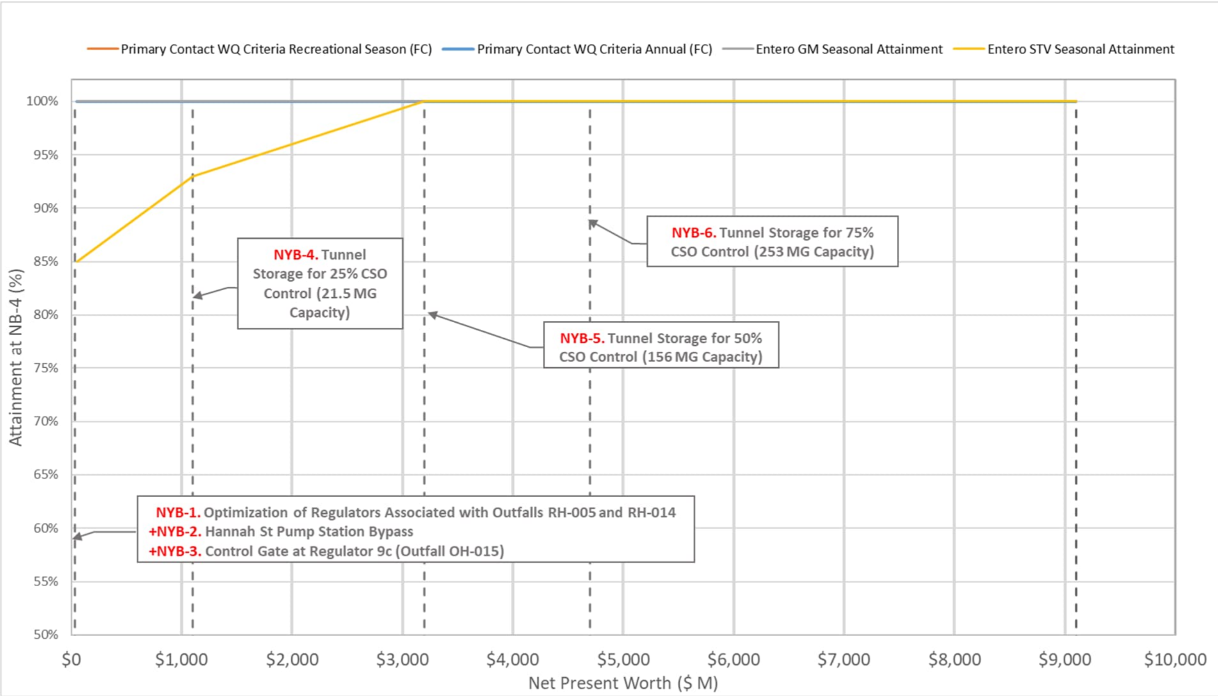


Figure SD-7. Cost vs. Bacteria Attainment at Class SB Coastal Primary Recreational Station NB-1

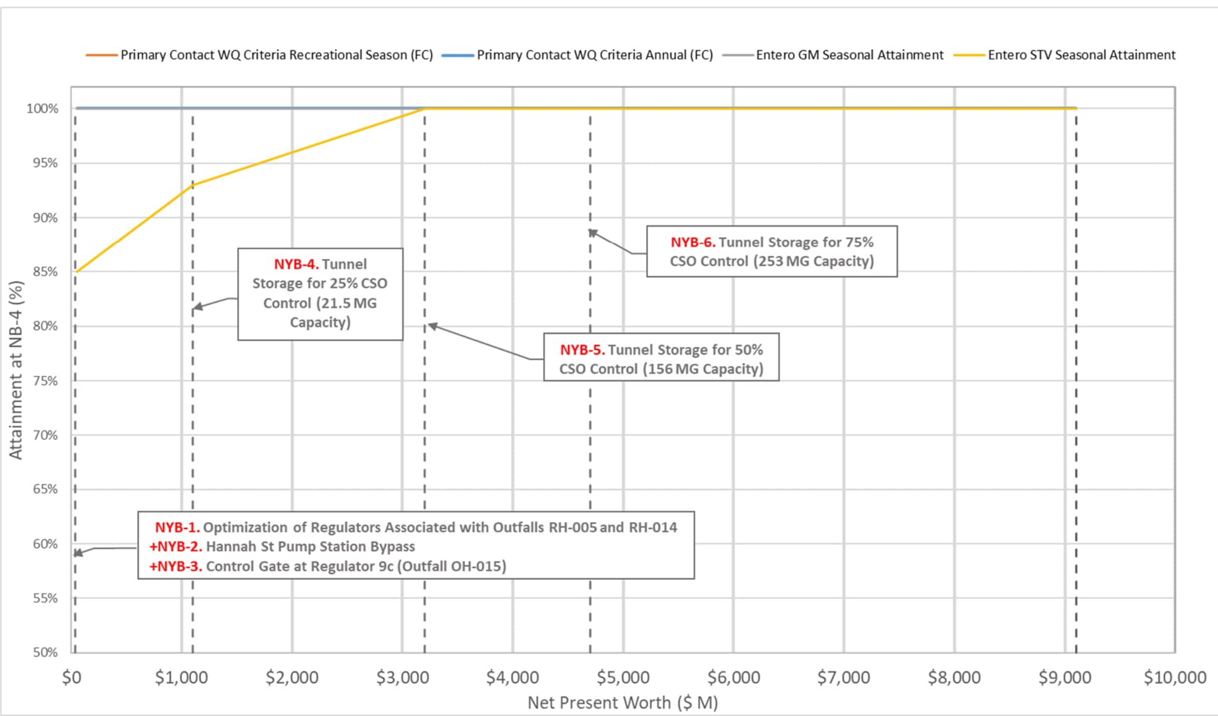


Figure SD-8. Cost vs. Bacteria Attainment at Class SB Coastal Primary Recreational Station NB-3

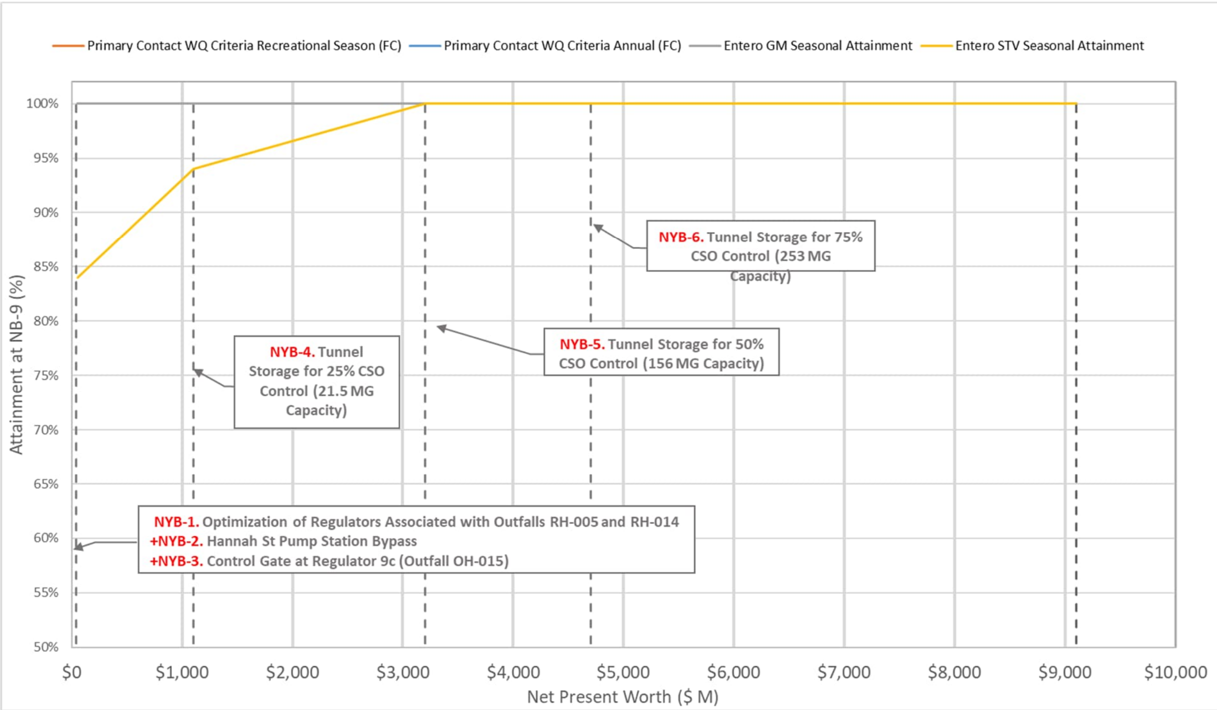


Figure SD-9. Cost vs. Bacteria Attainment at Class SB Coastal Primary Recreational Station NB-7

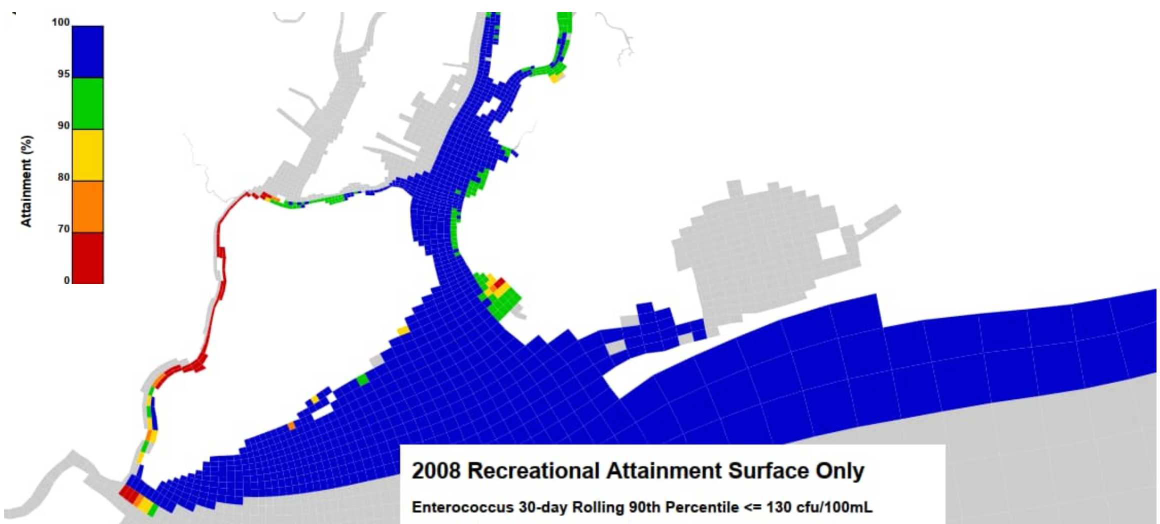


Figure SD-10. *Enterococcus* 2008 Recreational Season STV Attainment for 25% Capture of CSO Outfalls to New York Bay

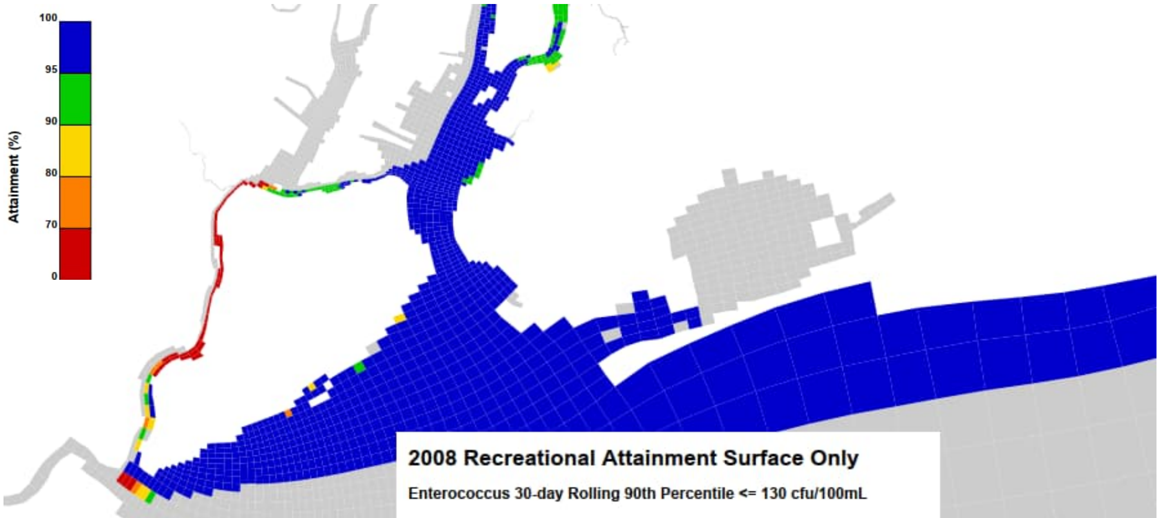


Figure SD-11. *Enterococcus* 2008 Recreational Season STV Attainment for 50% Capture of CSO Outfalls to New York Bay

D. ***Provide cost vs. attainment curves that include the newly considered alternatives for the same suite of stations and associated attainment heat maps****.*

As described above, none of the additional alternatives evaluated for outfall OH-015 were found to provide meaningful benefit in relation to the anticipated costs. For this reason, these alternatives were not incorporated into the cost vs. attainment curves.

3. **Sensitive Areas.** In accordance with the USEPA CSO Control Policy, the Citywide LTCP identified several sensitive areas (waters with primary contact recreation or bathing beaches and habitat for endangered and threatened species) within the waterbodies covered by the plan. Overall, there are 24 bathing beaches (7 public and 17 private) located primarily on the shores of the NY Harbor/Bay and Long Island Sound, and one beach located on the shore of the Upper East River. The habitat for the endangered or threatened species of concern, the Atlantic sturgeon, is located in the Hudson River, East River, and Long Island Sound. Notwithstanding the presence of these sensitive areas within the waterbodies covered by the LTCP, the plan does not propose any specific projects to eliminate or relocate CSOs away from these areas, as recommended by the CSO Control Policy.

   The Department recognizes the importance of protecting sensitive areas, but unfortunately, the CSO Control Policy and associated Guidance document do not provide specific criteria that can be used to delineate sensitive areas and determine when relocation or elimination of a CSO is warranted. Given the large areal extent of the waterbodies covered under this LTCP and the number of CSOs, such criteria are needed to better define the areas where action is needed. With respect to the bathing beaches, for example, the beaches are located on the shorelines of much larger waterbodies that receive CSO discharges, but it seems impractical to designate the entire waterbody as a sensitive area when only a very small portion of it would be used for swimming. In the absence of specific guidance for delineating the sensitive areas for recreational waters or bathing beaches, the Department will rely on best professional judgement in its review of abatement of CSOs for these areas, and consider the proximity of the CSOs to a reasonably defined sensitive area and the extent to which the CSOs are adversely and substantially impacting the beneficial uses of these areas.

Based on a review of the location of the 24 designated bathing beaches in relation to the CSO outfalls, it appears that most of the beaches are unlikely to be impacted by the CSO discharges. The beaches that may be impacted are 2 clusters of private beaches located near Eastchester Bay, which is part of the Long Island Sound (see Attachment B). According to the LTCP water quality analyses, the waters adjacent to these private beaches are projected to fully attain the primary contact fecal coliform geomean and enterococcus geomean and STV standards. However, there is an additional standard that applies to saline recreational beach waters. Pursuant to the New York State Sanitary Code and New York City Health Code, enterococci concentrations for a single sample shall not exceed 104 cfu/100 ml for these waters. As such, the Department requests the City reevaluate, using the InfoWorks model, the waters within a designated swimming area or a reasonable areal extent near these beaches where swimming may occur (e.g. 100 feet from the shoreline) to determine if the waters exceed the single sample standard during the recreational season, and if so, whether the impairment may be due to CSOs.

As a side note, it appears that the NYC DOH Beach Surveillance and Monitoring Program and associated wet-weather advisories relies on modeling of CSOs to provide notifications to the public on possible risks to bathing beaches. The Department recommends that the City consult with the NYC DOH to review the current modeling and notification protocols to ensure they reflect the most up-to-date understanding of CSOs to the waterbodies and possible risks to bathing beaches.

With respect to the habitat for threatened and endangered species, the Department has confirmed that the critical habitat for the Atlantic sturgeon occurs within the Hudson River only, not the East River or Long Island Sound (see Federal Register v. 82, no. 158, p. 39245). Based on a review of information available on impacts of pathogens, such as fecal coliform, on the sturgeon, the Department believes that the discharge of CSOs within the reach of the Hudson River covered under the Citywide LTCP is unlikely to adversely impact this species. Moreover, the LTCP projects high levels of attainment with the DO standard, which is a key water quality characteristic for species survival. As such, no CSO abatement action is required for this sensitive area.

DEP Response:

To respond to this comment, output from the water quality (WQ) model was post-processed to assess attainment with the Enterococcus Beach Criterion of 104 cfu/100mL. For each beach location identified in the Citywide/Open Waters LTCP, a model cell within the WQ model was identified that was adjacent to the beach location. The level of attainment for those model cells was then computed in two ways:

- *Average percent annual attainment with a single-sample maximum criterion of 104 cfu/100mL for the 10-year simulation*
- *Average number of days where 104 cfu/100mL Enterococcus was exceeded at 10 am (representative of once/day beach sampling)*

Attainment was evaluated for the Citywide/Open Waters LTCP Baseline Conditions, 100% CSO Control, and the Citywide/Open Waters LTCP Recommended Plan, and the assessment was based on the surface layer of the WQ model. Comparison of Baseline vs 100% CSO control identifies where CSOs have most impact on attainment at beaches. Figure SD-12 provides excerpts from Figures 2.3-39 and 2.4-26 from the Citywide/Open Waters LTCP showing the locations of the beaches.

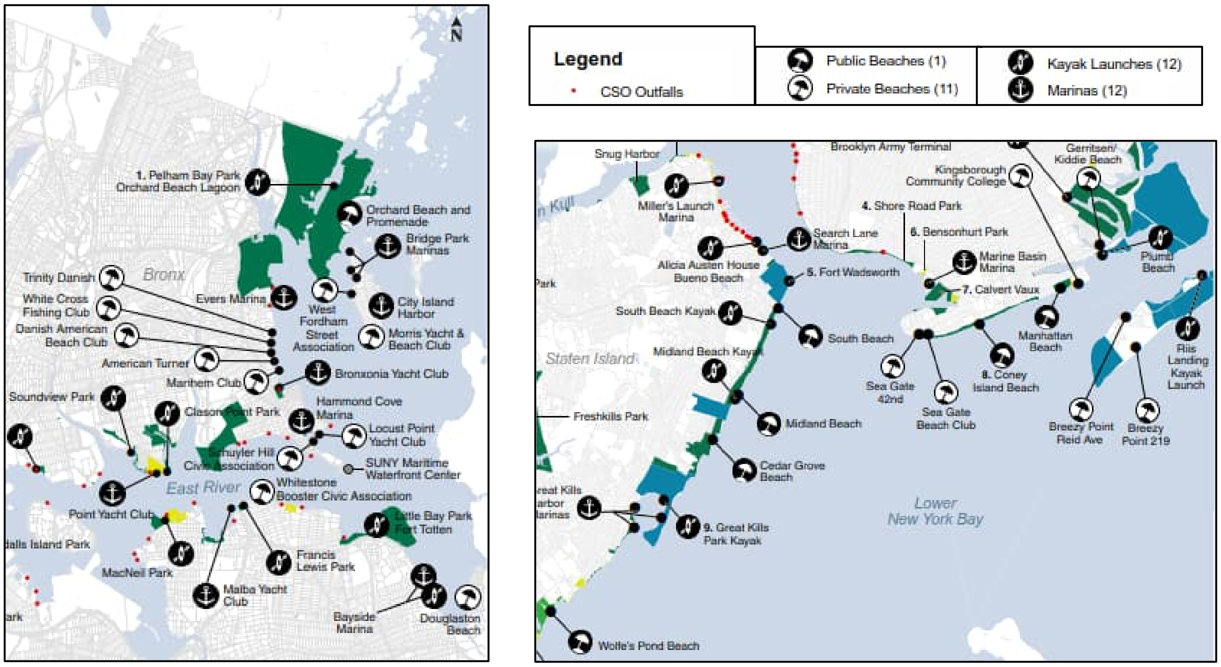


Figure SD-12. Locations of Beaches

Table SD-8 presents the percent attainment with the 104 cfu/100mL Beach Criterion during the bathing season (May 26-September 1) for the 10-year simulation, for Baseline Conditions, for each beach identified in Figure SD-12 above. Also presented in Table SD-8 are the average annual hours of exceedance of the 104 cfu/100mL Beach Criterion, and the number of days when the concentration was predicted to exceed 104 cfu/100mL at 10 am.

Table SD-8. Attainment with 104 cfu/100 mL *Enterococcus* at Beaches - Baseline 10-Year

Beach Description		Baseline 10-yr Bathing Season May 26-September 1 104 cfu/100mL *Enterococcus* Beach Criterion		
Name	Public/ Private	**Average Annual % Attainment - Surface**	**Average Annual Hours not in Attainment - Surface**	**Average Annual Days Exceeding 104 cfu/100mL *Enterococcus* at 10AM**
Coney Island Beach	Public	99.1	21.2	0.3
Sea Gate Beach Club	Private	95.3	111.5	4.8
Sea Gate 42nd	Private	95.3	111.5	4.8
Wolfe's Pond Beach	Public	96.8	74.8	2.8
Cedar Grove Beach	Public	99.8	5.4	0.0
Midland Beach	Public	99.0	22.6	0.9
South Beach	Public	98.1	45.6	1.3
Whitestone Booster Civic Association	Private	97.7	55.0	3.0

Table SD-8. Attainment with 104 cfu/100 mL *Enterococcus* at Beaches - Baseline 10-Year

Beach Description		Baseline 10-yr Bathing Season May 26-September 1 104 cfu/100mL *Enterococcus* Beach Criterion		
Name	Public/ Private	**Average Annual % Attainment - Surface**	**Average Annual Hours not in Attainment - Surface**	**Average Annual Days Exceeding 104 cfu/100mL *Enterococcus* at 10AM**
Locust Point Yacht Club	Private	99.9	1.4	0.1
Schuyler Hill Civic Association	Private	99.9	1.4	0.1
American Turner	Private	98.4	37.9	1.7
White Cross Fishing Club	Private	98.4	37.9	1.7
Danish Beach Club	Private	95.3	109.8	3.6
Manhem Club	Private	95.3	109.8	3.6
Trinity Danish	Private	98.4	37.9	1.7
Morris Yacht and Beach Club	Private	99.8	3.8	0.1
West Fordam Street Association	Private	99.4	15.1	0.2
Orchard Beach and Promenade	Public	99.9	3.3	0.1
Douglaston Beach	Private	95.8	99.5	3.7
Manhattan Beach	Public	99.3	16.9	0.7
Kingsborough Community College	Private	99.3	16.9	0.7
Breezy Point Reid Ave	Private	99.7	6.8	0.2
Breezy Point 219	Private	100.0	0.0	0.0
Rockaway Beach	Public	100.0	0.0	0.0

Table SD-9 presents similar results for the 100% CSO Control scenario, and Table SD-10 presents similar results for the LTPC Recommended Plan scenario. Table SD-11 summarizes the reduction in average annual hours exceeding the 104 cfu/100mL Beach Criterion for the LTCP Recommended Plan versus Baseline Conditions, and for the 100% CSO Control scenario versus Baseline Conditions.

Table SD-9. Attainment with 104 cfu/100 mL Enterococcus at Beaches - 100% CSO Control 10-Year

Beach Description		100% CSO Control 10-yr Bathing Season May 26-September 1 104 cfu/100mL *Enterococcus* Beach Criterion		
Name	Public/ Private	**% Attainment - Surface**	**Average Annual Hours not in Attainment - Surface**	**Average Annual Days Exceeding 104 cfu/100mL *Enterococcus* at 10AM**
Coney Island Beach	Public	100.0	0.0	0.0
Sea Gate Beach Club	Private	100.0	0.9	0.0
Sea Gate 42nd	Private	100.0	0.9	0.0
Wolfe's Pond Beach	Public	96.8	74.6	2.8
Cedar Grove Beach	Public	99.8	3.8	0.0
Midland Beach	Public	99.4	14.8	0.4
South Beach	Public	99.1	20.5	0.2
Whitestone Booster Civic Association	Private	100.0	0.0	0.0
Locust Point Yacht Club	Private	100.0	0.0	0.0
Schuyler Hill Civic Association	Private	100.0	0.0	0.0
American Turner	Private	99.4	15.3	0.4
White Cross Fishing Club	Private	99.4	15.3	0.4
Danish Beach Club	Private	96.3	87.0	2.4
Manhem Club	Private	96.3	87.0	2.4
Trinity Danish	Private	99.4	15.3	0.4
Morris Yacht and Beach Club	Private	100.0	0.0	0.0
West Fordam Street Association	Private	99.9	2.4	0.1
Orchard Beach and Promenade	Public	99.9	1.6	0.1
Douglaston Beach	Private	98.0	46.6	2.3
Manhattan Beach	Public	99.4	14.1	0.6
Kingsborough Community College	Private	99.4	14.1	0.6
Breezy Point Reid Ave	Private	99.9	3.1	0.2
Breezy Point 219	Private	100.0	0.0	0.0
Rockaway Beach	Public	100.0	0.0	0.0

Table SD-10. Attainment with 104 cfu/100 mL Enterococcus at Beaches - LTCP Recommended Plan 10-Year

Beach Description		LTCP Recommended Plan 10-yr Bathing Season May 26-September 1 104 cfu/100mL *Enterococcus* Beach Criterion		
Name	Public/ Private	**% Attainment - Surface**	**Average Annual Hours not in Attainment - Surface**	**Average Annual Days Exceeding 104 cfu/100mL *Enterococcus* at 10AM**
Coney Island Beach	Public	99.2	19.1	0.4
Sea Gate Beach Club	Private	95.5	106.3	4.7
Sea Gate 42nd	Private	95.5	106.3	4.7
Wolfe's Pond Beach	Public	96.8	74.8	2.8
Cedar Grove Beach	Public	99.8	5.4	0.0
Midland Beach	Public	99.1	21.9	0.9
South Beach	Public	98.2	42.6	1.1
Whitestone Booster Civic Association	Private	97.8	52.9	3.0
Locust Point Yacht Club	Private	99.9	1.4	0.1
Schuyler Hill Civic Association	Private	99.9	1.4	0.1
American Turner	Private	98.4	37.9	1.7
White Cross Fishing Club	Private	98.4	37.9	1.7
Danish Beach Club	Private	95.3	109.8	3.6
Manhem Club	Private	95.3	109.8	3.6
Trinity Danish	Private	98.4	37.9	1.7
Morris Yacht and Beach Club	Private	99.8	3.8	0.1
West Fordam Street Association	Private	99.4	15.1	0.2
Orchard Beach and Promenade	Public	99.9	3.3	0.1
Douglaston Beach	Private	96.0	93.6	3.4
Manhattan Beach	Public	99.3	16.5	0.7
Kingsborough Community College	Private	99.3	16.5	0.7
Breezy Point Reid Ave	Private	99.8	4.9	0.2
Breezy Point 219	Private	100.0	0.0	0.0
Rockaway Beach	Public	100.0	0.0	0.0

Table SD-11. Reduction in Hours of non-Attainment with 104 cfu/100 mL Enterococcus at Beaches - 10-Year

Beach Description		10-yr Bathing Season May 26-September 1104 cfu/100mL *Enterococcus* Beach Criterion	
		Reduction in Hours of non-Attainment	
Name	Public/ Private	LTCP Recommended Plan vs Baseline	100% CSO Control vs Baseline
Coney Island Beach	Public	2.1	21.2
Sea Gate Beach Club	Private	5.2	110.5
Sea Gate 42nd	Private	5.2	110.5
Wolfe's Pond Beach	Public	0.0	0.2
Cedar Grove Beach	Public	0.0	1.6
Midland Beach	Public	0.7	7.8
South Beach	Public	3.1	25.2
Whitestone Booster Civic Association	Private	2.1	55.0
Locust Point Yacht Club	Private	0.0	1.4
Schuyler Hill Civic Association	Private	0.0	1.4
American Turner	Private	0.0	22.6
White Cross Fishing Club	Private	0.0	22.6
Danish Beach Club	Private	0.0	22.8
Manhem Club	Private	0.0	22.8
Trinity Danish	Private	0.0	22.6
Morris Yacht and Beach Club	Private	0.0	3.8
West Fordam Street Association	Private	0.0	12.7
Orchard Beach and Promenade	Public	0.0	1.6
Douglaston Beach	Private	5.9	52.9
Manhattan Beach	Public	0.5	2.8
Kingsborough Community College	Private	0.5	2.8
Breezy Point Reid Ave	Private	1.9	3.8
Breezy Point 219	Private	0.0	0.0
Rockaway Beach	Public	0.0	0.0

Additional Information requested by DEC in March 9, 2021 Letter:

1. **Projected Attainment with Enterococcus Standards in Non-Recreational Waters.** The Citywide LTCP included the projected attainment levels for the enterococcus standards for the coastal recreational waterbodies where these standards currently apply, specifically the NY Harbor/Bay and Long Island Sound. As noted previously, these waterbodies will have good attainment with the enterococcus geomean standard but the Harbor/Bay will not meet the enterococcus STV standard in some areas of that waterbody. For informational purposes only, the Department requests attainment heat maps and summary tables of projected attainment for the 30-day, 35 cfu/100 ml geomean and 130 cfu/100 ml STV enterococcus standards for the other non-recreational waterbodies (e.g. Harlem River, Hudson River) covered under the LTCP that currently do not have applicable enterococcus standards. The City does not need to provide this information for waterbodies covered under other previously submitted LTCPs.

DEP Response: *The requested tables were presented to DEC during a technical meeting on May 26, 2021, and the attainment heat maps and the tables from the presentation were emailed to DEC on May 26, 2021.*

2. Percent Capture of CSOs. Since the USEPA CSO Control Policy went into effect in the 1990s, the City has relied on the demonstration approach, rather than the presumption approach, for analyzing and selecting alternatives for its CSO planning program. Given the size and complexity of the City's combined sewer systems and the areal extent of the waterbodies covered under its LTCPs, the Department believes that the demonstration approach is appropriate for the NYC waterbodies. That said, the Citywide LTCP marks the culmination of the CSO planning efforts for NYC waterbodies, and as such, for informational purposes only, the Department requests the percent capture for CSOs to waterbodies covered by the CSO program be provided. Specifically, the Department requests: 1) overall citywide capture rate, 2) overall captures rates for the 12 sewersheds with CSOs, at the sewershed-level, and 3) capture rates for waterbodies that are not projected to meet existing water quality standards at the waterbody-level. Because these capture rates are not required as part of the demonstration planning approach and include waterbodies not covered under the Citywide LTCP, the Department requests that the capture rate information be provided separate from this LTCP in a technical memorandum, in order not to confuse the public.

DEP Response: *As requested, the percent capture information will be provided as part of a separate technical memorandum.*

3. Floatables Control. In the Department's November 30, 2018 letter that granted a 15-month extension to the Citywide LTCP submittal milestone, it specifically requested that a detailed analysis of floatables control be included in the plan and conveyed an expectation that there should be substantial floatables control projects proposed in the LTCP. Although the selected alternative will result in some floatables reduction in proportion to the projected CSO reduction, the LTCP did not include a detailed analysis of floatables control despite the fact that there will still be around 11 BGY of CSO being discharged out 314 outfalls to the open waters. The LTCP included only a general discussion of current programmatic controls and a commitment to continue them. The City has proposed developing a city-wide floatables control program, which the Department agrees with in principle. However, to support development of that city-wide program in the future, the Department requests additional information on the general floatables condition of the waterbodies covered under this plan. Specifically, the Department requests that heat maps be developed using the 5-scale rating data from the annual floatables monitoring program to qualitatively reflect the general condition (shown geospatially) for the waterbodies. In addition, the maps should indicate the location of CSO outfalls that discharge to the waterbodies using a tiered-approach, but with a finer gradation than the 3-tier approach historically used by the City. In other words, the CSOs outfalls should be shown with varying size symbols that reflects the magnitude of the CSOs discharges (MGY) at each outfall. Small CSO outfalls with minimal overflows may be omitted.

In addition to the maps, the Department requests that the City provide a more detailed description of its plans for developing a more robust citywide floatables control program, beyond the stablished programmatic controls. This description should include the floatables control planning being completed under the MS4 SPDES permit.

DEP Response: *The requested figure was presented to DEC during a technical meeting on July 20, 2021. The figure is reproduced below in three parts as Figure SD-13, Figure SD-14 and Figure SD-15. A pdf version of this figure was transmitted to DEC on October 6, 2021. This figure shows color-coded symbols for the percent "Very Good" or "Good" ratings for floatables observations conducted by DEP and by volunteer observers.*

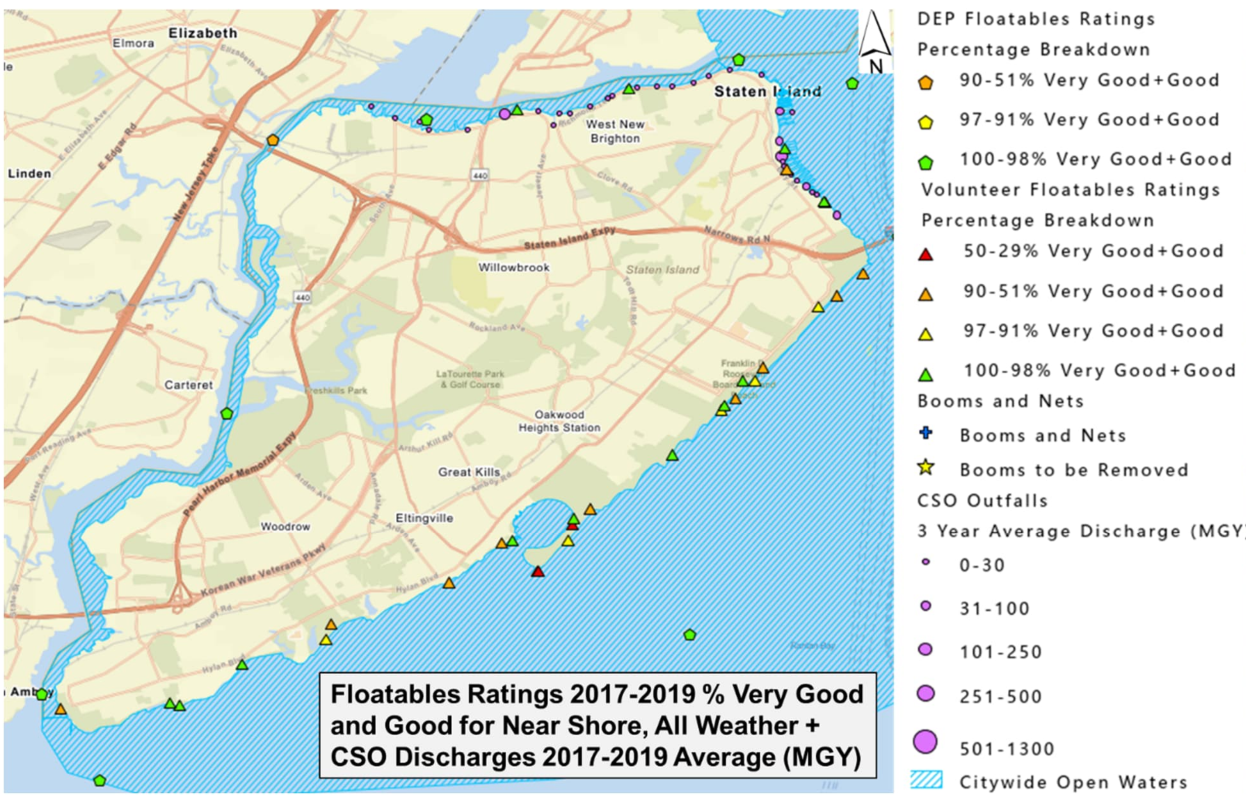


Figure SD-13. Floatables Ratings 2017 to 2019: Staten Island

Figure SD-14. Floatables Ratings 2017 to 2019: New York Bay/Rockaway

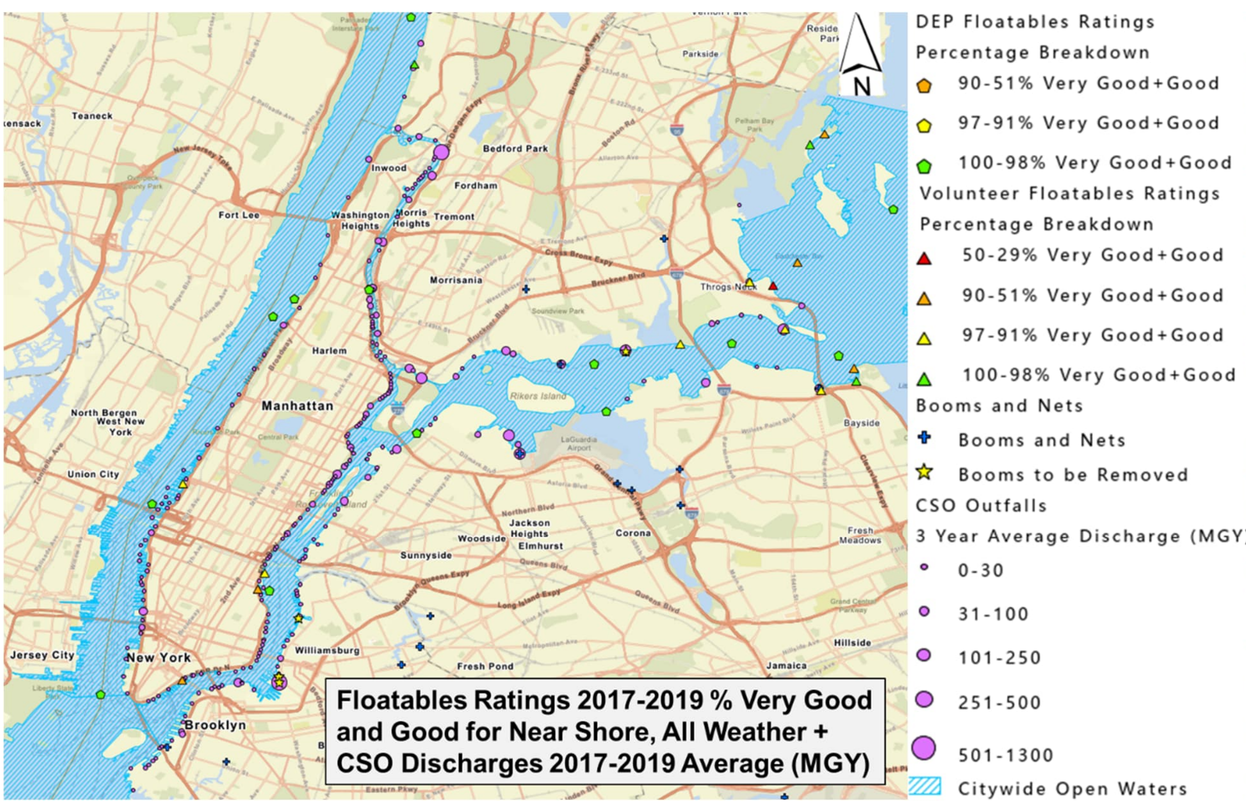


Figure SD-15. Floatables Ratings 2017 to 2019: East River, Hudson River, Harlem River, Eastchester Bay

DEP conducted a two-way ANOVA analysis on the percentage for "Good" or "Very Good" rating for weather and location. The results showed no statistically significant difference between wet and dry weather floatables "Good" or "Very Good" ratings for both DEP and volunteer data.

In addition to existing City programs to control trash and debris stemming from the MS4 area such as catch basin hooding and maintenance; catch basin inspection and cleaning; booming and netting; public education, outreach, involvement, and participation; stewardship programs (e.g., Parks Community Cleanups); and 311 which enables New Yorkers to report to the City dirty conditions they observe; the City developed a work plan to determine the loading rate of trash and debris from the MS4 to floatable-impaired waterbodies. The City's loading rate study is a hybrid approach that combines field monitoring with model analysis. Following the work plan, the City measured trash and debris discharging from 63 catch basins representing different combinations of characteristics such as street litter level, street sweeping frequency, and catch basin hood status. Following the floatables loading rate study, the City will develop a methodology to site, select, and size best management practices (BMPs) and controls to reduce floatable and settleable trash and debris.

4. Pollutant Loads from New Jersey. During development of the Citywide LTCP, the City indicated that it would be obtaining the data on the pollutant loads from New Jersey sources to be incorporated into the InfoWorks model to account for loads from outside its jurisdiction. Table 6-9 provides the overall fecal coliform and enterococcus loads from sources outside of NYC, however, it is not clear from the plan if these loads incorporated the data provided by New Jersey or were derived based solely on NYC ambient water quality sampling and modeling. Section 2.3.b.6 states that some water quality data from the Passaic Valley Sewerage Commission for some shared waters were compared to NYC monitoring data and were found to be generally consistent for comparable sampling stations, which implies that the data were not used in the LTCP modeling. The Department requests clarification on the extent to which pollutant load data from New Jersey were used in the LTCP modeling. Lastly, Section 8.1.a states that a model run was completed with all pollutant loads from outside of NYC zeroed out for evaluating attainment levels in the Arthur Kill and Kill van Kull. The Department requests the projected attainment levels from that model run.

DEP Response: *As part of the analysis of receiving water quality sampling data conducted in support of the water quality model calibration, sampling data received from PVSC was assessed. Data from the PVSC program from sampling stations that were in the vicinity of the LTCP/HSM sampling stations were compared to the LTCP/HSM data for the overlapping time periods. The PVSC data were found to be generally consistent with the LTPC/HSM data. The comparisons of PVSC data to LTCP/HSM data are presented in the series of Data Collection Memoranda that were prepared for each of the Citywide/Open/Waters waterbodies. Figure SD-16 presents an example comparison of PVSC and LTCP/HSM sampling data for the Hudson River, from the March 2019 Data Collection Memorandum for Hudson River.*

Within the water quality model, pollutant loadings from New Jersey were based on model outputs received from PVSC. For New Jersey community CSOs that were not covered by the PVSC model, loadings were estimated by the NJ RAINMAN model. Upstream boundary loadings for NJ rivers tributary to Arthur Kill/Kill Van Kull/NY Bay were based on bacterial sampling data collected by the New Jersey Harbor Dischargers Group and USGS river gauge data. The New Jersey loadings reflected Baseline Conditions for New Jersey, without implementation of future CSO control projects that may be identified in future New Jersey-based LTCPs.

The relative annual loadings of Enterococcus and fecal coliform to Kill Van Kull and Arthur Kill by source are presented in Figure SD-17 and Figure SD-18. The values for these loadings were taken from Table 6-9 of the CW/OW LTCP. As indicated in these figures, the loadings from outside of NYC are the predominant source of bacteria to Kill Van Kull and Arthur Kill.

A "no NJ Loads" scenario was evaluated with the water quality model, and the results were compared to Baseline Conditions for 2008. The results are presented in Figure SD-19.

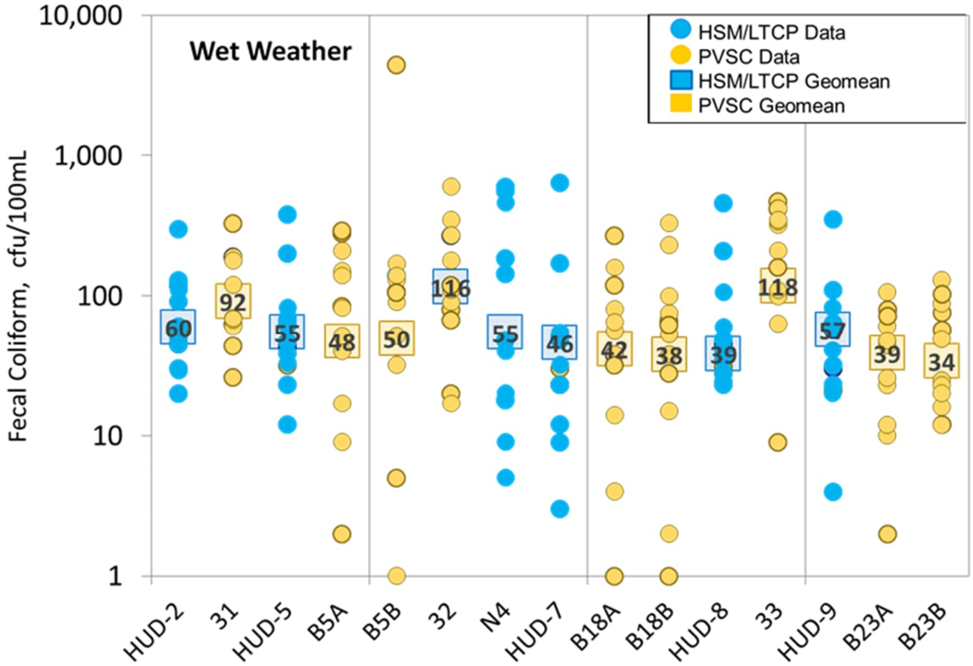


Figure SD-16. Example of Comparison of HSM/LTCP and PVSC Sampling Data for Hudson River

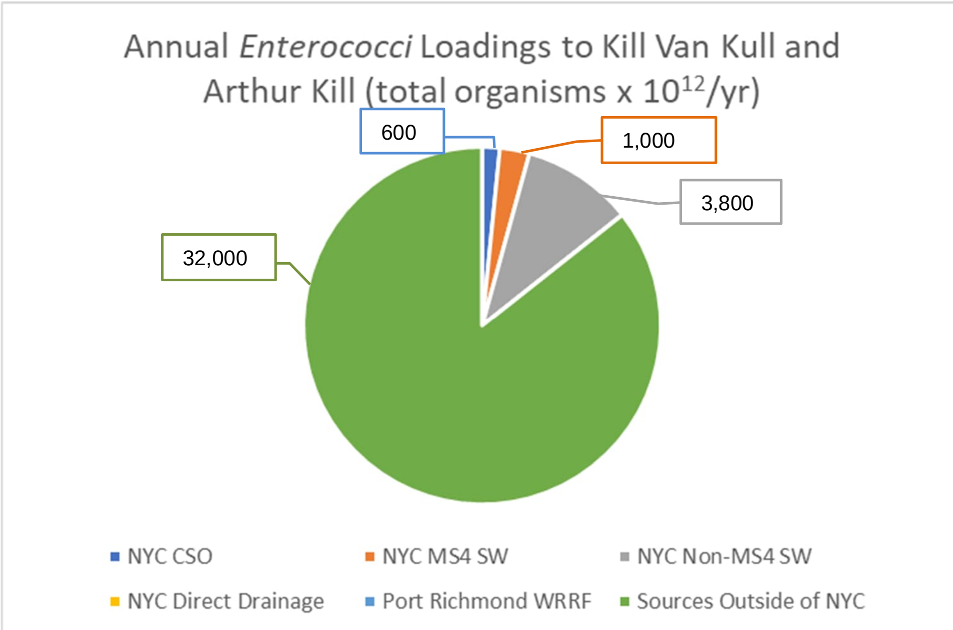


Figure SD-17. Annual *Enterococci* Loadings to Kill Van Kull and Arthur Kill

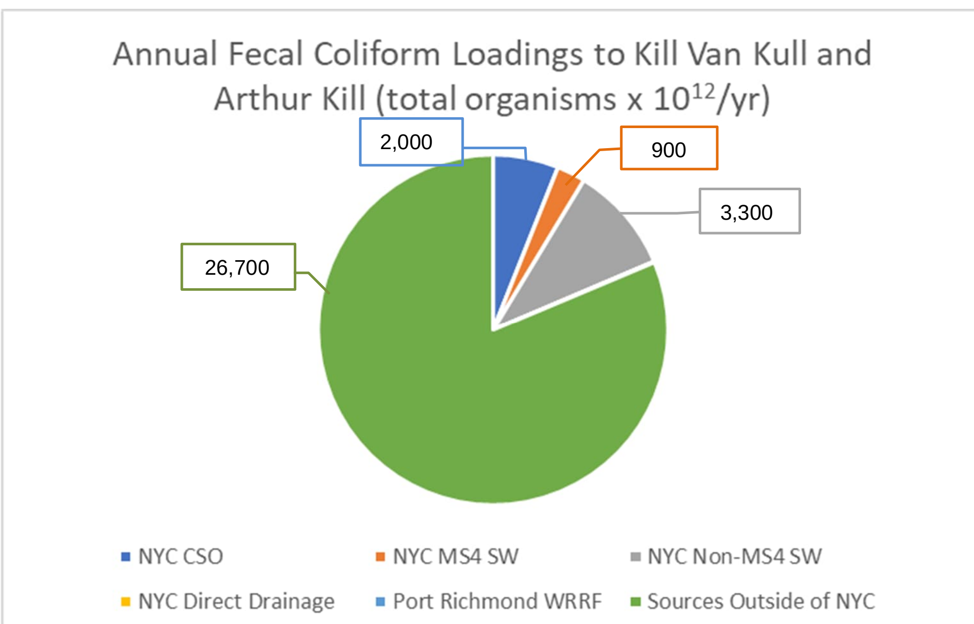
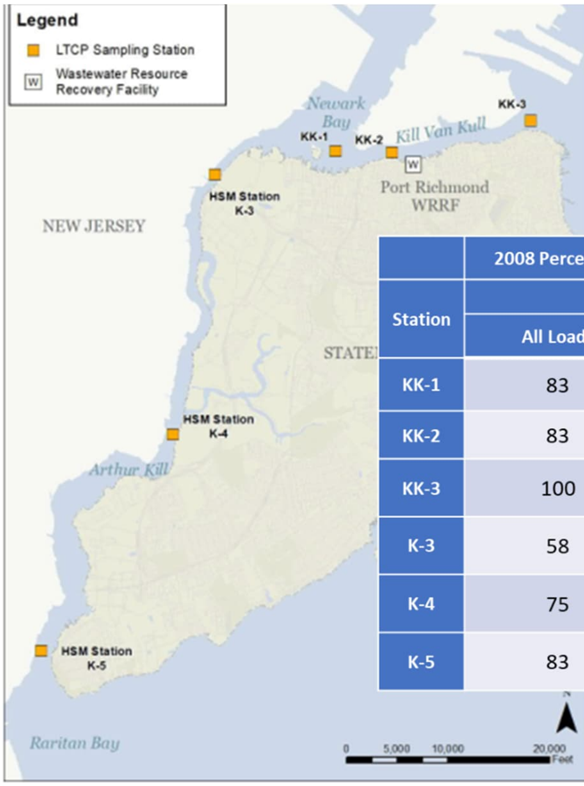


Figure SD-18. Annual Fecal Coliform Loadings to Kill Van Kull and Arthur Kill



Station	2008 Percent Attainment with Fecal coliform Monthly GM≤200 cfu/100mL			
	Annual		Recreational Season	
	All Loads	No NJ Loads	All Loads	No NJ Loads
KK-1	83	100	100	100
KK-2	83	100	100	100
KK-3	100	100	100	100
K-3	58	100	100	100
K-4	75	100	100	100
K-5	83	100	100	100

Figure SD-19. Percent Attainment at Arthur Kill and Kill Van Kull Stations with No NJ Loads - Fecal Coliform Monthly GM

5. CSO BMP Order Regulators. The Citywide LTCP includes a summary of the telemetered regulators in Table 3-3, classified into Categories A to E and key vs. other. Based on prior discussions with the City, the classification of these regulators has changed somewhat since they were first designated in 2016. The City should confirm the current classification shown in Table 3-3 is accurate, as it appears to be the initial classification from 2016.

DEP Response: *Table 3-3 has been updated based on the 14 Wastewater Resource Recovery Facilities' SPDES Permits Combined Sewer Overflows Best Management Practices Annual Report for the Period January 1, 2021 - December 31, 2021, dated April 2022 (2021 BMP Report). That report only provided updated categorization of the Key regulators, so no change to the categorization of the "Other" regulators is presented. The revised Table 3-3 is presented below.*

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Table SD-12. Summary of Classification of All Telemetered Regulators
~~(August 2014 through July 2015)~~ (January through December 2021)

Category	Definition	Key[(1)]	Other[(2)]	Total
A	Current or future capital improvements potentially render data unrepresentative of future conditions	~~13~~ 4	22	~~35~~ 26
B	Average one or fewer potential discharges per month outside the period of a critical wet-weather event	~~9~~ 15	23	~~32~~ 38
C	Average two or more potential discharges per month outside the period of a critical wet-weather event	~~5~~ 7	18	~~23~~ 25
D	Data collection issue/data not reported	~~0~~ 1	2	~~2~~ 3
E	Telemetered regulator that does not directly discharge to a waterbody	0	8	8
	TOTALS:	**27**	**73**	**100**

Notes:

(1) Numbers of Key Regulators within each category updated per the *14 Wastewater Resource Recovery Facilities' SPDES Permits Combined Sewer Overflows Best Management Practices Annual Report for the Period January 1, 2021 - December 31, 2021*, dated April 2022.

(2) The 2021 BMP Report did not update the classifications of "Other" regulators.

6. Model Updates to Reflect Proposed Changes to LTCP Projects. The modeling for the Citywide LTCP incorporated the selected alternatives from the other 10 LTCPs previously submitted, but the City has recently proposed some changes to the approved LTCP projects (e.g. disinfection projects). The City should confirm if these proposed changes could measurably impact the projected water quality outcomes for the Citywide LTCP.

DEP Response: *The proposed modifications to previously-approved LTCP projects that could potentially affect water quality in the Citywide/Open Waters waterbodies include the following:*

- *Deletion of disinfection at the Alley Creek CSO Detention Facility*
- *Replacement of the Hutchinson River outfall HP-023 outfall disinfection project with the Hutchinson River outfall HP-023 storage project.*
- *Deletion of the HP-007 relief conduit component from the Bronx River HP-007/HP-009 conveyance relief project.*

The water quality modeling for the Citywide/Open Waters LTCP was conducted using the LTCP Regional Model (LTCPRM), assuming the original approved LTCP projects were implemented at these locations. The water quality impacts of ~~each of~~ the proposed revised projects for the Hutchinson and Bronx Rivers were assessed individually using the East River Tributaries Model (ERTM), with enhanced detail in the respective tributaries (the ERTM was used to assess water quality impacts in the respective tributary LTCPs). For Alley Creek, the final components of the proposed alternative project have not been fully resolved. Therefore, for Alley Creek, the assessment was conducted assuming simply that disinfection would not be provided. To assess the potential impact of the proposed changed projects on the Citywide/Open Waters waterbodies, the modeled attainment at the boundaries of the ERTM water quality model was compared to the attainment in the LTCPRM at water quality stations closest to the boundaries with the affected tributaries.

These comparisons are presented for Little Neck Bay, the Hutchinson River and the Bronx River in the subsections below.

Little Neck Bay

Table SD-13 presents the fecal coliform attainment in the Little Neck Bay water quality stations for the original Baseline Conditions and Recommended Plan for the Alley Creek LTCP. DEC and DEP are currently negotiating a new modification request that would either defer disinfection milestones or eliminate these milestones pending an ongoing evaluation of the feasibility of Oakland Ravine Daylighting and Stormwater Diversion Technical Feasibility Study. The Technical Feasibility Study will apply a comprehensive watershed approach and include an evaluation of technical alternatives for the diversion of stormwater from separately sewered areas in Alley Creek watershed basin to seek to identify a cost-effective alternative to achieve up to 100% diversion of stormwater from the combined sewer system with the potential discharge directly to Alley Creek or daylighting Oakland Ravine/Lake as well as other locations. This feasibility study has initiated and these negotiations are underway. In addition, restored wetlands are being evaluated as an alternative to disinfection.

Table SD-13 provides the fecal coliform attainment for the original Baseline and LTCP Recommended Plan conditions, and Table SD-14 provides the Enterococcus attainment those conditions. Figure SD-20 shows the locations of the four water quality stations in Little Neck Bay. The results presented in Table SD-13 and Table SD-14 were generated from the East River Tributaries Model (ERTM) with an enhanced grid for Alley Creek and Little Neck Bay.

Table SD-13. Fecal Coliform Attainment in Little Neck Bay Stations for Alley Creek LTCP Baseline and Recommended Plan~~, and for the Proposed Revised Plan for Alley Creek~~

Station	% Attainment – Fecal Coliform Monthly GM ≤ 200 cfu/100mL			
	Original Baseline(1)		Original LTCP Recommended Plan(1)	
	Annual	Rec. Season(2)	Annual	Rec. Season(2)
OW2	98%	N/A(3)	97%	100%
DMA	100%	100%	100%	100%
LN1	99%	N/A(3)	99%	100%
E11	100%	100%	100%	100%

Notes:
(1) Values from Table 4-2 in the Citywide/Open Waters LTCP.
(2) The recreational season is from May 1st through October 31st.
(3) Recreational season fecal coliform attainment was not developed at these stations for this LTCP.

Table SD-14. Enterococcus Attainment in Little Neck Bay Stations for Alley Creek LTCP Baseline and Recommended Plan~~, and for the Proposed Revised Plan for Alley Creek~~

Station	% Attainment – *Enterococcus* Recreational Season(1)			
	Original Baseline(2)		Original LTCP Recommended Plan(2)(3)	
	30 day GM	30-day STV	30 day GM	30-day STV
	≤ 35 cfu/100mL	≤ 130 cfu/100mL	≤ 35 cfu/100mL	≤ 130 cfu/100mL
OW2	91%	25%	92%	29%
DMA	95%	49%	97%	62%
LN1	95%	51%	97%	62%
E11	99%	75%	99%	80%

Notes:
(1) The recreational season is from May 1st through October 31st.
(2) Values from Table 4-2 in the Citywide/Open Waters LTCP.
(3) The *Enterococcus* criteria were updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤110 cfu/100mL.

Figure SD-20. Location of Water Quality Stations in Little Neck Bay

As indicated in Table SD-13, the Recreational Season percent attainment for the fecal coliform criteria did not change between the original Baseline Conditions and the Recommended Plan (100% at stations DMA and E11). Annual fecal coliform attainment also did not change for the outer-most stations E11 and LN1. Enterococcus 30-day GM attainment remained the same at Station E11, while the Enterococcus 30-day STV attainment improved by 5% at Station E11.

For the Citywide/Open Waters LTCP water quality modeling using the LTCPRM, the closest water quality station to Little Neck Bay was Station EA-3, located in the East River adjacent to the mouth of Little Neck Bay (Figure SD-21). The Citywide/Open Waters Baseline Conditions included the original Alley Creek LTCP Recommended Plan. The Citywide/Open Waters Baseline Conditions attainment at Station EA-3 is presented in Table SD-15.

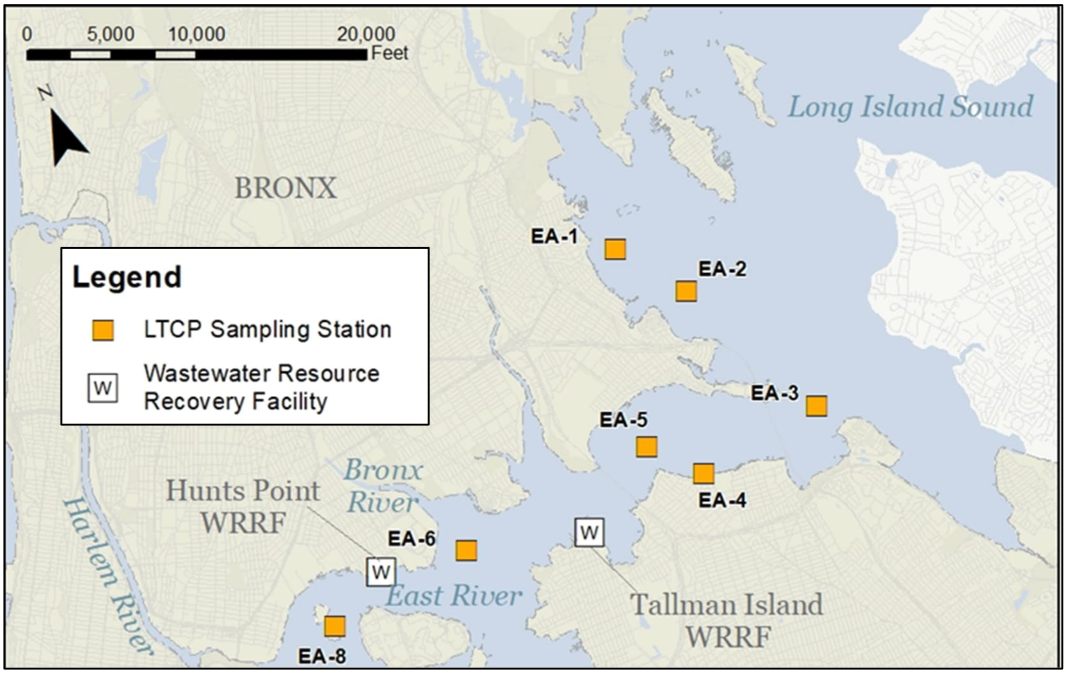

Figure SD-21. Citywide/Open Waters Water Quality Stations near Little Neck Bay

Table SD-15. Citywide/Open Waters LTCP Baseline Attainment at Station EA-3

	Monthly Fecal Coliform GM % Attainment (GM ≤200 cfu/100mL)		30-Day Recreational Season(1) *Enterococcus* % Attainment	
Station	**Annual**	**Recreational Season(1)**	**GM ≤ 35 cfu/100mL**	**90th Percentile STV ≤ 130 cfu/100mL**
EA-3	100%	100%	100%	100%

Note:
(1) The recreational season is from May 1st through October 31st.

Given that the original Recommended Plan for Alley Creek did not change the fecal coliform or 30-day GM Enterococcus attainment at Station E-11 and slightly improved the Enterococcus 30-day STV attainment at that station, and that the fecal coliform and Enterococcus attainment at Station EA-3 was already 100%, ~~the change to the proposed project for~~ deletion of the disinfection originally proposed for Alley Creek in the LTCP would ~~did~~ not affect the projected attainment levels in the East River as presented in the Citywide/Open Waters LTCP.

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Hutchinson River

Table SD-16 presents the fecal coliform attainment in the water quality stations at the mouth of the Hutchinson River and in Eastchester Bay for the original Baseline Conditions and Recommended Plan for the Alley Creek LTCP, and for the proposed modification to the Recommended Plan. This proposed modification would eliminate disinfection in lieu of constructing a 2.8 MG storage conduit with floatables control. Table SD-17 provides the Enterococcus attainment for those three conditions. Figure SD-22 shows the locations of the water quality stations at the mouth of the Hutchinson River and in Eastchester Bay. The results presented in Table SD-16 and Table SD-17 were generated from the ERTM, with an enhanced grid for the Hutchinson River/Eastchester Bay.

Table SD-16. Fecal Coliform Attainment in Hutchinson River/Eastchester Bay Stations for Hutchinson River LTCP Baseline and Recommended Plan, and for the Proposed Revised Plan for Hutchinson River

Station	% Attainment – Fecal Coliform Monthly GM ≤ 200 cfu/100mL					
	Original Baseline[1]		Original LTCP Recommended Plan[1]		Replace Outfall Disinfection with Storage	
	Annual	Rec. Season[2]	Annual	Rec. Season[2]I	Annual	Rec. Season[2]
HR-02	93%	N/A[3]	94%	97%	95%	98%
HR-01	100%	N/A[3]	100%	100%	100%	100%

Notes:
(1) Values from Table 4-6 in the Citywide/Open Waters LTCP.
(2) The recreational season is from May 1st through October 31st.
(3) Recreational season fecal coliform attainment was not developed at these stations for this LTCP.

Table SD-17. *Enterococcus* Attainment in Hutchinson River/Eastchester Bay Stations for Hutchinson River LTCP Baseline and Recommended Plan, and for the Proposed Revised Plan for Hutchinson River

Station	% Attainment – *Enterococcus* Recreational Season[1]					
	Original Baseline[2]		Original LTCP Recommended Plan[2][3]		Replace Outfall Disinfection with Storage	
	30 day GM	30-day STV	30 day GM	30-day STV	30 day GM	30-day STV
	≤ 35 cfu/100mL	≤ 130 cfu/100mL	≤ 35 cfu/100mL	≤ 130 cfu/100mL	≤ 35 cfu/100mL	≤ 130 cfu/100mL
HR-02	86%	15%	89%	15%	87%	12%
HR-01	99%	60%	99%	66%	99%	68%

Notes:
(1) The recreational season is from May 1st through October 31st.
(2) Values from Table 4-6 in the Citywide/Open Waters LTCP.
(3) The *Enterococcus* criteria were updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤110 cfu/100mL.

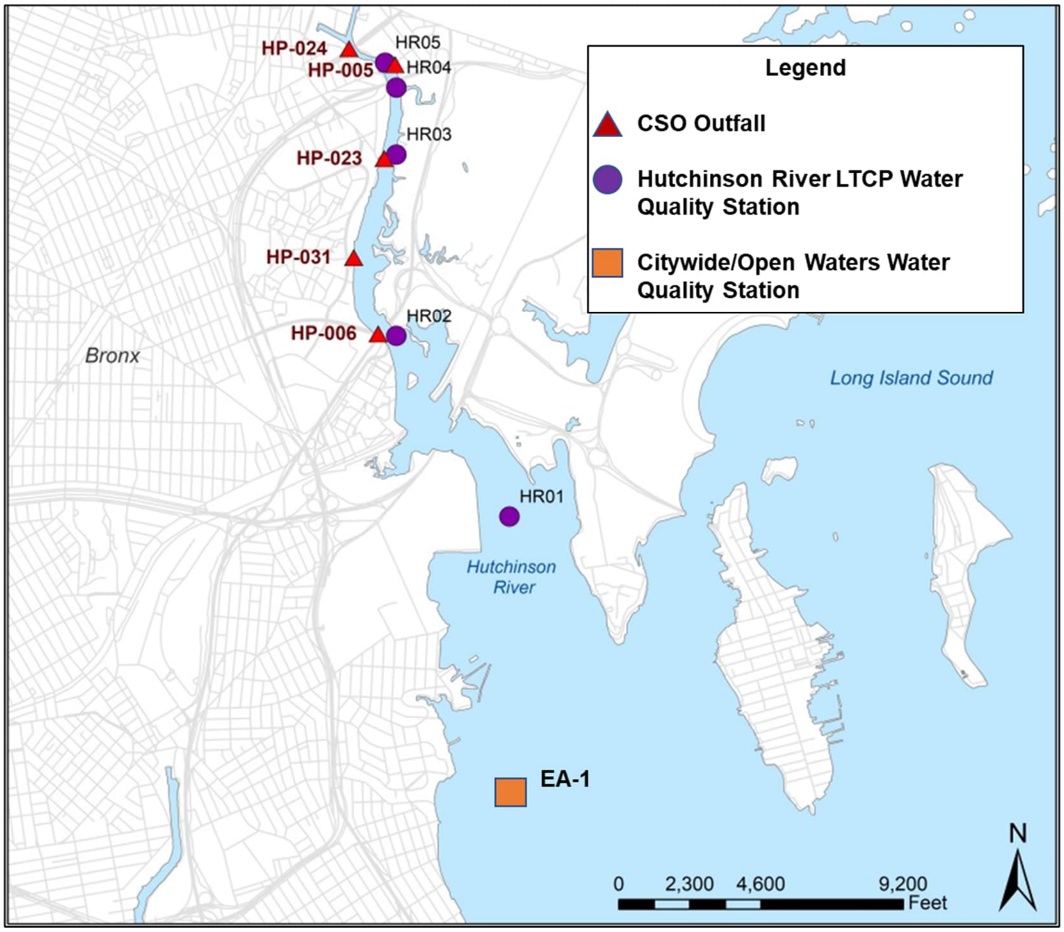

Figure SD-22. Location of Water Quality Stations in Lower Hutchinson River and Eastchester Bay

As indicated in Table SD-16, the annual percent attainment for the fecal coliform criteria did not substantially change between the original Recommended Plan and the Proposed Revised Plan at Stations HR-02 and HR-01. Enterococcus attainment also remained about the same, with a slight improvement in the 30-day GM at Station HR02, and a slight improvement in the 30-day STV at Station HR-01 (Table SD-17).

For the Citywide/Open Waters LTCP water quality modeling using the LTCP Regional Model (LTCPRM), the closest water quality station to the mouth of the Hutchinson River was Station EA-1, located along the Bronx shoreline south of the Hutchinson River (see Figure SD-21 above). The Citywide/Open Waters Baseline Conditions included the original Hutchinson River LTCP Recommended Plan. The Citywide/Open Waters Baseline Conditions attainment at Station EA-1 is presented in Table SD-18.

Table SD-18. Citywide/Open Waters LTCP Baseline Attainment at Station EA-1

Station	Monthly Fecal Coliform GM % Attainment (GM ≤200 cfu/100mL)		30-Day Recreational Season(1) *Enterococcus* % Attainment	
	Annual	Recreational Season(1)	GM ≤ 35 cfu/100mL	90th Percentile STV ≤ 130 cfu/100mL
EA-1	100%	100%	100%	99%

Note:
(1) The recreational season is from May 1st through October 31st.

Given that the proposed revised project for the Hutchinson River did not change the fecal coliform attainment at Station HR-1 and only slightly changed the Enterococcus attainment at that station, and that the fecal coliform and Enterococcus attainment at Station EA-1 was already 100%, the change to the proposed project for the Hutchinson River did not affect the projected attainment levels in the East River/Long Island Sound as presented in the Citywide/Open Waters LTCP.

Bronx River

Table SD-19 presents the fecal coliform attainment in the water quality stations at the mouth of the Bronx River and in the East River for the Baseline Conditions and Recommended Plan for the Bronx River LTCP, and for the proposed modification to the Recommended Plan. The proposed modification to the recommended plan would eliminate a diversion sewer in the upper portion of Bronx River but this is not projected to impact overall CSO reductions or water quality attainment. These water quality model results were based on inputs from versions of the InfoWorks collection system model that had been updated to reflect changed system conditions developed as part of the Bronx River project design. At the time that the Bronx River and Citywide/Open Waters LTCPs were developed, Enterococcus criteria were not applicable to the Bronx River or to the adjacent reach of the East River. Figure SD-23 shows the locations of the water quality stations at the mouth of the Bronx River and in the East River. The results presented in Table SD-19 were generated from the ERTM, with an enhanced grid for the Bronx River.

Table SD-19. Fecal Coliform Attainment in Bronx River/East River Stations for Baseline, Bronx River LTCP Recommended Plan, and Proposed Revised Plan for Bronx River

Station	% Attainment – Fecal Coliform Monthly GM ≤ 200 cfu/100mL(1)					
	Updated Bronx River LTCP Baseline(~~1~~2)		Updated Bronx River LTCP Recommended Plan(~~1~~2)		Delete HP-007 Relief Conduit(~~1~~2)	
	Annual	Rec. Season(~~2~~3)	Annual	Rec. Season(~~2~~3)I	Annual	Rec. Season(~~2~~3)
BR-08	83%	97%	85%	97%	90%	98%
BR-09(4)	92%	100%	92%	100%	95%	100%

Notes:
(1) Results based on East River Tributaries WQ Model used for the Bronx River LTCP
(2) Based on updated version of Bronx River Baseline Conditions model incorporating changes developed during design of Bronx River project.

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(3) The recreational season is from May 1st through October 31st.
(4) Bronx River LTCP Station BR-09 is the same location as Harbor Survey Monitoring Station E-14, and Citywide/Open Waters LTCP Station EA-6

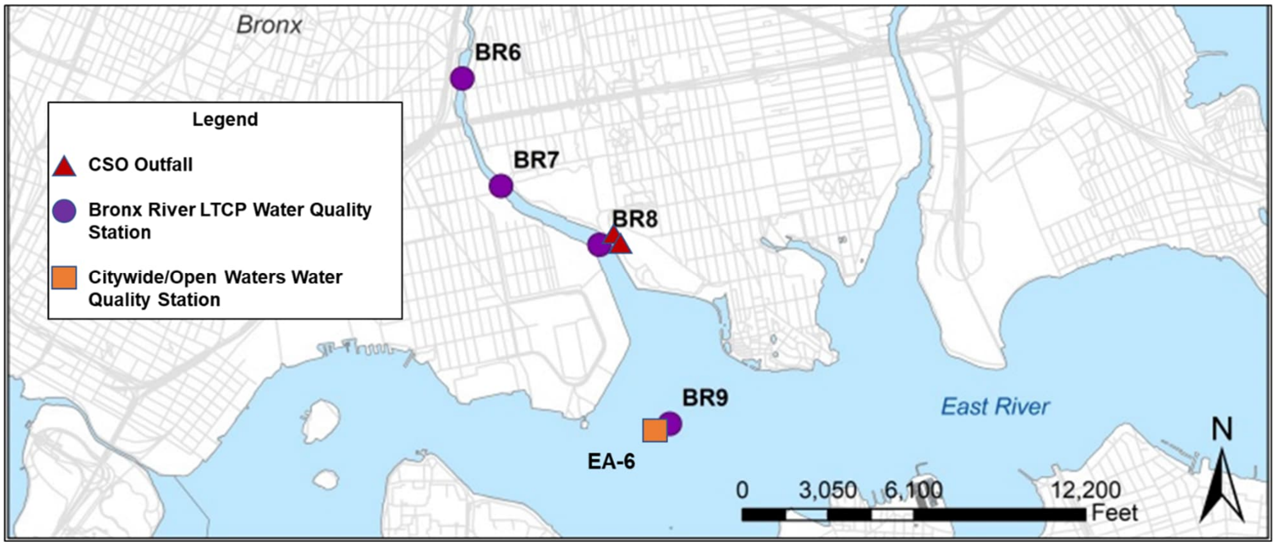

Figure SD-23. Location of Water Quality Stations in Lower Bronx River and East River

As indicated in Table SD-19, the fecal coliform attainment of the Proposed Revised Plan was slightly higher than for the original Recommended Plan at Stations BR08 and BR09.

For the Citywide/Open Waters LTCP water quality modeling using the LTCPRM, the closest water quality station to the mouth of the Bronx River was Station EA-6, located in the East River south of the mouth of the Bronx River (see Figure SD-21 above). The Citywide/Open Waters Baseline Conditions included the original Bronx River LTCP Recommended Plan. The Citywide/Open Waters Baseline Conditions attainment at Station EA-6 is presented in Table SD-20.

Table SD-20. Citywide/Open Waters LTCP Baseline Attainment at Station EA-6

Station	Monthly Fecal Coliform GM % Attainment (GM ≤200 cfu/100mL)(1)	
	Annual	Recreational Season(~~1~~2)
EA-6(3)	100%	100%

Notes:
(1) Results based on LTCP Regional WQ Model used for the Citywide/Open Waters LTCP
(2) The recreational season is from May 1st through October 31st.
(3) Citywide/Open Waters LTCP Station EA-6 is the same location as Harbor Survey Monitoring Station E-14, and Bronx River LTCP Station BR-09.

Given that the proposed revised project for the Bronx River slightly improved the fecal coliform attainment at Station BR-9, and that the fecal coliform attainment at Station EA-6 was already 100%, the change to the proposed project for the Bronx River did not affect the projected attainment levels in the East River as presented in the Citywide/Open Waters LTCP.

7. Tibbetts Brook Daylighting Project. The Citywide LTCP provides an overview of the proposed Tibbetts Brook daylighting project, to be completed as part of the Citywide Green Infrastructure Program. The scope and implementation of this project will not be defined within the context of this LTCP but the Department requests a clarification be added to the description of the project indicating that the final discharge of the flows from this project may be through a separate stormwater outfall, not the existing CSO outfall. Further discussions are required between the City and Department to reach agreement on the outfall to be used for the discharge.

DEP Response: *Based on correspondence with the DEC Region 2 Water Program subsequent to DEC's comment above, making the connection to the existing CSO outfall has been confirmed as the preferred approach. The last three sentences in the last paragraph on page 5-8 are revised as follows: (revised text in underlined red text):*

However, since the Metro North MTA tracks are live, the currently preferred option would be to connect to an existing regulator (Regulator WI-67) located east of the tracks and routing flow through Outfall WI-056 where the connection would be made downstream of the regulator's tide gates and would include an additional flap gate to prevent the backup of combined sewage into the daylighting system. This option also provides the least impacts to the natural environment, is more cost effective, and will keep the project on schedule. Per the discussion with DEC Region 2, the Water Program concurred with the decision to connect the Tibbetts Brook flow downstream of the regulator so that the construction of a new outfall is not needed (Sep 20, 2021 correspondence). ~~Alternatively, a new pipe could be microtunneled under the Metro North tracks and connected to a new outfall point. Detailed engineering analyses need to be to provide more details on final configurations.~~

Minor Comments/Errata:

1. **Section 2.3.b.2.** This section and others in the LTCP states "For non-designated beach areas of primary contact recreation which are only used infrequently for primary contact, the EPA has established an Enterococci reference level of 501 cfu/100 ml as indicative of pollution events." The Department does not use the term "non-designated beach areas" in regulations or elsewhere and it is not aware of any EPA standard for enterococci of 501 cfu/100 ml. This statement should be clarified or removed.

DEP Response: *The original source of the 501 cfu/100 mL value for Enterococcus appears to be Table 4 of the Ambient Water Quality Criteria for Bacteria - 1986 (EPA 440/5-84-002), where the value of 500 cfu/100 mL was listed as a single sample maximum for "Infrequently Used Full Body Contact Recreation". Given the age of that reference source and the more recent promulgation of Primary Contact Recreation criteria for bacteria, the sentence noted in DEC's comment is hereby deleted from the text in the location cited in DEC's comment, Section 2.3.b.2, page 2.3-54. The 501 cfu/100mL value was not referenced anywhere else in the LTCP.*

2. **Figure 2.3-13.** The legend is incomplete for this figure.

DEP Response: *Figure 2.3-13 is hereby revised to include the complete legend. The revised Figure 2.3-13 is presented below.*

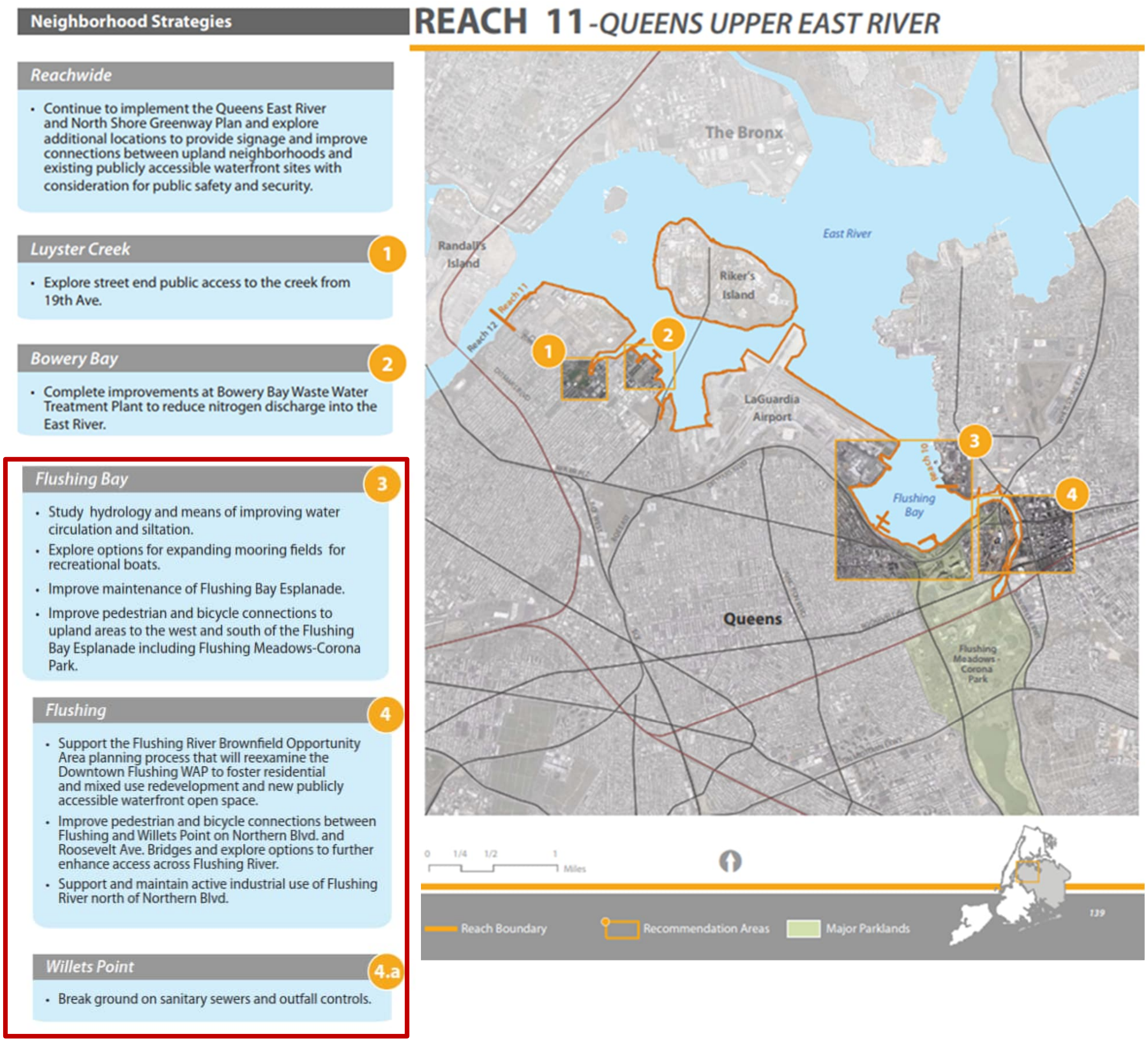

Figure 2.3 13. NYCDCP Vision 2020 Comprehensive Waterfront Plan – Reach 11

3. Table 3.2. This table lists only 21 beaches for the open waters, but Figures 2.3-39 and 2.4-26 indicate there are a total of 24 beaches in these waters.

DEP Response: *Table 3.2 has been revised to include the three missing beaches: Gerritson/Kiddie Beach, Breezy Point 219th Beach, and Douglaston Beach. Additional updates to Table 3.2 include correction of the location of Breezy Point Reid (Lower New York Bay), and correction of the number of warnings at Trinity Danish (19). The revised Table 3.2 is presented below.*

Table 3-2. Number of Beach Closings and Warnings due to Significant Rain Events for Citywide/Open Waters Waterbodies in 2018

Beach	Public/Private	Waterbody	2018 Closures	2018 Warnings Due to Significant Rain Events
Cedar Grove	Public	Lower New York Bay	0	25
Coney Island	Public	Lower New York Bay	0	0
Manhattan Beach	Public	Lower New York Bay	0	0
Midland Beach	Public	Lower New York Bay	0	2
South Beach	Public	Lower New York Bay	1	22
Wolfe's Pond Park	Public	Lower New York Bay	0	0
Orchard Beach	Public	Long Island Sound	0	0
		Public Beaches Sub-Total	**1**	**49**
American Turners	Private	Long Island Sound	0	19
Breezy Point Reid	Private	~~Long Island Sound~~ Lower New York Bay	0	13
Breezy Point 219th	Private	Lower New York Bay	0	0
Danish American Beach Club	Private	Long Island Sound	0	19
Trinity Danish	Private	Long Island Sound	0	~~0~~ 19
Loctus Point Yacht Club	Private	Long Island Sound	0	19
Manhem Beach Club	Private	Long Island Sound	0	19
Morris Yacht and Beach Club	Private	Long Island Sound	0	19
Schuyler Hill Civic Association	Private	Long Island Sound	0	19
West Fordham Street Association	Private	Long Island Sound	0	19
White Cross Fishing Club	Private	Long Island Sound	0	25

Table 3-2. Number of Beach Closings and Warnings due to Significant Rain Events for Citywide/Open Waters Waterbodies in 2018

Beach	Public/Private	Waterbody	2018 Closures	2018 Warnings Due to Significant Rain Events
Whitestone Booster Civic Association	Private	Upper East River	0	27
Douglaston Beach	Private	Little Neck Bay	0	53
Kingsborough Community College	Private	Lower New York Bay	0	0
Seagate 42nd	Private	Lower New York Bay	0	0
Seagate Beach Club	Private	Lower New York Bay	0	0
Gerritson Kiddie	Private	Lower New York Bay	0	36
		Private Beaches Sub-Total	**0**	**306**
		Citywide/Open Waters Beaches Total	**1**	**355**

4. Sections 4.4 and 6.1.d. These sections state that no CSO-specific grey infrastructure projects were completed for the outfalls discharging to the Citywide/Open Waters, however the City has completed several grey infrastructure projects to abate CSO discharge to these waterbodies. Under the Inner and Outer Harbor CSOs, the City completed regulator automations, the Port Richmond throttling facility, and the now decommissioned in-line storage project in Brooklyn. In addition, the City completed regulator modifications under the Whitestone Interceptor project for the Flushing Bay CSO. All these projects impacted CSOs discharging to the open waters, although due to their relatively small size, it may be difficult to discern their water quality impacts from post-construction monitoring.

DEP Response: *The text in Sections 4.4 and 6.1.d is hereby revised as follows:*

Section 4.4, on page 4-68:

As noted in Section 4.2 above, although the East River and Open Waters WWFP was not approved by DEC, a number of grey infrastructure projects were implemented that had beneficial impacts on CSO outfalls discharging to the Citywide/Open Waters waterbodies. These projects included headworks upgrades to WRRFs, projects to optimize system performance, and an in-line storage facility that has since been abandoned.

~~Since no CSO-specific grey infrastructure projects were implemented for outfalls discharging to the Citywide/Open Waters,~~ ~~a~~ A post-construction compliance monitoring (PCCM) program specific to the Citywide/Open Waters waterbodies ~~has~~ was not ~~been~~ implemented for those projects. However, ongoing sampling has been conducted over many years in the Citywide/Open Waters waterbodies as part of DEP's Harbor Survey Monitoring (HSM) and

Sentinel Monitoring (SM) programs. A PCCM program for the Recommended Plan from the Citywide/Open Waters LTCP is expected to consist of two basic components:

Section 6.1.d, on page 6-4:

As described in Sections 1.0 and 4.0, DEP submitted the East River and Open Waters Waterbody/Watershed Facility Plan Report to DEC in June 2007. This report recommended a series of projects focusing on maximizing the utilization of the existing collection system infrastructure and treatment of combined sewage at the City-owned WRRFs. ~~However~~, Although this WWFP was not approved by DEC, a number of grey infrastructure projects were implemented that had beneficial impacts on CSO outfalls discharging to the Citywide/Open Waters waterbodies. These projects included headworks upgrades to WRRFs, projects to optimize system performance, and an in-line storage facility that has since been abandoned.~~and no CSO-specific grey infrastructure projects were implemented for outfalls discharging to the Citywide/Open Waters waterbodies~~.

5. Table 6-10. Erie Basin, which is part of NY Harbor/Bay, is classified as SD but was not included in the table.

DEP Response: *Table 6-10 is hereby revised to include Erie Basin. The revised Table 6-10 is presented below.*

Table 6-10. Classifications and Standards Applied

Location	Numerical Criteria Applied	
• Long Island Sound east of Throgs Neck Bridge • Upper New York Bay • Lower New York Bay (including Rockaway Inlet and portions of Raritan Bay)	Class SB Coastal Primary Contact Recreational Waters	Fecal coliform monthly GM ≤ 200(1) *Enterococci*: rolling 30-day GM ≤ 35 cfu/100mL(2) *Enterococci*: rolling 30-day 90th percentile STV ≤ 130 cfu/100mL(2) Chronic DO between 3.0 & 4.8 mg/L(3) Acute DO ≥ 3.0 mg/L
• Hudson River north of Harlem River • East River between Whitestone Bridge and Throgs Neck Bridge	Class SB	Fecal coliform monthly GM ≤ 200(1) Chronic DO between 3.0 & 4.8 mg/L(3) Acute DO ≥ 3.0 mg/L
• East River from Battery to Whitestone Bridge • Hudson River from Battery to Harlem River • Harlem River • Arthur Kill from Raritan Bay to Outerbridge Crossing	Class I	Fecal coliform monthly GM ≤ 200(1) DO ≥ 4.0 mg/L

Table 6-10. Classifications and Standards Applied

Location	Numerical Criteria Applied	
• Arthur Kill from Outerbridge Crossing to Kill Van Kull • Kill Van Kull • Erie Basin	Class SD	Fecal coliform monthly GM ≤ 200$^{(1)}$ DO ≥ 3.0 mg/L

Notes:
(1) On an annual basis.
(2) For recreational season May 1st through October 31st.
(3) This is an excursion-based limit that allows for the average daily DO concentrations to fall between 3.0 and 4.8 mg/L for a limited number of days as described in more detail in Section 2.

6. Table 8.5-10. This table lists HP-009 as an East River outfall but it discharges to Bronx River.

DEP Response: *Outfall HP-009 is hereby deleted from Table 8.5-10. The revised Table 8.5-10 is presented below.*

Table 8.5-10. East River CSO Outfalls/Regulators Associated with the Hunts Point WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
HP-022	HP-01	28.8	29	✓		✓	✓
HP-021	HP-02	201.8	44	✓		✓	✓
HP-019	HP-03	15.3	35	✓		✓	✓
HP-011	HP-05	664.9	34	✓	✓	✓	✓
HP-025	HP-08	95.9	45	✓		✓	✓
HP-002	HP-09	47.8	19	✓		✓	✓
HP-003	HP-10	138.2	30	✓	✓		✓
HP-017	HP-11	38.5	28	✓		✓	✓
HP-018	HP-12	3.4	15	✓		✓	
~~HP-009~~	~~HP-13~~	~~323.2~~	~~36~~	~~✓~~	~~✓~~		~~✓~~

Attachment A

Supplemental Evaluation of BMP Regulators
in Tallman Island System

ATTACHMENT A: SUPPLEMENTAL EVALUATION OF BMP REGULATORS IN TALLMAN ISLAND SYSTEM

As part of on-going discussions with DEC following submittal of the Citywide/Open Waters LTCP, DEP agreed to conduct further evaluations of "BMP regulators" (i.e. regulators that discharge outside of the period of 2XDDWF at the WRRF) in the Tallman Island WRRF system. The intent of this additional evaluation was to assess both the potential for identifying additional optimization alternatives that would provide meaningful improvement beyond the alternatives considered in the evaluations presented in Section 3 of the LTCP, as well as the level of effort required to conduct the additional evaluations. The new evaluation for the Tallman Island system utilized the InfoWorks ICM collection system model but did not use the Optimatics software that was used to support the evaluations presented in Section 3 of the LTCP. The intent was to see if alternatives that may have been screened out by the evaluation criteria used in the Optimatics evaluations could be further modified to address the issues that caused the alternatives to be eliminated by the Optimatics algorithm.

Figure A-1 shows the locations of the BMP regulators in the Tallman Island system, as well as the location of the optimization measures recommended under the Citywide/Open Waters LTCP.

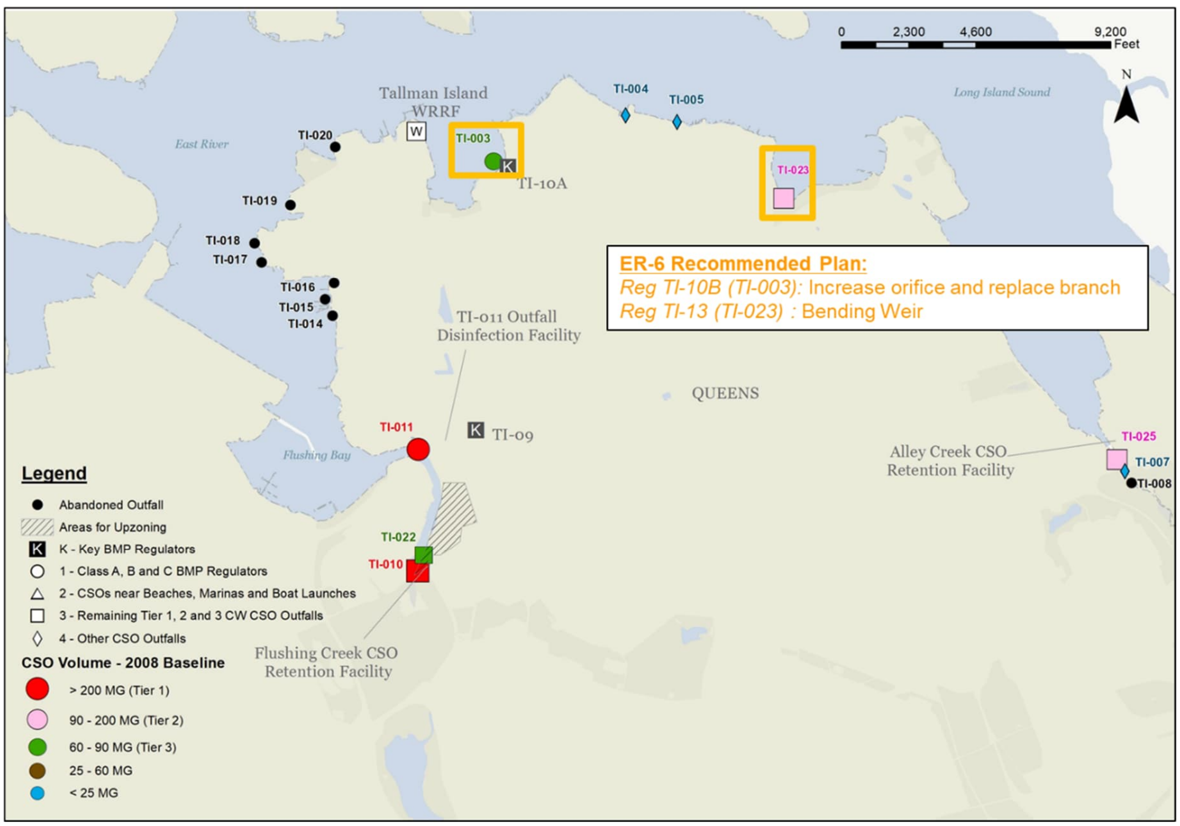

Figure A-1. Tallman Island Regulators

Table A-1 presents a summary of the performance of the recommended optimization measures for Tallman Island from the Citywide/Open Waters LTCP. As indicated in Table A-1, substantial reductions in BMP CSO volume, duration and frequency were predicted to be achieved at a

Table A-1. Results from CW/OW LTCP BMP Optimization for Tallman Island

Waterbody	Associated Regulator/Facility Name	Outfall SPDES	Outfall Tier[5]	Results Obtained from BMP Activation Tool with User defined 2 x DDWF = 160 mgd				Reductions (CW/OW Baseline – Rec. Plan)			
				Recommended Plan (2008 Conditions)							
				Total Annual CSO Volume (MG)	BMP Activation Volume[7] (MG)	BMP Activation Duration[7] (Hrs)	BMP Activations[7]	Δ Total Annual CSO Volume (MG)	Δ BMP Activation Volume[7] (MG)	Δ BMP Activation Duration[7] (Hrs)	Δ BMP Activations[7]
East River	R10A (K)	TI-003	3	0	0	0	0	0	0	0	0
East River	R10B			27	11	11	13	**44**	**30**	**46**	**26**
East River	R11	TI-004		4	1	4	6	0	0	1	1
East River	R12	TI-005		0	0	0	1	0	0	0	0
Alley Creek/LNB	ODPS Bypass	TI-007		0	0	0	0	0	0	0	0
Alley Creek/LNB	"Chamber 6" (46th Ave and 223rd Street)	TI-008		0	0	0	0	0	0	0	0
Alley Creek/LNB	Douglaston PS Overflow	TI-009		0	0	0	0	0	0	0	0
Flushing Creek	Overflow from Flushing Creek CSO Retention Facility	TI-010[1]	1	738	174	60	14	**-1**	**134**	**16**	**1**
								0	0	0	0
								0	0	0	0
Flushing Creek	R09[3] (K)	TI-011[2]	1	260	92	102	41	**0**	**17**	**14**	**4**
Flushing Creek	R51			106	57	114	55	**0**	**15**	**25**	**0**
Flushing Creek	R52			1	0	1	1	0	0	0	0
Flushing Creek	R53			16	5	25	26	**0**	**3**	**12**	**3**
Flushing Creek	R54			8	2	14	16	**0**	**1**	**5**	**3**
Flushing Bay	R07[4]	TI-014		0	0	0	0	0	0	0	0
Flushing Bay	R06[4]	TI-015		0	0	0	0	0	0	0	0
Flushing Bay	R05[4]	TI-016		0	0	0	0	0	0	0	0
Flushing Bay	R04[4]	TI-017		0	0	0	0	0	0	0	0
Flushing Bay	R03[4]	TI-018		0	0	0	0	0	0	0	0
East River	R02[4]	TI-019		0	0	0	0	0	0	0	0

Table A-1. Results from CW/OW LTCP BMP Optimization for Tallman Island

Waterbody	Associated Regulator/Facility Name	Outfall SPDES	Outfall Tier[5]	Results Obtained from BMP Activation Tool with User defined 2 x DDWF = 160 mgd — Recommended Plan (2008 Conditions)				Reductions (CW/OW Baseline – Rec. Plan)			
				Total Annual CSO Volume (MG)	BMP Activation Volume[7] (MG)	BMP Activation Duration[7] (Hrs)	BMP Activations[7]	Δ Total Annual CSO Volume (MG)	Δ BMP Activation Volume[7] (MG)	Δ BMP Activation Duration[7] (Hrs)	Δ BMP Activations[7]
East River	R01[4]	TI-020		0	0	0	0	0	0	0	0
Flushing Creek	R55	TI-022[3]	3	71	39	113	55	0	9	19	0
Flushing Creek	R56			6	3	6	8	0	1	3	4
Flushing Creek	R57			7	3	9	11	0	1	4	4
Flushing Creek	R58			5	2	7	9	0	1	3	4
East River	R13	TI-023	2	96	38	61	28	42	62	56	21
Alley Creek/LNB	R29/R30 (Overflow from Alley Creek CSO Retention Facility)	TI-025	2	159	35	68	17	0	43	24	1

Notes:

(1) No key regulators contribute to TI-010, so for simplification volume presented is total CSO at the outfall, downstream of the facility.
(2) Chlorination and de-chlorination facilities to be located along the TI-011 outfall.
(3) R55, R56, R57 are offline regulators that contribute to the Flushing Interceptor; diversion weir elevations become critical during pump out of Flushing Creek CSO Retention facility if the HGL gets too high.
(4) Regulators are abandoned in the future condition (baseline) but not as of 2020.
(5) Tiers are assigned from 2008 Baseline Condition results:
    Tier 1 : > 200 MG
    Tier 2 : 90- 200 MG
    Tier 3: 60 – 90 MG
(6) **Category A**: Key Regulators that may be influenced by planned capital improvements (projects are currently in design or construction that may result in CSO reductions and additional wet weather capture);
    Category B: Key Regulators averaging one or fewer potential discharge outside the period of a critical wet weather event per month;
    Category C: All other Key Regulators with an average of more than one potential discharge outside the period of a critical wet weather event per month.
(7) "BMP" activation, volume and duration refers to the CSO activation, volume and duration that occurs outside of the period of 2XDDWF at the WRRF.

number of locations in the Tallman Island system. This table was used as a starting point in identifying regulators to target for the additional optimization alternatives developed for this Supplemental Documentation. Looking at the remaining BMP volumes, durations and activations predicted after implementation of the recommended plan, the following regulators were targeted:

- R-09 (TI-011) – Key regulator, moderate BMP frequency/volume
- R-51 (TI-011) - High BMP frequency/volume, Tier 1 outfall
- R-55 (TI-022) – High BMP frequency/volume, Tier 3 outfall
- R-53 (TI-011) - Moderate BMP frequency/volume, Tier 1 outfall.

Figure A-2 presents a schematic of the Tallman Island system, showing the relative locations of the four regulators listed above for further evaluation. After some preliminary model runs, the evaluations coalesced around four options:

- **Option 1A:** Increase interceptor from TI-51 to TI-09 from current size (18 to 21-in.) to 36-in. and increase orifice/branch at regulator TI-053 from 12-in. to 18-in. An earlier version of this alternative that did not include increasing the orifice/branch at regulator TI-053 was predicted to have adverse HGL impacts, which were mitigated by increasing the orifice/branch at regulator TI-053. A schematic of this option is shown in Figure A-3.
- **Option 2:** Raise weir at Regulator TI-09. Raising the weir at this location would also reduce the open area available for flow above the weir. A schematic of this option is shown in Figure A-4.
- **Option 3:** Increase TI-53 branch interceptor from 12-in. to 24-in., increase size of conveyance from TI-53 to Linden Place PS from 18-in. to 30-in., and increase capacity of Linden Place PS from 5 mgd to 7 mgd. A schematic of this option is shown in Figure A-5. However, the model predicted significant (>3 foot) HGL increases associated with this option, with no clear means for mitigating the increase. As a result, this option was not considered further.
- **Options 4A and 4B:** Option 4A included increasing the orifice from 12x12-in. to 24x24-in. at Regulator TI-55, increasing the branch connection from 12-in. to 36-in., and monitoring impacts in interceptor to TI-09 and to Flushing Creek Facility. Option 4B was the same as Option 4A, but also included raising the weir at Regulator TI-55. A schematic of these options is shown in Figure A-6.

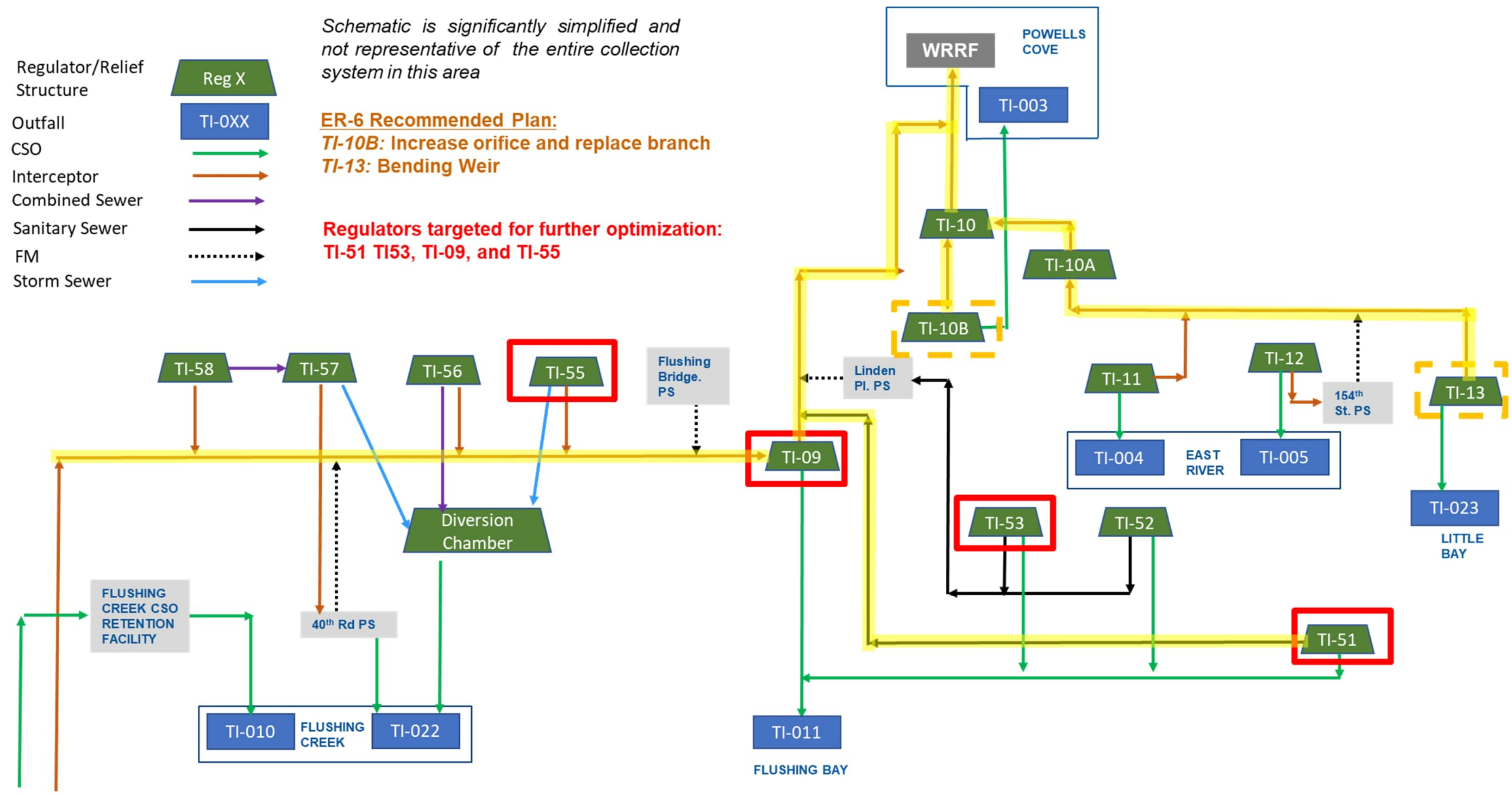

Figure A-2. Schematic of Tallman Island System

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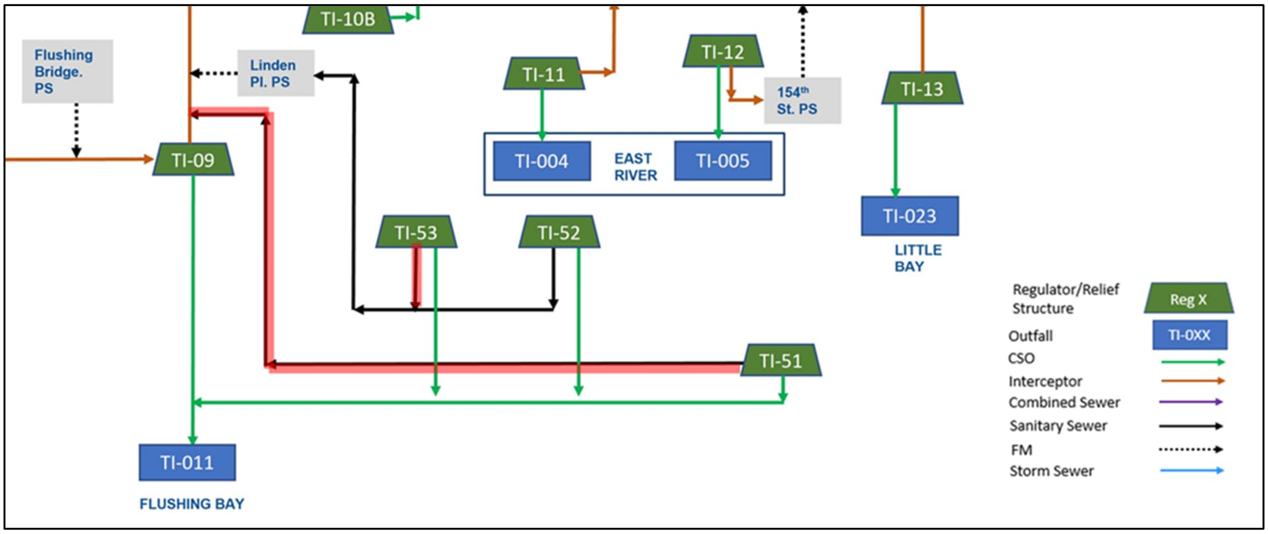

Figure A-3. Schematic of Option 1A

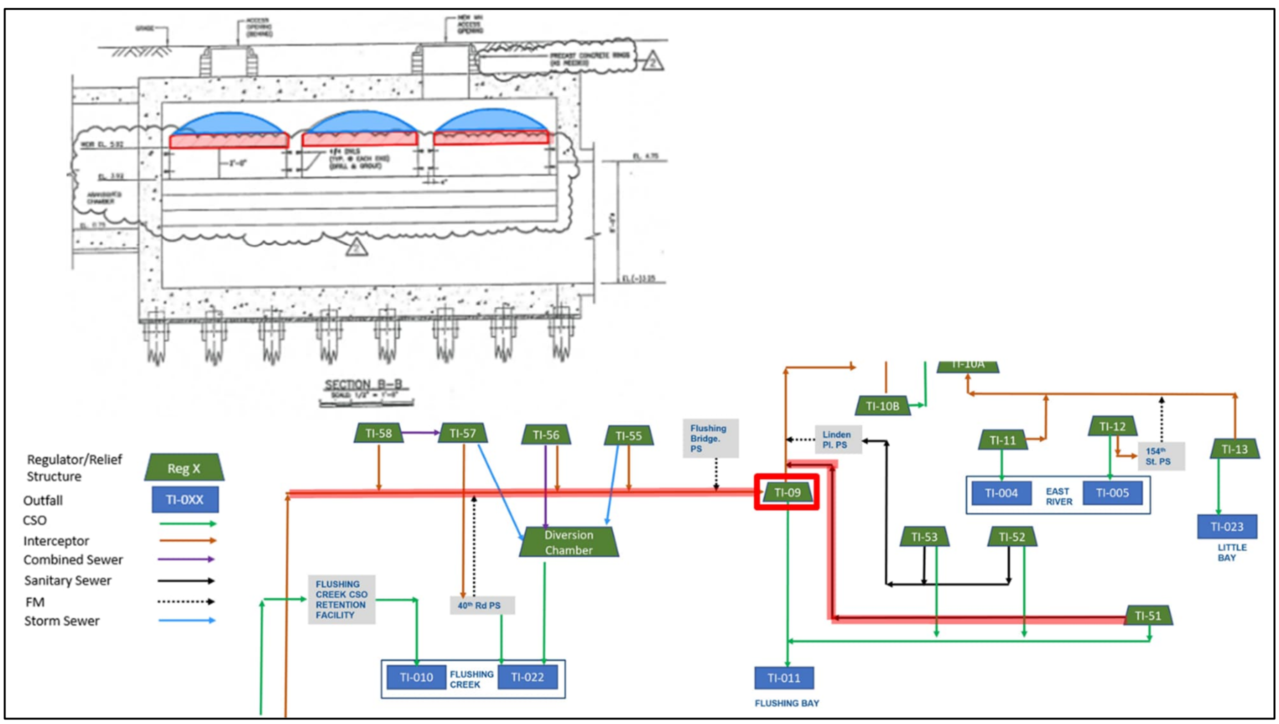

Figure A-4. Schematic of Option 2

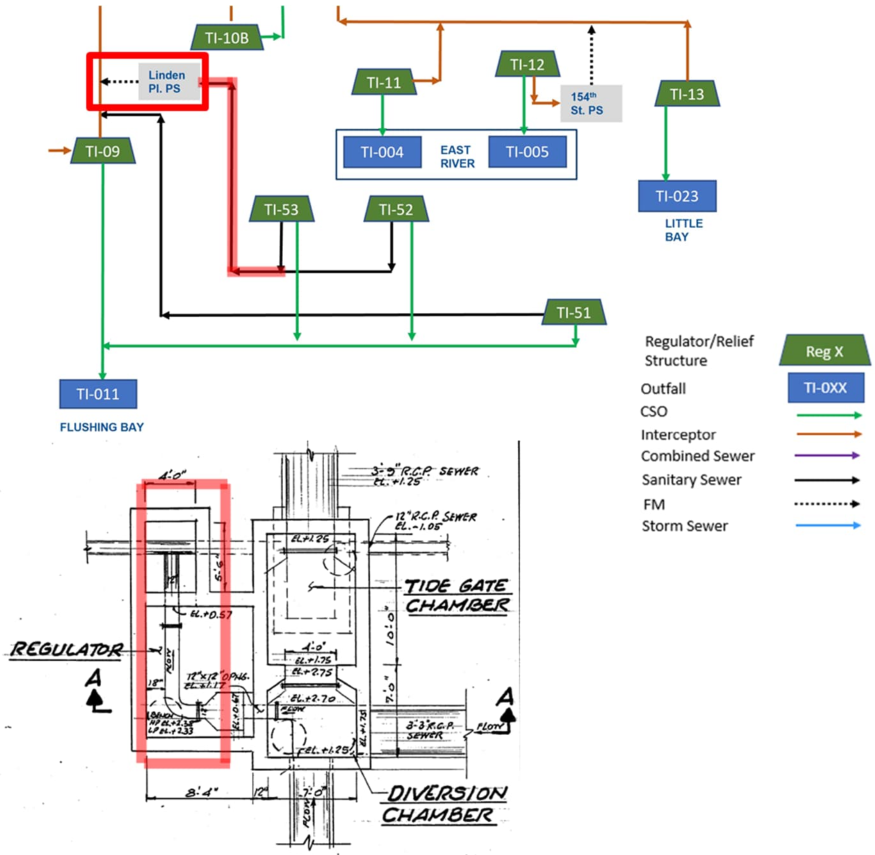

Figure A-5. Schematic of Option 3

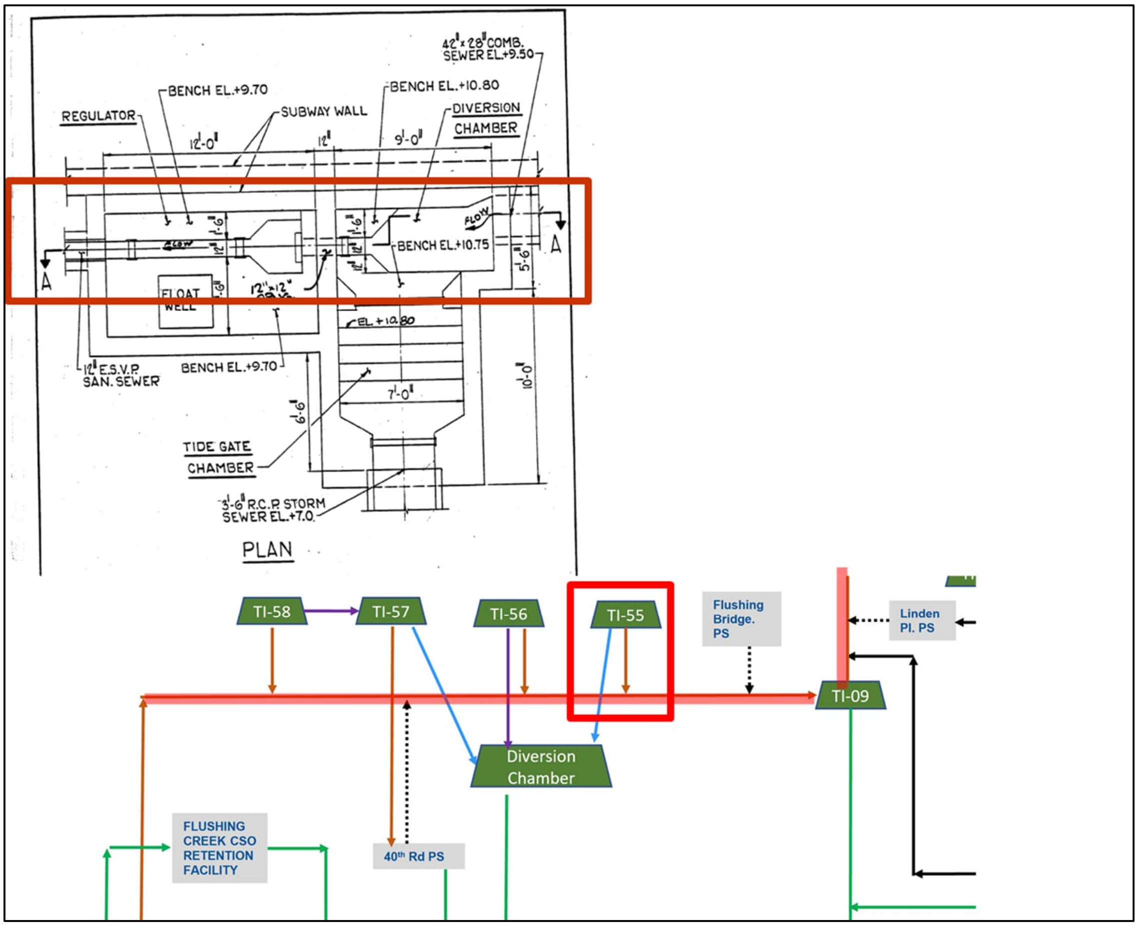

Figure A-6. Schematic of Options 4A and 4B

The results of the evaluations of these options, in terms of reduction in volume and number of BMP discharges, and a preliminary assessment of HGL impacts, are summarized in Table A-2. In this table, reductions in volume and number of discharges are indicated by positive values in green text, and increases are indicated by negative values in red text. As indicated in Table A-2, Alternative 2 (raise weir at regulator TI-09) provided the greatest reduction in BMP activations and volume, as well as the largest reduction in total CSO volume. All four of the options presented in Table A-2 were predicted to result in some level of increase in the peak HGL in the 5-year storm.

In order to better assess the risks associated with the increases in peak HGL, locations of reported sewer backups (SBUs) and predicted surface flooding were reviewed in the areas affected by the options. The SBU data were not entirely conclusive, but some SBUs had been reported along the interceptors affected by the four options. Inundation modeling conducted by the DEP, however, highlighted a number of potentially vulnerable areas that could be affected by the BMP options. Figure A-7 shows the locations of predicted flooding under conditions of a 10-year storm with 2.5 feet of sea level rise, from the flood mapping developed as part of the NYC Stormwater Resiliency Plan, along with the relative locations of BMP Options 1A, 2 and 3. Figure A-8 shows similar information for the location of Options 4A and 4B. These figures show projected flooding in the areas directly associated with Options 2, 3, 4A and 4B. For Option 1, no flooding was projected along 32nd Avenue between TI-51 and TI-09, but flooding was projected at TI-09.

Table A-2. Summary of BMP Evaluation Results for Tallman Island

Outfall SPDES	Regulator /Facility	Option 1A - Increase interceptor from TI-51 to TI-09 and increase orifice/branch at regulator TI-053				Option 2 - Raise weir at Regulator TI-09				Option 4A - Increase the orifice at Regulator TI-55, increase the branch connection, and monitor impacts in interceptor to TI-09 and to Flushing Creek Facility.				Option 4B - Same as Option 4A, but also raise the weir at Regulator TI-55.			
		∆ Total CSO Vol. (MG)	∆ Total CSO Act.	∆ BMP Act. Volume (MG)[1]	∆ BMP Act.[1]	∆ Total CSO Vol. (MG)	∆ Total CSO Act.	∆ BMP Act. Volume (MG)[1]	∆ BMP Act.[1]	∆ Total CSO Vol. (MG)	∆ Total CSO Act.	∆ BMP Act. Volume (MG)[1]	∆ BMP Act.[1]	∆ Total CSO Vol. (MG)	∆ Total CSO Act.	∆ BMP Act. Volume (MG)[1]	∆ BMP Act.[1]
TI-003	R10A (K)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R10B	0	0	1	1	0	0	2	4	0	0	0	-1	0	0	0	0
TI-004	R11	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1
TI-005	R12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TI-007	ODPS Bypass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TI-008	"Chamber 6" (46th Ave and 223rd Street)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TI-010	Overflow from Flushing Creek CSO Retention Facility	-2	0	61	2	-13	0	95	4	-10	0	14	0	-15	0	24	0
TI-011	R09 (K)	-27	0	10	-2	170	8	87	24	-19	0	-7	-2	-22	0	-8	-1
	R51	86	30	49	45	-2	0	19	3	0	0	1	0	0	0	2	0
	R52	0	-1	0	0	0	0	0	0	0	-1	0	0	0	-1	0	0
	R53	5	13	1	16	-1	0	1	6	-1	0	-1	-1	0	0	0	0
	R54	-7	-9	-2	-12	0	0	0	2	0	0	0	-2	0	0	0	-2
TI-022	R55	0	0	7	2	-1	0	11	1	51	27	29	29	63	42	35	42
	R56	0	0	0	0	0	0	0	1	0	0	0	0	-1	0	0	0
	R57	0	0	0	2	0	0	0	3	0	0	0	1	0	0	0	1
	R58	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
TI-023	R13	0	0	12	1	-1	0	13	10	0	0	2	0	0	0	3	0
TI-025	R29/R30 (Overflow from Alley Creek CSO Retention Facility)	0	0	16	0	0	0	21	4	0	0	3	0	0	0	5	0
System-wide Net:		**55**	**33**	**158**	**55**	**151**	**8**	**250**	**64**	**20**	**26**	**42**	**25**	**24**	**41**	**60**	**41**
Modeled HGL Impacts (5-yr. storm)		Increases < 1 foot				Increases of up to 1.5 feet				Increases < 1 foot				Increases < 1 foot			
Modeled Freeboard in Vicinity of HGL Increase (5-yr. storm)		Greater than 5 feet				As low as 3 feet in the immediate vicinity of the regulator				Less than 5 feet near TI-09				Less than 5 feet near TI-09			

Notes:
(1) "BMP" activation, volume and duration refers to the CSO activation, volume and duration that occurs outside of the period of 2XDDWF at the WRRF.

AECOM with Hazen

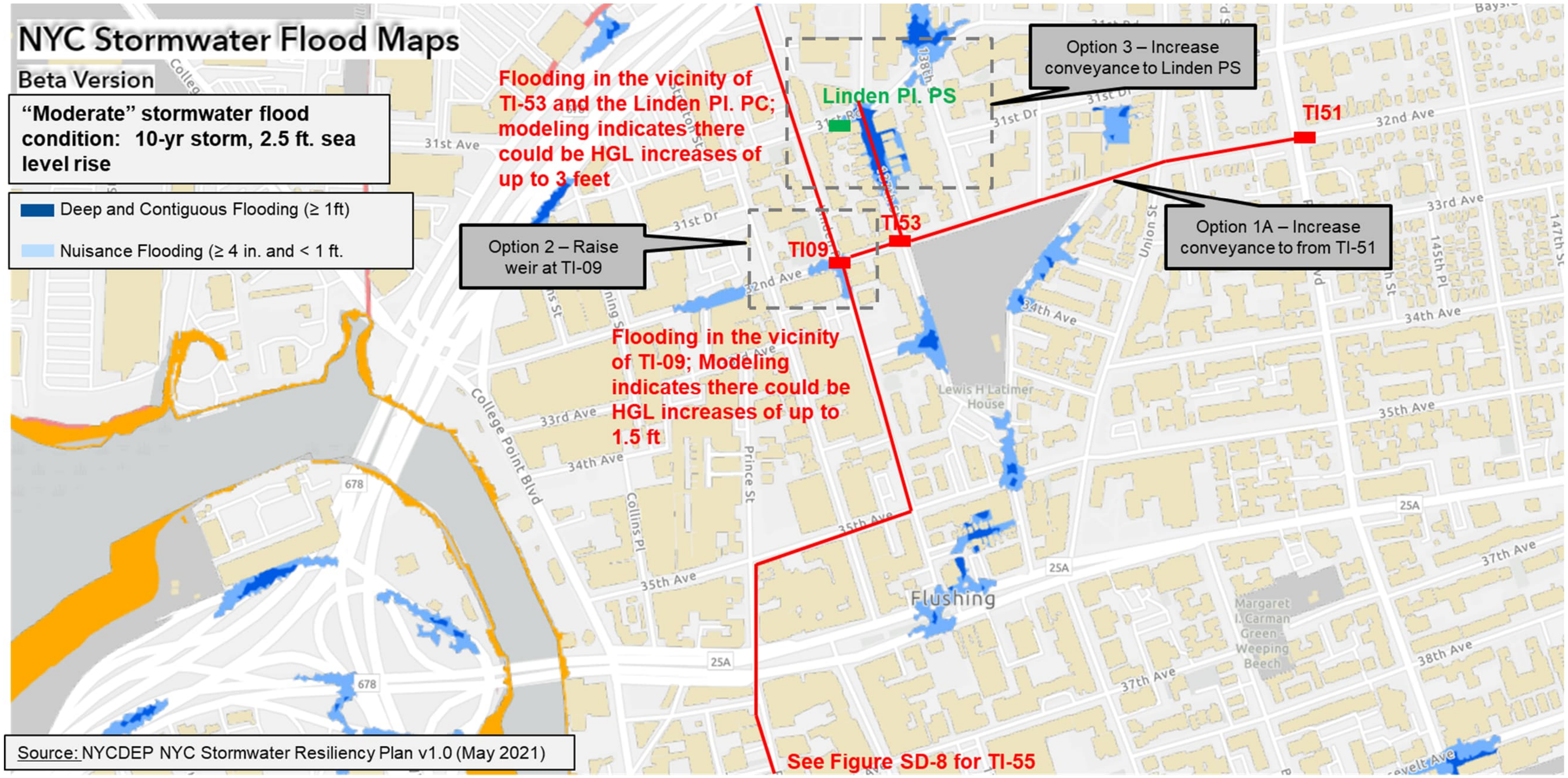

Figure A-7. Location of Projected Flooding in Vicinity of Options 1A, 2 and 3

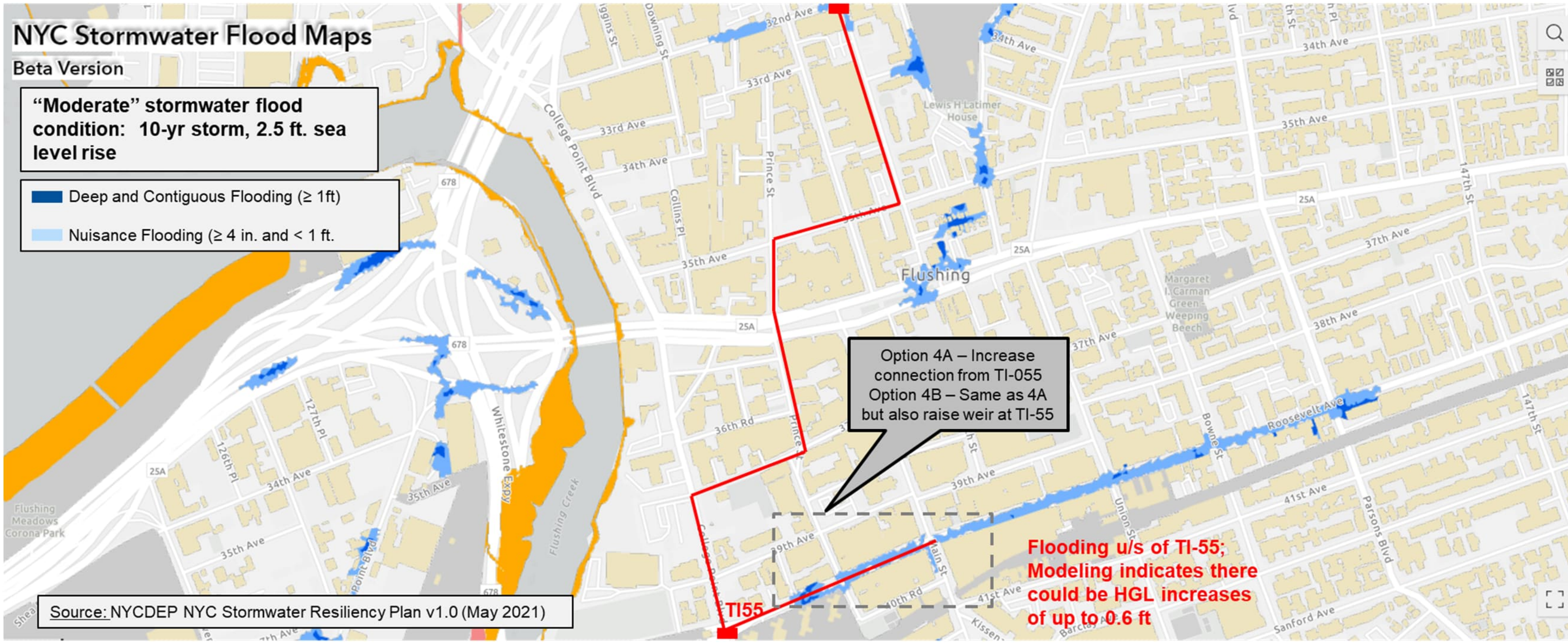

Figure A-8. Location of Projected Flooding in Vicinity of Option 4

Since each of the BMP options would result in some degree of increase in HGL, and the stormwater resiliency modeling that DEP has conducted has identified areas vulnerable to surface flooding in the vicinity of each of the options, none of these options were recommended for further evaluation. Option 1A appeared to have the least potential impact on projected areas of flooding, but Option 1A would provide relatively modest benefit in terms of reduction in annual CSO volume. The concern with Option 1A is that it would increase flow to regulator TI-09, where surface flooding was predicted under the stormwater resiliency conditions assessed.

~~With regard to conducting similar BMP evaluations in other sewersheds, any further evaluations would have to be done under a different planning contract, as the current LTCPIII contract does not have sufficient budget to support additional BMP evaluations. The experience with the Tallman Island evaluations indicates that future BMP evaluations would need to be closely coordinated with stormwater resiliency planning. The most practical path forward may be to tie the further investigations of BMP optimization opportunities to the parallel evaluations of options to address stormwater resiliency.~~

Summary

In accordance with the requirements of the CSO BMP Order, DEP completed various analyses of key regulators to identify options to reduce CSO discharges outside of the period of a critical wet weather event, including a focused analysis of key regulators in the Tallman Island sewershed, and determined that no cost-effective alternatives existed to reduce these CSO discharges. Similar analyses of other sewersheds will very likely result in similar outcomes because DEP has already undertaken many cost-effective projects over the years to maximize wet weather flow to the WRRFs consistent with the BMP. Per the WRRF SPDES permits, DEP will continue to monitor key regulators. Based on the foregoing, DEP has completed sufficient analyses of key regulators at this time to fulfill the requirements of the CSO BMP Order for analyzing these regulators.

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Attachment C

Revised Executive Summary

NYC Environmental Protection

Combined Sewer Overflow Long Term Control Plan For

CITYWIDE/OPEN WATERS

EXECUTIVE SUMMARY

May 2023

Table of Contents

1. Introduction

CSO Program

The waters surrounding New York City are cleaner and healthier than they have been since the Civil War. Over the last several decades, the City has invested more than $45 billion in the construction and upgrade of critical infrastructure to improve the health of our City's vital ecosystems. These improvements can be seen throughout the five boroughs; seals exploring the Bronx River, whales splashing in the Upper New York Bay, and millions of New Yorkers and tourists flocking to waterways for recreation. In recent years, the City has committed an additional $9 billion to continue the legacy of innovation and investment to usher in a new era of environmental protection for the harbor.

On March 8, 2012, the New York State Department of Environmental Conservation (DEC) and the New York City Department of Environmental Protection (DEP) signed a groundbreaking agreement to reduce combined sewer overflows (CSOs) using a hybrid green and grey infrastructure approach. As part of this agreement, DEP has developed 10 waterbody-specific Long Term Control Plans (LTCPs). The goal of each LTCP is to identify appropriate combined sewer overflow controls necessary to achieve waterbody-specific water quality standards, consistent with the Federal CSO Policy and the water quality goals of the Clean Water Act (CWA). More information about the City's CSO program can be found in Attachment 1 and Attachment 2 of this Summary.

Long Term Control Plan

identifies appropriate CSO controls to achieve applicable water quality standards consistent with the federal CSO Policy and Clean Water Act.

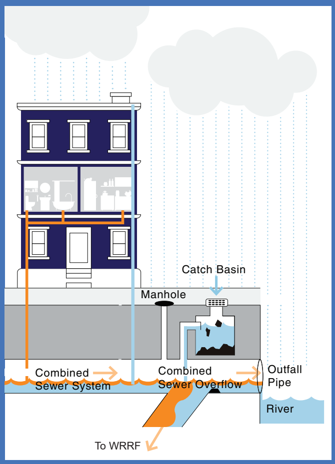
CSO Consent Order

an agreement between NYC and DEC that settles past legal disputes without prolonged litigation. DEC requires DEP to develop LTCPs and mitigate CSOs.

Combined Sewer Overflow

NYC's sewer system is approximately 60% combined, which means it is used to convey both sanitary and storm flows.

When the sewer system is at full capacity, a diluted mixture of rain water and sewage may be released into the local waterways. This is called a combined sewer overflow.

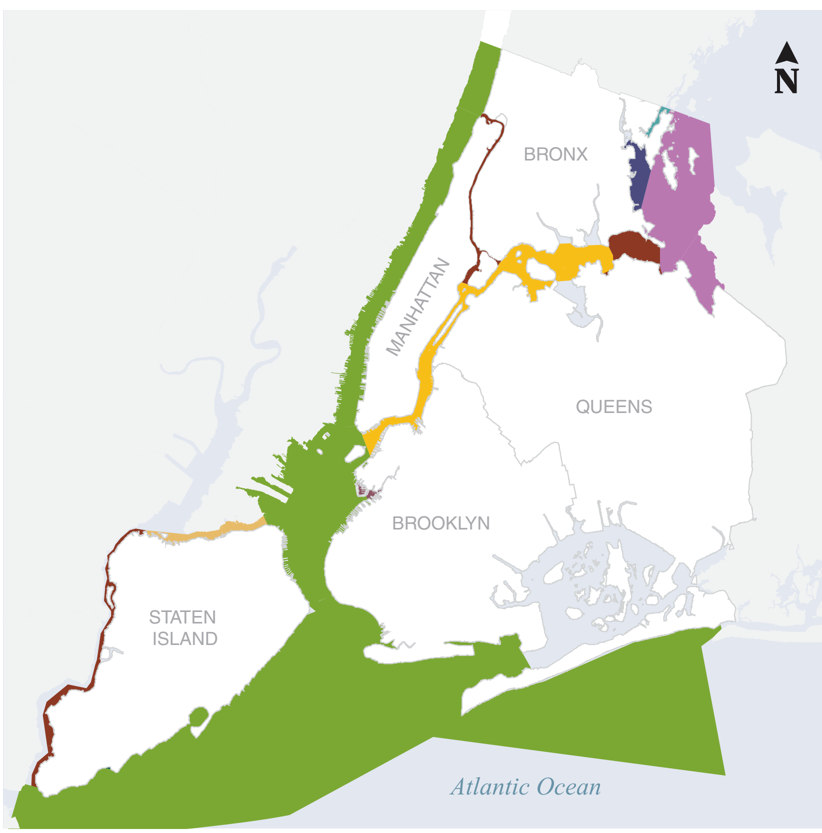


Citywide/Open Waters LTCP Areas

This Summary is for the Citywide/Open Waters LTCP which is due to DEC in September 2020. It is the largest LTCP, touching all five boroughs and covering the NYC portion of Hudson River, Harlem River, Upper and Lower New York Bay, Arthur Kill and Kill Van Kull, East River, and the western portion of Long Island Sound (NYC portion). The development of this LTCP began in 2016 and included water quality sampling, water quality modeling, collection system modeling, a review of existing CSO projects, alternatives analysis and robust public outreach.

Harlem River
Hudson River
East River/Long Island Sound
Upper and Lower New York Bay
Arthur Kill and Kill Van Kull

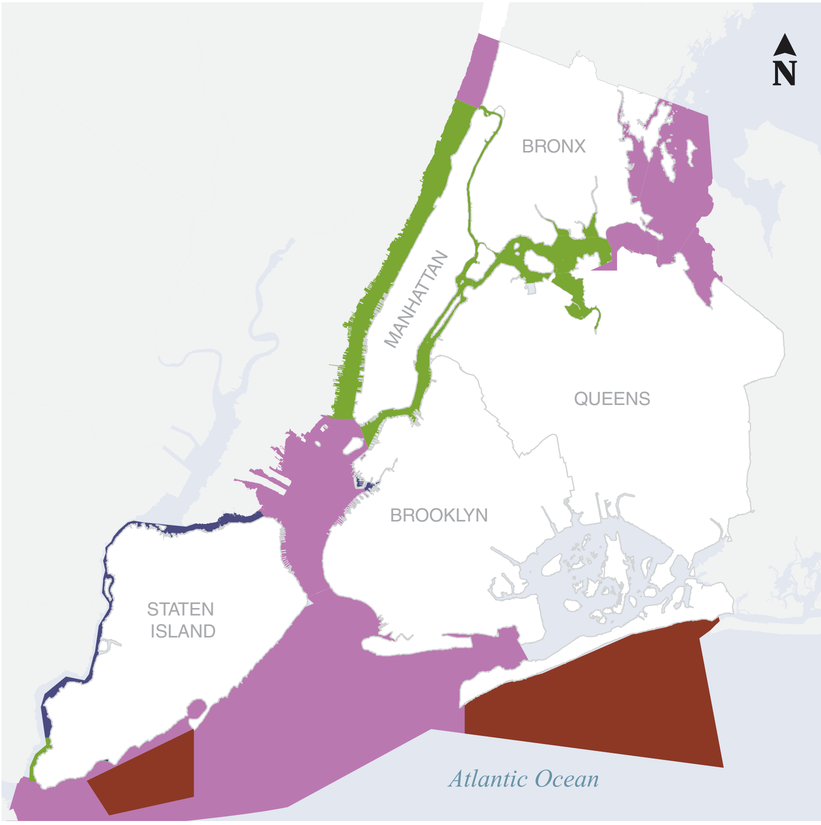
Causes of Impairment



Section 303(d) of the Clean Water Act requires states to identify impaired waters where specific designated uses are not fully supported. Based on the 2016 Final 303(d) list, Upper and Lower New York Bay, and Hudson River are not listed as impaired, while Harlem River, East River/Long Island Sound, Arthur Kill and Kill Van Kull are listed as impaired for the pollutants shown in the adjacent map.

Floatables
Dissolved Oxygen and Floatables
Dissolved Oxygen and Nitrogen
Pathogens
Not Listed as Impaired

Waterbody Classifications



In accordance with the provisions of the Clean Water Act, the State of New York (the "State") has established water quality standards for all navigable waters within its jurisdiction. The State has developed a system of waterbody classifications based on designated uses that include five classifications for saline waters. Water quality in Class SA and Class SB classifications support primary and secondary contact recreation and fishing. Classes SC, I and SD support aquatic life and recreation.

Class SA (Shellfishing, F, B and Ba)
Class SB (F, B and Ba)
Class SD (F)
Class I (F and B)

F = Fishing *B = Boating* *Ba = Bathing*

Water Quality Criteria

Class	Bacteria			Dissolved Oxygen
	Total Coliform	**Fecal Coliform(1)**	Enterococci(2)(3)	
SA	Median ≤ 70 MPN/10mL	-	30-day GM ≤ 35/100mL STV ≤ 130cfu/100mL	> 4.8 mg/L (daily avg) ≥ 3.0 mg/L
SB	Monthly Median ≤ 2,400/100mL 20% ≤ 5,000/100mL	Monthly GM ≤ 200/100mL	30-day GM ≤ 35/100mL STV ≤ 130cfu/100mL	> 4.8 mg/L (daily avg) ≥ 3.0 mg/L
SD	Monthly Median ≤ 2,400/100mL 80% ≤ 5,000/100mL	Monthly GM ≤ 200/100mL	-	≥ 3.0 mg/L
I	Monthly Median ≤ 2,400/100mL 80% ≤ 5,000/100mL	Monthly GM ≤ 200/100mL	-	≥ 4.0 mg/L

(1) Applies on an annual basis calculated based on geometric mean (GM).

(2) Applies in the recreational season (May 1st through October 31st).

(3) Enterococci criteria only applies to coastal primary contact recreational waters. Hudson River north of Harlem River is a class SB non-coastal recreational water.

Water quality criteria corresponding to the waterbody classifications are shown in the adjacent table.

Total and fecal coliform bacteria concentrations are the criteria that DEC uses to establish whether a waterbody supports recreational uses in non-coastal waterbodies, while fecal coliform and *Enterococci* criteria apply to coastal primary contact recreational waters.

Dissolved Oxygen (DO) is the numerical criterion that DEC uses to establish whether a waterbody supports aquatic life uses.

Acronyms

CFU = Colony Forming Unit

GM = Geometric Mean

MPN = Most Probable Number

STV = Statistical Threshold Value

Citywide/Open Waters Key Waterfront Access Points

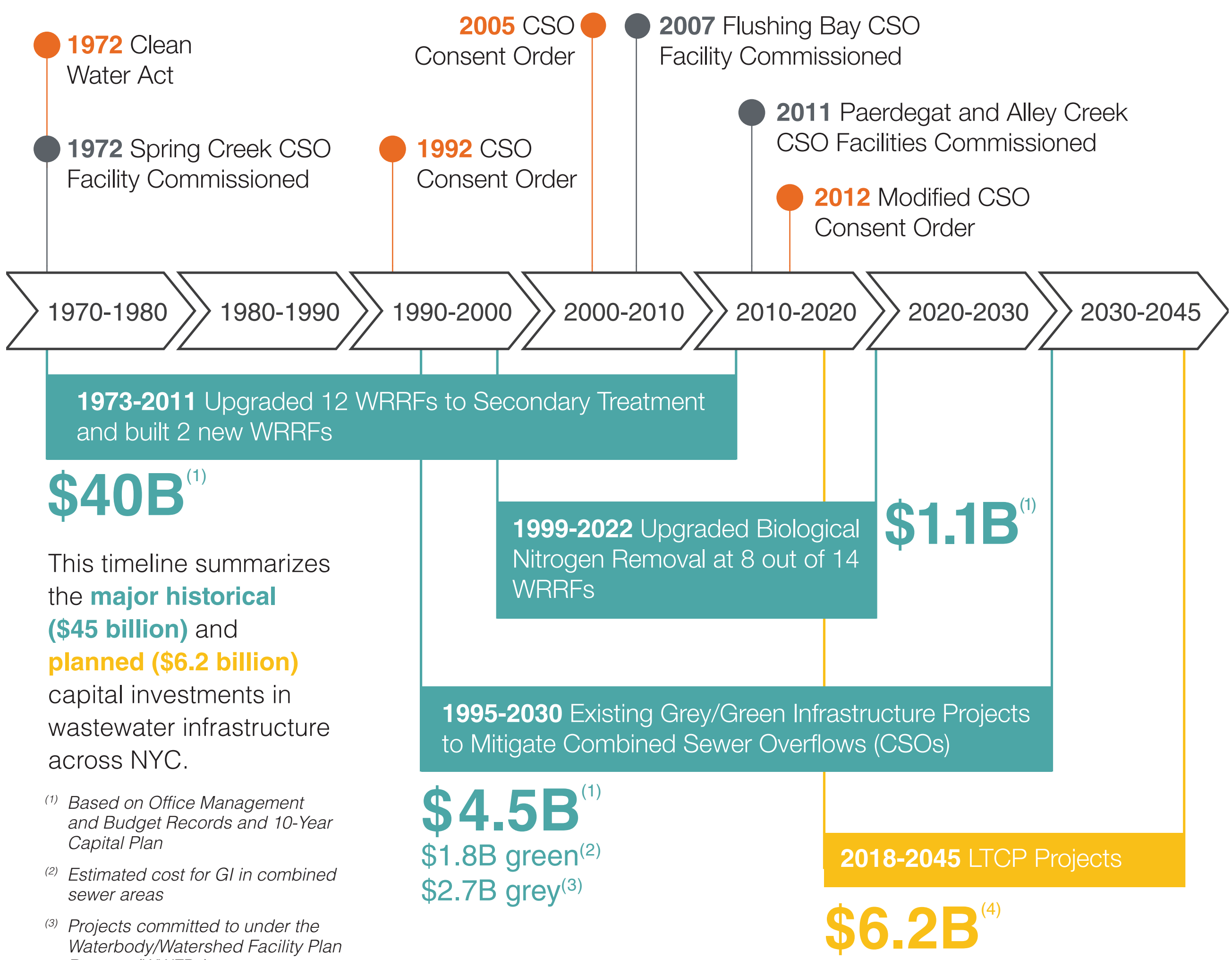
Waterfront access points along the shorelines of the Citywide/Open Waters waterbodies include beaches, kayak launch sites, marinas, and parkland located along the shoreline. Uses at these access points range from primary contact (swimming) at beaches, to secondary contact (boating), and passive, non-contact recreation along shoreline parks. The Citywide/Open Waters LTCP has evaluated water quality and CSO impacts at or adjacent to these waterfront access points as part of the overall assessment of CSO controls.

Investment and Success to Date

Historical Major Capital Investments in Wastewater Infrastructure

Improving New York Harbor's water quality has been a City and DEP priority for decades. According to the City's most recent Harbor Survey Report, the Harbor is cleaner now than at any time in the last 100 years. Continued improvements to the City's 14 wastewater resource recovery facilities (WRRFs), and ongoing investments have resulted in an 80% reduction in combined sewer overflows since the mid-1980s. With nine LTCPs approved, one pending, and this current one being submitted in September 2020, current and planned infrastructure investments will result in even further water quality improvements.

$45 Billion
in historic capital investments has led to
80% Reduction
in annual CSO discharges since the mid-1980's



This timeline summarizes the **major historical ($45 billion)** and **planned ($6.2 billion)** capital investments in wastewater infrastructure across NYC.

(1) *Based on Office Management and Budget Records and 10-Year Capital Plan*

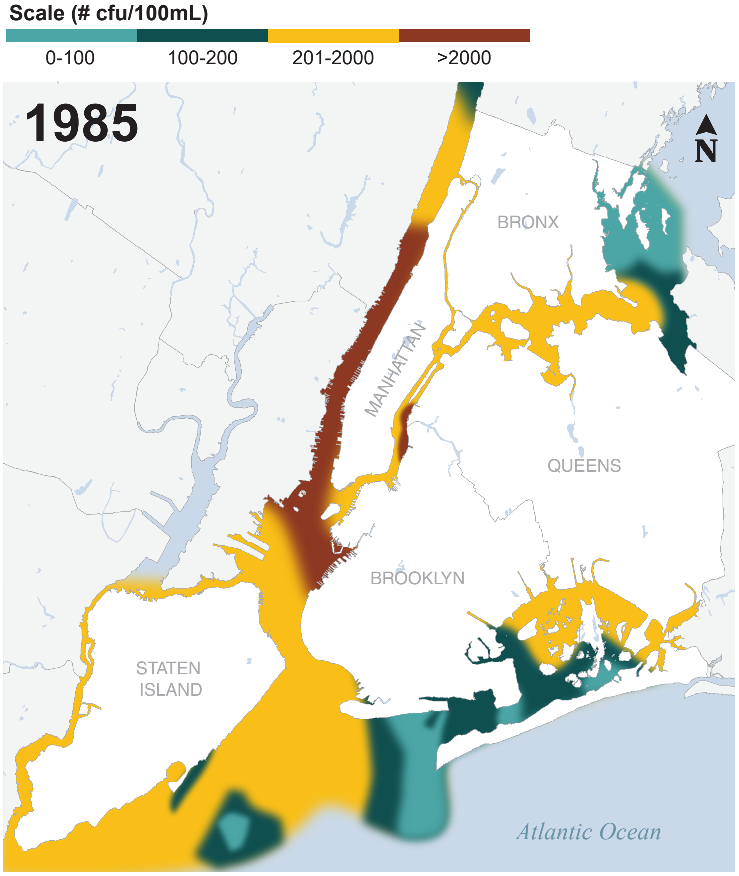
(2) *Estimated cost for GI in combined sewer areas*

(3) *Projects committed to under the Waterbody/Watershed Facility Plan Reports (WWFPs)*

(4) *Approved and submitted LTCPs and Superfund-mandated CSO control costs*

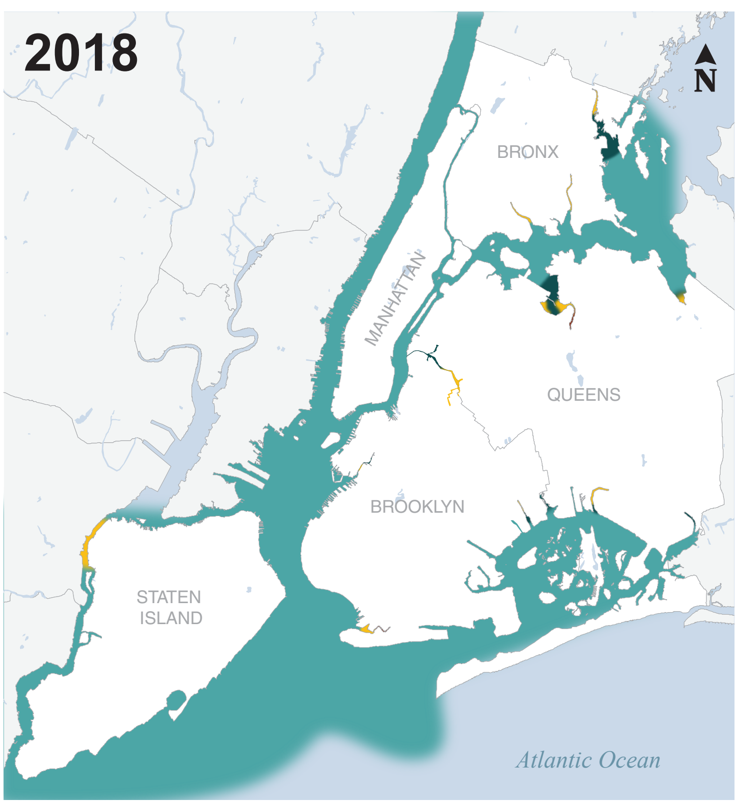
Water Quality Improvements Over Time

Fecal Coliform Summer Geometric Means (GM) from Harbor Survey Monitoring Program Sampling data



> 200 cfu/100mL
GM fecal coliform concentrations in Citywide/Open Waters

> 2,000 cfu/100mL
GM fecal coliform concentrations in portions of the Hudson River, East River, and Upper New York Bay



< 100 cfu/100mL
GM fecal coliform concentrations in most waterbodies

The additional $6.2 billion investment in projects in the current CSO LTCP Program will result in further water quality improvement.

COVID-19 Considerations and Prioritization of Future Investments

The COVID-19 pandemic brought a wave of hardship and fiscal uncertainty to the City of New York. Citywide employment declined by 18% between Q1 2020 and Q2 2022 with the steepest job losses taking place among low-wage sectors that require in-person activity (e.g., Accommodation & Food Services, Arts and Entertainment, and Recreation). Commercial districts emptied, with the reported vacancy rate for direct and sublet office real estate in Manhattan reaching 21.9%, twice the pre-pandemic rate. Commercial vacancy rates contributed to more than half of FY 2022's $1.7 billion decline in property taxes, the City's largest source of income. New York City Mayor Eric Adams lifted the COVID-19 vaccination mandates as of February 10, 2023, and employment rates have improved with current unemployment rates being about 5.3% but there are still challenges ahead. Nationally the post-COVID inflation surpassed a 40-year high with inflation rising by 8.56% on a year-over-year basis and energy prices rising by 32% during the period.

These difficulties have impacted many of our customers' ability to timely pay their bills, thus impacting DEP revenue necessary to maintain and expand the water and sewer systems. The City has not sold water and sewer liens since calendar year 2019, due to the City's decision to suspend lien sales during the Covid-19 pandemic and to the exclusion of water and sewer liens from the legislative authorizations obtained from the City Council for lien sales since the pandemic.

The City's Water Board acknowledged the stark economic realities of COVID-19 and did not propose a rate increase for the fiscal year beginning July 1, 2020. After adopting a smaller budget for Fiscal Year 2021, the Board resumed moderate rate increases in Fiscal Years 2022 and 2023 of 2.76% and 4.90%, respectively. The Board has also introduced a portfolio of customer assistance programs, in addition to its existing $30 million programs, with the objective of reducing customer delinquencies and encouraging customers with arrears to pay all or part of their bills, in exchange for an adjustment of late interest charges, in addition to authorizing $40 million of program funds for customers in the Low Income Home Water Assistance Program and certain categories of affordable multi-family properties.

In order to manage these complex challenges, DEP has begun to reach out to DEC and EPA to discuss mandated work so that design and construction schedules can align with expected revenues and expenditures on mandated work are balanced with sound investment in existing water and wastewater infrastructure. We will continue to engage stakeholders across the City as we navigate these unprecedented times and financial uncertainty while still investing in the future, providing New Yorkers with high levels of service, and keeping their rates affordable.

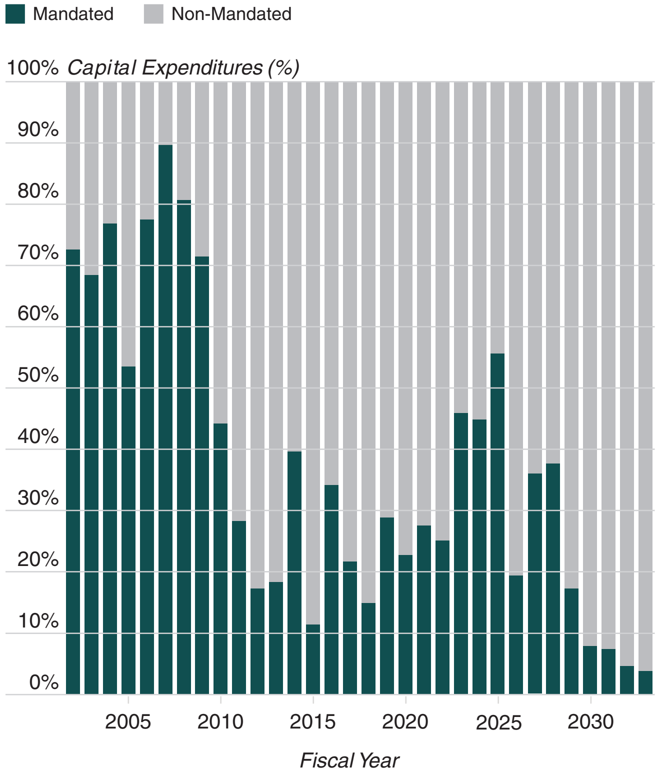
Holistic Adaptive Planning Framework

DEP recognizes the need to both prioritize short-term needs due to financial disruptions and post COVID-19 inflation, plus facilitate long-term planning and budget prioritization. DEP believes that taking a holistic adaptive planning approach will help to streamline DEP's efforts across all departments to maximize environmental and community benefits and achieve water quality goals as efficiently as possible, while maintaining sustainable rates.

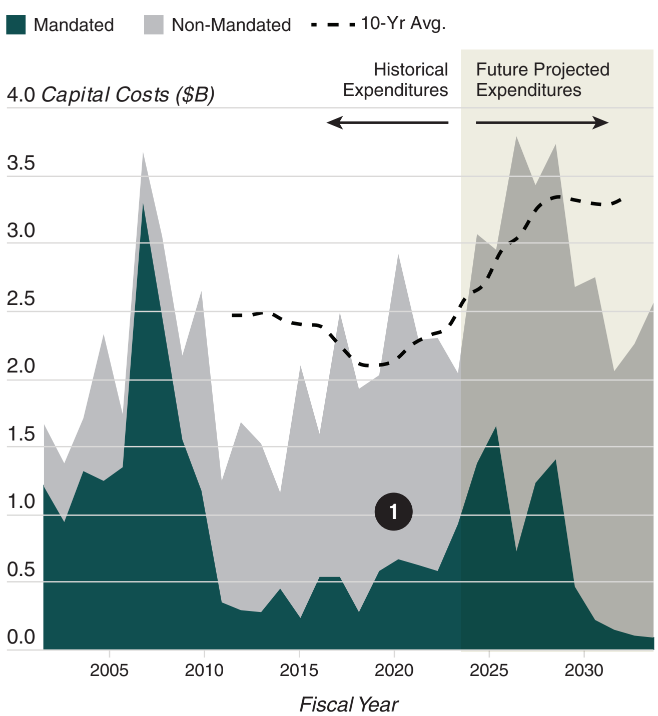
A holistic planning approach can:

- Provide an approach to evaluate opportunities to do more with less, that is, consider LTCP commitments as the baseline and determine whether other investments can achieve the equivalent or greater benefits with less spending
- Offer a balanced approach to meet operational needs and regulatory requirements, while considering affordability
- Provide a sound approach to prioritize capital projects that yield the highest benefits as efficiently as possible

Historical Mandated vs. Non-Mandated Capital Expenditures



Historical and Future Capital Commitments (pre-COVID-19)



1 *In FY20, DEP was only able to register about $1B of projects due to COVID19. As a result, $1.3B projects are being pushed in to the subsequent years that will likely displace other planned projects.*

DEP has historically had to balance several competing priorities between mandated and non-mandated programs. Although DEP has made substantial investments in meeting mandated commitments, other non-mandated priorities needed to be deferred to keep the capital budget affordable. Historically, capital spending was driven by state and federal mandates including Croton Water Filtration Plant, CAT/DEL UV, and Newtown Creek upgrades, which left limited resources for other critical needs like State of Good Repair. As shown in the adjacent bar chart from 2000 to 2009, DEP's capital commitments were primarily driven by mandates (ranging from 54% in 2000 to as high as 90% in 2007). Operational and State of Good Repair (SOGR) needs were significantly deferred until the early 2010's. DEP is still completing the deferred State of Good Repair, but additional disinvestment in State of Good Repair could exacerbate aging infrastructure and operational issues in the future. Thus, DEP is pursuing a more balanced approach to meet operational needs and regulatory requirements, while considering affordability.

Looking ahead, DEP's significant future capital commitments will need to be balanced with these SOGR and operational priorities, while also efficiently achieving water quality goals, enhancing resilience to climate change, and maintaining sustainable rates for all New Yorkers. Although DEP is currently balancing fiscal needs, COVID-19 is adding additional strain not previously accounted for. The adjacent area chart shows historical expenditures (2000 to 2022) and the current CIP expenditure forecast (2023 to 2033) for non-mandated and mandated projects. COVID-19 has created uncertainties for DEP, including uncertainty concerning the revenues likely to be available in the coming years and impacts that inflation will have on ability to construct these projects. Across Fiscal Years 2020 to 2024, DEP estimates that aggregate revenues will be more than $1.1 billion lower than the amounts forecast prior to the COVID-19 pandemic. In light of the lower revenue projections, DEP will need to look at a range of options, which could include re-examining the size and composition of its capital project budget. A holistic adaptive planning process will facilitate DEP's goal in evaluating the best strategies to maximize benefits efficiently. Multiple scenarios will be considered, including the possibility of extending mandated deadlines. Under all evaluation scenarios, DEP is committed to achieving the LTCP objectives, maintaining transparency, and continuing robust coordination with stakeholders to demonstrate viability and benefits of any potential alternatives.

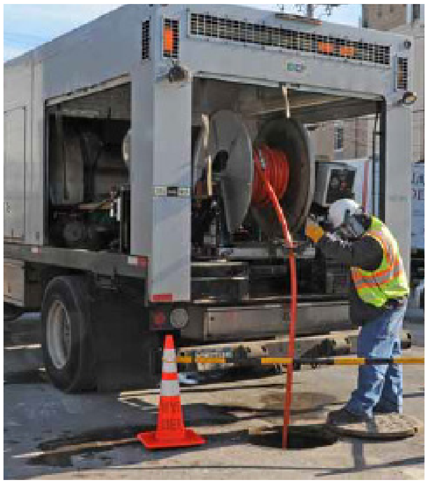
2. CSO Best Management Practices

CSO Best Management Practices (BMPs) address operation and maintenance procedures, maximizing use of existing systems and facilities, and related planning efforts to maximize capture of CSO and to reduce contaminants in the combined sewer system, thereby reducing water quality impacts. The State Pollutant Discharge Elimination System (SPDES) permits require DEP to report annually on its progress in implementing the 13 CSO BMPs summarized below.

The BMP Annual Reports are available on DEP's website:
https://www1.nyc.gov/site/dep/water/combined-sewer-overflows.page

BMP 1 - CSO Maintenance and Inspection Program

Schedule regular inspections of the CSO regulator structures and perform required repair, cleaning, and maintenance to minimize dry-weather overflows and to maximize flow to the WRRFs.



BMP 2 - Maximum Use of Collection System for Storage

Enable regulators and weirs to be adjusted to maximize system capacity for CSO storage through hydraulic capacity evaluations, along with cleaning and flushing to remove and prevent solids deposition within the collection system.

BMP 3 - Maximize Flow to Publicly Owned Treatment Plant

Maximize flow to WRRFs per the operating targets established by the SPDES permits for each WRRF to receive and treat a minimum of two times the design dry-weather flow during wet-weather events.

BMP 4 - Wet-Weather Operating Plan

Develop Wet-Weather Operating Plans (WWOPs) for each WRRF sewershed to maximize treatment during wet-weather events. DEP has submitted to DEC all WWOPs required by the Additional CSO BMP Special Conditions.

BMP 5 - Prohibition of Dry Weather Overflow

Abate and report any dry weather overflow event to DEC within 24 hours. Dry weather overflows from the combined sewer system are prohibited.

BMP 6 - Industrial Pretreatment

Maximize treatment of persistent toxics from industrial sources upstream of CSOs by regulating the discharges of toxic pollutants from unregulated, relocated, or new Significant Industrial Users (as defined by EPA under federal law) tributary to CSOs.

BMP 7 - Control of Floatable and Settleable Solids

Eliminate or minimize the discharge of floating solids, oil and grease, or solids of sewage origin that cause deposition in receiving waters through implementation of these four practices: Catch Basin Repair and Maintenance, Catch Basin Retrofitting, Booming, Skimming and Netting, and Institutional, Regulatory, and Public Education.

BMP 8 - Combined Sewer System Replacement

Replace combined sewers with separate sanitary and storm sewers whenever possible. All combined sewer replacements are to be approved by the New York City Department of Health and Mental Hygiene and to be specified within DEP's Master Plan for Sewage and Drainage.

BMP 9 - Combined Sewer Extension

Extend combined sewers through implementation of separate sewers whenever possible to minimize stormwater from entering the combined sewer system. If separate sewers must be extended from combined sewers, analyses must be performed to demonstrate that the sewage system and WRRFs are able to convey and treat the increased dry weather flows with minimal impact on receiving water quality.

BMP 10 - Sewer Connection and Extension Prohibitions

Prohibit, upon letter notification from DEC, sewer connections and extensions that would exacerbate recurrent instances of either sewer back-ups or manhole overflows. Wastewater connections to the combined sewer system downstream of the last regulator or diversion chamber are also prohibited.

BMP 11 - Septage and Hauled Waste

Prohibit discharge or release of septage or hauled waste upstream of a CSO. These wastes may only be discharged at designated manholes that never drain into a CSO, and only with a valid permit.

BMP 12 - Control of Runoff

Discharge only allowable flows into the combined or storm sewer system. All sewer certifications for new development must comply with DEP rules and regulations, be consistent with the DEP Master Plan for Sewers and Drainage, and be permitted by DEP.

BMP 13 - Public Notification

Place signage at or near CSO outfalls, with contact information for DEP, to allow the public to report observed dry weather overflows. DEP has a system in place to determine the nature and duration of an overflow event and notifies stakeholders of any resulting, potential harmful conditions.

3. Grey Infrastructure Strategies

Large-scale, centralized or end-of-pipe controls such as retention tanks or sewer modifications are called grey infrastructure. Recent DEP construction projects have included upgrades in key WRRFs, pump station improvements, storm sewer expansions, and the construction of several large CSO retention tanks to further mitigate CSO discharges. The following examples of grey infrastructure strategies have been or will be implemented across the watersheds included in the CSO LTCP Program.

Paerdegat Basin CSO Retention Facility

Example of a CSO Tunnel in Portland, OR

Example of a Typical Disinfection System

Retention Tanks

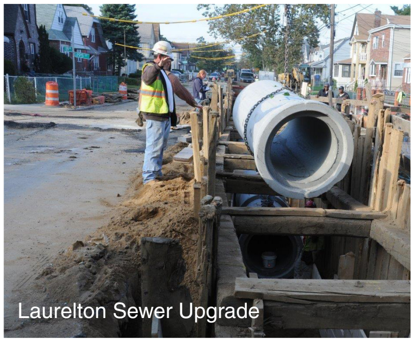
CSO retention tanks are large facilities that capture CSO during a wet-weather event, store it, and pump it back to a WRRF for treatment after the storm when capacity in the sewer system is restored. NYC has four existing CSO retention tanks located at Alley Creek, Flushing Creek, Paerdegat Basin and Spring Creek.

Tunnels

CSO storage tunnels function similarly to CSO retention tanks. The underground large diameter tunnel captures and temporarily stores the CSO. After the storm is over, the flow stored in the tunnel is pumped to the WRRF for treatment. NYC does not currently have any existing CSO storage tunnels.

Disinfection

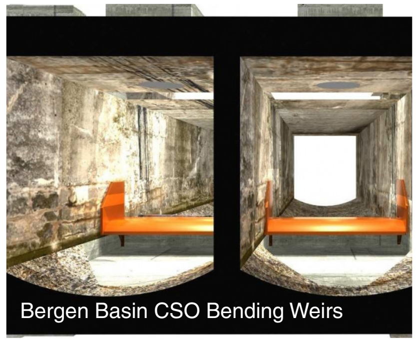
CSO disinfection kills bacteria in CSOs using a sodium hypochlorite solution (similar to concentrated bleach), often followed by dechlorination using sodium bisulfite. Disinfection facilities include chemical storage and feed equipment and a means to provide “contact time” between the disinfectant and the CSO, typically either in a tank or in a suitably-sized outfall pipe. Chlorination of sewage remains the most common and effective wastewater disinfection practice, but can be challenging at CSO facilities.



Laurelton Sewer Upgrade

Increasing Pipe Capacity

Providing larger combined sewer pipes can provide capacity to convey more flow to the WRRFs, or to relocate CSOs to less sensitive discharge locations.



Bergen Basin CSO Bending Weirs

Weir Modifications

Bending weirs, fixed weirs and regulator orifice modifications can prevent CSOs from discharging during smaller rainfall events. During a large rainfall event, the bending weir will bend or open, thus allowing a CSO to occur without increasing the risk of upstream flooding.

Glen Oaks Storm Sewer Extension

High Level Storm Sewers

High level storm sewers can be constructed to capture and divert stormwater from the combined sewer system, freeing up wet-weather capacity in the combined sewers and reduces the volume and frequency of CSO activations.

Jamaica Bay Floating Boom and DEP Skimmer Boat

Floatables Control

Floatables controls include structural controls such as booms, nets, screens or underflow baffles to prevent the discharge of floatables to waterbodies, as well as programmatic source controls such as catch basin improvements, street sweeping and public education campaigns to keep these materials out of the sewer system.

Upgraded Avenue V Pump Station

Pump Station Modifications

Pump station modifications can increase the conveyance of combined sewer flows to the WRRFs for treatment and can also relocate CSOs to less-sensitive discharge locations. The Gowanus and Avenue V Pump Stations in Brooklyn were previously upgraded, resulting in reduced CSOs to Gowanus Canal and Coney Island Creek.

26th Ward WRRF

Wastewater Resource Recovery Facility Upgrades

Upgrades to WRRFs can result in additional capture and treatment of combined sewage during wet-weather events, resulting in a decrease of the volume and frequency of CSOs to local waterways.

4. Green Infrastructure Strategies

The New York City Green Infrastructure (GI) Program was launched in January 2011 and committed $1.8 billion in funding through 2030 to manage stormwater and reduce CSOs in NYC. GI also provides many co-benefits such as neighborhood beautification, air quality improvements and cooler temperatures in hot summer months.

Green Infrastructure strategies detain stormwater runoff through capture and controlled release into the sewer system. GI may also retain runoff through capture and infiltration into the ground below or vegetative uptake and evapotranspiration.

Details on the GI Program elements and progress are described in the NYC Green Infrastructure Annual Reports available here: www.nyc.gov/dep/greeninfrastructure.

The GI Program entails four key strategies as summarized below:

Highlights

$1.8 Billion
GI investment in combined sewer areas through 2030

11,553
Assets constructed

2,094
Greened acres

Right-of-way Green Infrastructure

Rain Garden in Brooklyn

The public right-of-way (ROW) includes sidewalks, parking lanes, medians and the roadway. It makes up approximately 30% of the impervious cover in the city and generates stormwater runoff during rain events. In 2012, DEP launched area-wide GI projects, in partnership with Department of Transportation (DOT) and Department of Parks and Recreation (DPR). In addition to rain gardens, DEP constructs infiltration basins, porous pavements, green strips and stormwater greenstreets.

Public Property Retrofits


Green Infrastructure Playground at JHS 218K

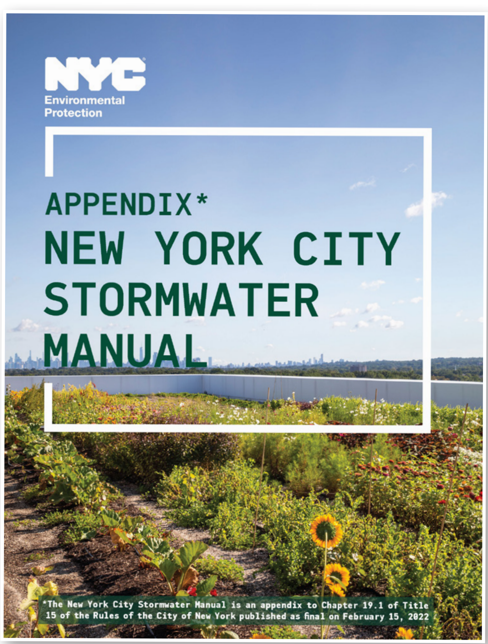
DEP partners with the Departments of Design & Construction, Parks & Recreation and Education and the New York City Housing Authority to design and construct "on-site" green infrastructure, meaning GI within the property lines of City-owned properties. Typical on-site green infrastructure types include rain gardens, turf fields, porous pavements and subsurface infiltration and storage. To date, over 140 on-site projects are constructed or in-construction and over 200 more are in design.

Private Property Incentives


Brooklyn Navy Yard Green Roof

Since 2011, DEP has offered a Grant Program to fund the design and construction of GI on non-City owned property. To date the Grant Program has committed over $14M to 34 projects. In May of 2021 DEP launched Resilient NYC Partners, marking a significant expansion of DEP's private incentives for GI. The program will focus on properties over 50,000 square feet (sf) in total lot area to maximize the cost effectiveness of the GI practices constructed under this program. DEP announced the first Resilient NYC Partners project in 2022.

Stormwater Rules

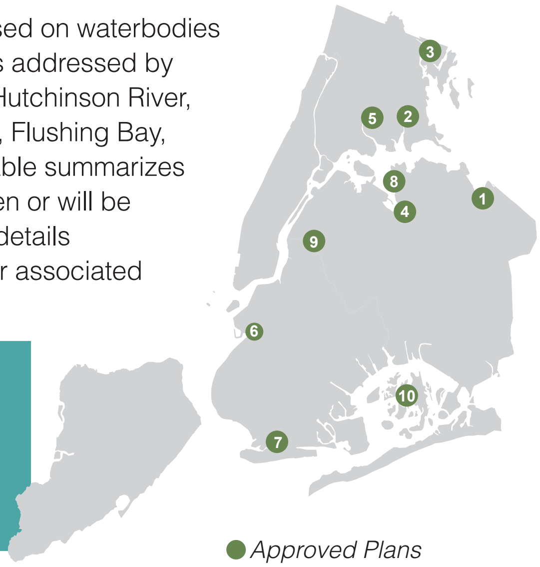


In February 2022 DEP promulgated the new Unified Stormwater Rule, which requires more effective on-site stormwater management as part of new and redevelopment, with updated requirements for stormwater quantity and flow rates and new requirements for water quality. Specific to GI, new and redevelopment projects that are greater than 20,000 sf will be required to infiltrate stormwater runoff on-site, when feasible. The Unified Stormwater Rule will result in more consistency across NYC stormwater regulations for public and private property and allow for more flexibility in design options.

5. Summary of Submitted LTCPs

Grey Infrastructure Implementation Plans

Prior to submittal of this LTCP, DEP submitted ten LTCPs that focused on waterbodies that are tributary to the open waters waterbodies. The waterbodies addressed by the ten previous LTCPs include: Alley Creek, Westchester Creek, Hutchinson River, Flushing Creek, Bronx River, Gowanus Canal, Coney Island Creek, Flushing Bay, Newtown Creek and Jamaica Bay and Tributaries. The adjacent table summarizes the existing and planned grey infrastructure projects that have been or will be implemented for these waterbodies. Attachment 2 provides more details regarding these cost-effective grey infrastructure projects and their associated benefits to each of the tributary waterbodies.



Highlights

CSO Volume Reductions

5.8 BGY	2.7 BGY*
WWFP CSO and GI Programs	LTCP CSO Program

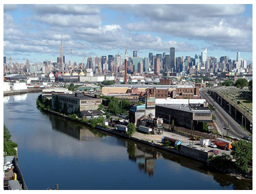
0.7 BGY receives disinfection treatment.

1 Alley Creek

3 Hutchinson River

5 Bronx River

7 Coney Island Creek



9 Newtown Creek

2 Westchester Creek

4 Flushing Creek

6 Gowanus Canal

8 Flushing Bay

10 Jamaica Bay and Tributaries

LTCP Program Commitments and Benefits

Waterbody	Existing Grey Infrastructure Projects	Dollars Spent (Millions)	CSO Volume Reduction (%)	LTCP Project	Escalated Capital Costs (Millions)[1]	Additional CSO Volume Reduction (%)[2]	Additional CSO Bacteria Reduction (%)[2]	Additional Treated CSO Volume (MGY)[2]
Alley Creek	CSO Storage Facility and Other Sewer Improvements	$141	60%	Seasonal Disinfection of Existing CSO Storage Tank	$25	-	59%	78
Westchester Creek	Weir Modifications and Parallel Sewer	$126	63%	None	$0	-	-	-
Hutchinson River	Hunts Point WRRF Headworks	$3	6%	2.8 MG Storage Conduit with Floatables Control	$204	15%	15%	-
Flushing Creek	CSO Storage Facility and Vortex Facilities	$363	50%	Seasonal Disinfection of Existing CSO Storage Tank and Outfall	$89	-	51%	584
Bronx River	Maximize Flow to WRRF and Floatables Control	$46	9%	Hydraulic Relief and Floatables Control	$122	37%	37%	-
Gowanus Canal	Flushing Tunnel and Pump Station Reconstruction	$198	44%	None per LTCP process; CSO Storage Tanks mandated per Superfund	$1,600	56%	56%	-
Coney Island Creek	Pump Station Expansion and Wet-Weather Force Main	$197	68%	None	$0	-	-	-
Flushing Bay	Sewer Diversion, Dredging, and Regulator Modifications	$71	19%	CSO Storage Tunnel	$1,471	51%	51%	-
Newtown Creek	Sewer and WRRF Improvements and Aeration	$262	20%	CSO Storage Tunnel and Upgrade of Borden Ave Pump Station	$2,401	61%	61%	-
Paerdegat Basin	CSO Storage Facility and Dredging	$394	57%	None	$0	-	-	-
Jamaica Bay & Tributaries	Sewer Improvements, CSO Storage Facility and Dredging	$706	47%	GI, Dredging, and other Environmental Improvements	$230	1%	10%	-
Open Waters	WRRF, Conveyance, and Regulator Improvements	$196	-	System Optimization	$84	2%	2%	-
TOTALS	**$2.7 Billion**			**$6.2 Billion[3]**				

[1] *Escalated costs include design, design services during construction, construction, and construction management costs, escalated per the implementation schedule.*
[2] *Additional reductions beyond existing grey infrastructure projects.*
[3] *Total LTCP and Superfund-mandated CSO control cost.*

Existing Green Infrastructure Program Total
$1.8 Billion
(thru 2030)

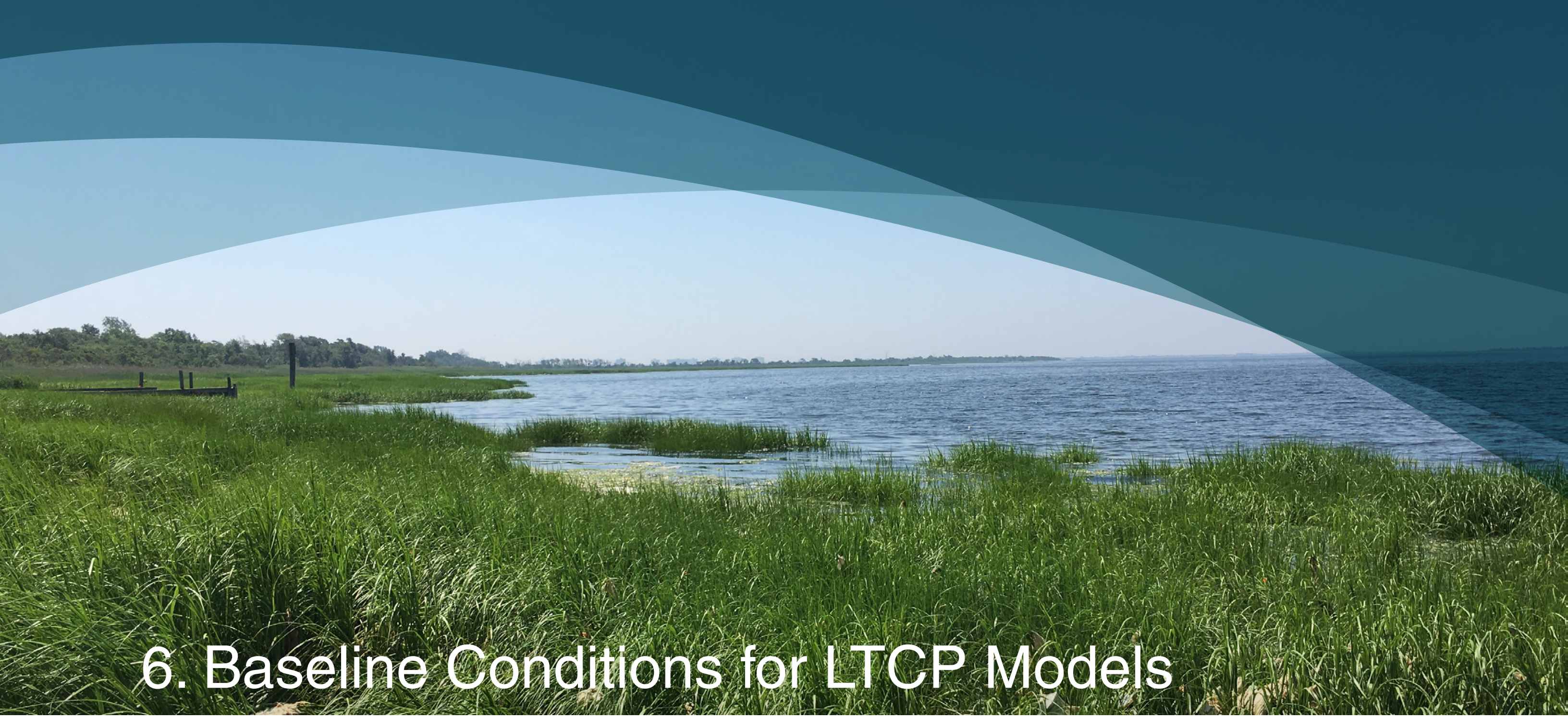
+

Existing Grey Infrastructure Projects
$2.7 Billion

=

Pre-LTCP CSO Program Total
$4.5 Billion

LTCP and Superfund-Mandated CSO Total
$6.2 Billion



6. Baseline Conditions for LTCP Models

Consistent with each of the previously-submitted LTCPs, a set of Baseline Conditions were established for this LTCP from which the potential benefits of additional CSO controls on the Open Waters waterbodies could be assessed. Most of the elements of the Baseline Conditions for this LTCP, such as the future dry weather flows, WRRF capacities and GI implementation, are similar to the Baseline Conditions established for the previously-submitted LTCPs. The one unique aspect of the Baseline Conditions for the Citywide/Open Waters LTCP is that for this LTCP, the recommended plans from the previously-submitted LTCPs are also included.

InfoWorks Model – Collection System Baseline Conditions

InfoWorks Model Level of Detail. The InfoWorks Model was developed to represent the sewer system on a macro scale, including conveyance elements generally greater than 48-inches in equivalent diameter, along with regulator structures and CSO outfall pipes. Smaller-diameter sewers were included for specific areas where greater model definition was desired.

Planning Horizon and Population. Year 2040 was established as the planning horizon and population for that time was developed by the Department of City Planning and the New York Metropolitan Transportation Council.

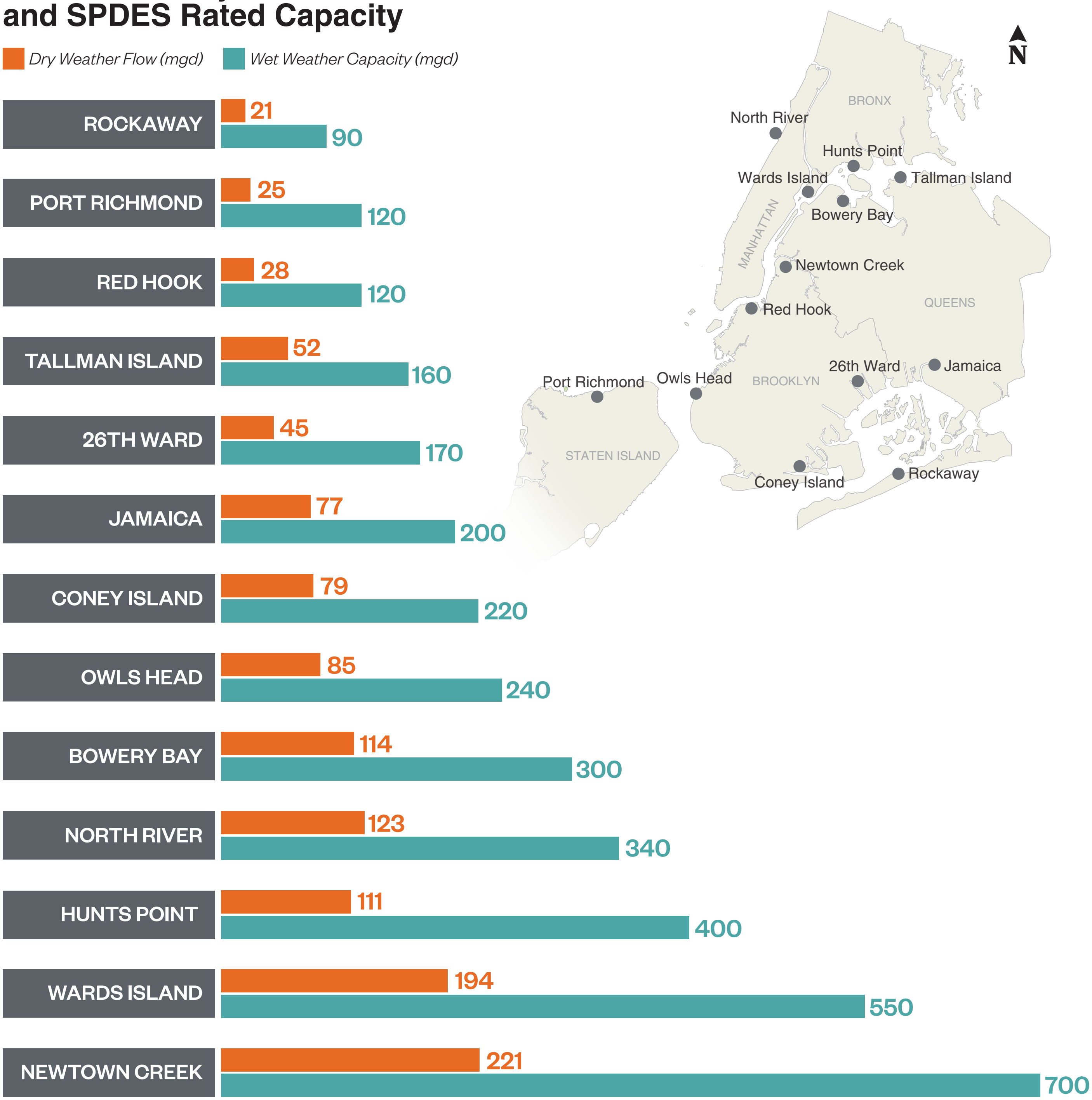
Submitted LTCP Recommended Plans and Existing Grey Infrastructure. Conditions in the tributaries to the Citywide/Open Waters waterbodies assume implementation of the recommended plans from the previously submitted LTCPs. The cost-effective grey infrastructure projects included are summarized in Attachment 2.

Green Infrastructure. Constructed or planned GI projects, as well as daylighting of Tibbetts Brook and potable water demand management projects for Central Park and Prospect Park were included in the baseline conditions for Citywide/Open Waters LTCP. The total anticipated CSO reduction benefit from the NYC GI program is 1.67 BGY.

Dry-Weather Flows. Year 2040 dry-weather wastewater flows to the WRRFs were established based on the 2040 population projection figures for each WRRF sewershed and DEP's projected 2040 dry weather per capita wastewater flow. These projections account for water conservation measures that have already significantly reduced flows to the WRRFs and freed up capacity in the conveyance system.

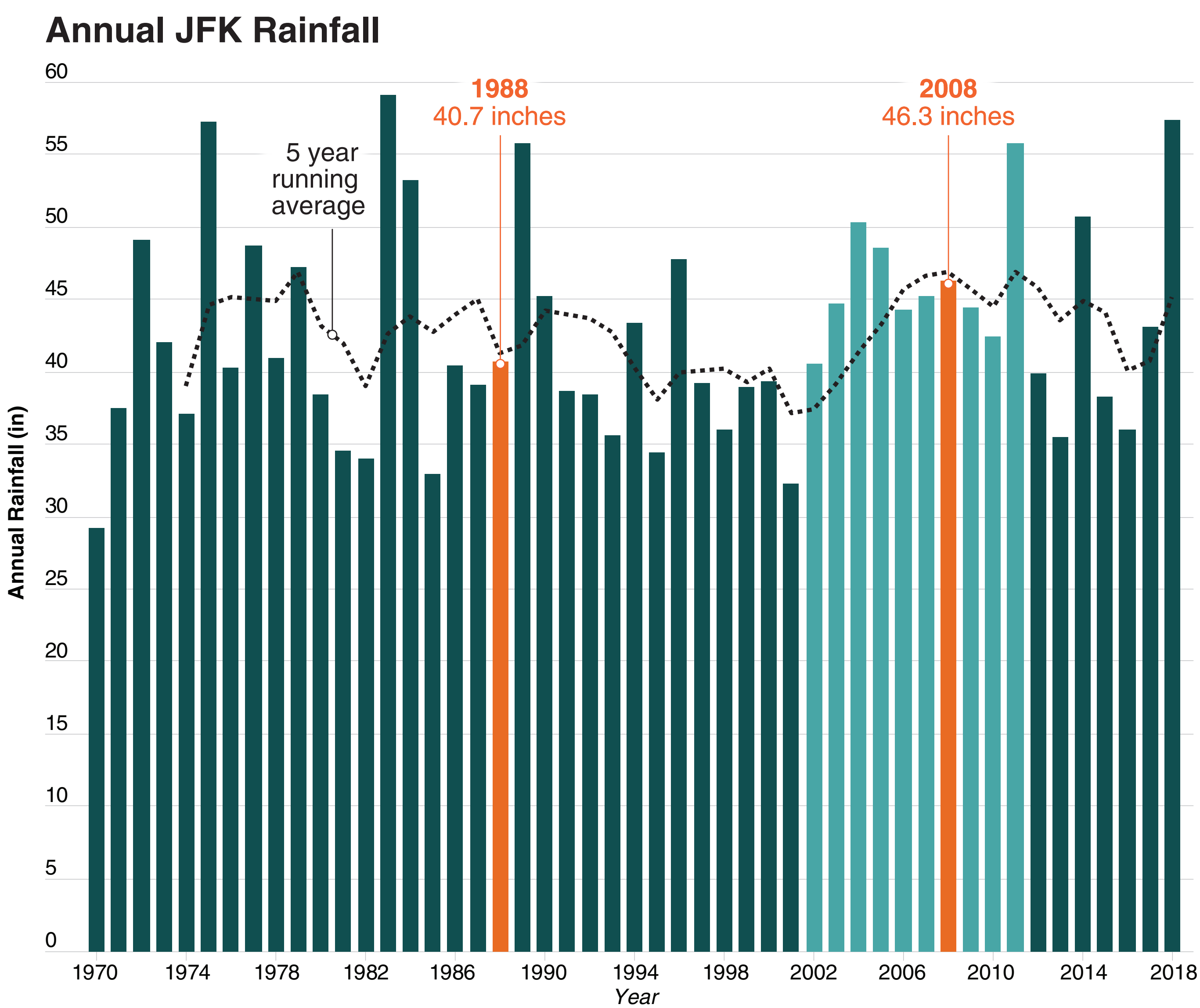
WRRF Capacities. The wet-weather (peak) rated capacity for each WRRF was based on two times the design dry-weather flow (2xDDWF) of each WRRF. The chart below summarizes the 2040 projected dry weather flows and SPDES rated wet-weather capacities for the WRRFs. The Oakwood Beach WRRF serves a separate sanitary system with no CSOs and is therefore not addressed in this LTCP.

WRRF 2040 Dry Weather Flow and SPDES Rated Capacity



Typical Year Rainfall. The 2008 rainfall from the JFK rainfall gauge was selected as the typical year rainfall. The 2002-2011 JFK rainfall period was also used to assess performance over a wider range of rainfall conditions. Tide data corresponding to the same timeframes as the rainfall were also incorporated into the InfoWorks Model. As indicated in the chart below, the JFK 2008 rainfall includes almost six inches more rainfall than the JFK 1988 rainfall that was used in previous CSO planning for the Waterbody/ Watershed Facility Plan (WWFP) evaluations, and is more consistent with recent rainfall trends.The 10-year period from (2002-2011) was the wettest continuous period over the past 50 years and provides a level of conservatism to the LTCP analysis.

InfoWorks Model Calibration. The InfoWorks models of the combined sewer systems with CSOs that discharge to the Open Waters waterbodies were calibrated to flow meter data from a total of 37 CSO regulators distributed throughout the combined sewer systems. The calibration process involved comparing modeled flows and volumes to the values measured at the 37 regulators for specific storms that occurred during the flow monitoring period. Minor adjustments to modeling parameters such as pipe roughness or runoff coefficients were made as appropriate to improve the match between the model and the meters. In some cases, field inspections were conducted to confirm the system configuration and to resolve differences between the meter and model data.



Water Quality Model – Water Quality Baseline Conditions

Pollutant Loadings. The Water Quality Model uses pollutant loadings that were generated by applying fecal coliform, *Enterococci*, and biological oxygen demand (BOD) concentrations to the projected flows from the InfoWorks Model. The concentrations were developed by employing either a mass balance procedure, or a statistical randomization of measured CSO concentrations.

CSO Bacteria Concentrations. Bacteria concentration data were collected at a total of 14 CSO outfalls that discharge directly to the Citywide/Open Waters waterbodies.

Stormwater Bacteria Concentrations. Bacteria concentration data were collected at a total of 20 stormwater outfalls that discharge to the Citywide/ Open Waters waterbodies and tributaries.

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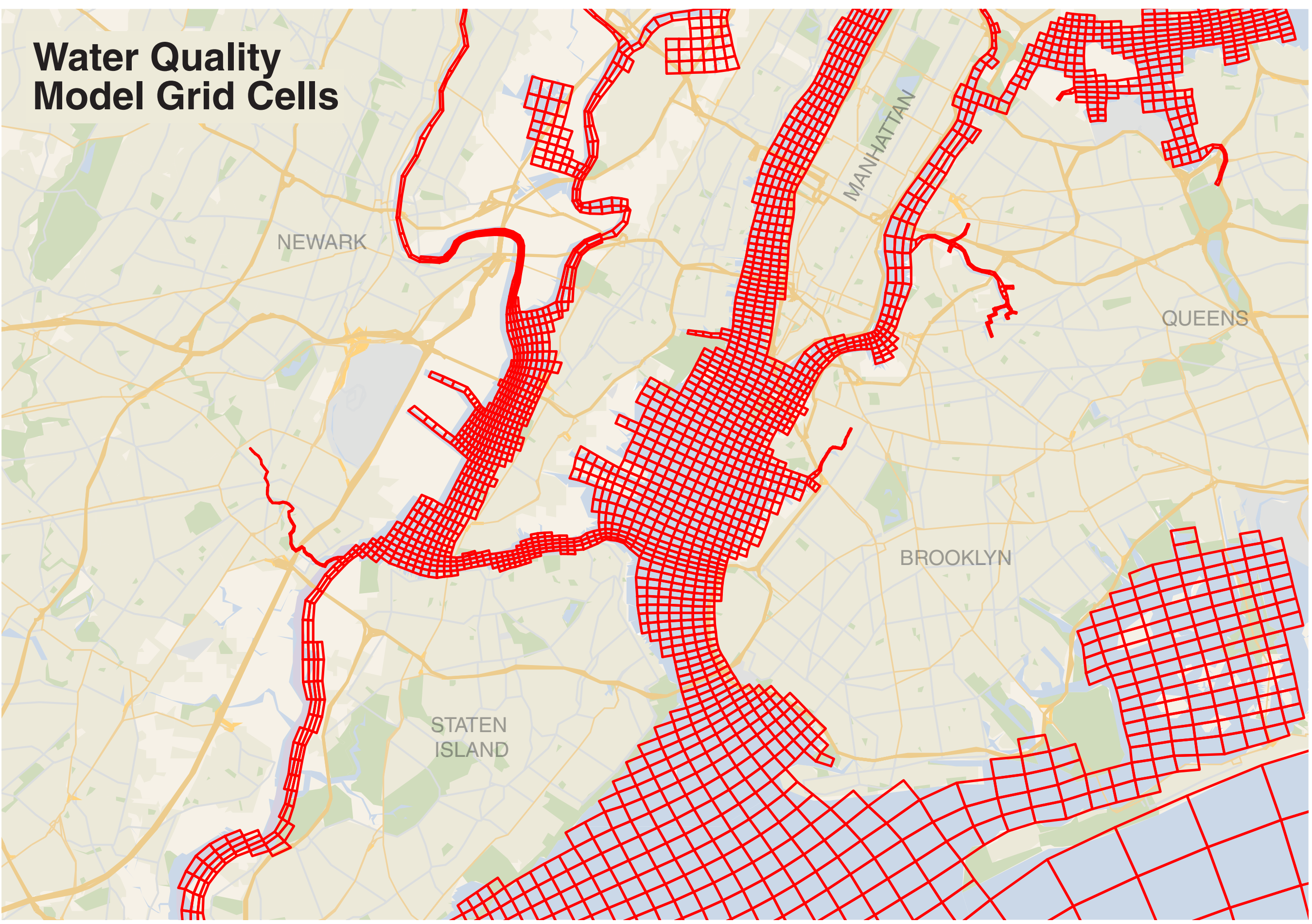
Direct Drainage Bacteria Concentrations. Bacteria concentrations in direct drainage areas were based on a range of literature sources.

WRRF Effluent Bacteria Concentrations. WRRF effluent bacteria concentrations were based on 2016 measurements, using a statistical selection of daily averages for fecal coliform and median of several months for *Enterococci*. BOD concentrations were based on model results.

Pollutant Loadings from Outside New York City. For some waterbodies pollutant loadings were identified from sources outside of NYC.

Water Quality Model Calibration. The water quality model was calibrated to sampling data collected from the Open Waters waterbodies through the LTCP program, as well as from DEP's Harbor Survey Monitoring and Sentinel Monitoring Programs. Collectively, these programs provided sampling data from over 150 locations throughout the Open Waters waterbodies.



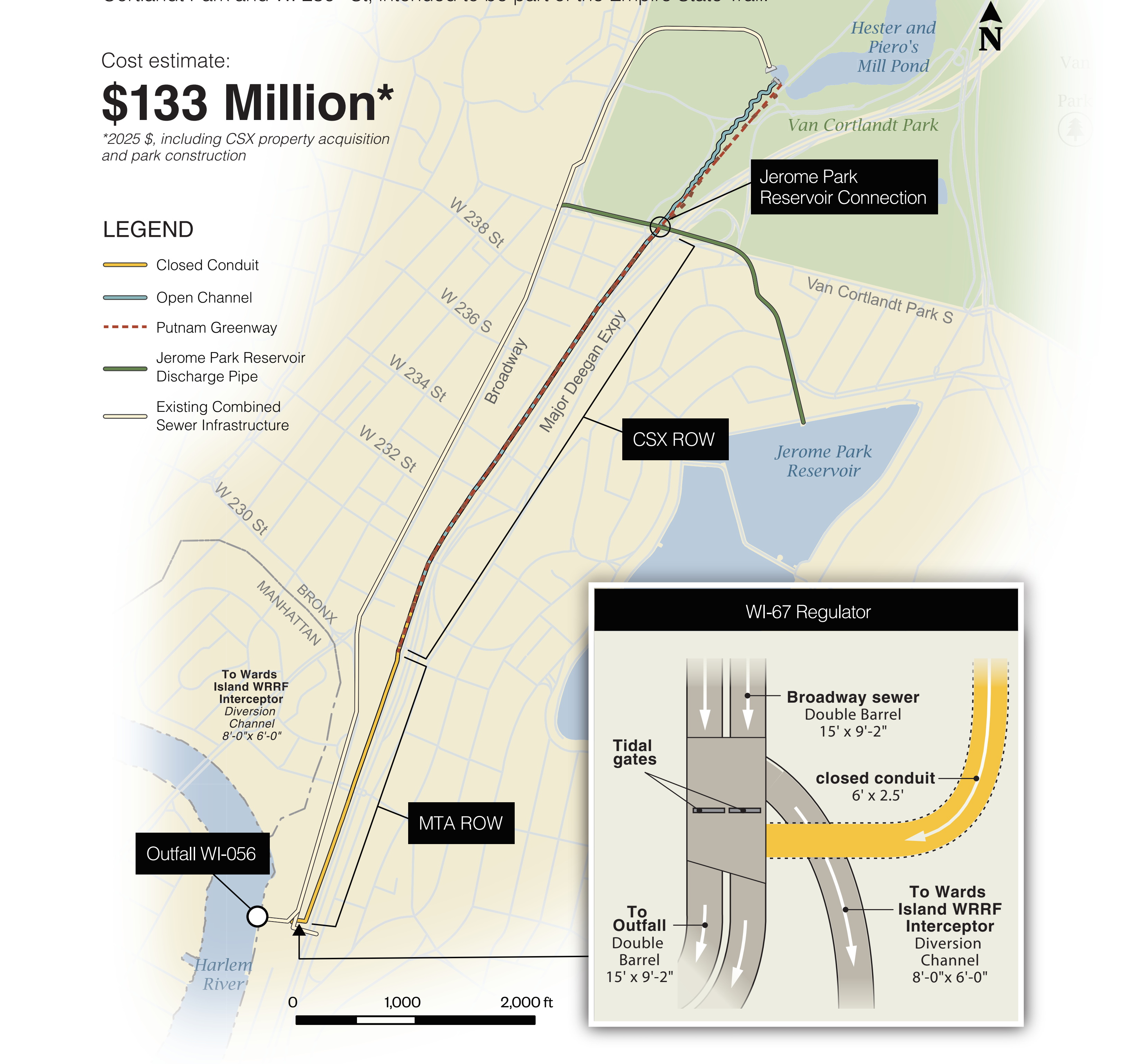
Tibbetts Brook Daylighting

Daylighting would restore the historical connection of Tibbetts Brook from Hester and Pierro's Mill Pond in Van Cortlandt Park to the Harlem River via new water conveyance system consisting of an open channel stream in Van Cortlandt Park and the former railroad right-of-way (CSX) and a closed conduit through the Metro North property, reducing flows to the combined sewer system. On a parallel path, DEP is also collaborating with NYC Parks Department to build a new public greenway between Van Cortlandt Park and W. 230th St, intended to be part of the Empire State Trail.

Cost estimate:

$133 Million*

**2025 $, including CSX property acquisition and park construction*



Benefits:

1. Reduces CSO discharges to Harlem River by 215-220 MGY
2. Reduces the dry-weather flows to the Wards Island WRRF associated with the pond overflow and Jerome Park Reservoir operations

Tibbetts Brook Daylighting effort includes:

1. Hester and Pierro's Mill Pond Improvements
2. Baseflow Daylighting of Tibbetts Brook via a water conveyance system

Rendering of new open channel south of the pond

Rendering of new side weir at southern end of Hester and Pierro's Mill Pond

Flow from Hester and Pierro's Mill Pond would be diverted through a new weir structure to a new open channel south of the pond

7. WQS Attainment and Alternatives Screening

Before starting on the analysis of CSO control alternatives for the Citywide/Open Waters waterbodies, it was important to establish baseline water quality (WQ) conditions, identify gaps between baseline water quality and attainment of water quality standards (WQS), and to determine if further CSO controls could close any identified gaps. The assessment of baseline water quality conditions identified future bacteria and DO levels assuming no additional control of the CSOs discharging directly to the Citywide/Open Waters waterbodies beyond those already required under the CSO Order as of the date of this LTCP. This baseline condition, however, also included implementation of the recommended plans for the 10 LTCPs covering tributary waterbodies previously submitted under the DEP's LTCP Program. Simulations were then performed to determine bacteria and DO levels under a theoretical condiition of no NYC CSO discharging directly to the Citywide/Open Waters waterbodies. The results of the baseline simulation were compared to the no NYC CSO load simulation, to determine whether bacteria and DO WQ criteria could be attained through the implementation of CSO controls. For bacteria, the gap was assessed for fecal coliform and for coastal primary recreational waters, *Enterococci*. As detailed below, a ten-year simulation using 2002-2011 JFK Airport rainfall was performed for the assessment of WQS attainment for bacteria and a one-year simulation was performed for DO using 2008 JFK Airport rainfall. These simulations served as the basis for the evaluation of the CSO control alternatives presented in Section 8.0.

Summary of WQ Standards Compliance

✓ *yes* ✗ *no* *not applicable*

		Fecal Coliform Monthly GM(1)		Enterococci 30-day GM(2)		Enterococci 30-day STV(2)		Dissolved Oxygen (DO)	
Waterbody	**Classification**	**Baseline Conditions**	**No NYC CSO**	**Baseline Conditions**	**No NYC CSO**	**Baseline Conditions**	**No NYC CSO**	**Baseline Conditions**	**No NYC CSO**
Harlem River	Class I	✓	✓					✓	✓
Hudson River	Class SB	✓	✓					✓	✓
	Class I	✓	✓					✓	✓
East River	Class SB	✓	✓					✓	✓
	Class I	✓	✓					✓	✓
Long Island Sound	Class SB Coastal	✓	✓	✓	✓	✓	✓	✓	✓
New York Bay	Class SB Coastal	✓	✓	✓	✓	✗	✓	✗ (3)	✗ (3)
Kill Van Kull	Class SD	✗ (3)	✗ (3)					✓	✓
Arthur Kill	Class SD	✗ (3)	✗ (3)					✓	✓
	Class I	✗ (3)	✗ (3)					✗ (3)	✗ (3)

(1) Fecal Coliform attainment is assessed on an annual basis. (2) Enterococci attainment is assessed for the recreational season (May 1st through October 31st).
(3) With no NYC CSO loads, WQS will not be fully attained due to sources from outside of NYC.

Highlights

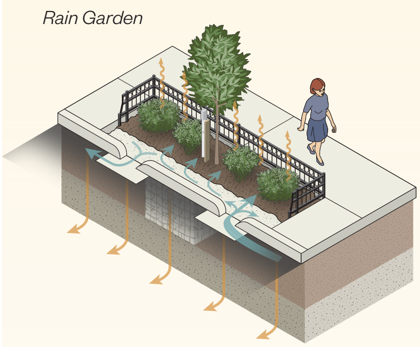
- **Over $9B** in investments have been made or committed as part of the CSO Program to date
- **Total CSO discharge to open waters is about 11 BGY**. This is a small fraction (5%) compared to the total 251 BGY that is captured and treated at the city's Citywide/Open Waters WRRFs
- Baseline WQ shows high levels of attainment with applicable WQS with exception of:
  - Upper/Lower Bay WQ shows some localized exceedances of the new (2019) *Enterococci* STV criteria
  - Arthur Kill and Kill Van Kull (located between NY and NJ) shows some non-attainment with the fecal coliform criteria
    - Staten Island is primarily MS4
    - With no NYC CSO loads, WQS will not be fully attained due to sources outside of NYC
- Large-scale, expensive CSO control alternatives will provide minimal improvement in WQS attainment in most areas
- **Citywide/Open Waters LTCP will focus on lower-cost system optimization** alternatives, but 25/50/75/100% Control was assessed per CSO Policy, through tank/tunnel storage

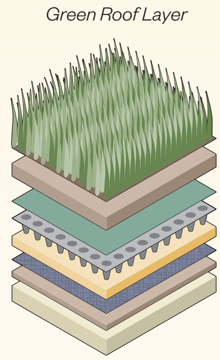
Consistent with previous LTCPs, the alternatives screening process begins with a toolbox of alternatives to evaluate. These alternatives are subject to a series of screening steps where infeasible or less favorable alternatives are screened out and retained alternatives are subject to further evaluation. The toolbox for the Citywide/Open Waters LTCP alternatives is presented below.

CSO Mitigation	Toolbox of Alternatives				
Source Control	Green Infrastructure		Storm Sewers		
System Optimization	Regulator Modifications	Parallel Interceptor Sewer	Bending Weirs or Control Gates	Pump Station Optimization	Pump Station Expansion
CSO Relocation	Gravity Flow Diversion to other Watersheds	Pump Station Modifications	Flow Diversion with New Conduit and/or Pumping		
Water Quality/ Ecological Enhancement	Floatables Control	Environmental Dredging	Wetland Restoration and Daylignting		
Satellite Treatment	Outfall Disinfections	Retention Treatment Basin (RTB)	High Rate Clarification (HRC)		
Centralized Treatment	WRRF Expansion				
Storage	In-System	Tank	Tunnel		

Retained Alternatives · Screened-out Technologies · Ongoing Projects

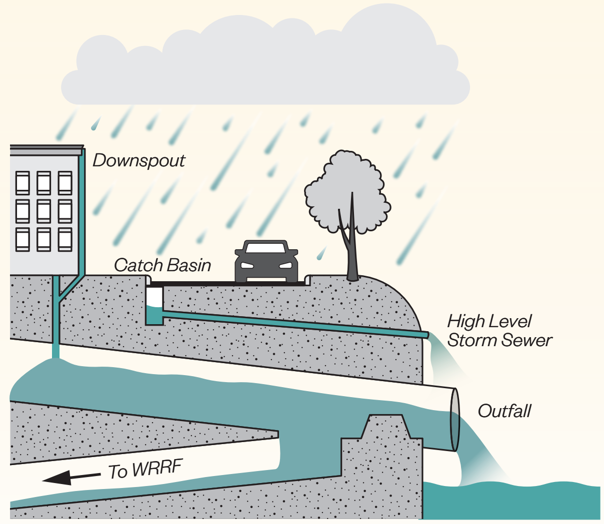
Ongoing Projects





Green infrastructure

Green infrastructure is being implemented throughout the Citywide/Open Waters waterbodies in accordance with the GI Implementation Plan. Opportunities for GI continue to be evaluated through the various outreach and incentive programs offered by DEP.



Storm Sewers

High level storm sewers and/or sewer separation will continue to be evaluated throughout the Citywide/Open Waters waterbodies as a means to address drainage level of service issues and in conjunction with potential new development.

Screened-out Technologies

Pump Station Optimization/ Expansion

These alternatives were considered using optimization software, but no viable alternatives were identified.

WRRF Expansion

WRRF expansion was evaluated for each WRRF using the collection system models, but no substantial reduction in CSO discharge was identified.

Environmental Dredging

Solids deposition from CSOs was not identified as an aesthetic issue. As a result, no locations for environmental dredging were identified.

Outfall Disinfection

Outfall Disinfection was screened out due to insufficient length/volume within existing outfalls and little potential improvement to attainment with WQS.

Retention Treatment Basin (RTB)

RTBs were screened out due to limited potential impact on WQS attainment.

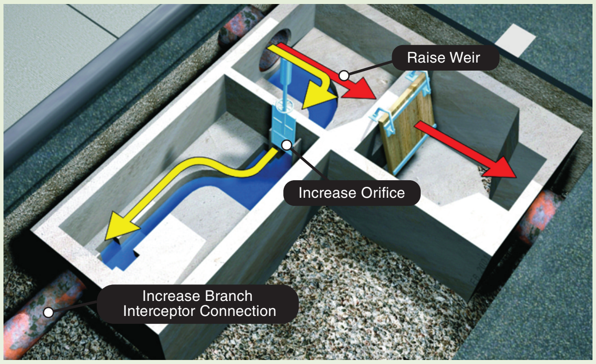
In-System Storage

In-System storage within CSO outfalls was screened out due to insufficient length/volume to provide meaningful volume reduction.

Flow Diversion with New Conduit and Pumping & Pump Station Modification

No cost-effective opportunities for CSO relocation via flow relocation to a less-sensitive receiving water with a conduit/tunnel and pumping or via pump station modification were identified.

What is Being Retained



System Optimization

System optimization measures include relatively low-cost modifications to CSO regulators or the connections between the regulators and the interceptors. These modifications typically include raising/lengthening overflow weirs and/or removing hydraulic restrictions. These modifications can reduce CSOs by allowing more flow into the interceptor for conveyance to the downstream WRRF.

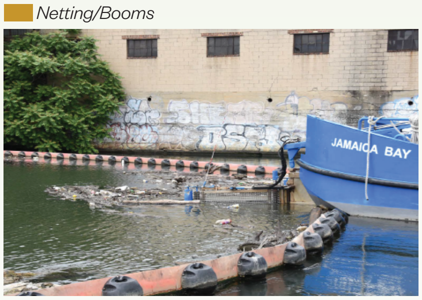
Storage Tunnels

Storage tunnels can capture large volumes of CSO for storage. Drop shafts are provided to convey the CSO from the surface piping to the storage tunnel, and a dewatering pump station is typically provided at the downstream end of the tunnel for pumping the stored flow to a WRRF. For the sizes of the storage tunnels described in this LTCP, separate treatment systems would be required to treat the dewatered flow, to prevent over-taxing the WRRF treatment systems.

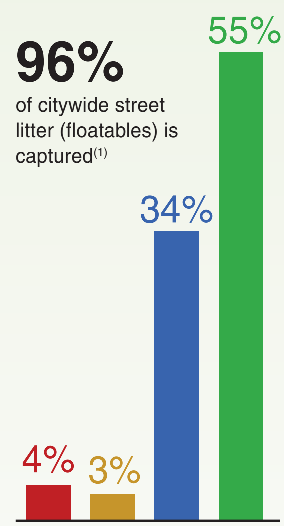
Street Sweeping

Catch Basin Hooding

Netting/Booms



Wastewater Resource Recovery Facility (WRRF)



Citywide Floatables Capture

(1) **Source**: NYC Stormwater Management Program, NYCDEP, August 2018

Floatables Control

Floatables control approaches can include capturing materials at or near the end of the pipe, using screens, nets or booms, and can also include actions and programs implemented to keep floatables and trash from entering the sewer system. These programs can include street sweeping, catch basin hooding and cleaning, and public awareness campaigns to reduce street litter. These programs, which the DEP has been implementing for a number of years, have been demonstrated to significantly reduce the quantities of floatables released to the surrounding waterbodies. DEP intends to continue and expand upon these and other programs to address floatables control in the Open Waters.

8. Waterbody Snapshots and Retained Alternatives

Harlem River

Hudson River

East River/Long Island Sound

Lower and Upper New York Bay

Arthur Kill and Kill Van Kull

Harlem River

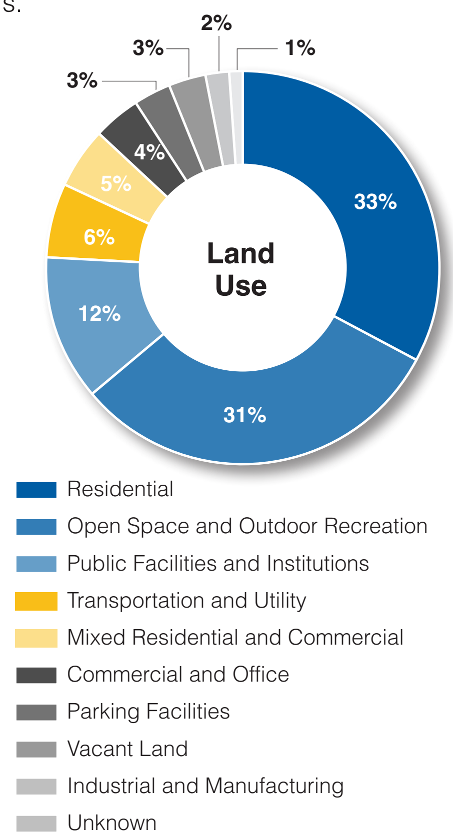
Introduction

The Harlem River is an 8-mile long, navigable tidal channel which separates the island of Manhattan from the Bronx, and connects the Hudson River to the East River. The sewershed within NYC tributary to the Harlem River (the "sewershed") is approximately 9,674 acres and is served by combined and storm sewer systems. The shorelines of Harlem River are composed of a mix of bulkheads, rip-rap, and natural areas.

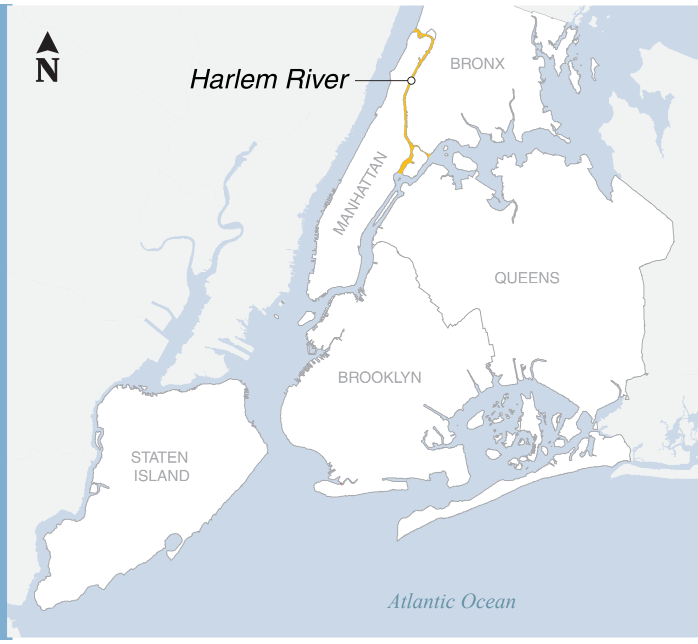
Parts of the collection systems of the Wards Island and North River WRRFs are located within the Harlem River sewershed. During wet-weather, if the sewer system or WRRF is at full capacity, a diluted mixture of combined storm and sanitary flow may discharge through one or more of the 65 SPDES-permitted CSO outfalls to the Harlem River. No MS4 outfalls are located along the Harlem River.

DEC has classified Harlem River as a Class I waterbody, where best uses are secondary contact recreation and fishing, and the waters should be suitable for fish, shellfish, and wildlife propagation and survival. Water quality in the Harlem River is influenced by CSO discharges, direct drainage runoff and tidal exchanges with the Hudson River and the East River.

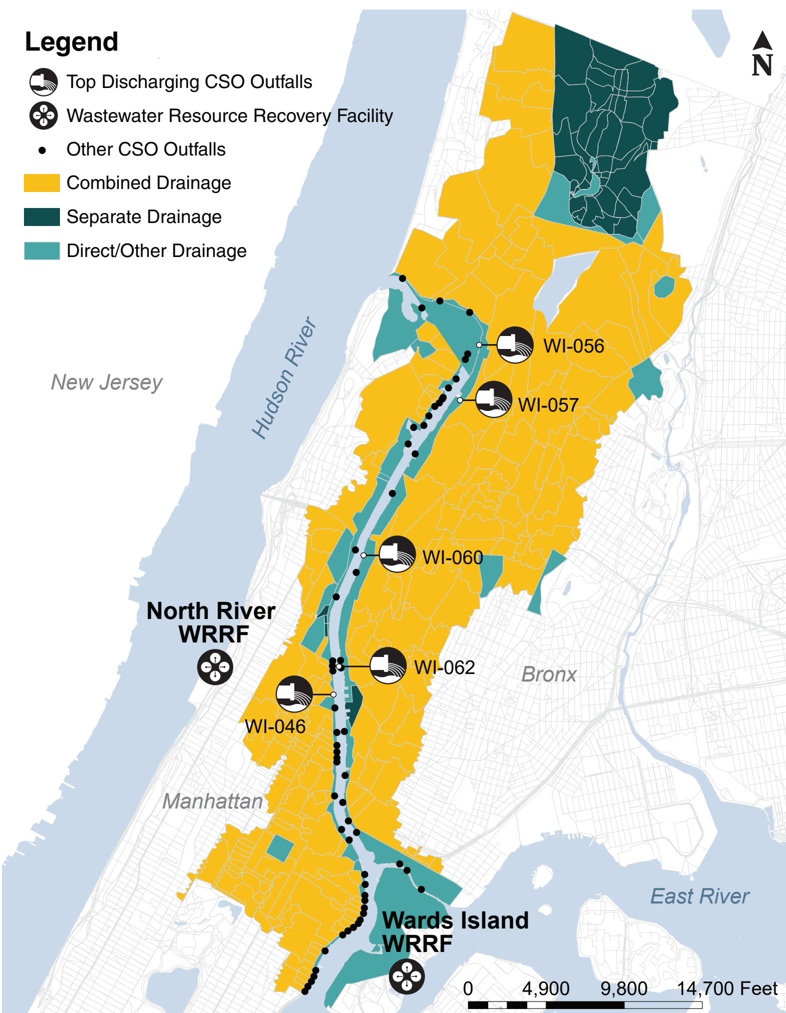
The multiple bridges over the Harlem River tend to limit the use of the Harlem River as a route for large commercial/industrial marine vessels. Boat traffic along the Harlem River generally tends to be mostly private recreational vessels or smaller commercial vessels.



The Harlem River is located at the north end of Manhattan, separating the island from the Bronx. The 8-mile long tidal strait flows between the Hudson River and the East River.

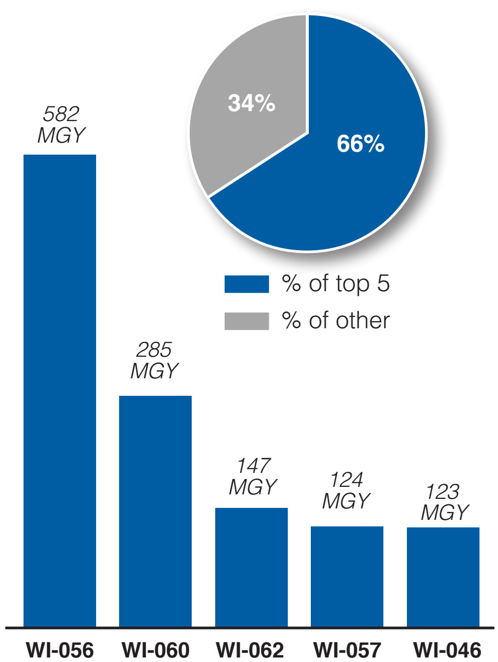


Harlem River Sewershed CSO Outfalls

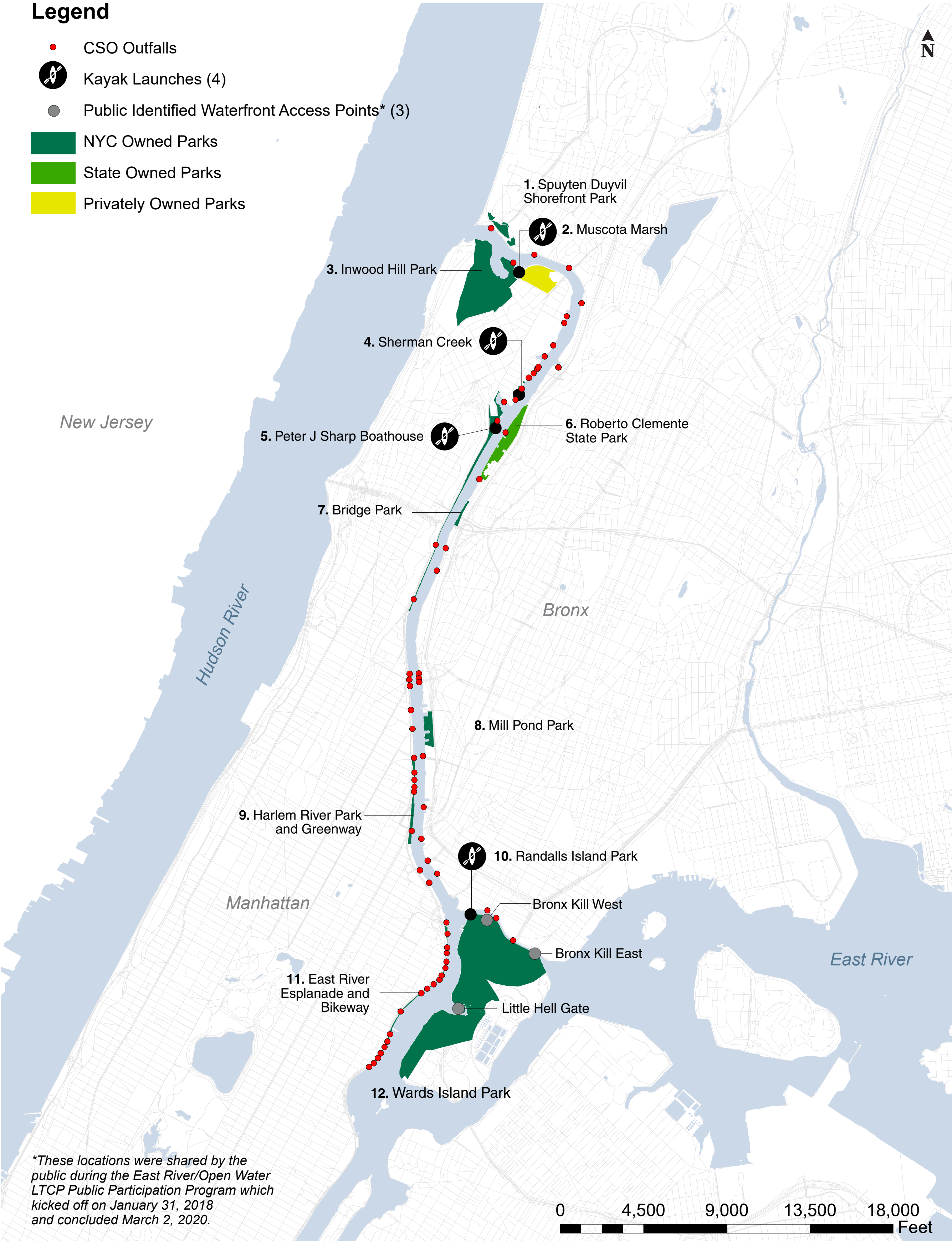


Top Discharging CSO Ouftalls

A total of 65 CSO outfalls are located along the shorelines of the Harlem River. The total CSO discharge volume is about 1,900 million gallons per year (MGY). The top 5 discharging CSO outfalls account for 66% of this total volume and their associated average annual discharge volumes are shown in the bar chart below.



Key Waterfront Access Points

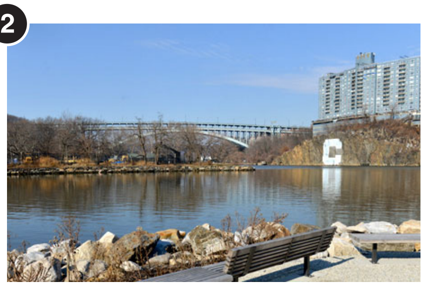


Open Space/Outdoor Recreation Areas

The Harlem River sewershed is highly urbanized and is primarily composed of residential and open space/outdoor recreational areas within the boroughs of Bronx and Manhattan. Open space and recreation make up 31 percent of the sewershed, due to the numerous City parks which cover a significant fraction of the area. Notable outdoor recreation areas within this sewershed include the Roberto Clemente State Park and City-owned parks such as Randalls Island Park, Wards Island Park, Inwood Hill Park, and the Harlem River Park and Greenway. The map on the left highlights the key waterfront access points with some associated photos shown below.

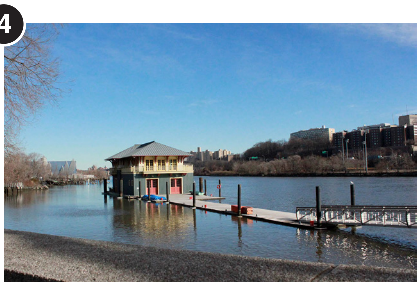
1

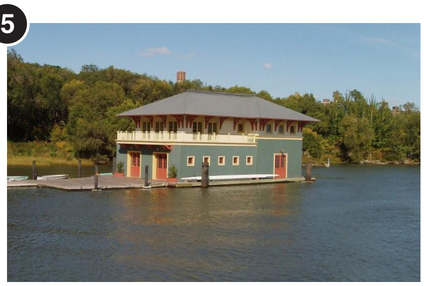
Spuyten Duyvil Shorefront Park

2

Muscota Marsh

3

Inwood Hill Park

4

Sherman Creek

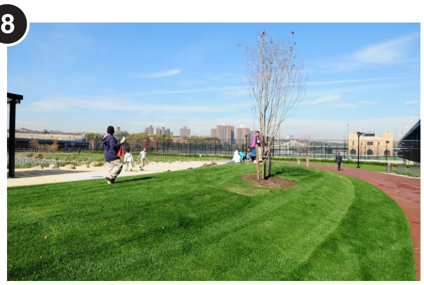
5

Peter J Sharp Boathouse

6

Roberto Clemente State Park

7

Bridge Park

8

Mill Pond Park

9

Harlem River Park and Greenway

10

Randalls Island Park

11

East River Esplanade and Bikeway

12

Wards Island Park

Harlem River Retained Alternatives

As described in the WQS Attainment and Alternatives Screening section, a range of alternatives were considered for the Harlem River. These alternatives went through a sequential screening process to arrive at a list of alternatives to be retained for cost performance evaluations. The retained alternatives for the Harlem River are summarized below. The locations of the regulators to be modified under these alternatives are shown in the figure below.

Retained Alternative HAR-1

Optimization of regulators associated with Outfalls NR-008, NR-009, NR-017 and NR-007; replacement of the regulator associated with Outfall NR-010; relocating and upsizing the main interceptor in the vicinity of NR-008, NR-009, and NR-010. This alternative results in a reduction of 19 MG of CSO to the Harlem River in the typical year. This reduction is offset by a 4 MG increase in volume to the Hudson River for an overall net reduction of 15 MG.

Retained Alternative HAR-2

Optimization of regulator associated with Outfall NR-008; replacement of the regulator associated with Outfall NR-010; relocating and upsizing the main interceptor in the vicinity of NR-008 and NR-010. This alternative results in a reduction of 17 MG of CSO to the Harlem River in the typical year. This reduction is offset by a 4 MG increase in volume to the Hudson River for an overall net reduction of 13 MG.

Location of the regulators to be modified under HAR-1 and HAR-2

Retained Alternative HAR-3 through HAR-6

These alternatives consist of storage tunnels sized to provide a range of 25/50/75/100 percent control of CSO volume to the Harlem River for the 2008 typical year. The table below summarizes the dimensions of these tunnels.

	HAR-3	HAR-4	HAR-5	HAR-6
Level of CSO Control [1]	**25%**	**50%**	**75%**	**100%**
WRRF Outfalls Captured	Wards Island	Wards Island	Wards Island	Wards Island, North River
Length (mi)	5	5	6	6
Diameter (ft)	11	28	32	39
Volume (MG)	20	130	190	269
# of Outfalls Captured	3 of 5 Top Discharge Outfalls	3 of 5 Top Discharge Outfalls	5 of 5 Top Discharge Outfalls • 4 Other Outfalls	5 of 5 Top Discharge Outfalls • 60 Other Outfalls

(1) Modeled annual percent reduction based on 2008 typical year.

Summary of Retained Alternatives

The table below summarizes the CSO volume reduction and estimated cost associated with each of the retained alternatives for the Harlem River.

✓ *yes* ✗ *no* *not applicable*

Alternative	Net CSO Volume Reduction (MGY)	Estimated Probable Bid Cost (2019 $M)	Cost Effective[1]	No Additional CSO to Tributaries
HAR-1: Optimization	15[2]	$36	✗	✓
HAR-2: Optimization	13[3]	$31	✗	✓
HAR-3: 25% Tunnel	476	$800	✗	✓
HAR-4: 50% Tunnel	991	$1,900	✗	✓
HAR-5: 75% Tunnel	1,486	$3,200	✗	✓
HAR-6: 100% Tunnel	1,899	$8,000	✗	✓

(1) An alternative is defined as cost-effective if it provides substantial reduction in CSO volume and/or improvement in WQS attainment relative to its cost.

(2) Alternative HAR-1 reduces CSO volume to the Harlem River by 19 MG. This reduction is offset by a 4 MG increase in CSO volume to the Hudson River for an overall net reduction of 15 MG.

(3) Alternative HAR-2 reduces CSO volume to the Harlem River by 17 MG. This reduction is offset by a 4 MG increase in CSO volume to the Hudson River for an overall net reduction of 13 MG.

Retained Alternatives Selected for the Recommended Plan

The Tibbetts Brook Daylighting project, part of the baseline conditions for the LTCP, will result in 228 MG reduction in CSO volume to the Harlem River in the typical rainfall year. None of the five retained alternatives for grey infrastructure were selected for the Recommended Plan, as none were determined to be cost-effective in terms of CSO volume controlled or change in WQS attainment.
For more information on Tibbetts Brook Daylighting project please see page 21.

Summary of WQ Standards Compliance

✓ *yes* ✗ *no* *not applicable*

		Fecal Coliform Monthly GM[1]		Enterococci 30-day GM[2]		Enterococci 30-day STV[2]		Dissolved Oxygen (DO)	
Waterbody	**Classification**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**
Harlem River	Class I	✓	✓					✓	✓

(1) Fecal Coliform attainment is assessed on an annual basis. (2) Enterococci attainment is assessed for the recreational season (May1st through October 31st).

Hudson River

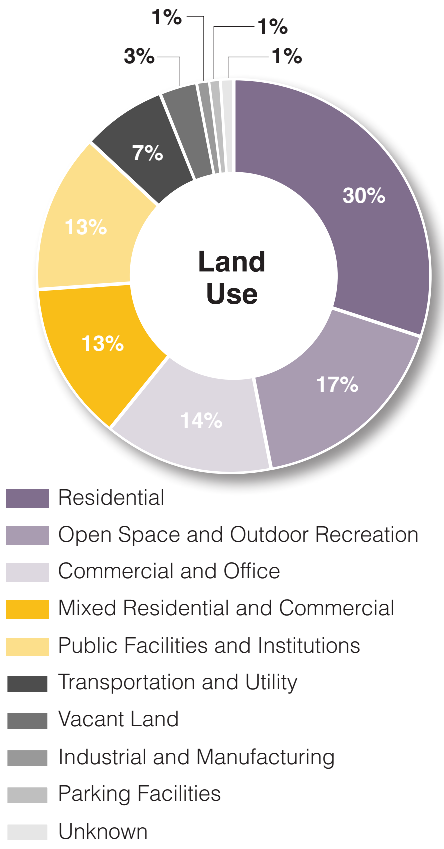
Introduction

This LTCP focuses on the 21-mile long portion of the Hudson River that flows along New York City, from Riverdale in the Bronx, into the Upper New York Bay at The Battery. The sewershed within New York City tributary to the Hudson River is approximately 6,635 acres. The shorelines of the Hudson River are composed of a mix of bulkheads, rip-rap, and natural areas.

Parts of the collection systems of the Wards Island, North River, and Newtown Creek WRRFs are located within the Hudson River sewershed. During wet-weather, a diluted mixture of combined storm and sanitary flow may discharge through one or more of the 52 New York City SPDES-permitted CSO outfalls to the Hudson River. Two New York City MS4 outfalls are located along the Hudson River.

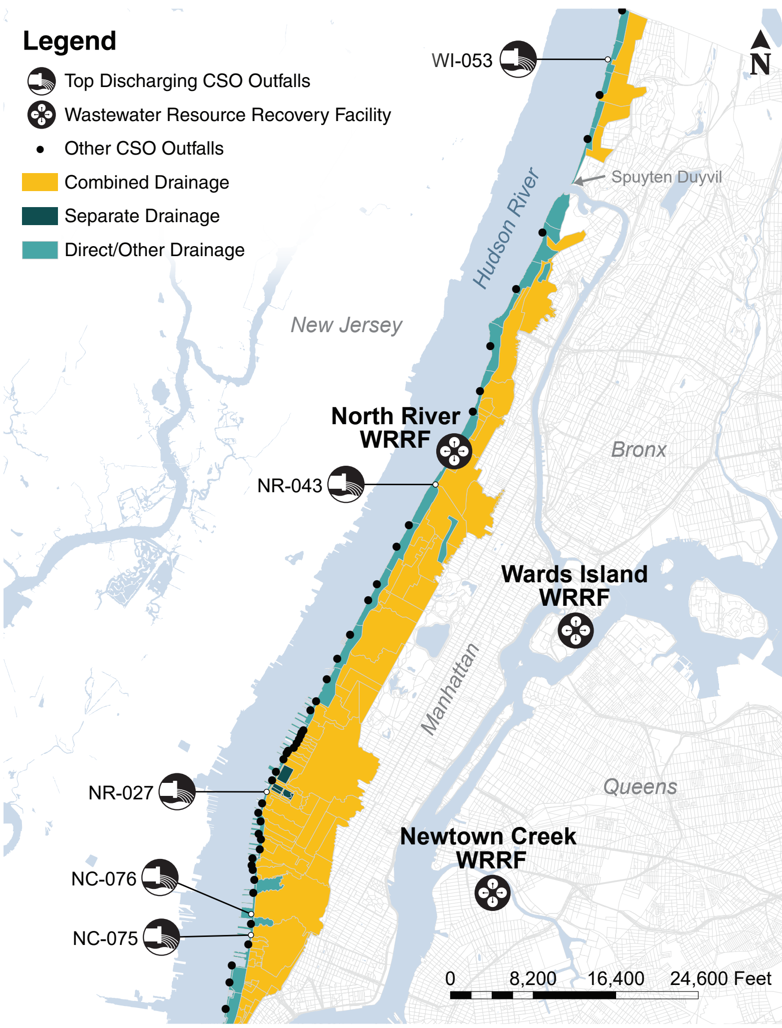
DEC has classified the Hudson River north of Spuyten Duyvil as a Class SB waterbody, and the portion south of Spuyten Duyvil to The Battery as a Class I waterbody. Best uses for Class SB waterbodies are primary and secondary contact recreation and fishing, while best uses for Class I waterbodies are secondary contact recreation and fishing. Both Class SB and Class I waterbodies should be suitable for fish, shellfish, and wildlife propagation and survival. Water quality in the Hudson River is influenced by CSO, stormwater, tidal exchanges, and sources from outside of NYC.

Boat traffic along the Hudson River can include commercial/industrial marine vessels such as tankers, barges, tugboats, cruise ships and ferries, in addition to private recreational vessels.



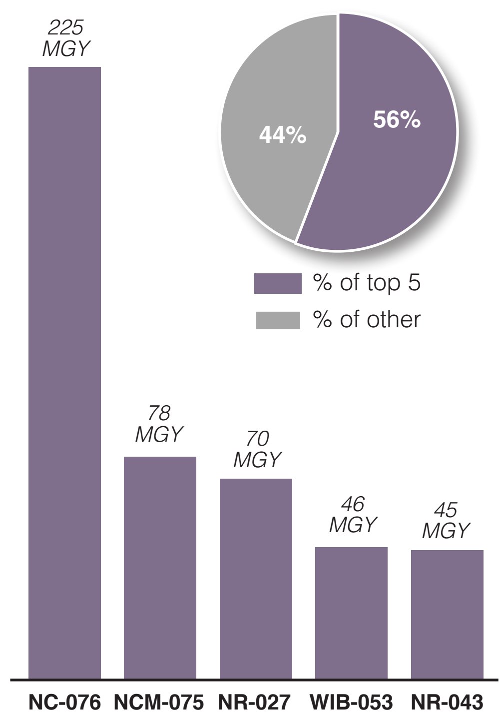
The Hudson River is located along the west shoreline of Manhattan, running between Manhattan and New Jersey.

Hudson River Sewershed CSO Outfalls

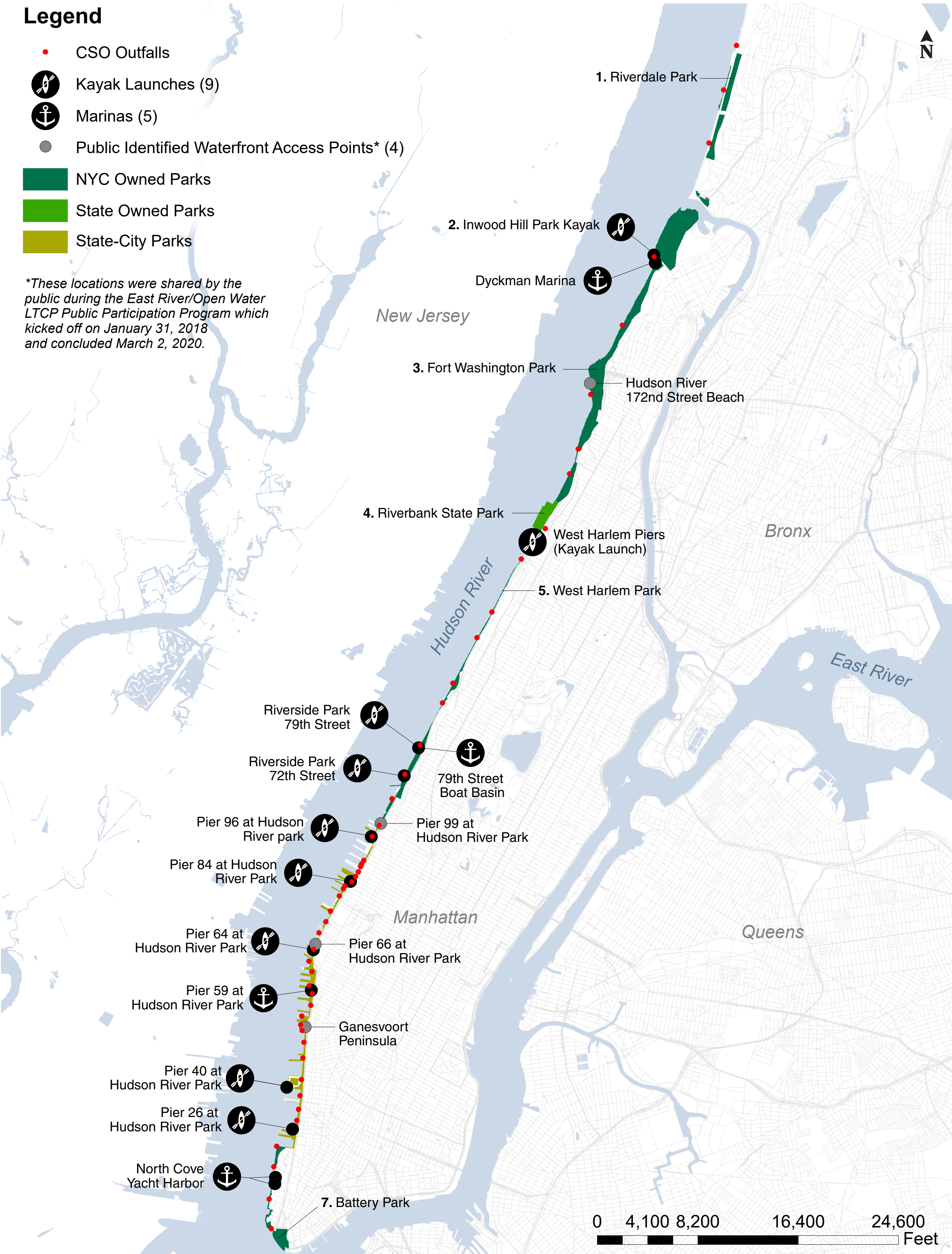


Top Discharging CSO Ouftalls

A total of 52 CSO outfalls are located along the shoreline of the Hudson River. The total CSO discharge volume is about 833 million gallons per year (MGY). The top 5 discharging CSO outfalls account for 56% of this total volume and their associated average annual discharge volumes are shown in the bar chart below.

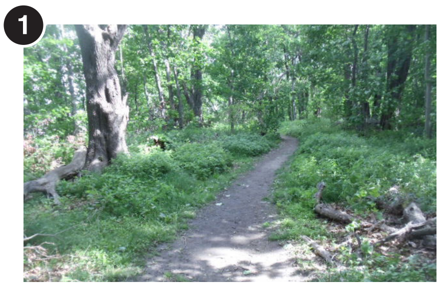


Key Waterfront Access Points



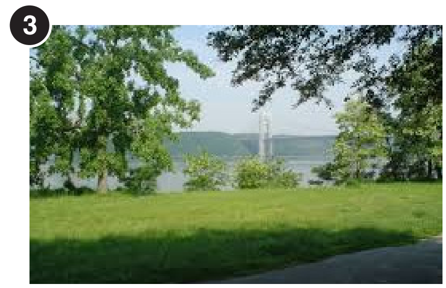
Open Space/Outdoor Recreation Areas

The Hudson River sewershed is highly urbanized and is primarily composed of residential and open space/outdoor recreational areas within the boroughs of Bronx and Manhattan. Open space and recreation make up 17 percent of the sewershed, due to the numerous City parks which cover a significant fraction of the area. Notable outdoor recreation areas within this sewershed include the State-owned Riverbank State Park and City-owned parks such as Inwood Hill Park, Fort Washington Park, Riverside Park, and Battery Park. The map on the left highlights the key waterfront access points with some associated photos shown below.

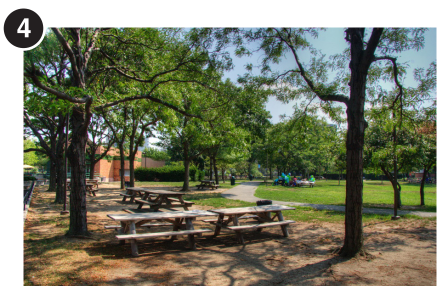


Riverdale Park

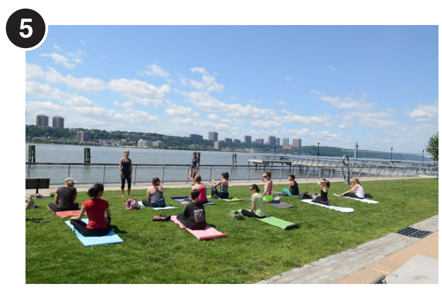
Inwood Hill Park



Fort Washington Park



Riverbank State Park



West Harlem Park

Pier 96

Battery Park

Hudson River Retained Alternatives

As described in the WQS Attainment and Alternatives Screening section, a range of alternatives were considered for the Hudson River. These alternatives went through a sequential screening process to arrive at a list of alternatives to be retained for cost performance evaluations. The retained alternatives for the Hudson River are summarized below. The location of the regulators to be modified under these alternatives are shown in the figure below.

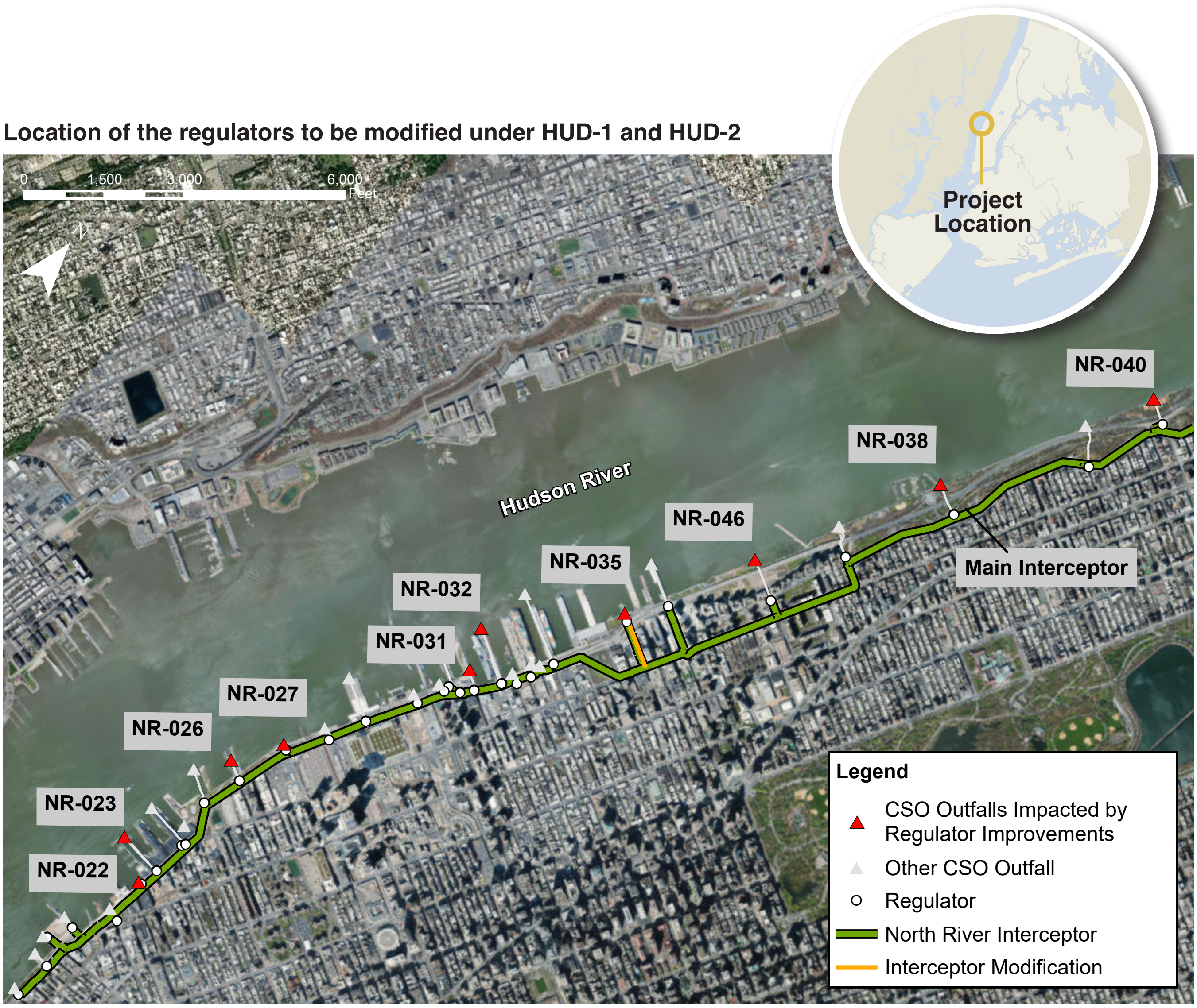
Retained Alternative HUD-1

Optimization of regulators associated with Outfalls NR-040, NR-038, NR-046, NR-035, NR-032, NR-031, NR-027, NR-026, NR-023 and NR-022. This alternative results in a reduction of 12 MG of CSO to the Hudson River in the typical year. This reduction is partially offset by a 3 MG increase to the Harlem River, resulting in a net 9 MG reduction.

Retained Alternative HUD-2

Optimization of regulators associated with Outfalls, NR-040, NR-038 and NR-046. This alternative results in a reduction of 10 MG of CSO to the Hudson River in the typical year. This reduction is partially offset by a 3 MG increase to the Harlem River, resulting in a net 7 MG reduction.

Location of the regulators to be modified under HUD-1 and HUD-2



Retained Alternative HUD-3 through HUD-6

These alternatives consist of storage tunnels sized to provide a range of 25/50/75/100 percent control of CSO volume to the Hudson River for the 2008 typical year. The table below summarizes the dimensions of these tunnels.

	HUD-3	HUD-4	HUD-5	HUD-6
Level of CSO Control(1)	**25%**	**50%**	**75%**	**100%**
WRRF Outfalls Captured	Newtown Creek	Newtown Creek, North River	Newtown Creek, North River	Newtown Creek, North River, Wards Island
Length (mi)	2	7	11	15
Diameter (ft)	14	19	18	18
Volume (MG)	14	79	114	142
# of Outfalls Captured	2 of 5 Top Discharge Outfalls	4 of 5 Top Discharge Outfalls • 1 Other Outfall	4 of 5 Top Discharge Outfalls • 13 Other Outfalls	5 of 5 Top Discharge Outfalls • 47 Other Outfalls

(1) Modeled annual percent reduction based on 2008 typical year.

Summary of Retained Alternatives

The table below summarizes the CSO volume reduction and estimated cost associated with each of the retained alternatives for the Hudson River.

✓ *yes* ✗ *no* *not applicable*

Alternative	Net CSO Volume Reduction (MGY)	Estimated Probable Bid Cost (2019 $M)	Cost Effective(1)	No Additional CSO to Tributaries
HUD-1: Optimization	9(2)	$19	✗	✗
HUD-2: Optimization	7(3)	$3	✓	✓
HUD-3: 25% Tunnel	209	$600	✗	✓
HUD-4: 50% Tunnel	438	$1,500	✗	✓
HUD-5: 75% Tunnel	613	$2,900	✗	✓
HUD-6: 100% Tunnel	833	$5,200	✗	✓

(1) An alternative is defined as cost-effective if it provides substantial reduction in CSO volume and/or improvement in WQS attainment relative to its cost.
(2) 12 MGY reduction to Hudson River, and 3 MGY increase to Harlem River. (3) 10 MGY reduction to Hudson River, and 3 MGY increase to Harlem River.

Retained Alternatives Selected for the Recommended Plan

Alternative HUD-2 was selected for inclusion in the Recommended Plan, as this alternative provides a cost-effective reduction in CSO volume to the Hudson River. HUD-1 was less cost-effective than HUD-2, and the tunnel alternatives (HUD-3, HUD-4, HUD-5, HUD-6) all carried very high costs without substantially changing the level of WQS attainment.

Summary of WQ Standards Compliance

✓ *yes* ✗ *no* *not applicable*

		Fecal Coliform Monthly GM(1)		Enterococci 30-day GM(2)		Enterococci 30-day STV(2)		Dissolved Oxygen (DO)	
Waterbody	**Classification**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**
Hudson River	Class SB Coastalvv	✓	✓					✓	✓
	Class I	✓	✓					✓	✓

(1) Fecal Coliform attainment is assessed on an annual basis. (2) Enterococci attainment is assessed for the recreational season (May 1st through October 31st).

East River/Long Island Sound

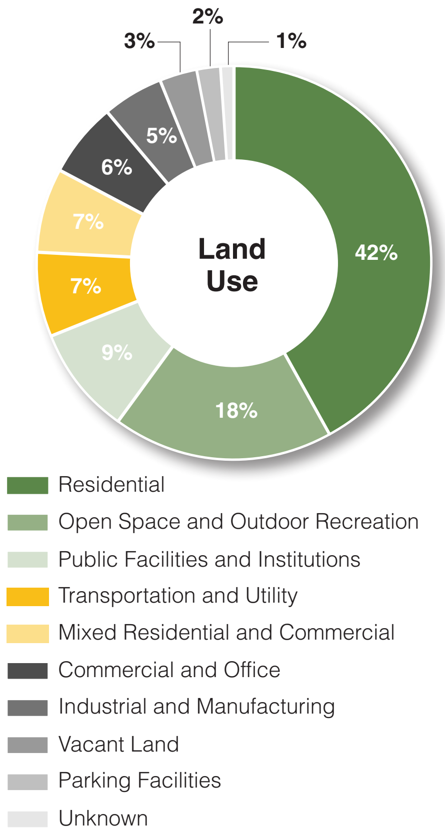
Introduction

The East River is 16 miles long, connecting Upper New York Bay to Long Island Sound. The portion of Long Island Sound addressed in this LTCP extends from the East River to Eastchester Bay. The sewershed tributary to the East River/Long Island Sound (ER/LIS) is approximately 30,000 acres. The shorelines of the ER/LIS include a mix of bulkheads, rip-rap, marinas, piers, natural areas and several beaches located along Eastchester Bay.

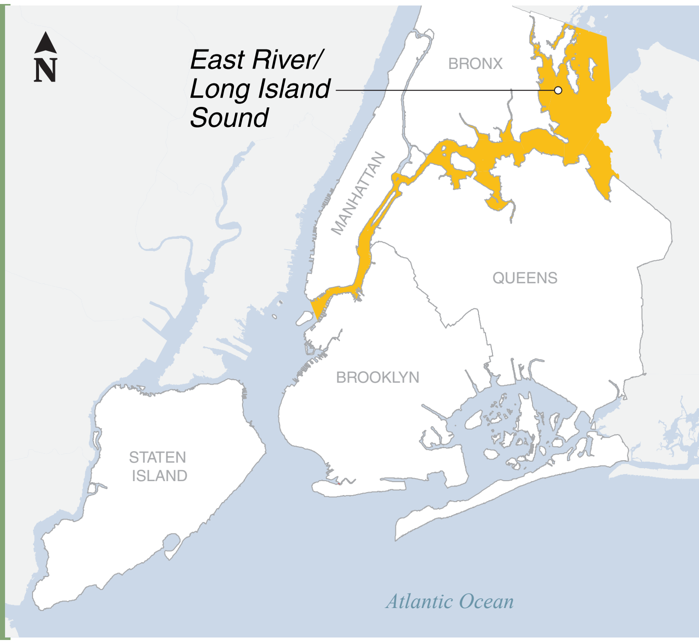
Parts of the collection systems of the Hunts Point, Wards Island, Tallman Island, Bowery Bay, Newtown Creek, and Red Hook WRRFs are located within the ER/LIS sewershed. During wet-weather, a diluted mixture of combined storm and sanitary flow may discharge through one or more of the 139 SPDES-permitted CSO outfalls to the ER/LIS. A total of 28 MS4 outfalls are located along the ER/LIS.

DEC has classified the LIS as Class SB Coastal Primary Recreational. The ER is Class SB between the Whitestone and Throgs Neck Bridges, while the remainder of the ER is designated Class I. Best uses for Class SB waterbodies are primary and secondary contact recreation and fishing, while best uses for Class I waterbodies are secondary contact recreation and fishing. Both Class SB and Class I waterbodies should be suitable for fish, shellfish, and wildlife propagation and survival. Water quality in the ER/LIS is influenced by CSO, stormwater, tidal exchanges, and tributaries.

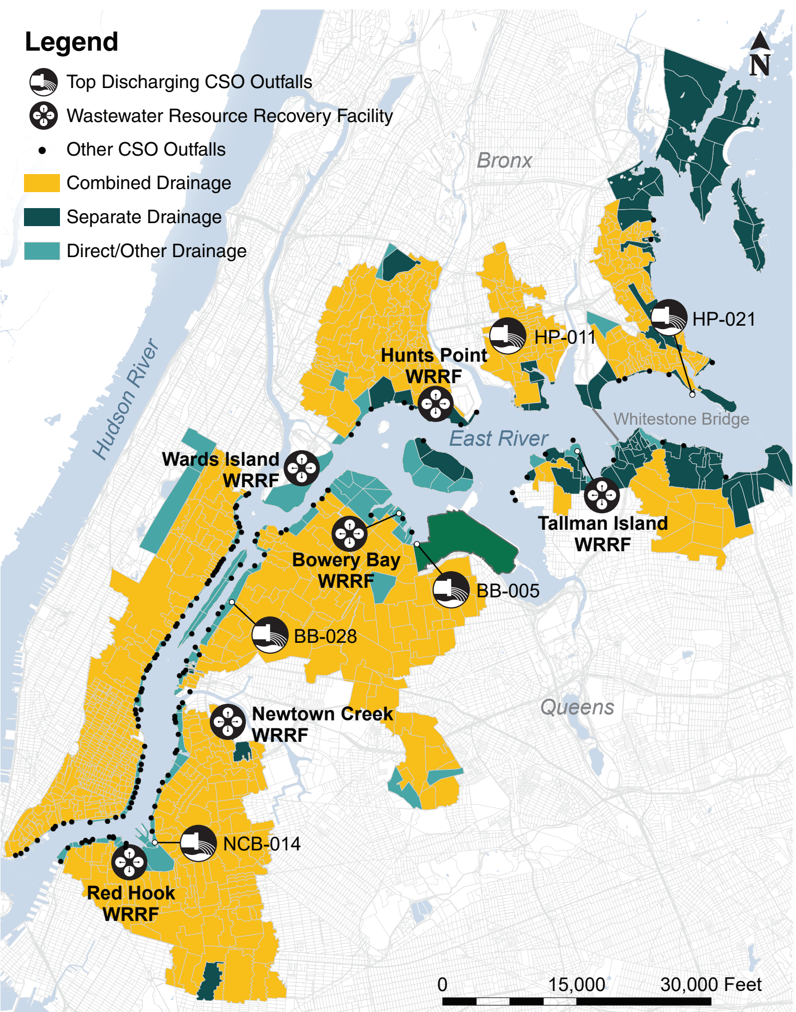
Boat traffic along the East River can include commercial/industrial marine vessels such as tankers, barges, tug boats, cruise ships, and ferries, in addition to private recreational vessels.



The East River is a navigable tidal strait which connects Long Island Sound to Upper New York Bay and separates the boroughs of Queens and Brooklyn from Manhattan and the Bronx. Long Island Sound is a tidal estuary of the Atlantic Ocean located between the eastern shore of the Bronx, southern shore of Connecticut, and northern shore of Long Island.

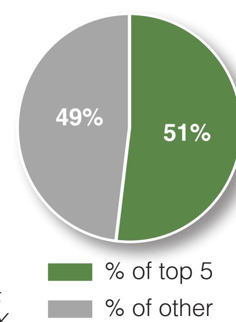


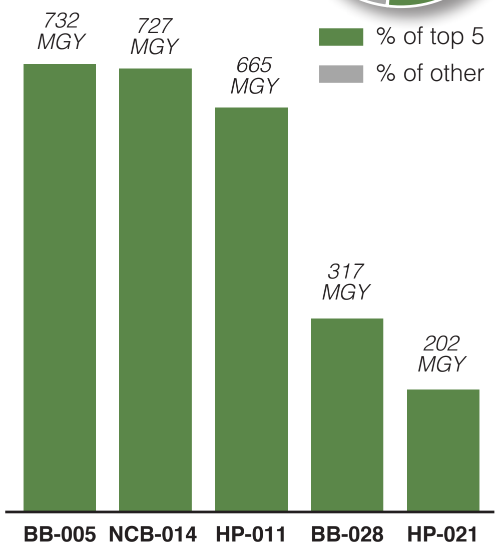
East River/Long Island Sound Sewershed CSO Outfalls



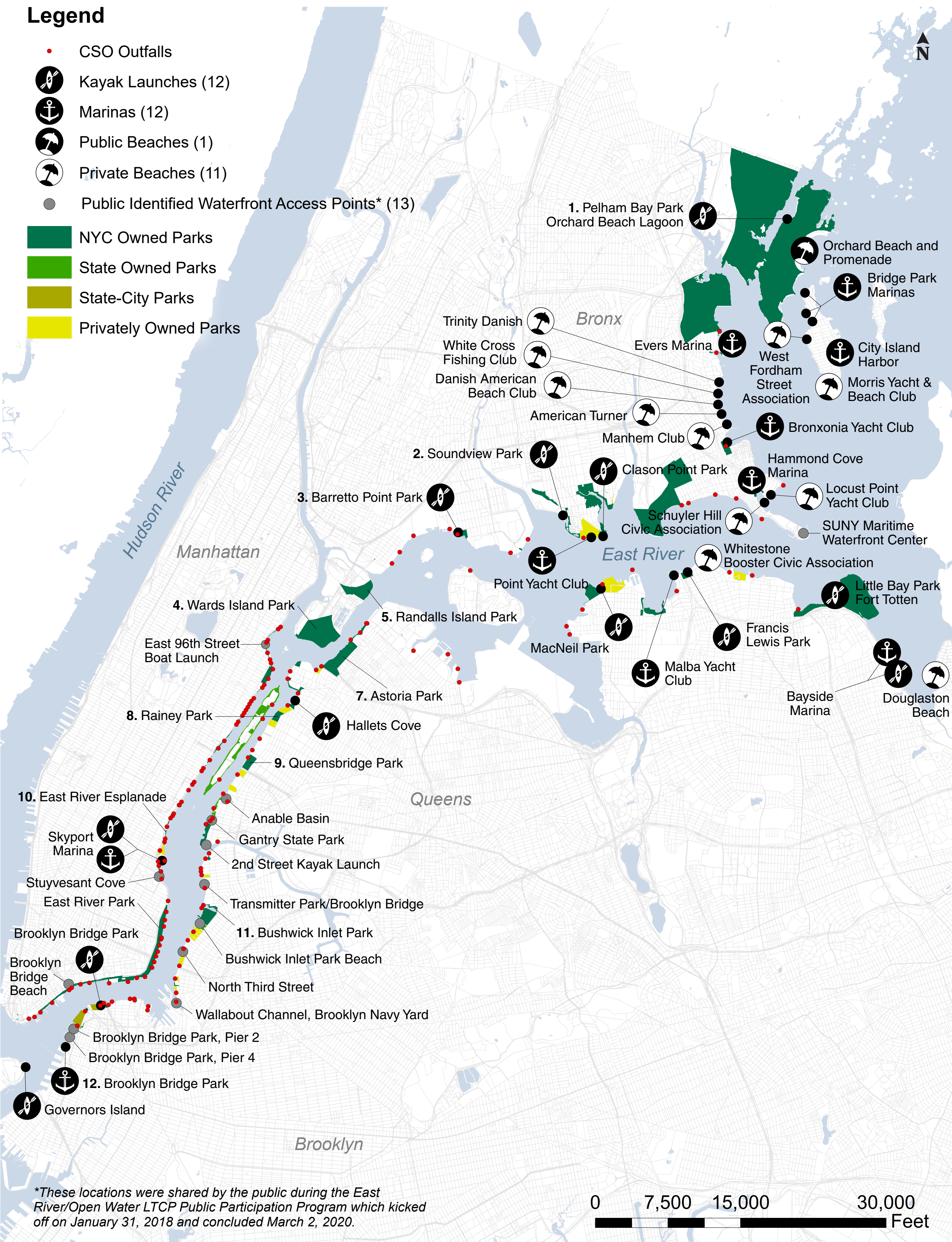
Top Discharging CSO Ouftalls

A total of 139 CSO outfalls are located along the shorelines of the East River and western portion of Long Island Sound. The total CSO discharge volume is about 5,190 million gallons per year (MGY). The top 5 discharging CSO outfalls account for 51% of this total volume and their associated average annual discharge volumes are shown in the bar chart below.





Key Waterfront Access Points



Open Space/Outdoor Recreation Areas

The East River and Long Island Sound sewershed is highly urbanized and is primarily composed of residential and open space/outdoor recreational areas within the boroughs of Bronx, Manhattan, Queens, and Brooklyn. Open space and recreation make up 18 percent of the sewershed, due to the presence of state, city, and local park properties and facilities. Notable outdoor recreation areas within this sewershed include State and City-owned parks such as Pelham Bay Park, Ferry Point Park, Randalls Island, Wards Island Park, and several parks on Roosevelt Island. The map on the left highlights the key waterfront access points with some associated photos shown below.

1

Pelham Bay

2

Soundview Park

3

Barretto Point Park

4

Wards Island Park

5

Randalls Island Park

6

Francis Lewis Park

7

Astoria Park

8

Rainey Park

9

Queensbridge Park

10

East River Esplanade

11

Bushwick Inlet Park

12

Brooklyn Bridge Park

East River Retained Alternatives

As described in the WQS Attainment and Alternatives Screening section, a range of alternatives were considered for the East River. These alternatives went through a sequential screening process to arrive at a list of alternatives to be retained for cost performance evaluations. The retained alternatives for the East River are summarized below. The location of the regulators to be modified under these alternatives are shown in the figure below.

Retained Alternative ER-1

Optimization of regulator associated with Outfall HP-025. This alternative reduces CSO volume to the East River by 37 MG in the typical year. This reduction is offset by a 15 MG increase in volume to the Bronx River, and a 1 MG increase in volume to Westchester Creek.

Retained Alternative ER-2

Optimization of regulators associated with Outfalls HP-016, HP-018, HP-019 and HP-025. This alternative reduces CSO volume to the East River and Westchester Creek by 34 MG and 2 MG respectively in the typical year. This reduction is offset by a 14 MG increase in volume to the Bronx River.

Retained Alternative ER-3

Optimization of regulators associated with Outfall TI-003 and TI-022. This alternative reduces CSO volume to the East River by 44 MG, and reduces untreated CSO volume to Flushing Creek by 58 MG in the typical year. This alternative increases the total treated volume to Flushing Creek at TI-010 and TI-011 by 77 MG.

Retained Alternative ER-4

Optimization of regulators associated with Outfalls TI-003, TI-022 and TI-023. This alternative reduces CSO volume to the East River by 55 MG, and reduces untreated CSO volume to Flushing Creek by 67 MG in the typical year. This alternative increases the total treated volume to Flushing Creek at TI-010 and TI-011 by 77 MG.

Retained Alternative ER-5

Installation of a bending weir at the regulator associated with Outfall TI-023. This alternative reduces CSO volumes to the East River by 42 MG in the typical year.

Retained Alternative ER-6

Alternative ER-5 plus optimization of the regulator associated with Outfall TI-003. This alternative reduces CSO volume to the East River by 86 MG in the typical year.

Location of the regulators to be modified under ER-1 to ER-6

Retained Alternative ER-7 through ER-10

These alternatives consist of storage tunnels sized to provide a range of 25/50/75/100 percent control of CSO volume to the East River for the 2008 typical year. The table below summarizes the dimensions of these tunnels

	ER-7	ER-8
Level of CSO Control(1)	**25%**	**50%**
WRRF Outfalls Captured	Bowery Bay, Newtown Creek	Hunts Point, Bowery Bay, Newtown Creek
Length (mi)	8	15
Diameter (ft)	17	28
Volume (MG)	71	367
# of Outfalls Captured	3 of 5 Top Discharge Outfalls	5 of 5 Top Discharge Outfalls

	ER-9		
Level of CSO Control(1)	**75%**		
WRRF Outfalls Captured	Bowery Bay, Red Hook, Newtown Creek	Tallman Island	Hunts Point, Wards Island, Newtown Creek
Length (mi)	8	3	11
Diameter (ft)	37	17	22
Volume (MG)	340	23	163
# of Outfalls Captured	3 of 5 Top Discharge Outfalls ● 6 Other Outfalls	0 of 5 Top Discharge Outfalls ● 2 Other Outfalls	2 of 5 Top Discharge Outfalls ● 3 Other Outfalls

	ER-10		
Level of CSO Control(1)	**100%**		
WRRF Outfalls Captured	Bowery Bay, Newtown Creek, Red Hook	Tallman Island	Hunts Point, Wards Island, Newtown Creek
Length (mi)	10	3	16
Diameter (ft)	37	17	26
Volume (MG)	394	23	321
# of Outfalls Captured	3 of 5 Top Discharge Outfalls ● 49 Other Outfalls	0 of 5 Top Discharge Outfalls ● 4 Other Outfalls	2 of 5 Top Discharge Outfalls ● 79 Other Outfalls

(1) Modeled annual percent reduction based on 2008 typical year.

Summary of Retained Alternatives

The table below summarizes the CSO volume reduction and estimated cost associated with each of the retained alternatives for the East River.

✓ yes ✗ no ▢ not applicable

Alternative	Net CSO Volume Reduction (MGY)	Estimated Probable Bid Cost (2019 $M)	Cost Effective(1)	No Additional CSO to Tributaries
ER-1: HP Optimization	21(2)	$16	✓	✗
ER-2: HP Optimization	22(3)	$24	✓	✗
ER-3: TI Optimization	102(4)	$4	✓	✗
ER-4: TI Optimization	122(5)	$7	✓	✗
ER-5: TI Bending Weir	42	$3	✗	✓
ER-6: TI Bending Weir & Optimization	86	$6	✓	✓
ER-7: 25% Tunnel	1,294	$1,500	✗	✓
ER-8: 50% Tunnel	2,643	$4,700	✗	✓
ER-9: 75% Tunnels	3,824	$8,000	✗	✓
ER-10: 100% Tunnels	5,172	$18,200	✗	✓

(1) An alternative is defined as cost-effective if it provides substantial reduction in CSO volume and/or improvement in WQS attainment relative to its cost.

(2) Alternative ER-1 reduces CSO volume to the East River by 37 MG. This reduction is offset by a 15 MG increase in CSO volume to the Bronx River and a 1 MG increase in CSO volume to Westchester Creek, for an overall net reduction of 21 MG.

(3) Alternative ER-2 reduces CSO volume to the to the East River by 34 MG and to Westchester Creek by 2 MG. This reduction is offset by a 14 MG increase in CSO volume to the Bronx River for an overall net reduction of 22 MG.

(4) Alternative ER-3 reduces CSO volume to the East River by 44 MG and results in a reduction in untreated CSO volume to Flushing Creek of 58 MG for a total overall untreated CSO reduction of 102 MG. This alternative results in an increase in treated CSO volume at TI-010 and TI-011 of 77MG.

(5) Alternative ER-4 reduces CSO volume to the East River by 55 MG and results in a reduction in untreated CSO volume to Flushing Creek of 67 MG for a total overall untreated CSO reduction of 122 MG. This alternative results in an increase in treated CSO volume at TI-010 and TI-011 of 77MG.

Retained Alternatives Selected for the Recommended Plan

Alternative ER-6 was selected for inclusion in the Recommended Plan, as this alternative provides a cost-effective reduction in CSO volume to the East River. ER-5 was not cost-effective and the other East River optimization alternatives were not selected for the Recommended Plan because each one would have resulted in an increase in CSO volume to one of the tributaries to the East River (Westchester Creek, Bronx River, or Flushing Creek). The tunnel alternatives all carried very high costs without substantially changing the level of WQS attainment.

Summary of WQ Standards Compliance

✓ yes ✗ no ▢ not applicable

		Fecal Coliform Monthly GM(1)		Enterococci 30-day GM(2)		Enterococci 30-day STV(2)		Dissolved Oxygen (DO)	
Waterbody	**Classification**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**
Long Island Sound	Class SB Coastal	✓	✓	✓	✓	✓	✓	✓	✓
East River	Class SB	✓	✓					✓	✓
	Class I	✓	✓					✓	✓

(1) Fecal Coliform attainment is assessed on an annual basis. (2) Enterococci attainment is assessed for the recreational season (May 1st through October 31st).

Lower and Upper New York Bay

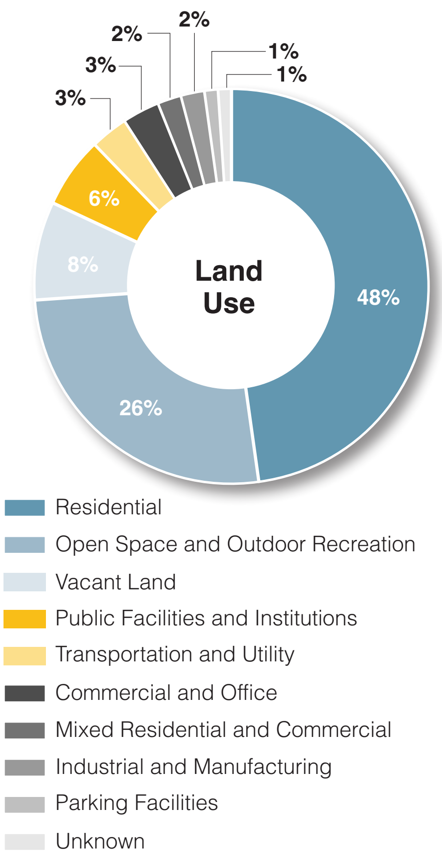
Introduction

New York Bay (NYB) is an approximately 146,000-acre natural harbor bordering on portions of the boroughs of Manhattan, Brooklyn, and Staten Island. The Upper Bay is fed by the waters of the Hudson River and East River, while the Lower Bay opens directly into the Atlantic Ocean. The land area within New York City served by combined and separate storm sewer systems that are tributary to NYB (the "sewershed") is approximately 30,000 acres. The NYB shorelines are primarily composed of a mix of piers, bulkhead and riprap, with natural shoreline and beaches along the Lower Bay.

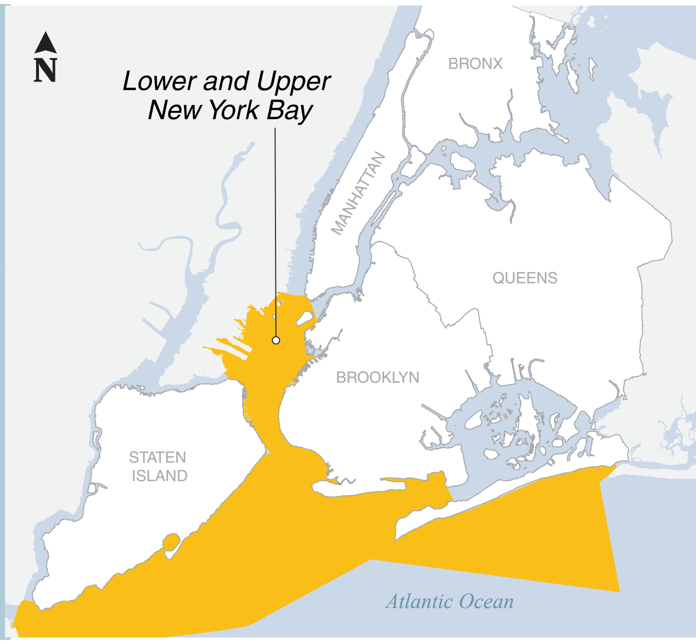
Parts of the collection systems of the Red Hook, Owls Head, Port Richmond and Oakwood Beach WRRFs are located within the NYB sewershed. During wet-weather, a diluted mixture of combined storm and sanitary flow may discharge through one or more of the 39 SPDES-permitted CSO outfalls to NYB. No CSOs are associated with the Oakwood Beach WRRF. A total of 41 MS4 outfalls are located along New York Bay.

DEC has classified Upper and Lower NYB as a Class SB Coastal Primary Recreational waterbody. Best uses for Class SB waterbodies are primary and secondary contact recreation and fishing. Class SB waterbodies should be suitable for fish, shellfish, and wildlife propagation and survival. Water quality in NYB is influenced by NYC CSO and stormwater, tidal exchanges with the Hudson River, East River, Kill Van Kull, Jamaica Bay and the Atlantic Ocean, and other sources from outside of NYC.

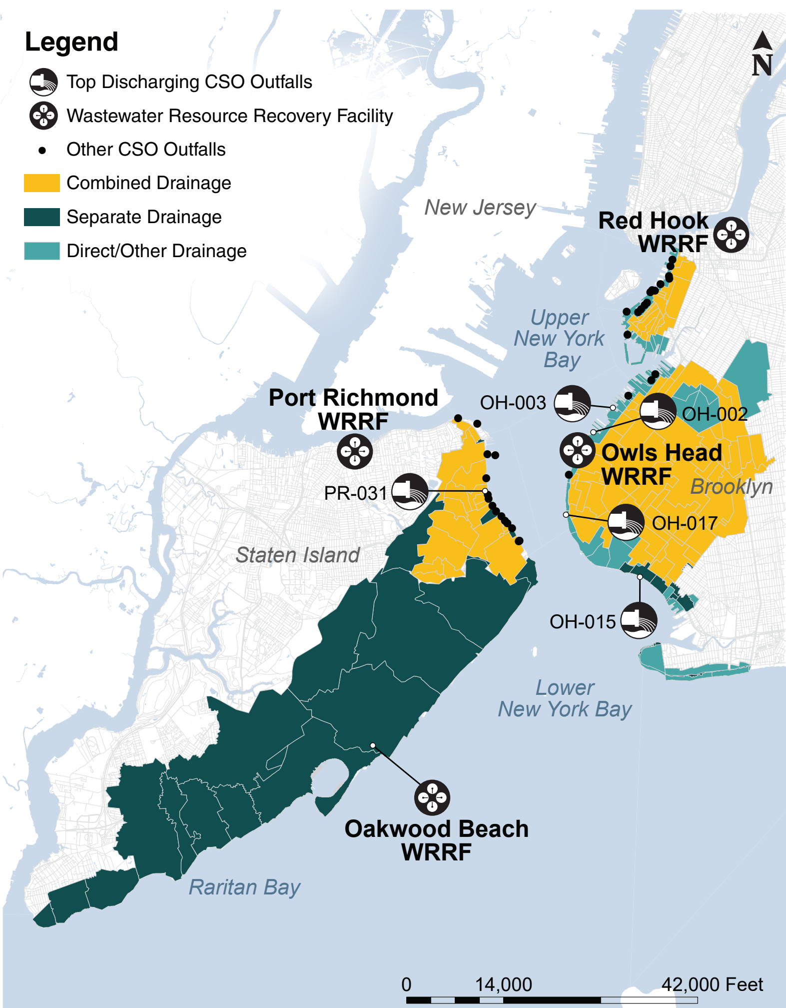
Boat traffic in NYB can include commercial/industrial marine vessels such as container ships, tankers, tug boats, barges, cruise ships, and ferries, in addition to private recreational vessels.



The New York Bay is a large natural harbor bordering on portions of Manhattan, Brooklyn, and Staten Island. The Upper Bay is fed by the waters of the Hudson River and East River, while the Lower Bay opens directly into the Atlantic Ocean.

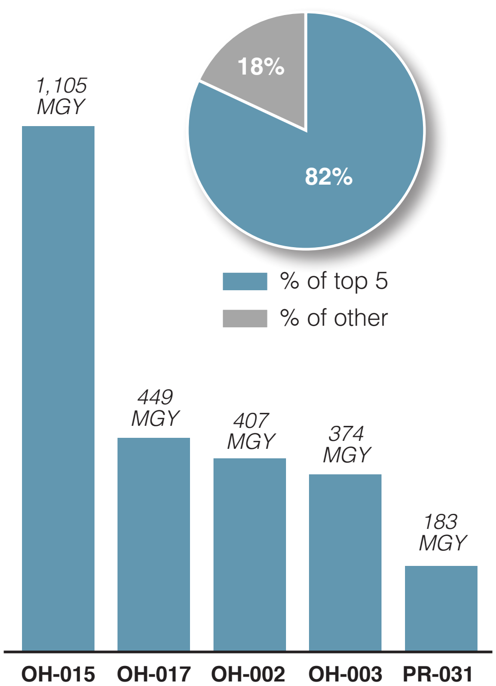


New York Bay Sewershed CSO Outfalls



Top Discharging CSO Outfalls

A total of 39 CSO outfalls are located along the shorelines of the Upper and Lower New York Bay. The total CSO discharge volume is about 3,060 million gallons per year (MGY). The top 5 discharging CSO outfalls account for 82% of this total volume and their associated average annual discharge volumes are shown in the bar chart below.



Key Waterfront Access Points

*These locations were shared by the public during the East River/Open Water LTCP Public Participation Program which kicked off on January 31, 2018 and concluded March 2, 2020.

Open Space/Outdoor Recreation Areas

The New York Bay sewershed is highly urbanized and is primarily composed of residential and open space/recreation areas within the boroughs of Manhattan, Brooklyn, and Staten Island. Open space and recreation make up 26 percent of the sewershed, due to the presence of federal, state, city, and local park properties and facilities. The sewershed contains several beaches along Staten Island and Coney Island. Notable outdoor recreation areas within this sewershed include Ellis Island, Governors Island, Liberty Island, and Great Kills Park in Staten Island. The map on the left highlights the key waterfront access points with some associated photos shown below.

1

Governors Island

2

Ellis Island

3

Valentino Park & Pier

4

Shore Road Park

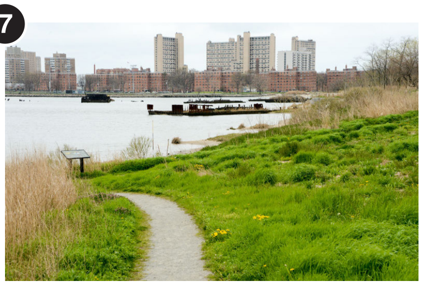
5

Fort Wadsworth

6

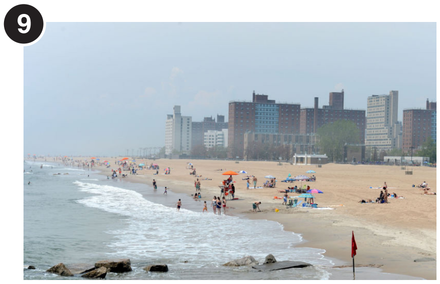
Bensonhurt Park

7



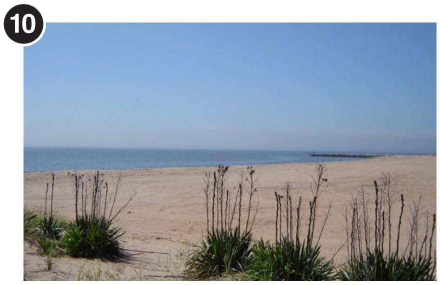
Calvert Vaux

9



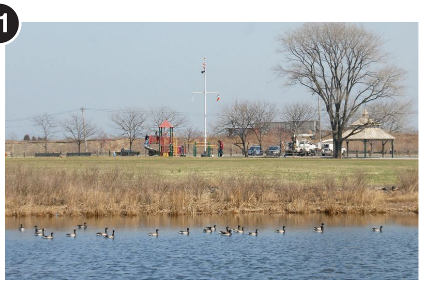
Coney Island Beach

10



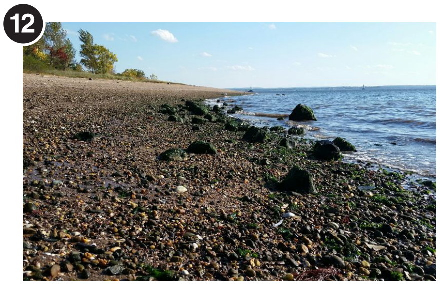
Great Kills Park

11



Lemon Creek Park

12



Conference House Park

New York Bay Retained Alternatives

As described in the WQS Attainment and Alternatives Screening section, a range of alternatives were considered for New York Bay. These alternatives went through a sequential screening process to arrive at a list of alternatives to be retained for cost performance evaluations. The retained alternatives for New York Bay are summarized below.

Retained Alternative NYB-1

Optimization of regulators associated with Outfall RH-005 and RH-014. The locations of the regulators to be modified under this alternative are shown in the figure below. This alternative reduces CSO volume to New York Bay by 5 MG in the typical year.

Retained Alternative NYB-2

The Hannah Street Pump Station Bypass alternative consist of construction of a gravity flow connection between the Victory Blvd. combined sewer and the East Interceptor. This alternative will divert dry and wet-weather flow around the Hannah Street Pump Station, reducing flows to the pump station as well as CSO volume at Outfall PR-013. The location of the proposed bypass is shown in the figure below. This alternative reduces CSO volume to New York Bay by 37 MG in the typical year.

Retained Alternative NYB-3

Remotely-controlled gate at Regulator 9C, associated with Outfall OH-15. The location of this regulator is shown in the figure below. This alternative reduces CSO volume to New York Bay by 90 MG in the typical year with a net increase of 3 activations to New York Bay.

Location of the regulators to be modified under NYB-1 and NYB-3, and location of bypass pipe for NYB-2

Retained Alternative NYB-4 through NYB-7

These alternatives consist of storage tunnels sized to provide a range of 25/50/75/100 percent control of CSO volume to New York Bay for the 2008 typical year. The table below summarizes the dimensions of these tunnels. Alternatives NYB-5, NYB-6, and the Owls Head/Red Hook tunnel for NYB-7 each consists of two parallel tunnels. Alternative NYB-4, and the Port Richmond tunnel for NYB-7 are single bore tunnels.

	NYB-4	NYB-5	NYB-6	NYB-7	
Level of CSO Control(1)	**25%**	**50%**	**75%**	**100%**	
WRRF Outfalls Captured	**Owls Head**	**Owls Head**	**Owls Head**	**Owls Head/ Red Hook**	**Port Richmond**
Length (mi)	5	2 x 5	2 x 5	2 x 9	3
Diameter (ft)	12	23	28	23	25
Volume (MG)	22	156	253	300	61
# of Outfalls Captured	2 of 5 Top Discharge Outfalls	2 of 5 Top Discharge Outfalls	4 of 5 Top Discharge Outfalls	4 of 5 Top Discharge Outfalls ● 18 Other Outfalls	1 of 5 Top Discharge Outfalls ● 14 Other Outfalls

(1) Modeled annual percent reduction based on 2008 typical year.

Summary of Retained Alternatives

The table below summarizes the CSO volume reduction and estimated cost associated with each of the retained alternatives for the New York Bay.

✓ *yes* ✗ *no* *not applicable*

Alternative	Net CSO Volume Reduction (MGY)	Estimated Probable Bid Cost (2019 $M)	Cost Effective(1)	No Additional CSO to Tributaries
NYB-1: RH Optimization	5	$6	✓	✓
NYB-2: Hannah Street PS Bypass	37	$22	✓	✓
NYB-3: OH-15 Control Gate	90	$5	✓	✓
NYB-4: 25% Tunnel	768	$900	✗	✓
NYB-5: 50% Tunnel	1,554	$2,900	✗	✓
NYB-6: 75% Tunnels	2,335	$4,300	✗	✓
NYB-7: 100% Tunnels	3,061	$8,500	✗	✓

(1) An alternative is defined as cost-effective if it provides substantial reduction in CSO volume and/or improvement in WQS attainment relative to its cost.

Retained Alternatives Selected for the Recommended Plan

Alternatives NYB-1, NYB-2 and NYB-3 were all selected for inclusion in the Recommended Plan. Each of these alternatives provides a cost-effective reduction in CSO volume to New York Bay. The tunnel alternatives all carried very high costs, and only the tunnel that provides 100% control in the 2008 typical year, with an un-escalated probable bid cost of $8.5 billion, would allow for full attainment with the Enterococci STV criteria. This tunnel is not considered a cost-effective alternative.

Summary of WQ Standards Compliance

✓ *yes* ✗ *no* *not applicable*

		Fecal Coliform Monthly GM(1)		Enterococci 30-day GM(2)		Enterococci 30-day STV(2)		Dissolved Oxygen (DO)	
Waterbody	**Classification**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**
New York Bay	Class SB	✓	✓	✓	✓	✗	✗	✗(3)	✗(3)

(1) Fecal Coliform attainment is assessed on an annual basis. (2) Enterococci attainment is assessed for the recreational season (May 1st through October 31st). (3) With no NYC CSO loads, WQS would not be fully attained due to sources from outside of NYC.

Arthur Kill and Kill Van Kull

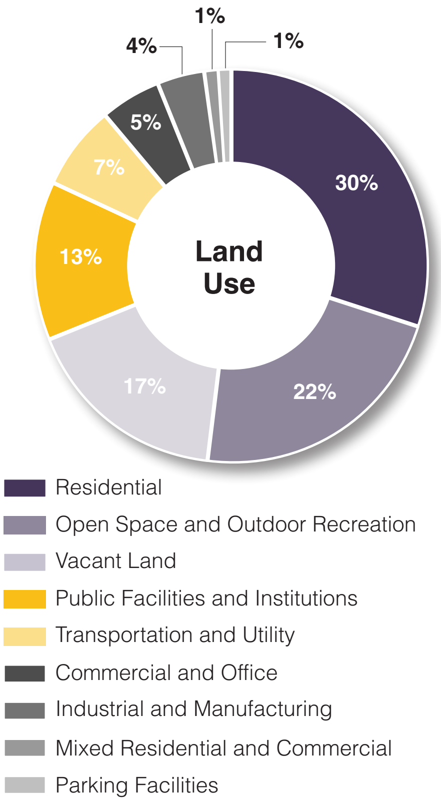
Introduction

Arthur Kill (AK) is a 10-mile long, navigable tidal channel connecting Newark Bay with Raritan Bay. Kill Van Kull (KVK) is a 4.5-mile long, navigable tidal channel connecting Newark Bay with Upper New York Bay. The sewershed within NYC tributary to AK/KVK is approximately 20,000 acres. The Staten Island shoreline along AK/KVK includes piers, bulkhead, rip-rap and natural areas.

Parts of the collection systems of the Port Richmond and Oakwood Beach WRRFs are located within the AK/KVK sewershed. During wet-weather, a diluted mixture of combined storm and sanitary flow may discharge through one or more of the 19 NYC SPDES-permitted CSO outfalls to KVK. No CSOs discharge directly to AK from NYC. No CSOs are associated with the Oakwood Beach WRRF. A total of 12 NYC MS4 outfalls are located along AK/KVK.

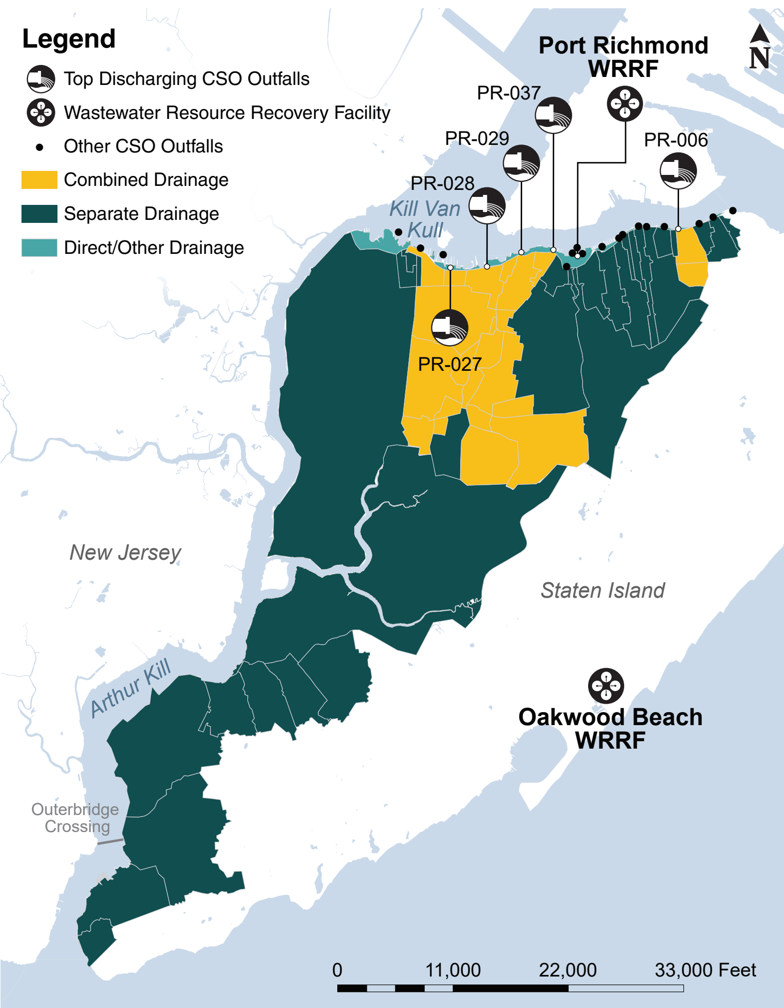
DEC has classified KVK and most of AK as Class SD waterbodies. South of the Outerbridge Crossing Bridge, AK is designated as Class I. The best use for Class SD waterbodies is fishing, while for Class I it's secondary contact recreation and fishing. Class SD waterbodies should be suitable for fish, shellfish and wildlife survival, while Class I waters also support propagation. Water quality in AK/KVK is influenced by stormwater, tidal exchanges, and sources outside of NYC while KVK is also influenced by CSO from NYC.

Boat traffic in Authur Kill and Kill Van Kull can include commercial/industrial marine vessels such as container ships, tankers, barges, and passenger ships in addition to private recreational vessels.



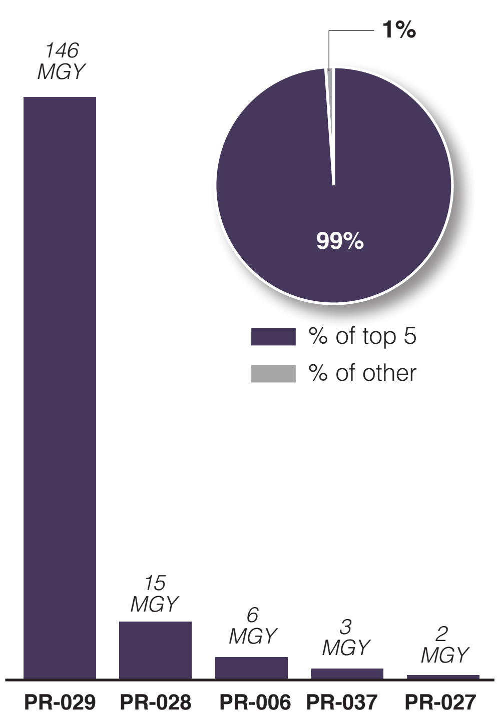
Arthur Kill is a 10-mile long tidal strait located between the west coast of Staten Island, and Union and Middlesex Counties in NJ. Kill Van Kull is approximately 3 miles long and located between the north coast of Staten Island, and Bayonne, NJ.

AK/KVK Sewershed CSO Outfalls

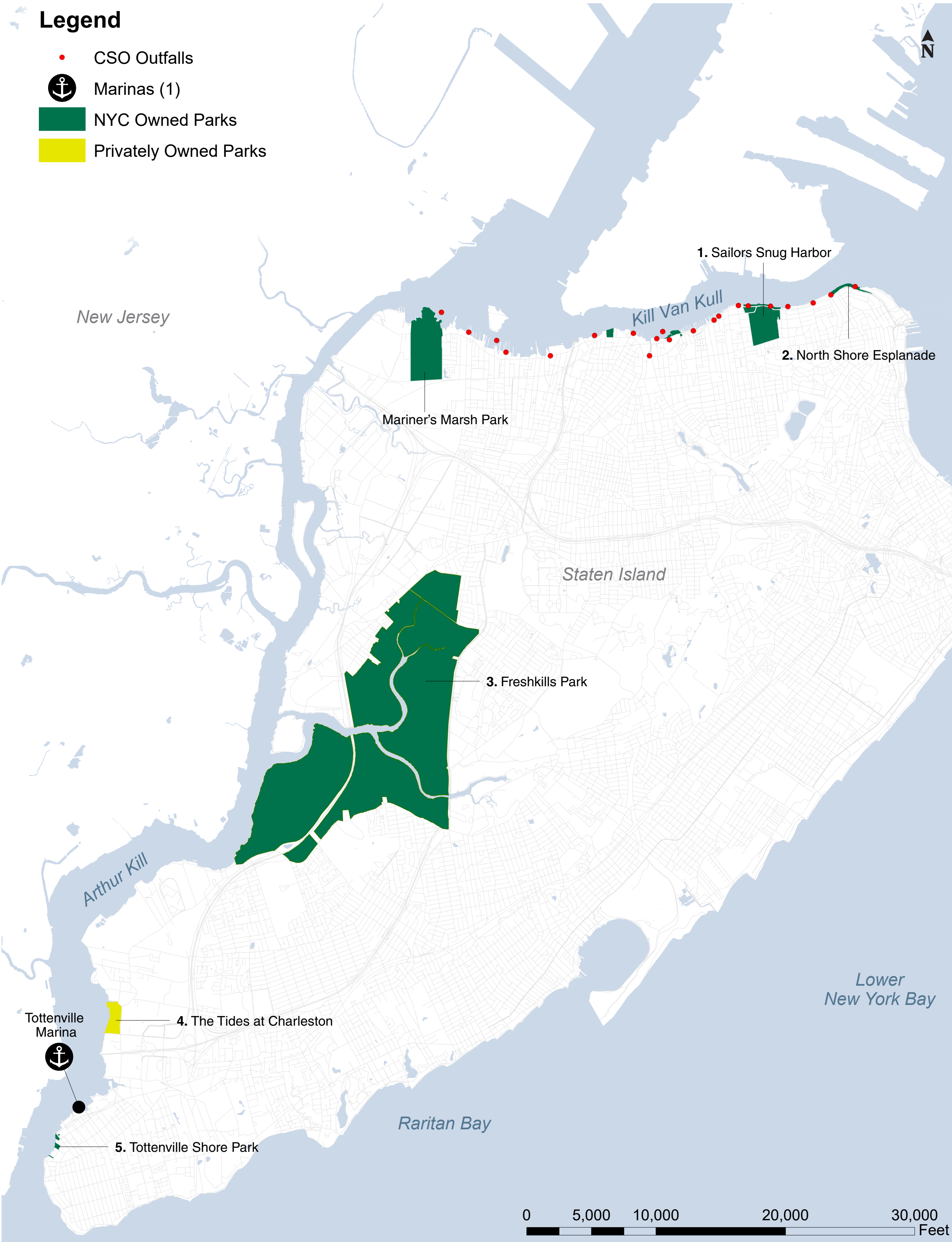


Top Discharging CSO Ouftalls

A total of 19 CSO outfalls are located along the shoreline of KVK. The total CSO discharge volume is about 173 million gallons per year (MGY). The top 5 discharging CSO outfalls account for 99% of this total volume and their associated average annual discharge volumes are shown in the bar chart below.



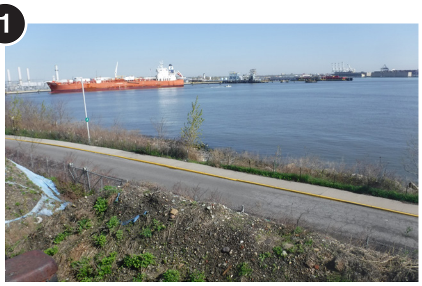
Key Waterfront Access Points



Open Space/Outdoor Recreation Areas

The Arthur Kill and Kill Van Kull sewershed within New York City is highly urbanized and primarily composed of residential and open space/outdoor recreational areas. Open space and recreation make up 22 percent of the sewershed, due to the presence of state, city, and local park properties and facilities. The northern shoreline along Kill Van Kull is the most urbanized part of Staten Island while the western shoreline is the least populated and most industrial. Along Kill Van Kull, notable outdoor recreation areas include the Snug Harbor Botanical Garden and Alison Pond Park, in Staten Island. Along Arthur Kill, notable outdoor recreation areas include the Freshkills Park, North Mount Lorretto State Forest, Clay Pit Pond State Park Preserve, and Long Pond Park, in Staten Island. Several wetlands are also located within both channels along the New York and the New Jersey shorelines. This LTCP focuses on the New York portion of the Kill Van Kull and Arthur Kill sewershed. The map on the left highlights the key waterfront access points with some associated photos shown below.

1



Sailors Snug Harbor

2

North Shore Esplanade

3

Freshkills Park

4

The Tides at Charleston

5

Tottenville Shore Park

Kill Van Kull Retained Alternatives

Since NYC CSO outfalls discharge directly to Arthur Kill, and the Oakwood Beach WRRF service area is separately-sewered with no CSOs, the alternative analysis for this area focused on the CSOs discharging to Kill Van Kull. The alternatives went through a sequential screening process to arrive at a list of alternatives to be retained for cost performance evaluations. The retained alternatives for the Kill Van Kull are summarized below.

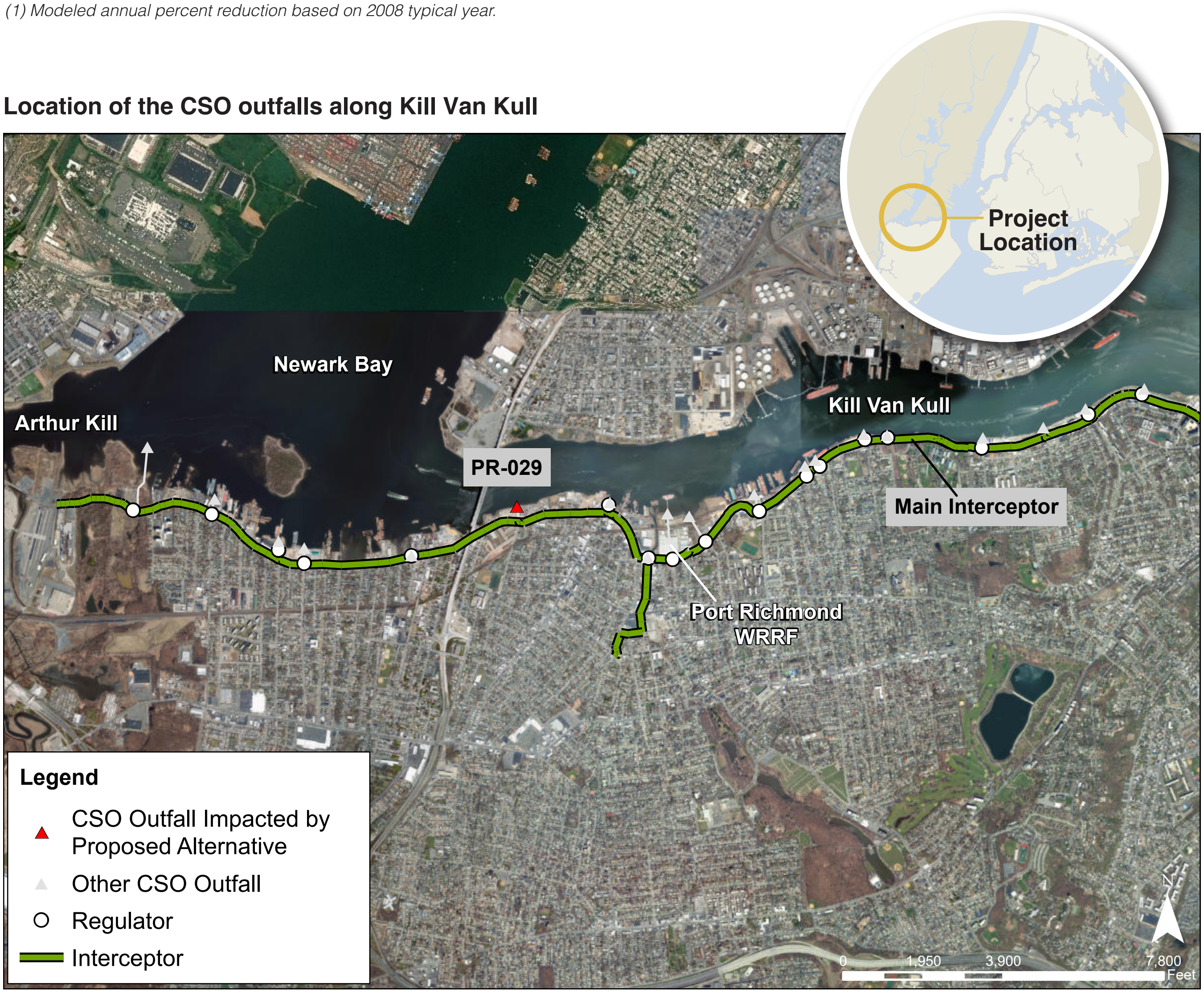
Retained Alternative KVK-1, KVK-2, and KVK-3

These alternatives consist of storage tanks for Outfall PR-029, sized to provide 25, 50 and 75 percent control of the total CSO volume to Kill Van Kull, for the 2008 typical year respectively. The table below summarizes the sizes of these tanks.

	KVK-1	KVK-2	KVK-3
Level of CSO Control[(1)]	**25%**	**50%**	**75%**
Volume (MG)	2.5	7	16
# of Outfalls Captured	1	1	1

(1) Modeled annual percent reduction based on 2008 typical year.

Location of the CSO outfalls along Kill Van Kull



Retained Alternative KVK-4

This alternative consists of a storage tunnel sized to provide 100 percent control of CSO volume to the Kill Van Kull for the 2008 typical year. The table below summarizes the dimensions of this tunnel.

KVK-4	
Level of CSO Control(1)	**100%**
WRRF Outfalls Captured	Port Richmond
Length (mi)	4
Diameter (ft)	16
Volume (MG)	30
# of Outfalls Captured	5 of 5 Top Discharge Outfalls ● 1 Other Outfall

(1) Modeled annual percent reduction based on 2008 typical year.

Summary of Retained Alternatives

The table below summarizes the CSO volume reduction and estimated cost associated with each of the retained alternatives for the Kill Van Kull.

✓ *yes* ✗ *no* *not applicable*

Alternative	CSO Volume Reduction (MGY)	Estimated Probable Bid Cost (2019 $M)	Cost Effective(1)	No Additional CSO to Tributaries
KVK-1: 25% Tank	44	$300	✗	✓
KVK-2: 50% Tank	87	$500	✗	✓
KVK-3: 75% Tank	130	$800	✗	✓
KVK-4: 100% Tunnel	173	$1,000	✗	✓

(1) An alternative is defined as cost-effective if it provides substantial reduction in CSO volume and/or improvement in WQS attainment relative to its cost.

Retained Alternatives Selected for the Recommended Plan

None of the three retained alternatives were selected for the Recommended Plan, as none were determined to be cost-effective in terms of CSO volume controlled or improvement in WQS attainment.

Summary of WQ Standards Compliance

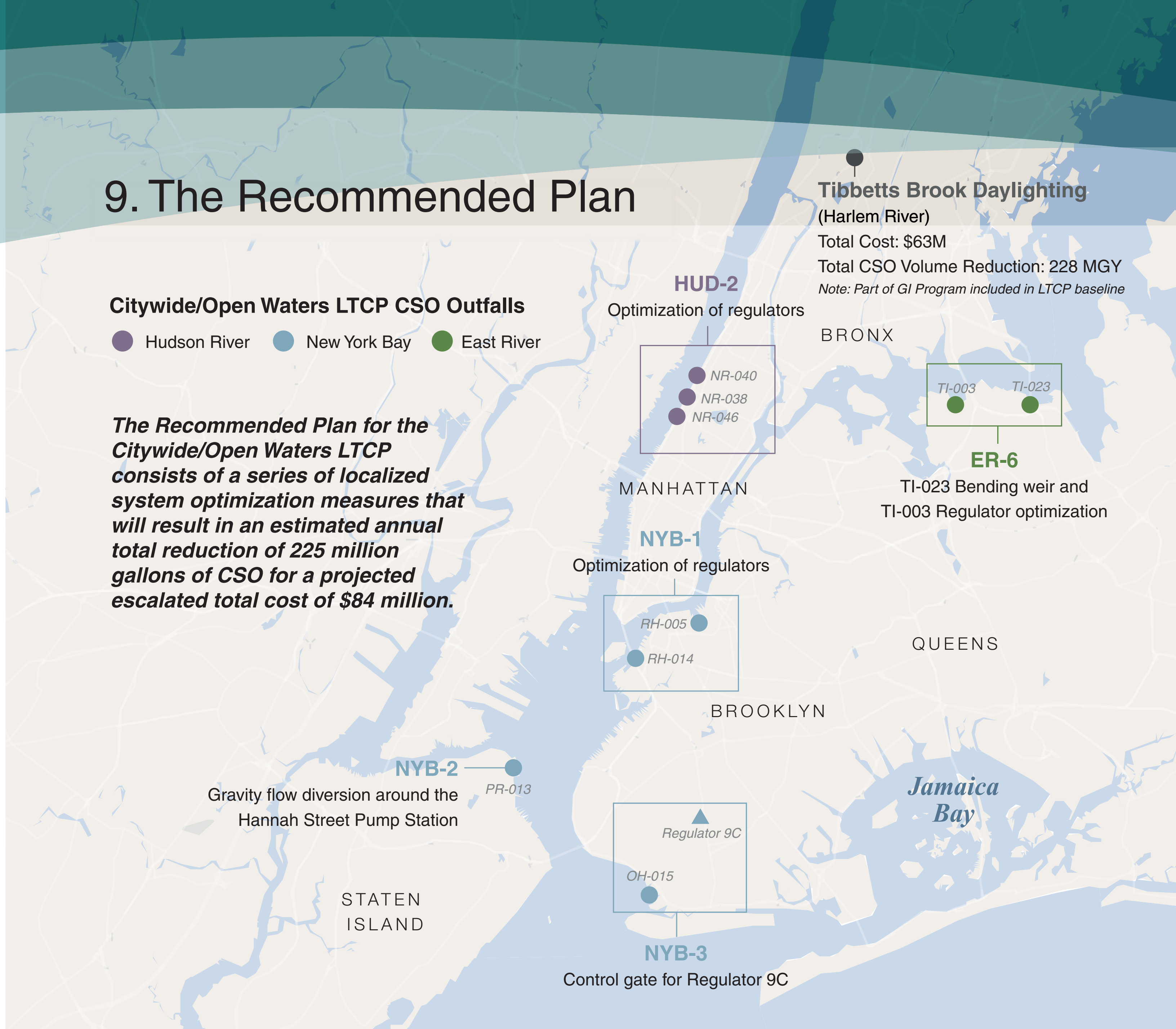
✓ *yes* ✗ *no* *not applicable*

		Fecal Coliform Monthly GM(1)		Enterococci 30-day GM(2)		Enterococci 30-day STV(2)		Dissolved Oxygen (DO)	
Waterbody	**Classification**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**	**Baseline Conditions**	**Recommended Plan**
Kill Van Kull	Class SD	✗(3)	✗(3)					✓	✓
Arthur Kill	Class SD	✗(3)	✗(3)					✓	✓
	Class I	✗(3)	✗(3)					✗(3)	✗(3)

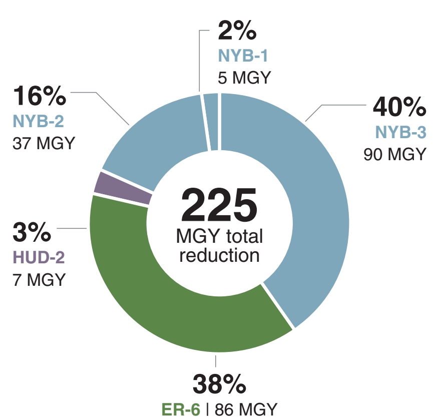
(1) Fecal Coliform attainment is assessed on an annual basis. (2) Enterococci attainment is assessed for the recreational season (May 1st through October 31st).
(3) With no NYC CSO loads, WQS would not be fully attained due to sources from outside of NYC.

9. The Recommended Plan

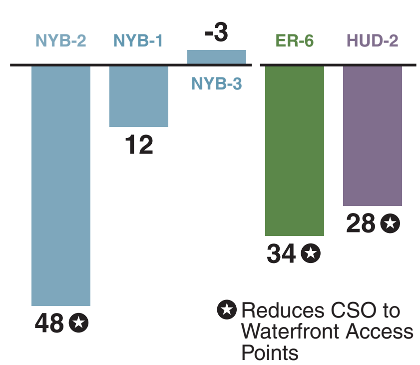
The Recommended Plan for the Citywide/Open Waters LTCP consists of a series of localized system optimization measures that will result in an estimated annual total reduction of 225 million gallons of CSO for a projected escalated total cost of $84 million.



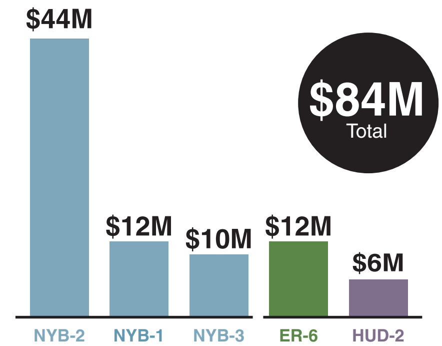
Net Reduction in CSO Volume(1)



CSO Activation Reduction(1)



Projected Escalated Cost(2)



(1) Based on CSO LTCP 2008 JFK Typical Year Rainfall.
(2) Projected escalated costs includes design/DSDC escalated to mid-point of design and construction/CM escalated to mid-point of construction.

WQ Standards Compliance

✓ yes ✗ no ▭ not applicable

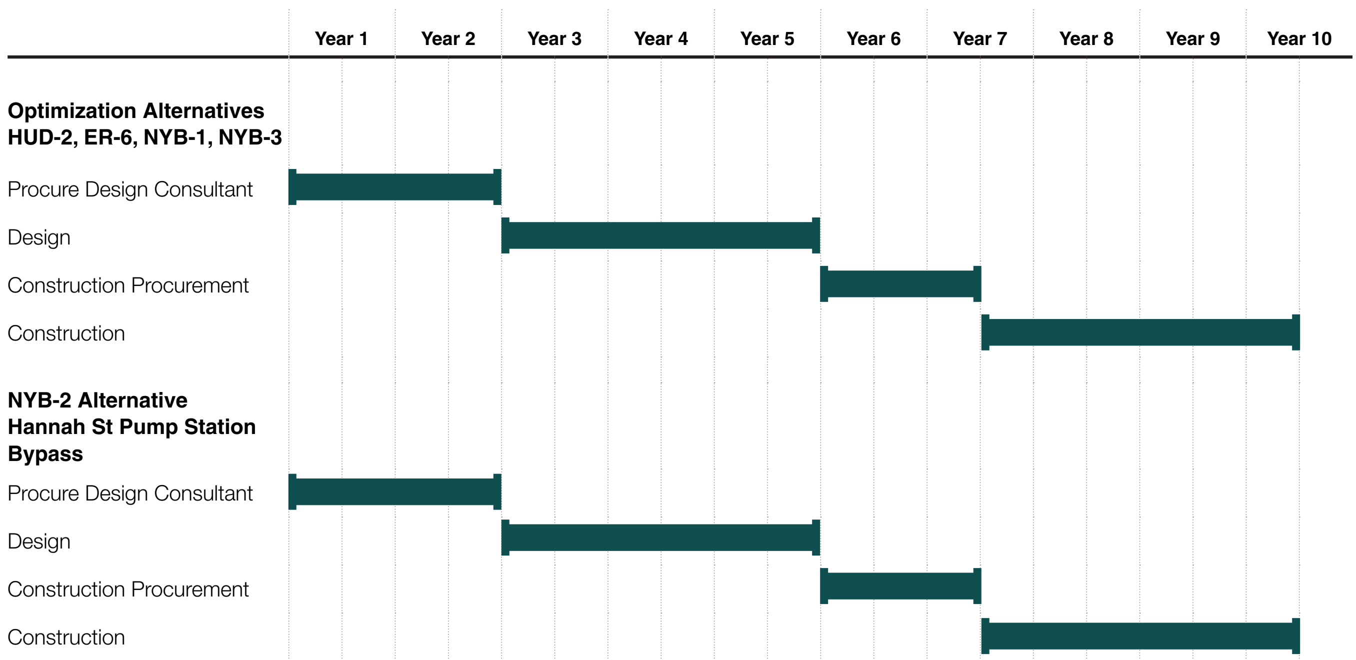
		Fecal Coliform Monthly GM(1)	Enterococci 30-day GM(2)	Enterococci 30-day STV(2)	Dissolved Oxygen (DO)
Waterbody	**Classification**	**Recommended Plan**	**Recommended Plan**	**Recommended Plan**	**Recommended Plan**
Harlem River	Class I	✓			✓
Hudson River	Class SB	✓			✓
	Class I	✓			✓
Long Island Sound	Class SB Coastal	✓	✓	✓	✓
East River	Class SB	✓			✓
	Class I	✓			✓
New York Bay	Class SB Coastal	✓	✓	✗	✗(3)
Kill Van Kull	Class SD	✗(3)			✓
Arthur Kill	Class SD	✗(3)			✓
	Class I	✗(3)			✗(3)

(1) Fecal Coliform attainment is assessed on an annual basis.

(2) Enterococci attainment is assessed for the recreational season (May 1st through October 31st) and applies only to coastal primary contact recreational waters.

(3) With no NYC CSO loads, WQS would not be fully attained due to sources from outside of NYC.

Recommended Plan Schedule*



**See the COVID-19 discussion on pages 7 and 8 for potential impacts of COVID-19 on the implementation schedule.*

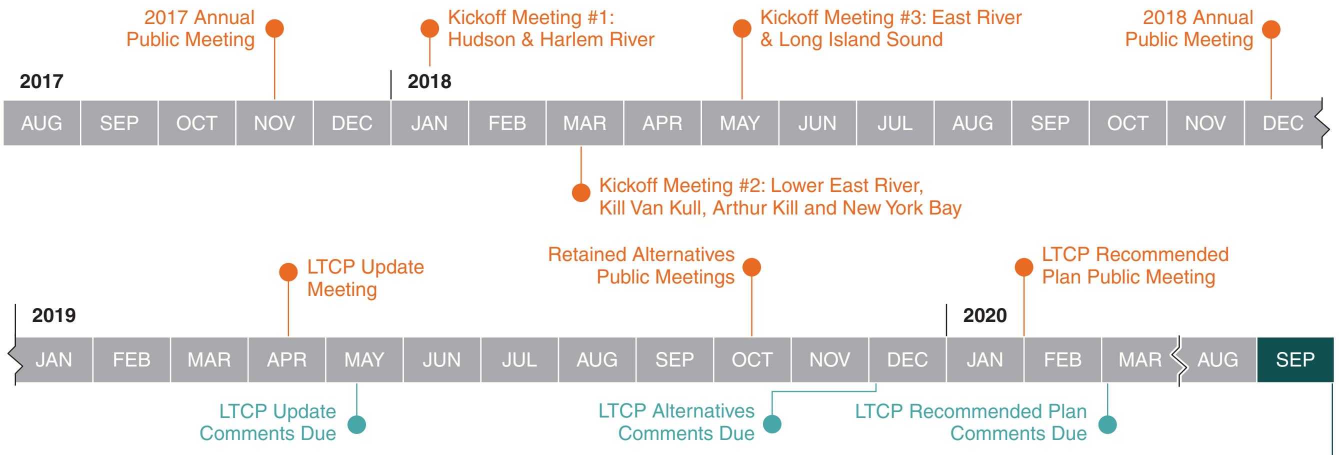
10. Public Outreach

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

Public Outreach Goals

- Raise awareness about water quality conditions
- Increase understanding of DEP's historical and ongoing efforts
- Identify areas of concern
- Encourage public input on the retained CSO control alternatives
- Balance expectations associated with the costs of the LTCP program
- Provide timely and accessible information

Public Outreach Schedule



Note: Responses to public comments received following the 1/29/2020 LTCP Recommended Plan Meeting are provided in Appendix B of the LTCP. Responses from previous Public Meeting Comments are posted on the DEP website at http://www.nyc.gov/dep/ltcp

Public Engagement Media

Based on stakeholder feedback since 2012, DEP has continued to work to improve public engagement.

Waterbody Excursions & Videography

2016 Newtown Creek Canoeing with Newtown Creek Alliance

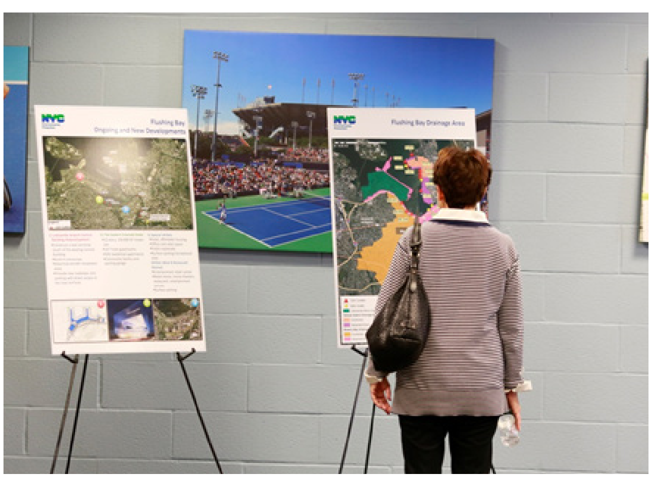
Expanded Meetings

Over 100 attendees at 2017 and 2018 Annual Meetings and over 300 attendees at the Citywide/Open Waters Public Meetings from 2018 to 2020.

Meeting Materials

Brochure and Fact Sheets

Improved Presentation Format



Display of Informative Posterboards

Enhanced Website and Social Media

NYCDEP

NYC Water

11. Affordability and Financial Capability

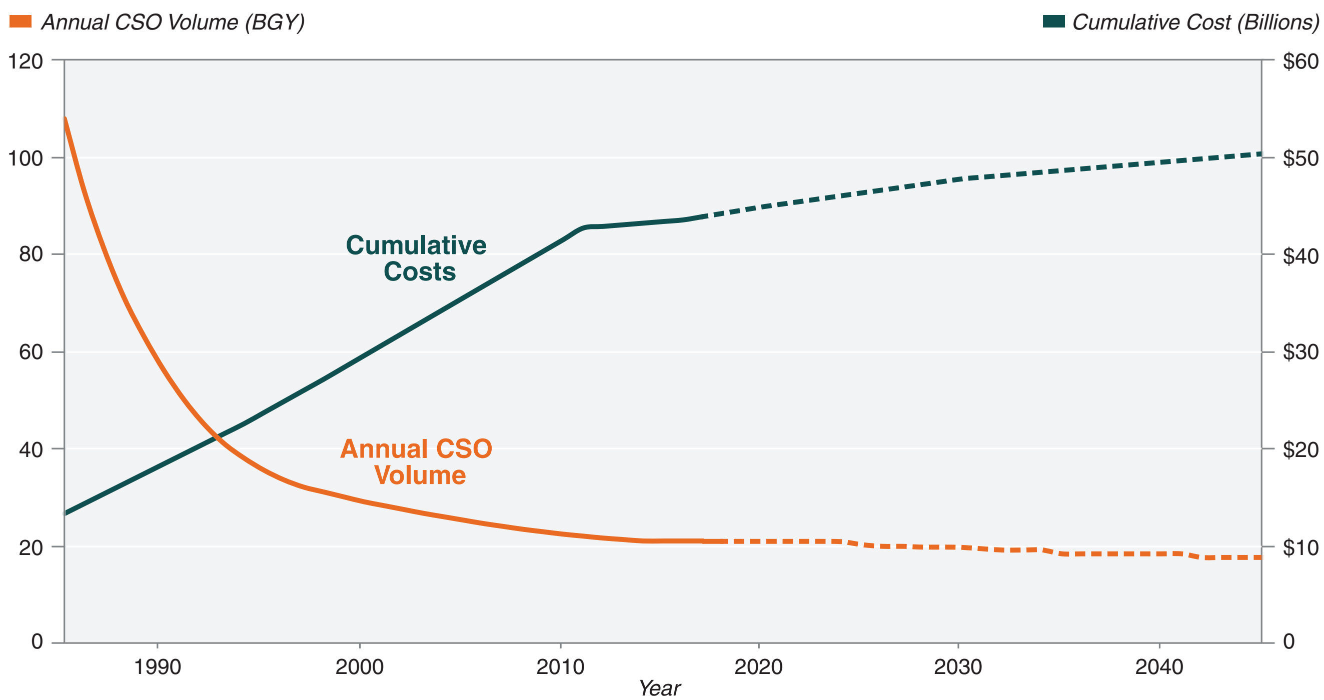
DEP is fully focused on making critical investments to support our mission of protecting the health and safety of New Yorkers, while being mindful of rates. We seek to prioritize smart investments that produce the greatest social, economic and environmental benefits without putting undue financial burden on our rate payers.

Investments in CSO Reduction

DEP investments have reduced CSO volumes by a total of over 80 billion gallons a year since the 1980s and resulted in substantial improvements in water quality. As CSO volumes have decreased, capturing further CSOs is becoming more challenging and expensive.

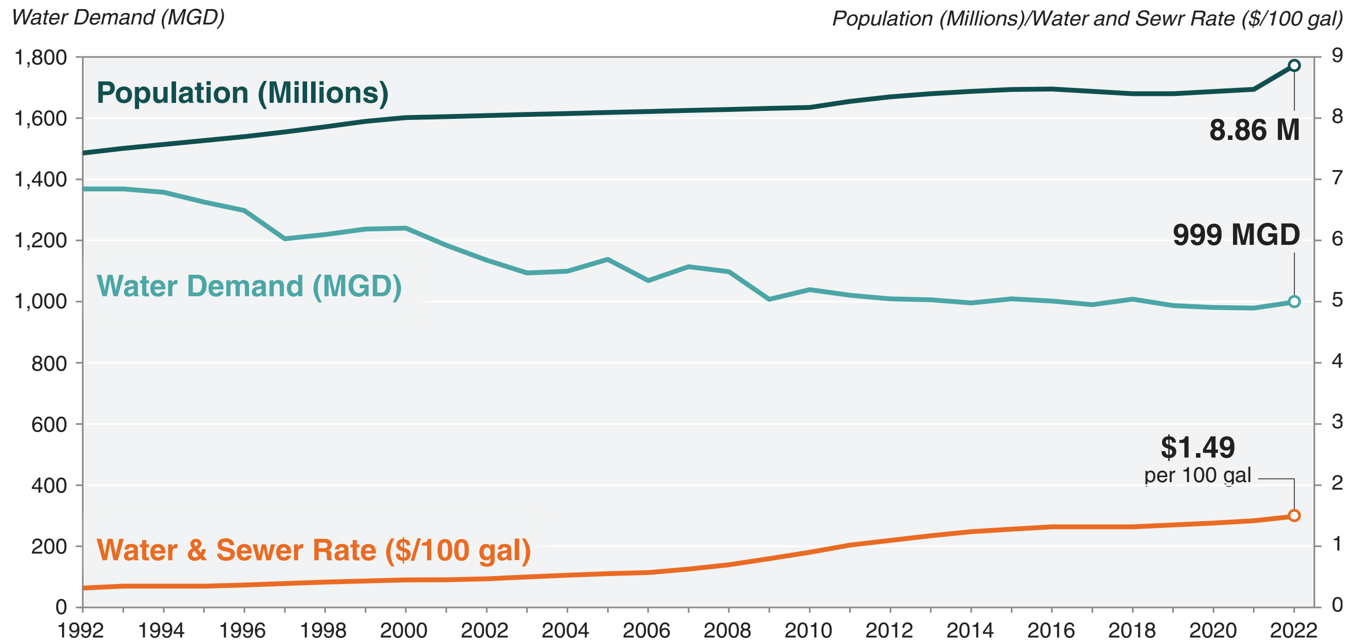
Future Capital Spending

As DEP invests in attaining the highest water quality standards and most robust system possible, we must balance our investments in mandated projects, like the CSO program, with other critical investments that protect the health and safety of New Yorkers, such as maintaining and upgrading our century-old system (state of good repair) and sewer investments.



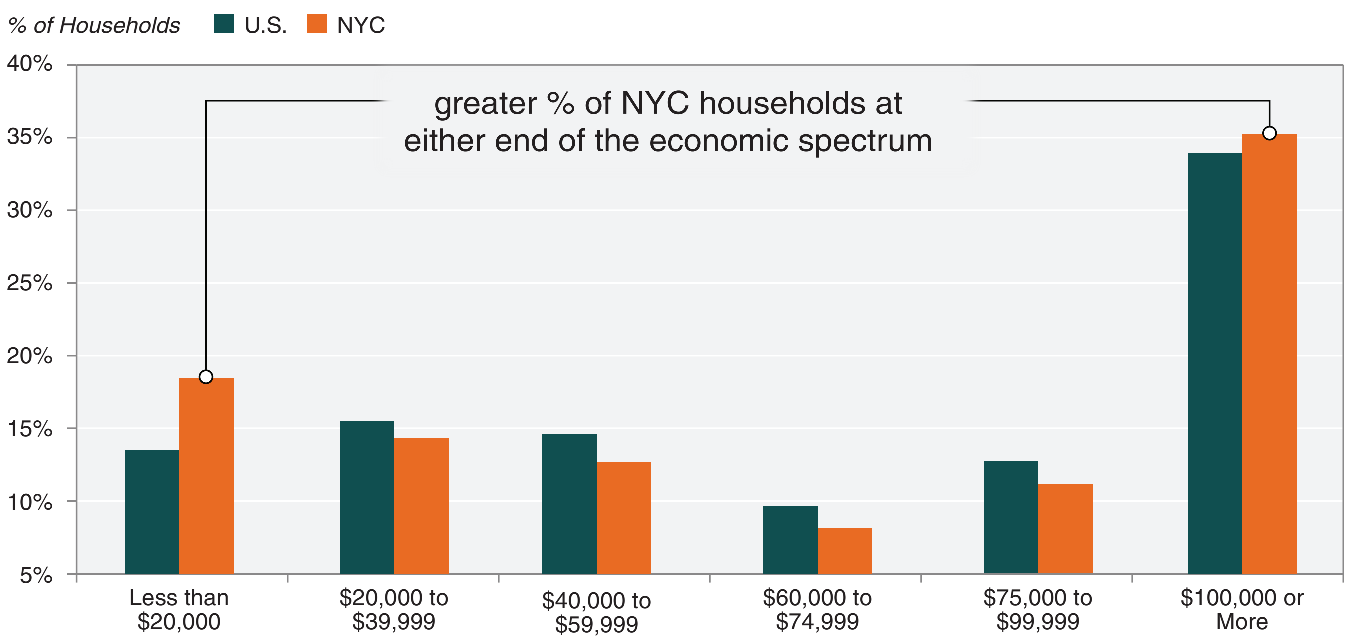
Water and Sewer Rates Over Time

DEP operations are funded almost entirely through rates paid by our customers. Water demand has declined more than 40% since 1990, despite a population increase of more than one million people. At the same time, DEP spending has increased to support mandated projects and critical investments in our water and wastewater infrastructure. As a result, water and sewer rates have increased by almost 137% (adjusted for inflation) since 2000 to meet the increasing cost of service.



Affordability Considerations

While the cost of NYC water is still less than the national average, New Yorkers are burdened by a high overall cost of living, in a city with one of the largest income gaps in the nation. Due to this, DEP must stay focused on managing the impacts our investments have on our rates, and in turn the wallets of average New Yorkers. See the COVID-19 discussion on pages 7 and 8 for additional affordability and financial capability considerations.



Source: *2018 American Community Survey 1-Year Estimates*

Attachment 1

Timeline of Key Events in CSO Planning for NYC

Timeline of Key Events in CSO Planning for NYC

CSO planning in New York City dates back to the 1950's, when conceptual plans for reduction of CSOs to the tributaries of Jamaica Bay and the East River were first initiated. Passage of the Clean Water Act in the 1970's and development of a National CSO Policy in 1994 triggered further planning and implementation of projects for CSO control.

An Administrative Consent Order signed in 1992 was followed by a series of CSO Orders on Consent to establish enforceable compliance schedules for elements of the CSO program. The current CSO LTCP program is driven by the 2005 Order on Consent, as modified by the 2012 Order on Consent and subsequent minor modifications.

WWFP and LTCP Acronyms

Alley Creek	**AC**	Flushing Creek	**FC**	Newtown Creek	**NC**
Bronx River	**BR**	Gowanus Canal	**GC**	Westchester Creek	**WC**
Coney Island Creek	**CIC**	Hutchinson River	**HR**		
Flushing Bay	**FB**	Jamaica Bay and Tributaries	**JBT**		

1950s

Developed first conceptual plans to reduce CSO discharges into the tributaries of Jamaica Bay and the East River

1972

Passage of the Clean Water Act

Establishment of the National Pollution Discharge Elimination System (NPDES) permit program

Completed construction of the Spring Creek CSO Facility


Spring Creek CSO Facility

1975

Initiated the State Pollution Discharge Elimination System (SPDES) permit program

1984

Developed a Citywide CSO Abatement Program

1992

Entered into an Administrative Consent Order **(1992 Consent Order)** with DEC

1993

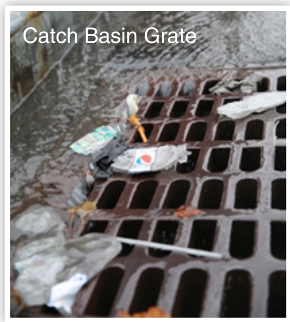
Completed Citywide Floatables Study Part 1 (1989 – 1993) – identified primary source of floatable trash is street litter reaching waterways through the sewer system

1994

EPA issued a National CSO Policy requiring development of CSO LTCPs

1995

Completed Citywide Floatables Study Part 2 (1993 – 1995) – identified street sweeping, catch basin grates and hoods, and end of pipe containment are effective floatable control strategies


Catch Basin Grate

1996


Catch Basin Cleaning

Modified the 1992 Consent Order to include a catch basin maintenance and repair program

1997

Submitted a Floatables Abatement Plan

Submitted the Nine Minimum CSO Control Report

Completed construction of the Corona Avenue CSO Vortex Facility

2000

Passage of the Wet-Weather Water Quality Act

EPA's National CSO Policy became law

2005

Entered into the **2005 CSO Consent Order** with DEC

Committed to developing 11 Waterbody/Watershed Facility Plans (WWFPs)

Submitted a Revised Floatables Abatement Plan

2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2014 | 2015 | 2016 | 2017 | 2018


Flushing Bay CSO Facility (Underground Storage Tank Construction)

Submitted a Revised Paerdegat Basin LTCP

DEC approved the Revised Paerdegat Basin LTCP

Submitted 2 WWFPs: HR and East River/ Open Waters

Completed construction of the Flushing Bay CSO Facility

Submitted GC WWFP

Submitted 3 WWFPs: FC, AC, and CIC

Submitted BR WWFP

Published the NYC Green Infrastructure Plan (GI Plan)


Paerdegat CSO Facility

Submitted 4 WWFPs: WC, NC, FB, JBT

Completed construction of the Paerdegat and Alley Creek CSO Facilities


Avenue V Pump Station

DEC approved the **2012 Modified CSO Consent Order** which incorporates DEP's strategy to further reduce CSOs by investing in green infrastructure

DEP committed to developing 11 CSO Long Term Control Plans

Completed construction of the Avenue V Pump Station


Gowanus Pump Station and Flushing Tunnel

DEC issued the 2014 CSO BMP Consent Order

Submitted 4 LTCPs: AC, WC, HR, FC

Completed CSO control upgrades at the Gowanus Pump Station and Flushing Tunnel

Submitted 2 LTCPs: BR, GC

Incorporated the 2014 BMP Order requirements into the SPDES permits for 13 WRRFs

Submitted 2 LTCPs: CIC, FB

Submitted Regulator CSO Monitoring Report

Submitted the NC LTCP

DEC approved 7 LTCPs: AC, HR, FC, BR, FB, GC, WC

Submitted the JBT LTCP

DEC approved 2 LTCPs: CIC, NC

Attachment 2

Submitted Long Term Control Plans

Alley Creek

Westchester Creek

Hutchinson River

Flushing Creek

Bronx River

Gowanus Canal

Coney Island Creek

Flushing Bay

Newtown Creek

Jamaica Bay and Tributaries

Alley Creek Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Commissioned a 5 million-gallon CSO storage facility along with other outfall and sewer system improvements.

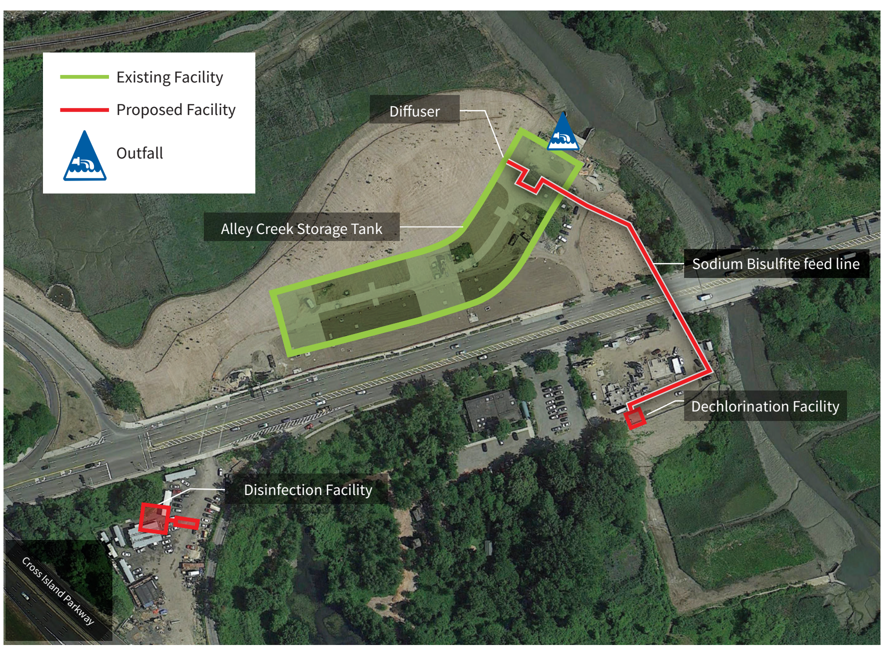
Status:

In Operation

Total Dollars Spent:

$141 Million

Approved LTCP Investments



Planned Cost-Effective Grey Investments: Provide seasonal (May 1st through October 31st) disinfection with dechlorination of the discharge from the existing CSO storage facility.

LTCP Approval Date:

March 2017

Current Completion Milestone*:

2024

Total Escalated Cost**:

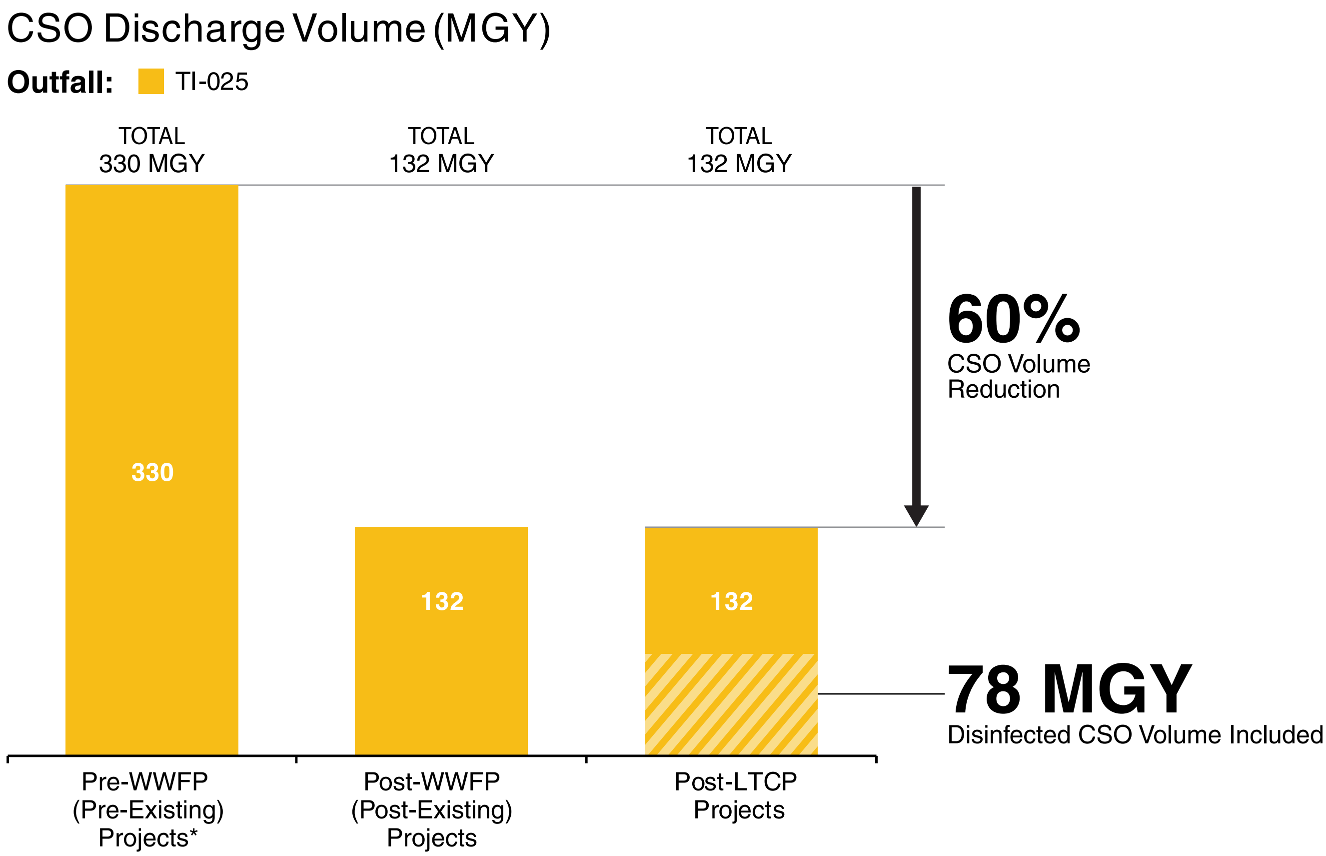
$25 Million

**Milestone dates may be subject to revision by DEC based on additional facility planning.*

***Includes costs for design, design services during construction, construction, and construction management. All costs are escalated per the implementation schedule.*

Benefits to Alley Creek and Little Neck Bay

The overall reduction in CSO volume to Alley Creek from the Pre-Existing Projects condition is predicted to be 198 MGY (60% reduction). The approved LTCP Project is predicted to provide an additional 59% reduction in the annual bacteria load by disinfecting 78 MGY of CSO volume discharging to Alley Creek.



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Model Calculated Water Quality Attainment Post-LTCP Projects

	Water Quality Criteria (as established by DEC)	**Alley Creek** (Class I)	**Little Neck Bay** (Class SB Coastal)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 90% Seasonal(1): 98%	Annual: 97% Seasonal(1): 100%
Enterococci(2)	30-Day Rolling GM ≤ 35 cfu/100mL	59%	92%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	10%	29%
Dissolved Oxygen	Class SB acute never < 3.0 mg/L	-	99%
	Class SB daily average ≥ 4.8 mg/L	-	89%
	Class I acute never < 4.0 mg/L	98%	-

(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to Alley Creek. Attainment with these criteria is shown for informational purposes only.

Westchester Creek Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Sewer system improvements including weir modifications and Pugsley Creek parallel relief sewer.

Status:

Ongoing Construction

Total Dollars Spent:

$126 Million

Approved LTCP Investments

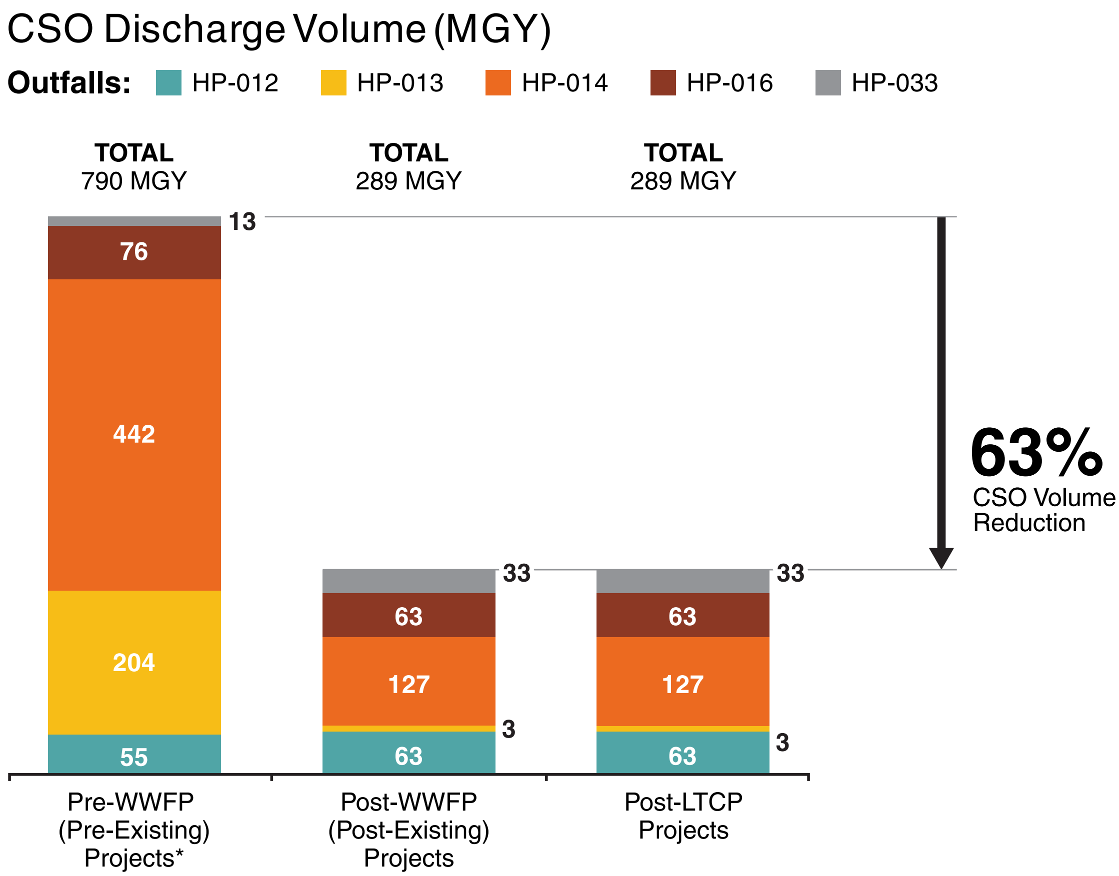
Planned Cost-Effective Grey Investments: The LTCP did not recommend an additional project for Westchester Creek beyond continued implementation of green infrastructure.

LTCP Approval Date:

August 2017

Benefits to Westchester Creek

The overall reduction in CSO volume to Westchester Creek from the Pre-Existing Projects condition is predicted to be 501 MGY (63% reduction).



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Model Calculated Water Quality Attainment Post-LTCP Projects

	Water Quality Criteria (as established by DEC)	Westchester Creek (Class I)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 93% Seasonal(1): 95%
Enterococci(2)	30-Day Rolling GM ≤ 35 cfu/100mL	88%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	25%
Dissolved Oxygen	Class I acute never < 4.0 mg/L	80%

(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to Westchester Creek. Attainment with these criteria is shown for informational purposes only.

Hutchinson River Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Commissioned headworks improvements to the Hunts Point Wastewater Resource Recovery Facility.

Status:

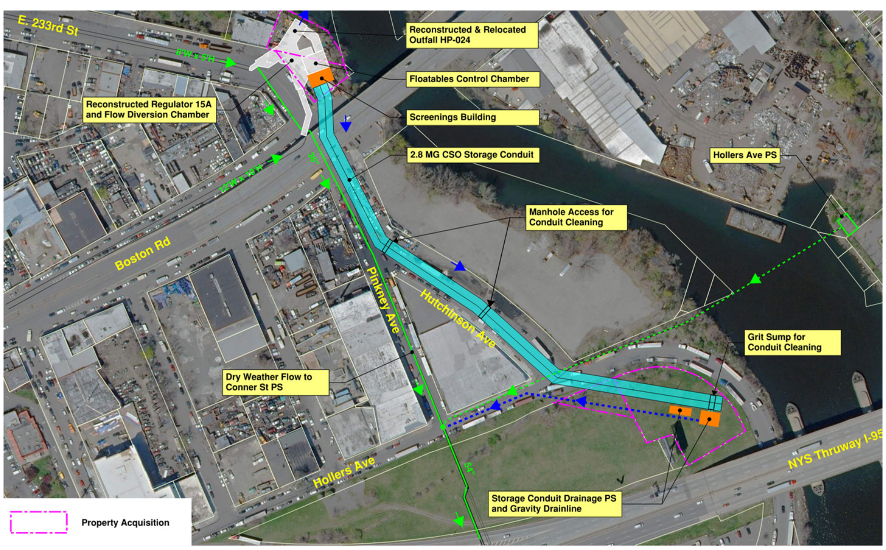
In Operation

Total Dollars Spent:

$3 Million

Headworks Improvements at Hunts Point WRRF

Approved LTCP Investments



**Includes costs for design, design services during construction, construction, and construction management. All costs are escalated per the implementation schedule.*

Planned Cost-Effective Grey Investments: Provide 2.8 MG storage conduit and floatables control for Outfall HP-024

Project Modification Approval Date:

March 2023

Current Completion Milestone:

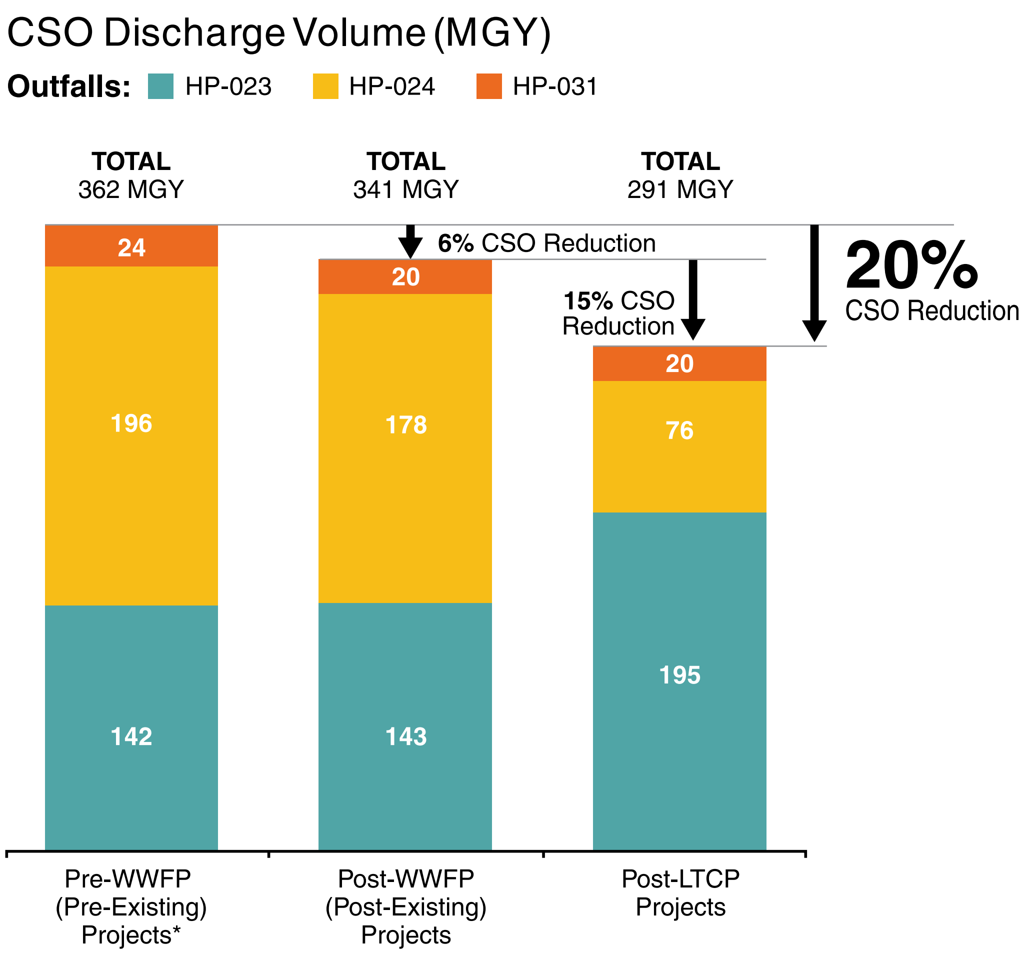
2033

Total Escalated Cost*:

$204 Million

Benefits to Hutchinson River

The revised LTCP Project is predicted to provide 50 MG (15%) reduction in annual CSO volume and bacteria load to the Hutchinson River from the Post-Existing Projects condition. The overall reduction in CSO volume to the Hutchinson River from the Pre-Existing Projects condition is predicted to be 71 MGY (20% reduction).



Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.

Model Calculated Water Quality Attainment Post-LTCP Projects

	Water Quality Criteria (as established by DEC)	**Hutchinson River** (Class SB)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 83% Seasonal(1): 95%
Enterococci(2)	30-Day Rolling GM ≤ 35 cfu/100mL	58%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	3%
Dissolved Oxygen	Class SB acute never < 3.0 mg/L	97%
	Class SB daily average ≥ 4.8 mg/L	78%

(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to Hutchinson River. Attainment with these criteria is shown for informational purposes only.

Flushing Creek Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Commissioned a 43 million-gallon CSO storage facility along with other sewer system improvements.

Status:

In Operation

Total Dollars Spent:

$363 Million

Approved LTCP Investments

Planned Cost-Effective Grey Investments: Provide seasonal (May 1st through October 31st) disinfection with dechlorination at the existing CSO storage facility and Outfall TI-011, and floatables control.

LTCP Approval Date:

March 2017

Current Completion Milestone*:

2025

Total Escalated Cost**:

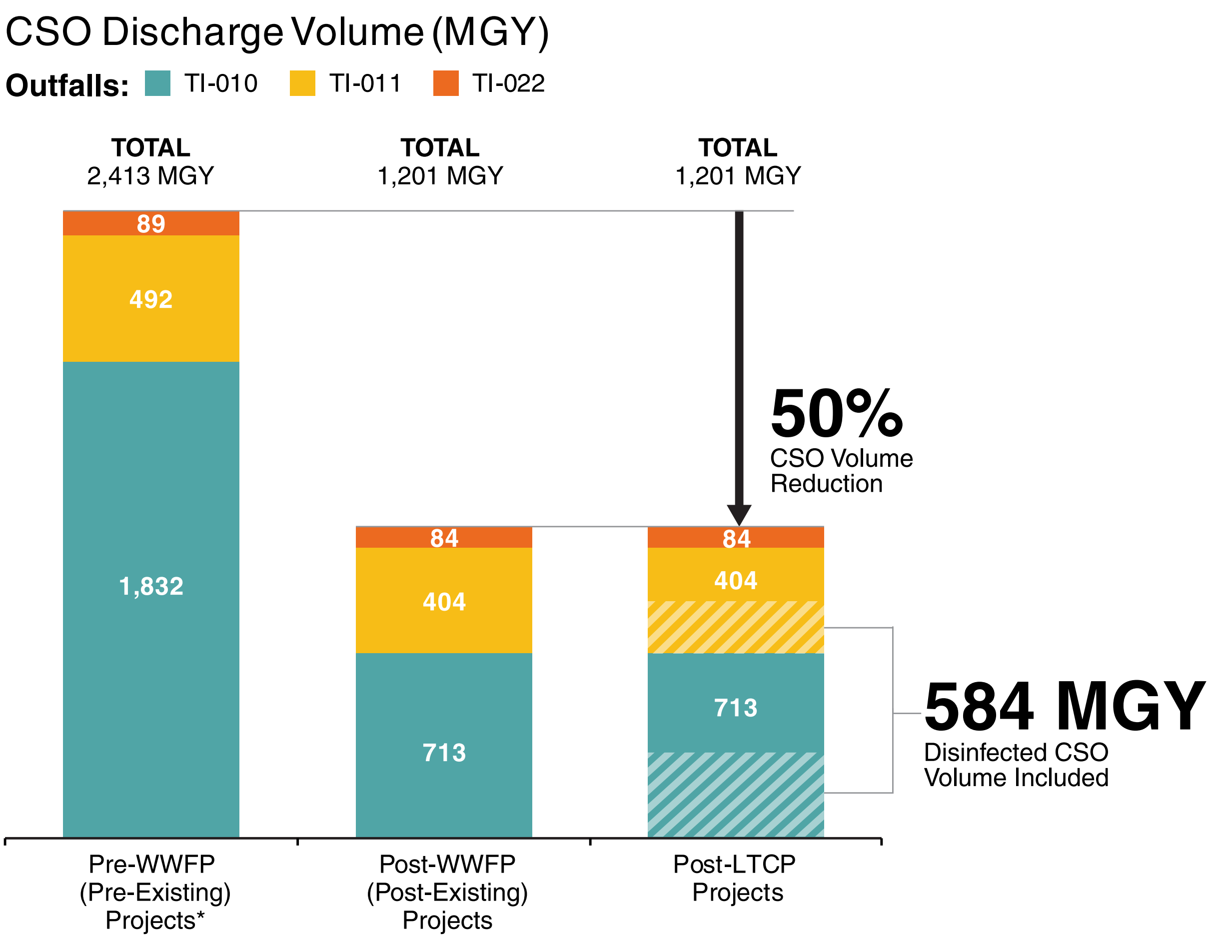
$89 Million

**Milestone dates may be subject to revision by DEC based on additional facility planning.*

***Includes costs for design, design services during construction, construction, and construction management. All costs are escalated per the implementation schedule.*

Benefits to Flushing Creek

The overall reduction in CSO volume to Flushing Creek from the Pre-Existing Projects condition is predicted to be 1,212 MGY (50% reduction). The approved LTCP Project is predicted to provide an additional 51% reduction in the annual bacteria load by disinfecting 584 MGY of CSO volume discharging to Flushing Creek.



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Model Calculated Water Quality Attainment Post-LTCP Projects

	Water Quality Criteria (as established by DEC)	Westchester Creek (Class I)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 67% Seasonal(1): 78%
Enterococci(2)	30-Day Rolling GM ≤ 35 cfu/100mL	69%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	7%
Dissolved Oxygen	Class I acute never < 4.0 mg/L	85%

(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to Flushing Creek. Attainment with these criteria is shown for informational purposes only.

Bronx River Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Commissioned sewer system upgrades to maximize flow to the Hunts Point Wastewater Resource Recovery Facility and implemented outfall netting and screens to control floatable materials.

Status:

In Operation

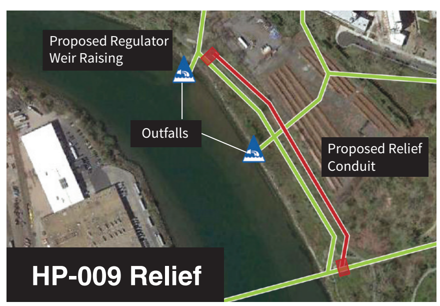
Total Dollars Spent:

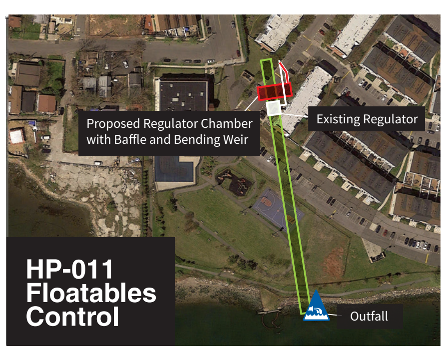
$46 Million

Floatables Control

Approved LTCP Investments

Planned Cost-Effective Grey Investments: Implement sewer modifications to provide hydraulic relief at Outfalls HP-007 and HP-009 and provide floatables control at Outfall HP-011.





LTCP Approval Date:

March 2017

Current Completion Milestone*:

2026

Total Escalated Cost**:

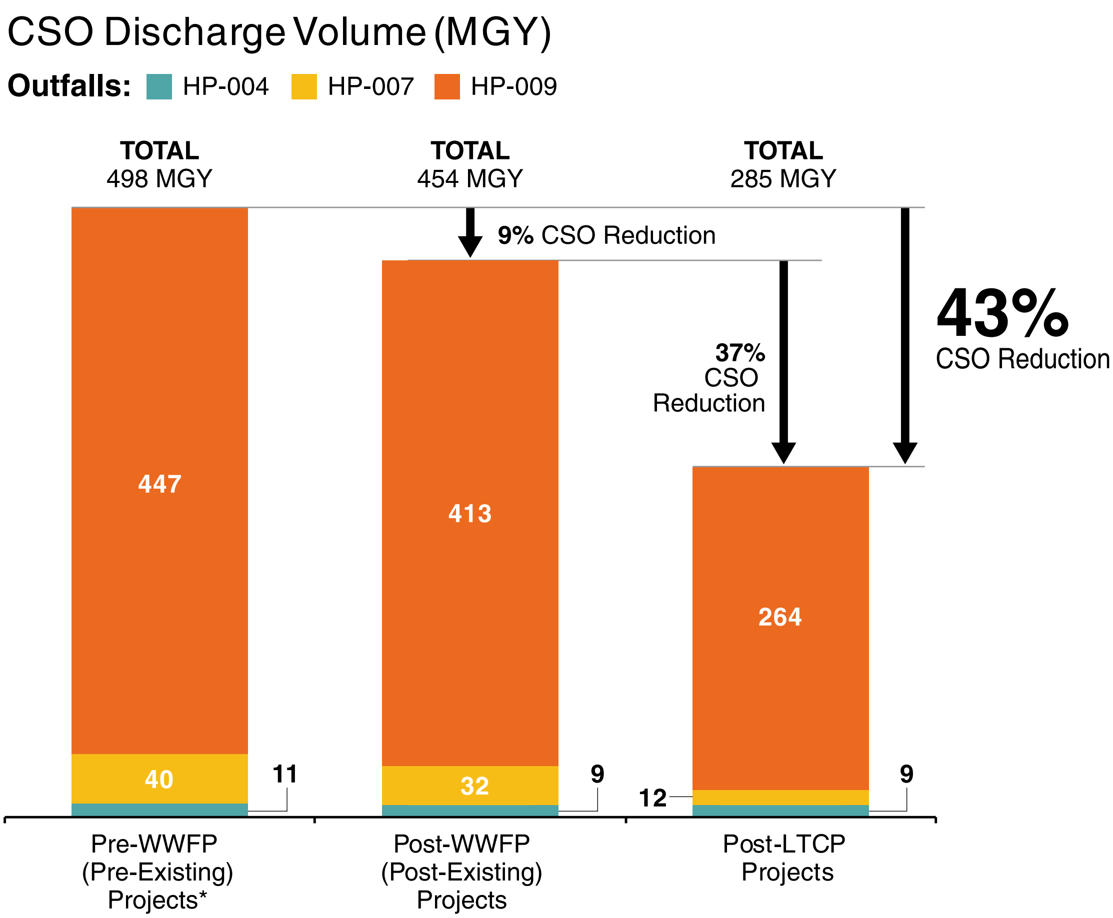
$122 Million

**Milestone dates may be subject to revision by DEC based on additional facility planning.*

***Includes costs for design, design services during construction, construction, and construction management. All costs are escalated per the implementation schedule.*

Benefits to Bronx River

The approved LTCP Project is predicted to provide 169 MG (37%) reduction in annual CSO volume and bacteria load to the Bronx River from the Post-Existing Projects condition. The overall reduction in CSO volume to the Bronx River from the Pre-Existing Projects condition is predicted to be 213 MGY (43% reduction).



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Model Calculated Water Quality Attainment Post-LTCP Projects

	Water Quality Criteria (as established by DEC)	**Bronx River** (Class I)(1)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 83% Seasonal(2): 80%
Enterococci(3)	30-Day Rolling GM ≤ 35 cfu/100mL	82%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	10%
Dissolved Oxygen	Class I acute never < 4.0 mg/L	95%

(1) As indicated in the Bronx River LTCP, the Class B freshwater stations in the Bronx River were not affected by Bronx River CSOs, which are all located in the saline section of the river.
(2) The recreational season is from May 1st through October 31st.
(3) Enterococci criteria do not apply to Bronx River. Attainment with these criteria is shown for informational purposes only.

Gowanus Canal Long Term Control Plan

Investments made Prior to the LTCP Process

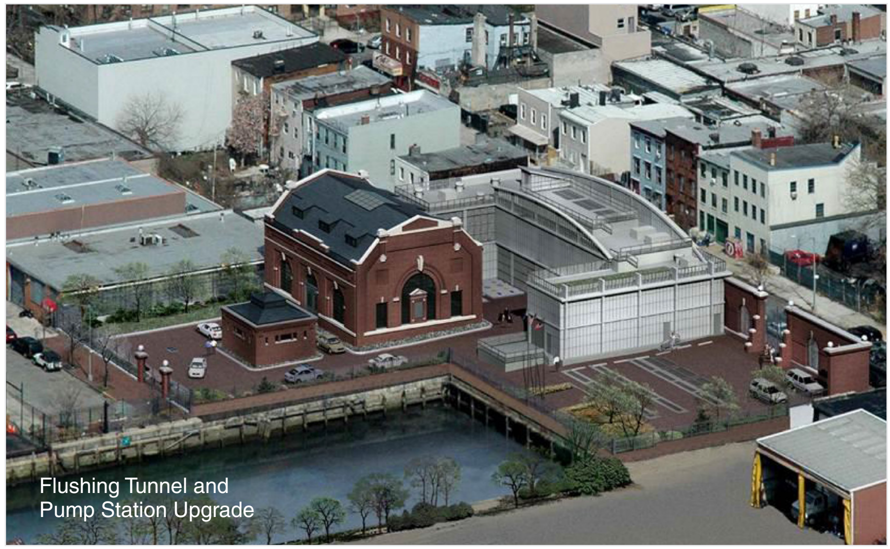
Existing Cost-Effective Grey Investments: Sewer system improvements including the restoration of the flushing tunnel and reconstruction of the Gowanus Pump Station.

Status:

In Operation

Total Dollars Spent:

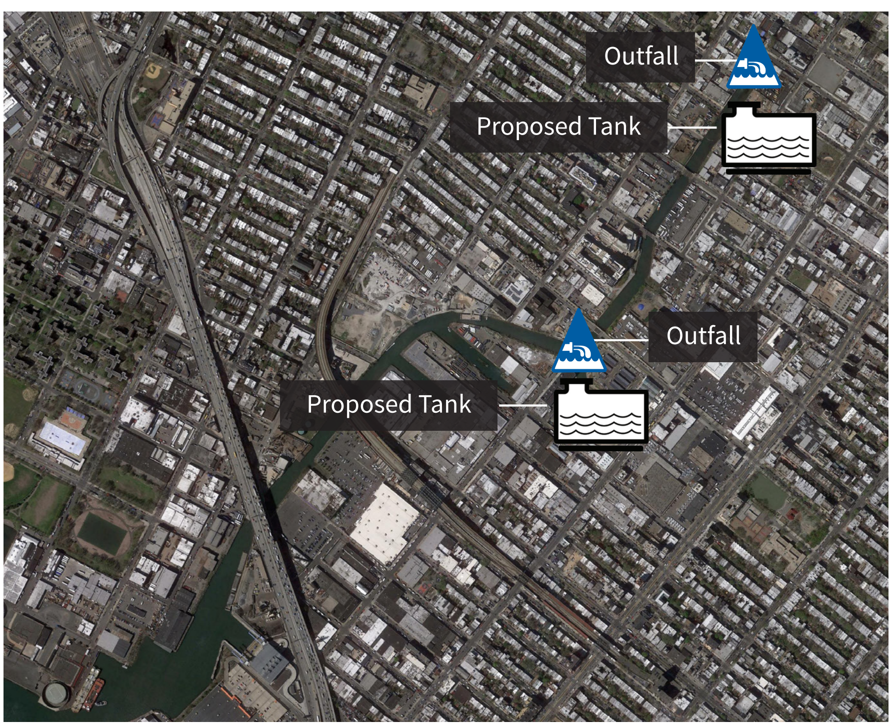
$198 Million



Flushing Tunnel and Pump Station Upgrade

Approved LTCP Investments

Planned Cost-Effective Grey Investments: The LTCP did not recommend an additional project for Gowanus Canal beyond continued implementation of green infrastructure, but as part of a Superfund program, two CSO storage tanks (8 MG and 4 MG) are proposed to be constructed.



LTCP Approval Date:

March 2017

Superfund Project Total Escalated Cost*:

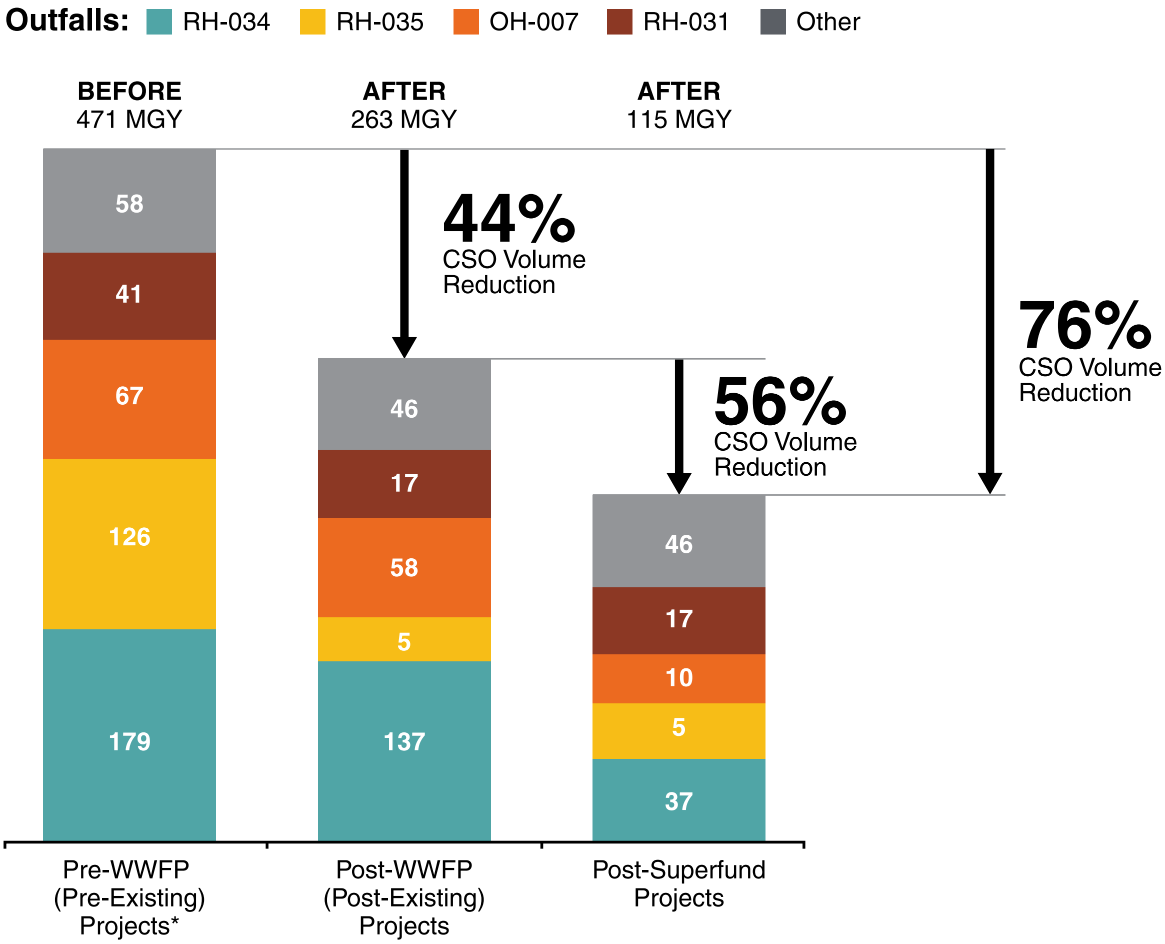
$1,600 Million

**Includes costs for design, design services during construction, construction, and construction management. All costs are escalated per the implementation schedule.*

Benefits to Gowanus Canal

The Superfund Project is predicted to provide 148 MGY (56%) reduction in the annual CSO volume and bacteria load to the Gowanus Canal from the Post-Existing Projects condition. The overall reduction in CSO volume to Gowanus Canal from the Pre-Existing Projects condition is predicted to be 356 MGY (76% reduction).

CSO Discharge Volume (MGY)



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Model Calculated Water Quality Attainment Post-Superfund Projects

	Water Quality Criteria (as established by DEC)	**Gowanus Canal** (Class SD)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 98% Seasonal(1): 100%
Enterococci(2)	30-Day Rolling GM ≤ 35 cfu/100mL	100%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	90%
Dissolved Oxygen	Class SD acute never < 4.0 mg/L	100%

(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to Gowanus Canal. Attainment with these criteria is shown for informational purposes only.

Coney Island Creek Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Sewer system improvements including the upgrade of the Avenue V Pump Station and a new wet-weather force main.

Status:

In Operation

Total Dollars Spent:

$197 Million

Avenue V Pump Station

Approved LTCP Investments

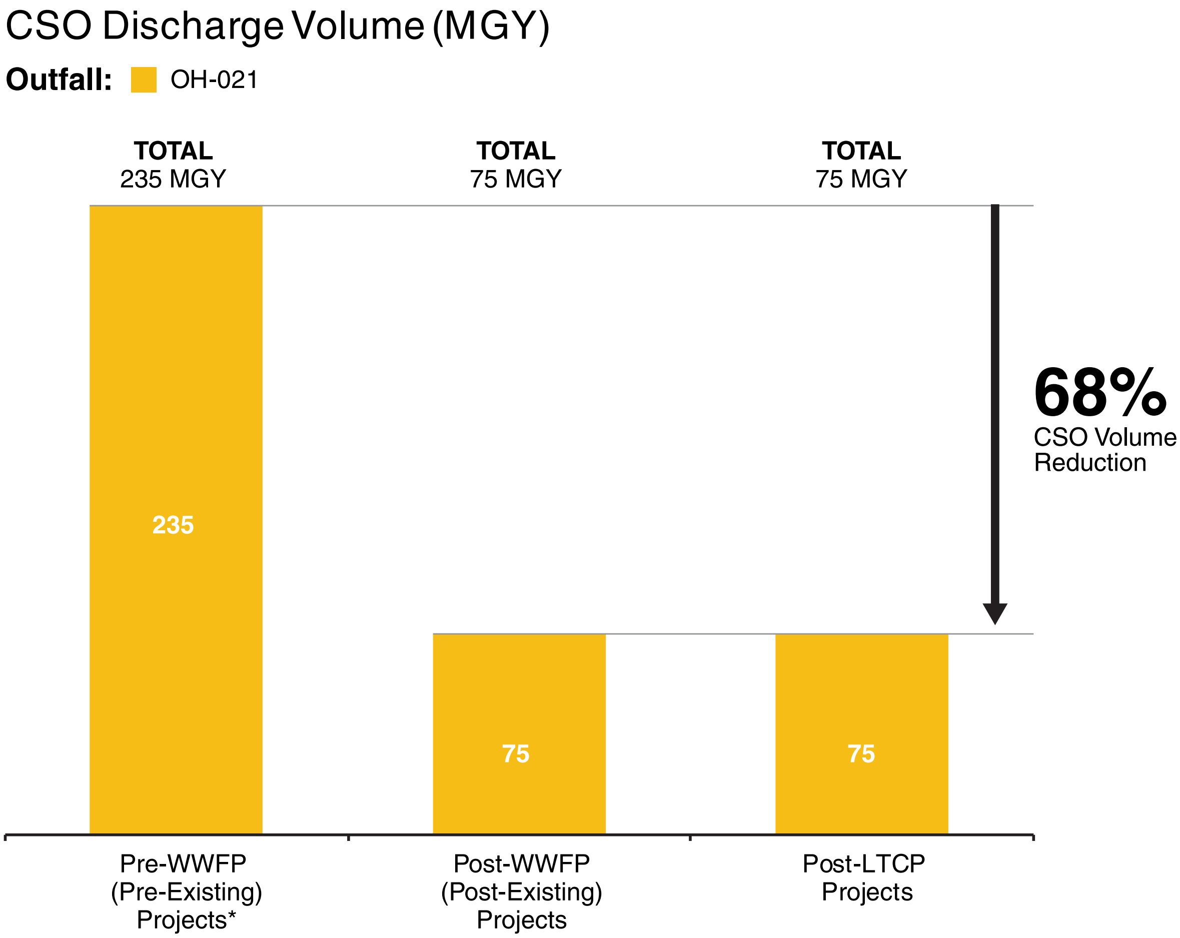
Planned Cost-Effective Grey Investments: The LTCP did not recommend an additional project for Coney Island Creek. DEP will conduct ongoing illicit sewer connection trackdown, additional flow monitoring and MS4 prioritization.

LTCP Approval Date:

April 2018

Benefits to Coney Island Creek

The overall reduction in CSO volume to Coney Island Creek from the Pre-Existing Projects condition is predicted to be 160 MGY (68% reduction).



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Model Calculated Water Quality Attainment Post-LTCP Projects

	Water Quality Criteria (as established by DEC)	Coney Island Creek (Class I)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 56% Seasonal(1): 93%
Enterococci(2)	30-Day Rolling GM ≤ 35 cfu/100mL	53%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	3%
Dissolved Oxygen	Class I acute never < 4.0 mg/L	90%

(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to Coney Island Creek. Attainment with these criteria is shown for informational purposes only.

Flushing Bay Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Sewer system improvements including diverting low-lying sewers and regulator modifications; and dredging and restoration of Flushing Bay.

Status:

Ongoing Construction and Restoration

Total Dollars Spent:

$71 Million

Approved LTCP Investments

Planned Cost-Effective Grey Investments: Commission a 25 million-gallon CSO storage tunnel with dewatering pump station to capture overflows from Outfalls BB-006 and BB-008.

LTCP Approval Date:
March 2017

Current Completion Milestone*:
2035

Total Escalated Cost**:
$1,471 Million

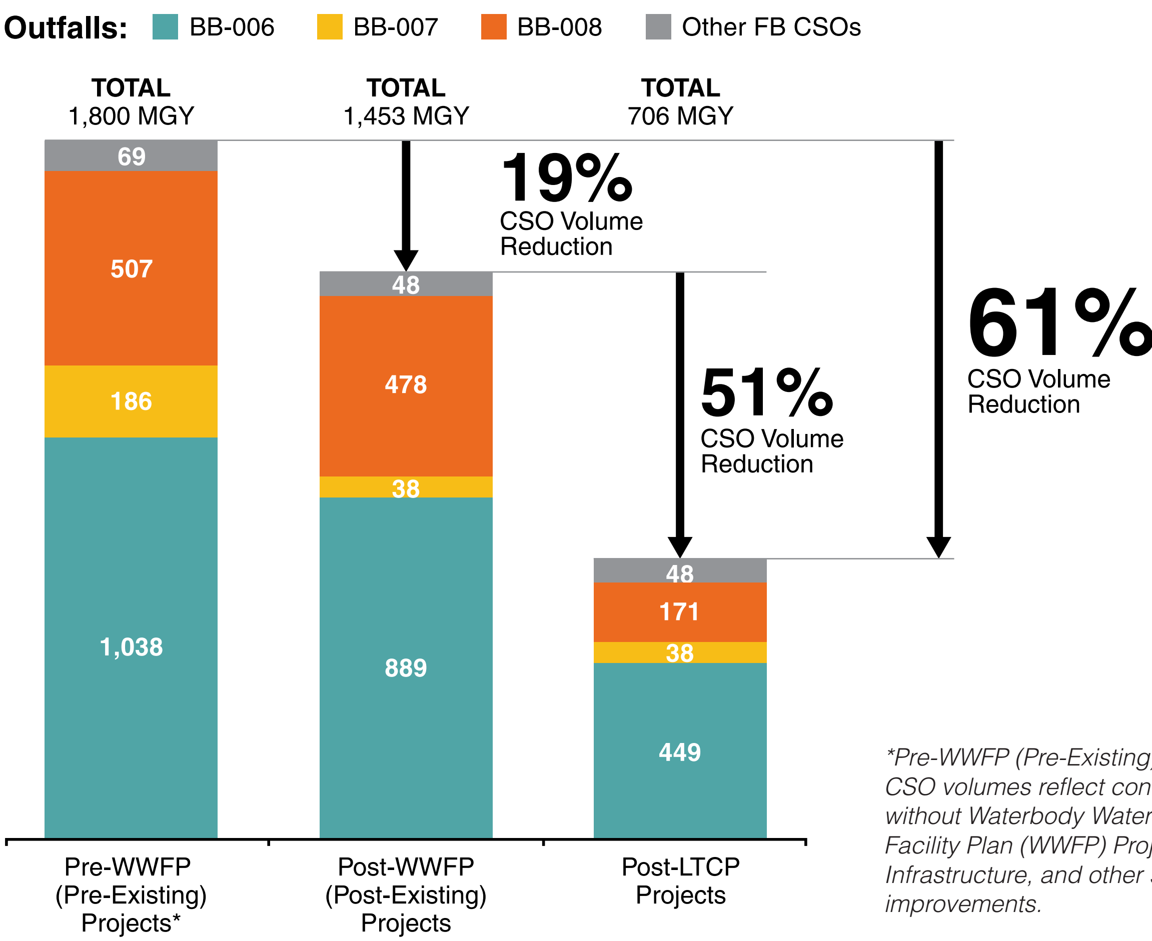
**Milestone dates may be subject to revision by DEC based on approval of engineering design report per September 2022 Consent Order Modification.*

***Includes costs for design, design services during construction, construction, and construction management. All costs are escalated per the implementation schedule.*

Benefits to Flushing Bay

The approved LTCP Project is predicted to provide an additional 747 MGY (51%) reduction in annual CSO volume and bacteria load to Flushing Bay from the Post-Existing Projects condition. The overall reduction in CSO volume to Flushing Bay from the Pre-Existing Projects condition is predicted to be 1,094 MGY (61% reduction).

CSO Discharge Volume (MGY)



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Model Calculated Water Quality Attainment Post-LTCP Projects

	Water Quality Criteria (as established by DEC)	Flushing Bay (Class I)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 100% Seasonal(1): 100%
Enterococci(2)	30-Day Rolling GM ≤ 35 cfu/100mL	98%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	55%
Dissolved Oxygen	Class I acute never < 4.0 mg/L	97%

(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to Flushing Bay. Attainment with these criteria is shown for informational purposes only.

Newtown Creek Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Sewer system improvements including bending weirs and floatables control; Newtown Creek Wastewater Resource Recovery Facility headworks expansion; and in-stream aeration.

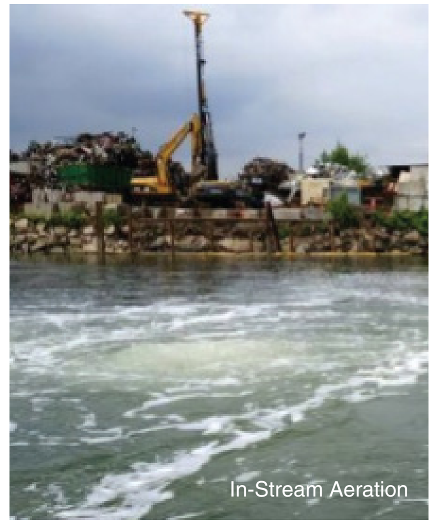
Status:

In Operation

Total Dollars Spent:

$262 Million

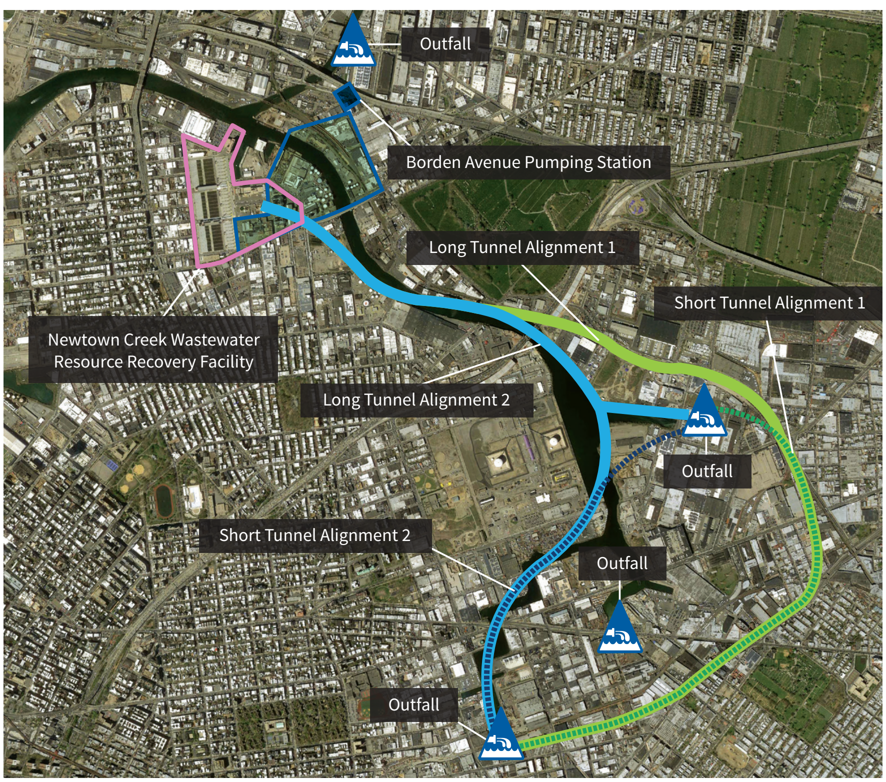
Headworks Expansion



In-Stream Aeration

Approved LTCP Investments

Planned Cost-Effective Grey Investments: Commission a 39 million-gallon CSO storage tunnel to capture overflows from Outfalls NCB-015, NCB-083, and NCQ-077; and expansion of the Borden Avenue Pump Station to reduce overflows at Outfall BB-026.



LTCP Approval Date:

June 2018

Pump Station Expansion Current Completion Milestone*:

2029

CSO Storage Tunnel Current Completion Milestone*:

2042

Total Escalated Cost**:

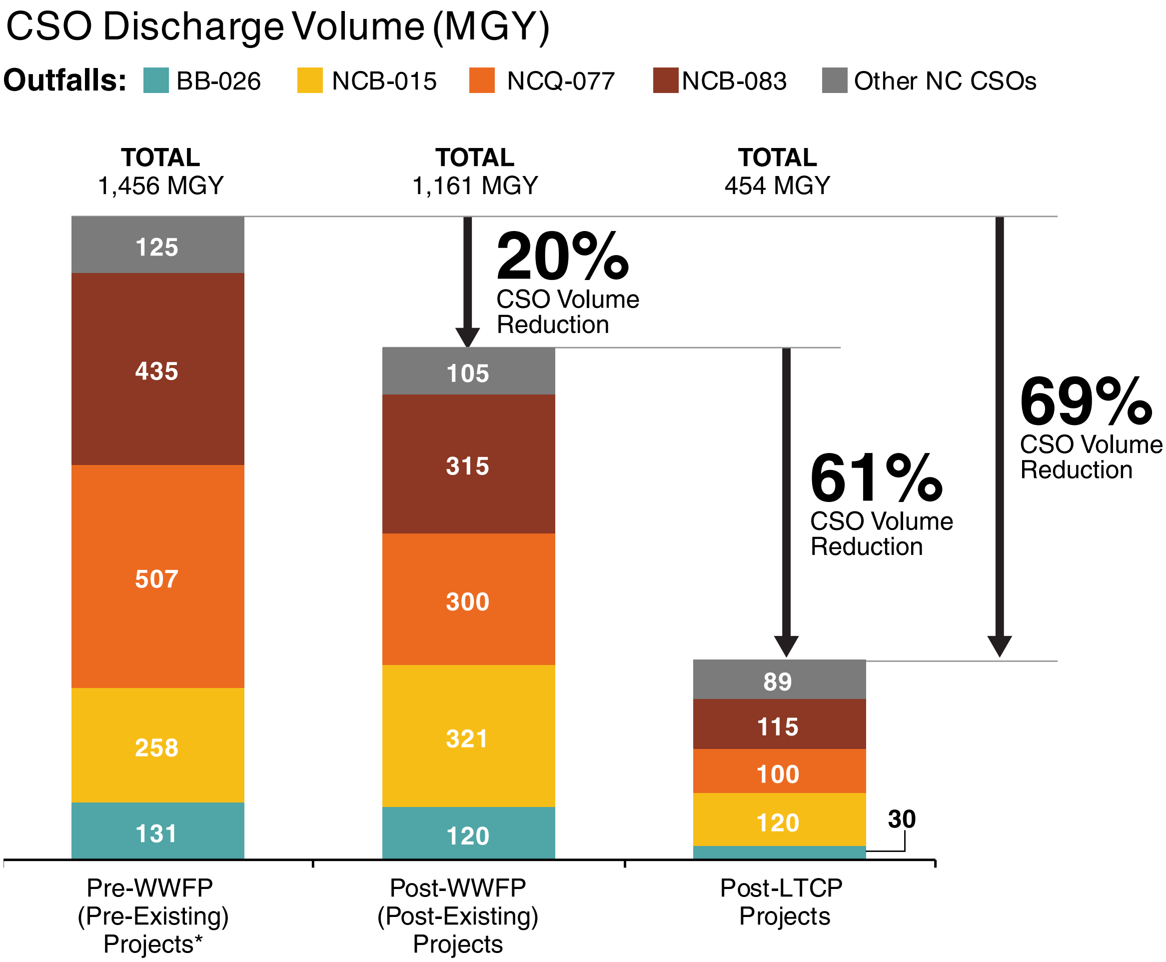
$2,401 Million

**Milestone dates may be subject to revision by DEC based on additional facility planning.*

***Includes costs for design, design services during construction, construction, and construction management. All costs are escalated per the implementation schedule.*

Benefits to Newtown Creek

The approved LTCP Project is predicted to provide an additional 707 MGY (61%) reduction in annual CSO volume and bacteria load to Newtown Creek from the Post-Existing Projects condition. The overall reduction in CSO volume to Newtown Creek from the Pre-Existing Projects condition is predicted to be 1,001 MGY (69% reduction).



***Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Model Calculated Water Quality Attainment Post-LTCP Projects

	Water Quality Criteria (as established by DEC)	Newtown Creek (Class SD)
Fecal Coliform	Monthly GM ≤ 200 cfu/100mL	Annual: 83% Seasonal(1): 83%
Enterococci(2)	30-Day Rolling GM ≤ 35 cfu/100mL	78%
	30-Day 90th Percentile STV ≤ 130 cfu/100mL	7%
Dissolved Oxygen	Class SD acute never < 4.0 mg/L	97%

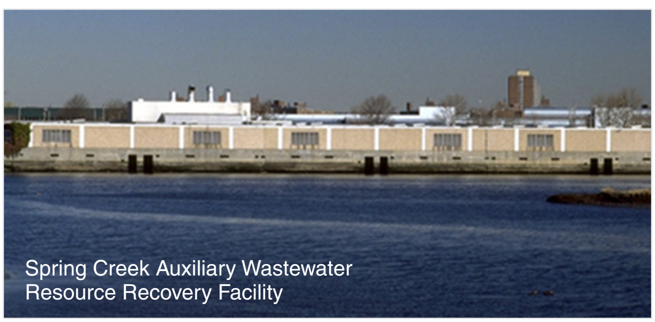
(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to Newtown Creek. Attainment with these criteria is shown for informational purposes only.

Jamaica Bay and Tributaries Long Term Control Plan

Investments made Prior to the LTCP Process

Existing Cost-Effective Grey Investments: Commissioned Spring Creek Auxiliary WRRF upgrade; 30 million-gallon Paerdegat CSO storage facility; Warnerville Pump Station and forcemain; 26th Ward WRRF drainage area sewer cleaning; regulator improvements and bending weirs; a new parallel sewer to the west interceptor; Hendrix Creek and Paerdegat Basin dredging and Shellbank Basin destratification. On-going construction on Bergen Basin lateral sewer; and 26th Ward WRRF wet-weather stabilization and high-level storm sewers.

Sewer Flushing



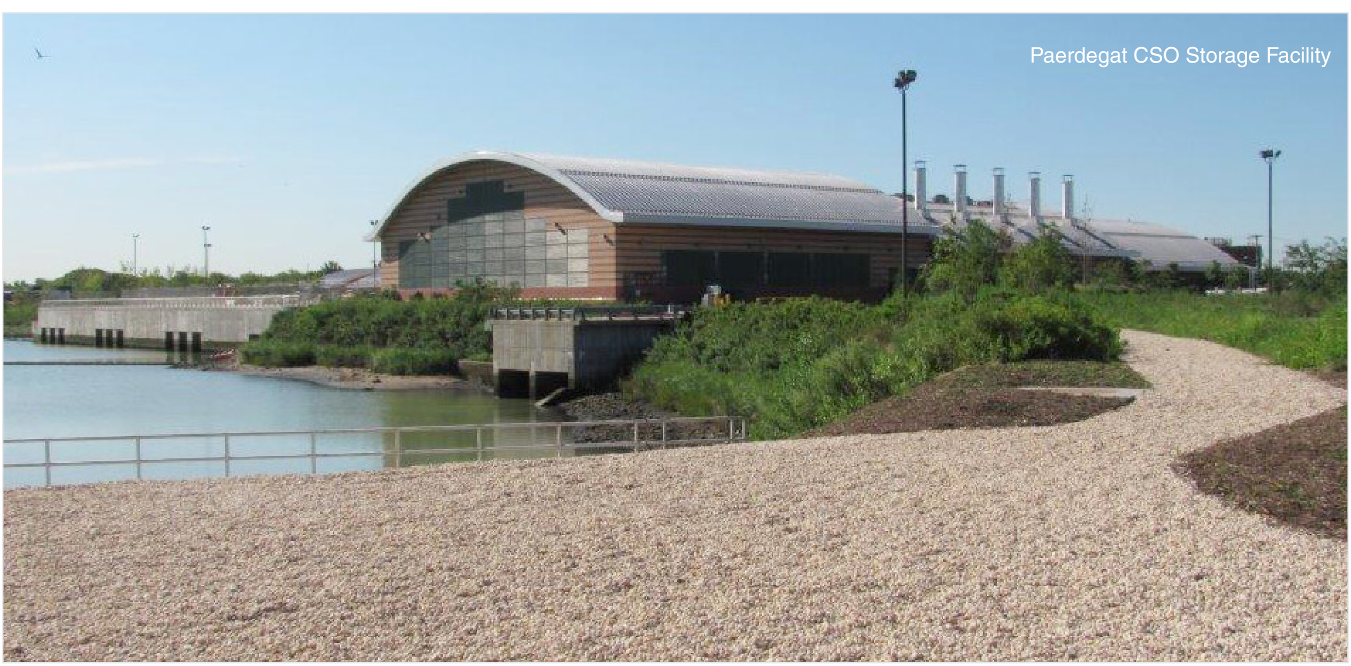
Spring Creek Auxiliary Wastewater Resource Recovery Facility

Status:

In Operation and Ongoing Construction

Total Dollars Spent:

$1,100 Million



Paerdegat CSO Storage Facility

Submitted LTCP Investments

Planned Cost-Effective Green Investments: Provide ribbed mussel colony creation in Bergen and Thurston Basins; environmental dredging in Bergen Basin; and wetland restoration in Spring Creek, Hendrix Creek, Fresh Creek, Paerdegat Basin, and Jamaica Bay.

LTCP Approval Date:

January 2023

Total Escalated Cost*:

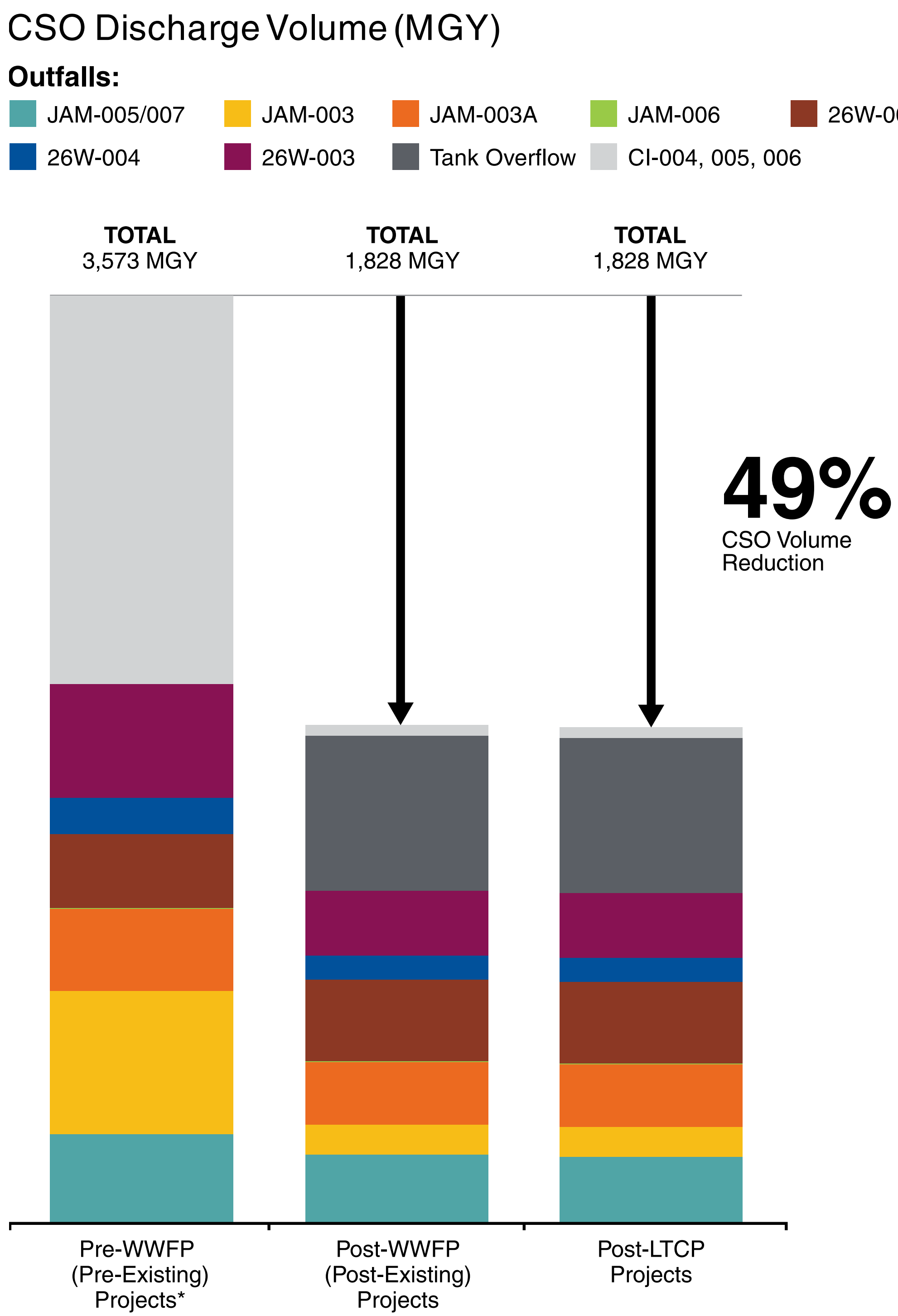
$230 Million

Includes costs for design, design services during construction, construction, and construction management. All costs are escalated per the implementation schedule.

Will be cost sharing with USACE

Benefits to Jamaica Bay and Tributaries

The approved LTCP Project does not change the CSO volume to Jamaica Bay and Tributaries, but provides other benefits through ribbed mussel installation, dredging and wetlands restoration. The overall reduction in CSO volume to Jamaica Bay and Tributaries from the Pre-Existing Projects condition is predicted to be 1,745 MG (49% reduction).



*Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.

Model Calculated Water Quality Attainment Post-LTCP Projects

Waterbody	Water Quality Criteria (as established by DEC)				
	Fecal Coliform Monthly GM ≤ 200 cfu/100mL	**Enterococci** 30-Day Rolling GM ≤ 35 cfu/100mL	**Enterococci** 30-Day 90th Percentile STV ≤ 130 cfu/100mL	**Dissolved Oxygen** Class SB acute never < 3.0 mg/L	**Dissolved Oxygen** Class SB daily average ≥ 4.8 mg/L
Jamaica Bay (Class SB)	Annual: 100% Seasonal(1): 100%	100%	57%	100%	99%

Tributaries (Class I)	Water Quality Criteria (as established by DEC)			
	Fecal Coliform Monthly GM ≤ 200 cfu/100mL	**Enterococci(2)** 30-Day Rolling GM ≤ 35 cfu/100mL	**Enterococci(2)** 30-Day 90th Percentile STV ≤ 130 cfu/100mL	**Dissolved Oxygen** Class I acute never < 4.0 mg/L
Thurston Basin	Annual: 77% Seasonal(1): 88%	65%	5%	90%
Bergen Basin	Annual: 57% Seasonal(1): 72%	29%	0%	89%
Spring Creek	Annual: 100% Seasonal(1): 100%	100%	78%	99%
Hendrix Creek	Annual: 99% Seasonal(1): 98%	98%	32%	94%
Fresh Creek	Annual: 85% Seasonal(1): 93%	98%	16%	99%
Paerdegat Basin	Annual: 97% Seasonal(1): 95%	96%	28%	99%

(1) The recreational season is from May 1st through October 31st.
(2) Enterococci criteria do not apply to these tributaries. Attainment with these criteria is shown for informational purposes only.

Attachment 3

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

AK: Arthur Kill

AMP: Asset Management Plan

AR: Affordability Ratio

AWRRF: Auxiliary Wastewater Resource Recovery Facility

AWWA: American Water Works Association

BCEQ: Bronx Council for Environmental Quality

BEACH: Beaches Environmental Assessment and Coastal Health

BGY: Billion Gallons per Year

BMP: Best Management Practice

BNR: Biological Nutrient Removal

BOD: Biochemical Oxygen Demand

BODR: Basis of Design Report

BYO: Bring Your Own

CEG: Cost Effective Grey

CIP: Capital Improvement Plan

COLI: Cost of Living Index

CPK: Central Park

CREC: Center for Regional Economic Competitiveness

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

DMA: Douglaston Manor Association

DO: Dissolved Oxygen

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 & Recreation

DSNY: New York City Department of Sanitation

EDC: New York City Economic Development Corporation

EO: Executive Order

EPA: United States Environmental Protection Agency

ER: East River

ESMIA: Ecologically Sensitive Maritime and Industrial Area

EWR: Newark Liberty International Airport

FAD: Filtration Avoidance Determination

FANCJ: First Amended Nitrogen Consent Judgement

FCI: Financial Capability Indicators

FMPV: Full Market Property Value

FPL: Federal Poverty Level

FS: Feasibility Study

FT: Abbreviation for “Feet”

FY: Fiscal Year

GHG: Greenhouse Gases

GI: Green Infrastructure

GIS: Geographical Information System

GM: Geometric Mean

G.O.: General Obligation

GoFB: Guardians of Flushing Bay

GRTA: NYC Green Roof Tax Abatement

HBI: Household Burden Indicator

HEAP: Home Energy Assistance Program

HGL: Hydraulic Grade Line

HH: Household

HLI: High Level Interceptor

HLSS: High Level Storm Sewers

HSM: Harbor Survey Monitoring Program

HVAC: Heating, Ventilation and Air Conditioning

IEC: Interstate Environmental Commission

in.: Abbreviation for “Inches”.

in/hr: Inches per hour

IW:	InfoWorks CS™
JEM:	Jamaica Eutrophication Model
JFK:	John F. Kennedy International Airport
KOTC:	Knee-of-the-Curve
KVK:	Kill Van Kull
lbs/day:	pounds per day
LF:	linear feet
LGA:	LaGuardia Airport
LIRR:	Long Island Rail Road
LIS:	Long Island Sound
LLI:	Low Level Interceptor
LQI:	Lowest Quintile of Income
LT2:	Long Term 2
LTCP:	Long Term Control Plan
LTCPRM:	Long Term Control Plan Regional Model
MCP:	Multifamily Conservation Program
MEG:	Model Evaluation Groups
mg/L:	milligrams per liter
MG:	Million Gallons
MGD:	Million Gallons Per Day
MGY:	Million Gallons Per Year
MHI:	Median Household Income
MIH:	Mandatory Inclusionary Housing
MMP:	Mercury Minimization Program
MOU:	Memorandum of Understanding
MPN:	Most Probable Number
MS4:	Municipal separate storm sewer systems
MSP:	Main Sewage Pump
MTA:	Metropolitan Transportation Authority
MWFA:	New York City Municipal Water Finance Authority
NCA:	Newtown Creek Alliance
ng/L:	Nanograms per Liter
NMC:	Nine Minimum Control
NOAA:	National Oceanic and Atmospheric Administration
NPDES:	National Pollutant Discharge Elimination System
NPW:	Net Present Worth
NWI:	National Wetlands Inventory
NYB:	New York Bay
NYC:	New York City
NYCHA:	New York City Housing Authority
NYCRR:	New York State Code of Rules and Regulations
NYNHP:	New York Natural Heritage Program
NYPD:	New York City Police Department
NYS:	New York State
NYSDOH:	New York State Department of Health
O&M:	Operation and Maintenance
PANYNJ:	Port Authority of New York and New Jersey
PATH:	Port Authority Trans-Hudson
PBC:	Probable Bid Cost
PCM:	Post-Construction Compliance Monitoring
PMAZ:	Priority Marine Activity Zones
POTW:	Publicly Owned Treatment Works
PPI:	Poverty Prevalence Indicator
PS:	Pump Station
PVSC:	Passaic Valley Sewerage Commission
Q:	Symbol for Flow (designation when used in equations)
REC:	Recognized Ecological Complexes
RI:	Remedial Investigation
ROD:	Record of Decision
ROW:	Right-of-Way
RTC:	Real Time Control
RWQC:	Recreational Water Quality Criteria
S&P:	Standard and Poor
SAFE:	Solvents, Automotive, Flammables, and Electronics
SCADA:	Supervisory Control and Data Acquisition
SDWA:	Safe Drinking Water Act
sf:	square feet
SM:	Sentinel Monitoring
SMIA:	Significant Maritime and Industrial Areas
SNWA:	Significant Natural Waterfront Area
SOGR:	State of Good Repair
SPDES:	State Pollutant Discharge Elimination System
STEM:	Science, Technology, Engineering, and Mathematics
STV:	Statistical Threshold Value
SW:	Stormwater
SWEM:	System-Wide Eutrophication Model
S.W.I.M.:	Stormwater Infrastructure Matters Coalition
SWMP:	Stormwater Management Program
TBD:	To Be Determined
TBM:	Tunnel Boring Machine
TMDL:	Total Maximum Daily Load
TRC:	Total Residual Chlorine
UAA:	Use Attainability Analysis
ug/L:	Micrograms Per Liter
U.S.:	United States
USFWS:	U.S. Fish & Wildlife Service
UV:	Ultraviolet Light
VCPA:	Van Cortlandt Park Alliance
WDAP:	Water Debt Assistance Program
WQ:	Water Quality
WQBEL:	Water Quality Based Effluent Limitations
WQS:	Water Quality Standards
WRP:	Waterfront Revitalization Program
WRRF:	Wastewater Resource Recovery Facilities
WWFP:	Waterbody/Watershed Facility Plan
WWOP:	Wet-Weather Operating Plan
WWTP:	Wastewater Treatment Plant

Attachment D

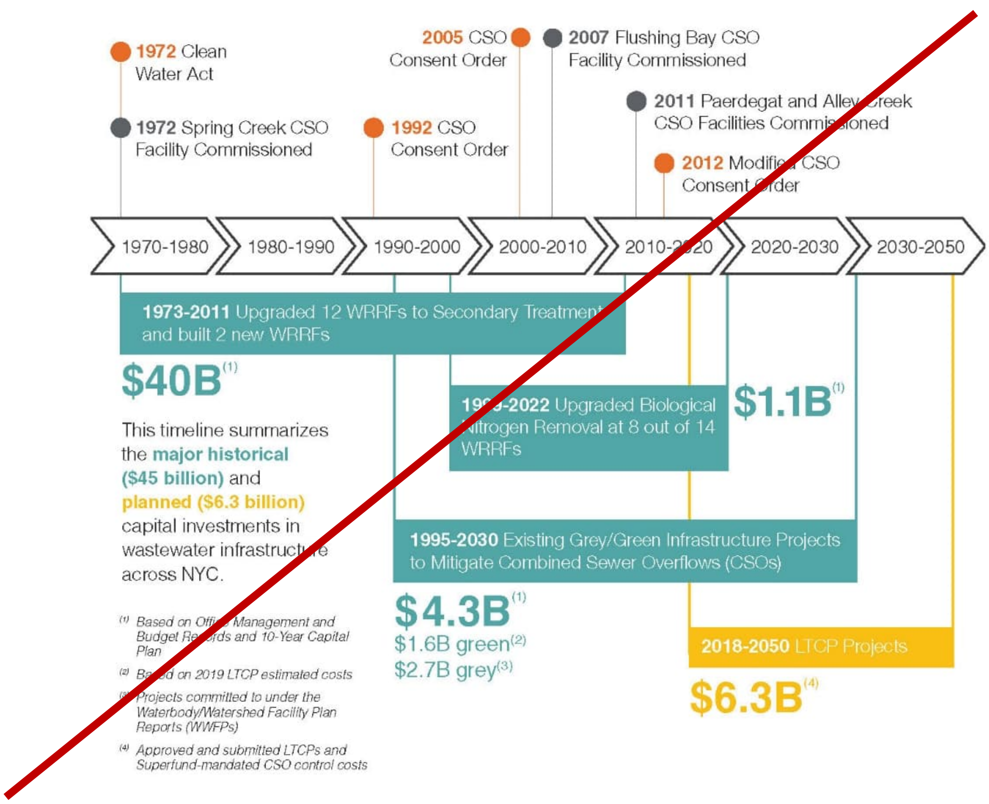
Revised Section 4 Grey Infrastructure

4.0 GREY INFRASTRUCTURE

4.1 Historical Context for Water Quality Improvements through DEP Capital Investments

CSO planning in New York City dates back to the 1950's, when conceptual plans for reduction of CSO to the tributaries of Jamaica Bay and the East River were first initiated. Passage of the Clean Water Act in the 1970's and development of a National CSO Policy in 1994 triggered further planning and implementation of projects for CSO control. An Administrative Consent Order signed in 1992 was followed by a series of CSO Orders on Consent to establish enforceable compliance schedules for elements of the CSO program. As described in Section 1, the current CSO LTCP program is driven by the 2005 Order on Consent, as modified by the 2012 Order on Consent and subsequent minor modifications.

Figure 4-1 presents a timeline of capital investments in wastewater infrastructure in the categories of WRRF upgrades to secondary treatment, WRRF upgrades for biological nitrogen removal, existing grey/green infrastructure projects to mitigate CSOs, and projects recommended in the current CSO LTCP program. As indicated in Figure 4-1, DEP spent $41.1B to upgrade its WRRFs to secondary treatment, construct two new WRRFs, and install upgraded biological nutrient removal facilities at eight WRRFs. With these WRRFs operating at their peak wet-weather flow capacity of 2xDDWF, annual CSO volumes were reduced significantly. The ~~$4.3B~~ $4.5B investment in green infrastructure and cost-effective grey infrastructure recommended in the WWFPs further reduced annual CSO volumes and pollutant loads.



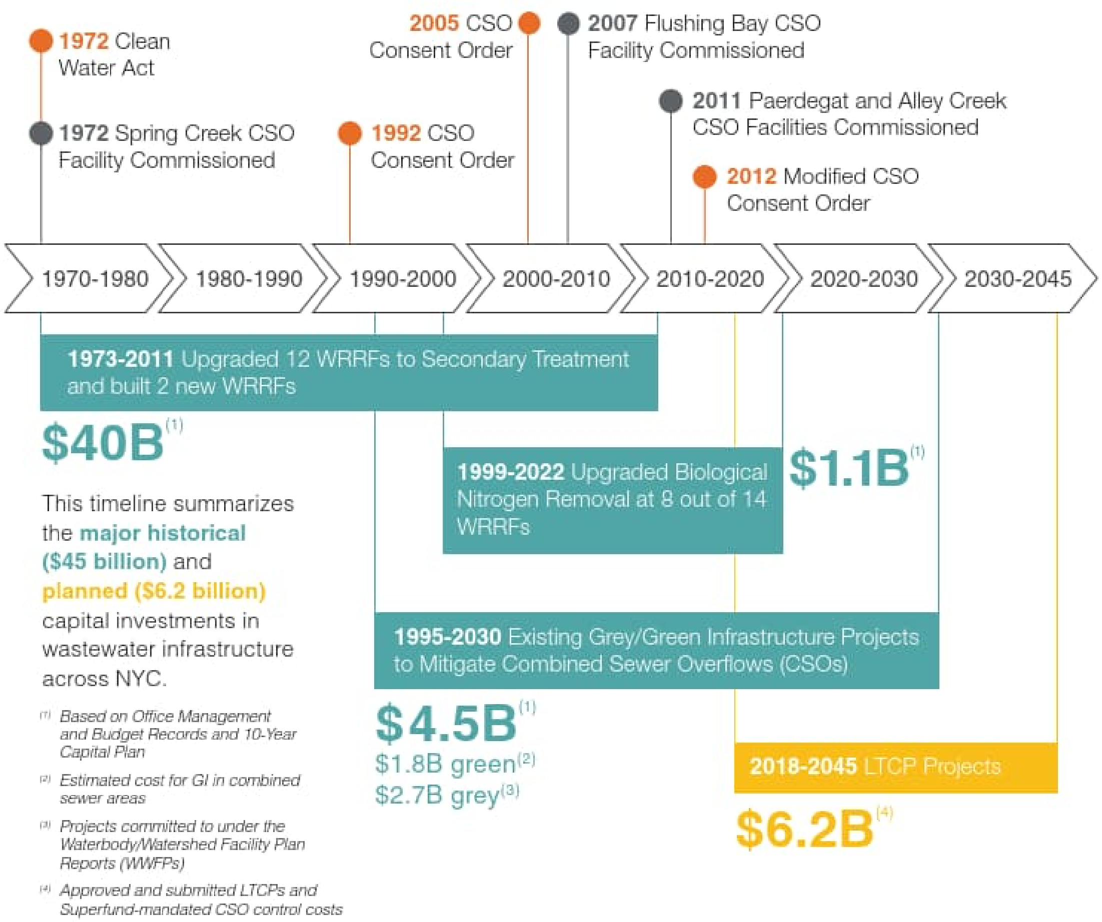


Figure 4-1. Timeline of Major Capital Investments in Wastewater Infrastructure

The benefits of these investments to-date are evident in the improvement in water quality in the waters in and around NYC. Figure 4-2 presents a comparison of summer geometric mean fecal coliform sampling results from DEP's Harbor Survey Monitoring Program for 1985 versus 2018. As indicated in Figure 4-2, sampling for much of the Citywide/Open Waters waterbodies in 1985 had geometric mean fecal coliform concentrations of greater than 200 cfu/100mL, and portions of the Hudson River, East River, and Upper New York Bay had geometric mean concentrations greater than 2,000 cfu/100mL. By 2018, however, the summer geometric mean fecal coliform concentrations from sampling data were under 100 cfu/100mL for the Citywide/Open Waters waterbodies. The $6.3B investment in projects recommended in the previously-submitted LTCPs and Superfund mandated CSO control for the tributaries in and around NYC will result in further improvement in the water quality in those waterbodies. Projected attainment with water quality standards for the tributary waterbodies associated with the previously-submitted LTCPs is presented below in Section 4.3. Impacts of the Citywide/Open Waters Recommended Plan on attainment of water quality standards are presented in Section 8.

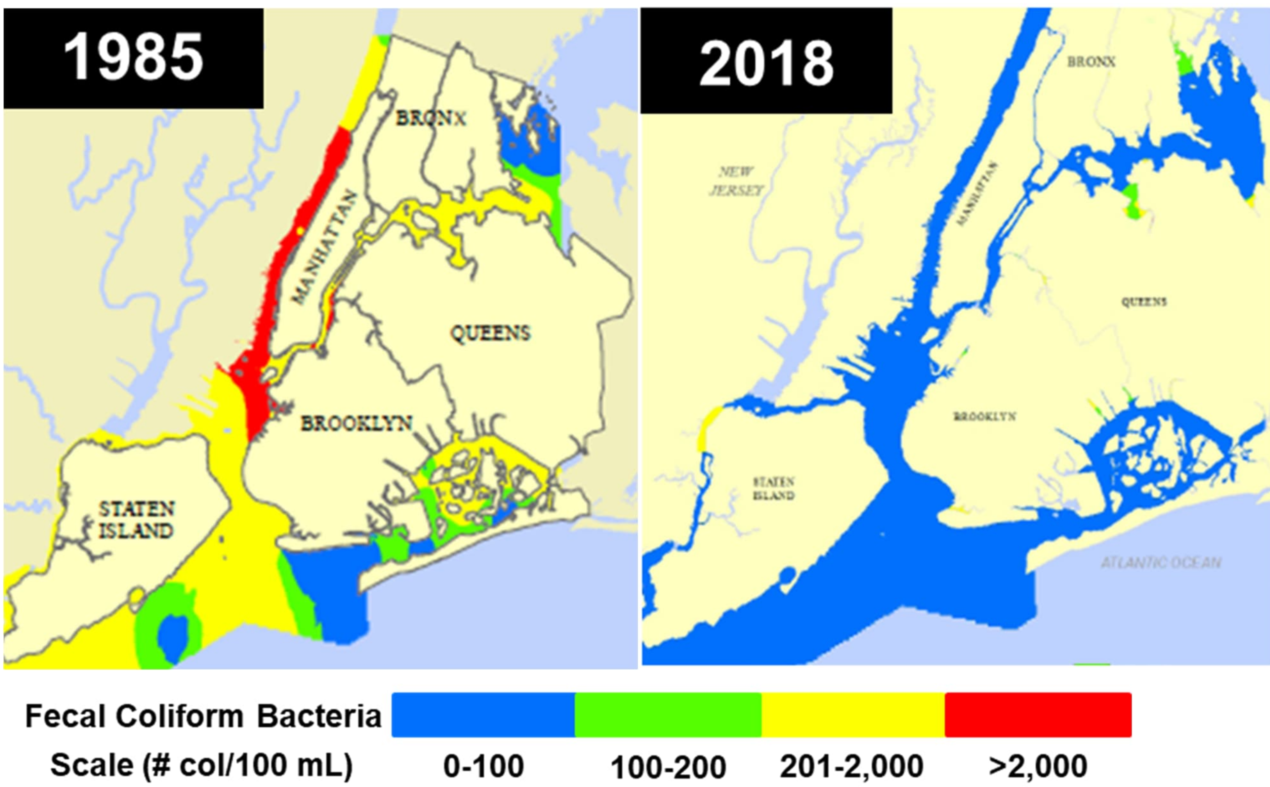


Figure 4-2. Comparison of Summer Geometric Mean Fecal Coliform Sampling Results for 1985 vs. 2018

4.2 Status of Grey Infrastructure Projects Recommended in Facility Plans

As described in Section 1, DEP submitted the East River and Open Waters Waterbody/Watershed Facility Plan Report to DEC in June 2007. This report recommended a series of projects focusing on maximizing the utilization of the existing collection system infrastructure and treatment of combined sewage at the City owned WRRFs. Although this WWFP was not approved by DEC, a number of grey infrastructure projects were implemented that had beneficial impacts on CSO outfalls discharging to the Citywide/Open Waters waterbodies. These projects included the following:

- Headworks Upgrades to the Bowery Bay, Hunts Point, North River, Tallman Island and Wards Island WRRFs to sustain 2xDDWF
- Port Richmond WRRF Throttling Facilities
- Tallman Island Conveyance Improvements
- Outer Harbor CSO Regulator Improvements
- Inner Harbor In-line Storage

The total cost of the grey infrastructure projects that are complete or under construction is $196M.

4.3 Summary of Recommended Plans from LTCPs Developed Under the LTCP Program

Prior to submittal of this Citywide/Open Waters LTCP, DEP submitted 10 LTCPs that focused on waterbodies that are tributary to the Citywide/Open Waters waterbodies. The waterbodies addressed by the 10 previous LTCPs include:

- Alley Creek
- Westchester Creek
- Hutchinson River
- Flushing Creek
- Bronx River
- Gowanus Canal
- Coney Island Creek
- Flushing Bay
- Newtown Creek
- Jamaica Bay and Tributaries

The general locations of the waterbodies covered by these previous LTCPs are shown in Figure 4-3.

As described further in Section 6, the Baseline Conditions for the Citywide/Open Waters LTCP includes the implementation of the Recommended Plans from the 10 previous LTCPs. The following sections provide summaries of those Recommended Plans, organized by the waterbodies. These sections also list the cost-effective grey infrastructure projects that have been or will be implemented for these waterbodies as a result of recommendations from the previous WWFPs. The reader is referred to each specific LTCP for further details on the waterbody-specific Recommended Plans and the cost-effective grey projects.

Figure 4-3. Locations of Waterbodies Addressed in LTCPs

4.3.a Alley Creek

4.3.a.1 WWFP Projects

The following summarizes the cost-effective grey projects implemented for Alley Creek based on the WWFP recommendations.

- 5 Million Gallon (MG) Alley Creek CSO Retention Facility
- Diversion chamber (Chamber 6) to direct CSO to the new Alley Creek CSO Retention Facility and to provide tank bypass to Outfall TI-008
- 1,475 foot long multi-barrel outfall sewer extending to a new outfall on Alley Creek (TI-025)
- New CSO outfall, TI-025, for discharge from the Alley Creek CSO Retention Facility
- Fixed baffle at Outfall TI-025 for floatables retention, minimizing release of floatables to Alley Creek
- Expansion and upgrade of Old Douglaston Pumping Station to empty the storage tank and convey flow to Tallman Island WRRF after the end of the storm

The total cost of the constructed grey infrastructure projects was $141M.

4.3.a.2 Approved LTCP Recommended Plan

The following summarizes the Recommended Plan from the June 2014 Alley Creek and Littleneck Bay LTCP that was approved by DEC on March 7, 2017.

- **Description:** Seasonal disinfection with dechlorination of the discharge from the Alley Creek CSO Retention Facility (Figure 4-4)
- **Probable bid cost presented in the LTCP:** $7.6M (May 2013 dollars)
- **Current total project cost, including engineering, escalated to the midpoint of construction:** $25M

  Current Completion Milestone*: 2024

  ***** *Milestone dates may be subject to revision by DEC based on additional facility planning.*

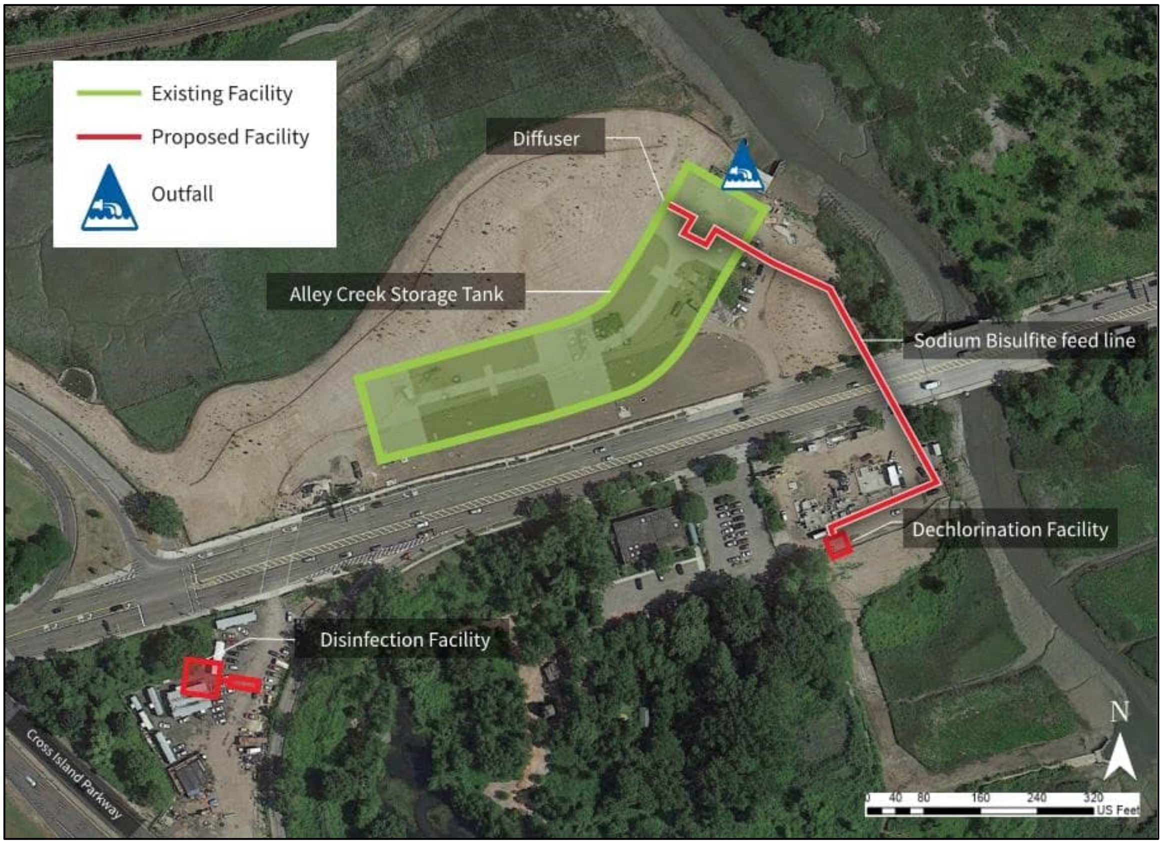


Figure 4-4. Disinfection at Alley Creek CSO Retention Facility

4.3.a.3 Benefits and Challenges of Implementing the Recommended Plan for Alley Creek

Figure 4-5 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-5, the cost-effective grey projects (post WWFP) resulted in a 198 million gallons per year (MGY) (60 percent) reduction in the annual CSO volume to Alley Creek. The LTCP Recommended Plan does not change the volume of CSO discharged but will provide disinfection for 78 MG of the remaining 132 MG of discharge, based on the Typical Year rainfall. The disinfection facilities will be operated during the recreational season (May 1st through October 31st). Additional benefits include the following:

- The Recommended Plan sought to identify retrofits to existing infrastructure to cost-effectively enhance facility performance.
- DEP staff are familiar with the procedures for safe handling and use of sodium hypochlorite and sodium bisulfite through its application at each of the City's WRRFs.

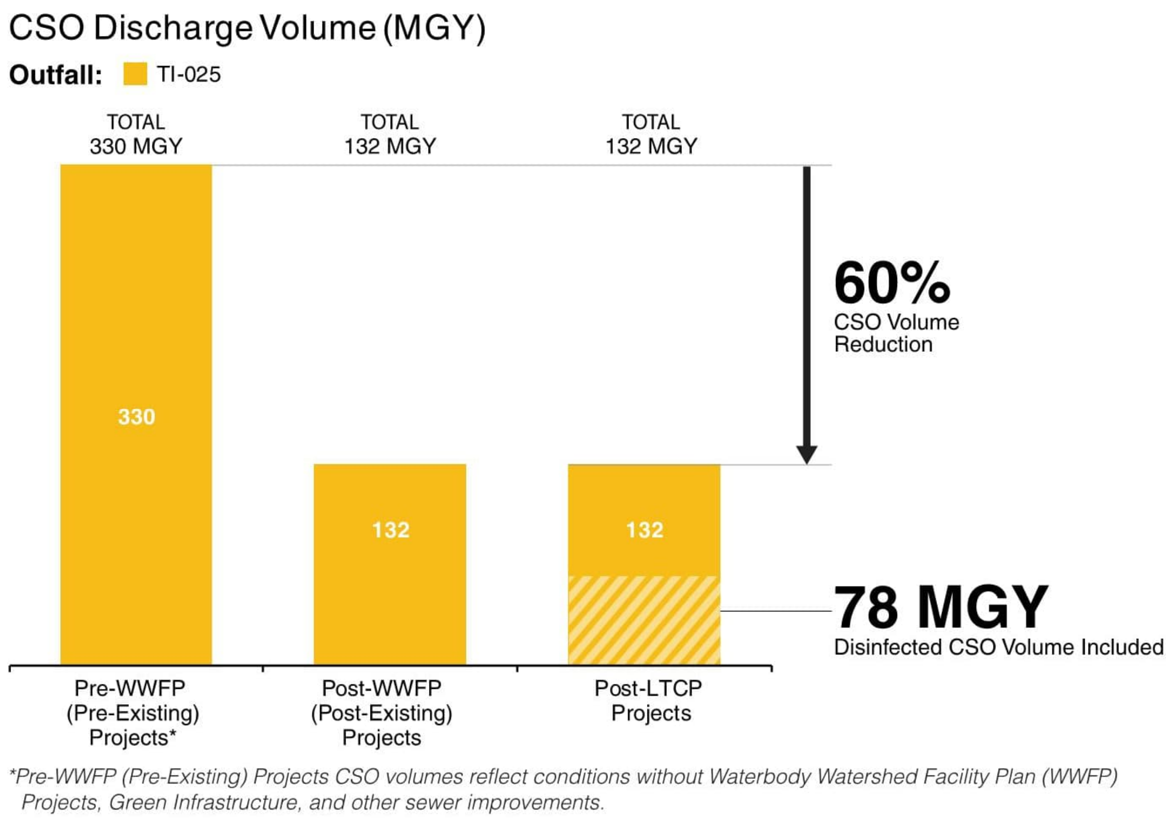


Figure 4-5. Benefits to Alley Creek and Little Neck Bay

While seasonal disinfection is a highly cost-effective approach to reduce the pathogen loads from the remaining CSO discharges to Alley Creek by an additional 60 percent, several construction and operational challenges must be overcome. The challenges and associated risks include the following:

- Chemical feed facilities for chlorination and dechlorination will need to be constructed and maintained at multiple locations.
- Available space for new facilities is limited, and much of the area around the existing facility is parkland.
- The existing retention facility is currently operated remotely but will require staffing during wet-weather events to monitor and maintain the disinfection facilities.
- The outfall sewer feeding the CSO retention facility is tidally influenced and consists of multiple pipe barrels resulting in variable flow conditions within each sewer barrel during overflow events.
- Multiple feed lines must be provided and individually controlled for application of chemicals to each of the individual sewer barrels and channels within the CSO tank.
- To address the highly variable flow conditions and multiple feed points an extremely high degree of system automation and sophistication will be required to operate the disinfection system.

- As the disinfection chemicals are being applied to multiple sewer barrels, it may be difficult to simulate the highly variable operational conditions for accurate calibration of instrumentation and controls.

- There is a risk that overdosing to overcome operational complexities and achieve anticipated permit limits for pathogens may make it difficult to achieve the chlorine residual permit limits.

- Thorough flushing of the chemical feed lines will be required after each storm event to minimize the risk of crystallization of the chemicals and the formation of blockages within the feed lines.

The siting challenges are expected to affect the project cost and schedule given the surrounding parkland and limited space for siting of new facilities. As determined in the BODR, the combination of siting and operating challenges for this facility will require DEP to conduct additional assessments in order to proceed. In response to the multiple siting and operational challenges DEP is exploring alternatives to disinfection. Any proposed alternatives would be subject to DEC review and approval.

4.3.a.4 Water Quality Standards Attainment

At the time that the Alley Creek LTCP was submitted, the water quality classification for Alley Creek was Class I, and the classification for Little Neck Bay was Class SB. While the classification for Alley Creek has not changed, Little Neck Bay is now classified as a coastal primary contact recreational waterbody. In addition, the water quality criteria associated with these classifications have changed. For Alley Creek, the previous water quality criteria for bacteria included a fecal coliform monthly geometric mean of ≤2,000 cfu/100mL, assessed on an annual basis. The current criterion is for a fecal coliform monthly geometric mean of ≤200 cfu/100mL. Since Littleneck Bay has been reclassified as a coastal primary contact recreational waterbody, the bacteria criteria include a fecal coliform monthly geometric mean of ≤200 cfu/100mL, an *Enterococcus* 30-day geometric mean of ≤35 cfu/100mL, and a 30-day 90th percentile STV for *Enterococcus* of ≤130 cfu/100mL, applicable for the recreational season (May 1st through October 31st).

Table 4-1 presents the percent attainment with the current Class I water quality criteria for bacteria at Harbor Survey Monitoring (HSM) Station AC-1 in Alley Creek for Baseline Conditions and the Recommended Plan, for the 10-year simulation (2002 to 2011). Also shown in Table 4-1 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and attainment with recreational season (May 1st through October 31st) *Enterococcus* criteria. The *Enterococcus* criteria do not apply to Alley Creek, and are shown for informational purposes only. Table 4-2 presents the percent attainment with the current Class SB and coastal primary contact recreational waters water quality criteria for bacteria at HSM Stations OW-1, LN-1, and E-11, along with a station at the Douglaston Manor Association (DMA) beach in Little Neck Bay for Baseline Conditions and the Recommended Plan.

Table 4-3 presents the annual percent attainment with the applicable DO criteria for the Alley Creek and Little Neck Bay stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-1, Table 4-2, and Table 4-3 are shown in Figure 4-6.

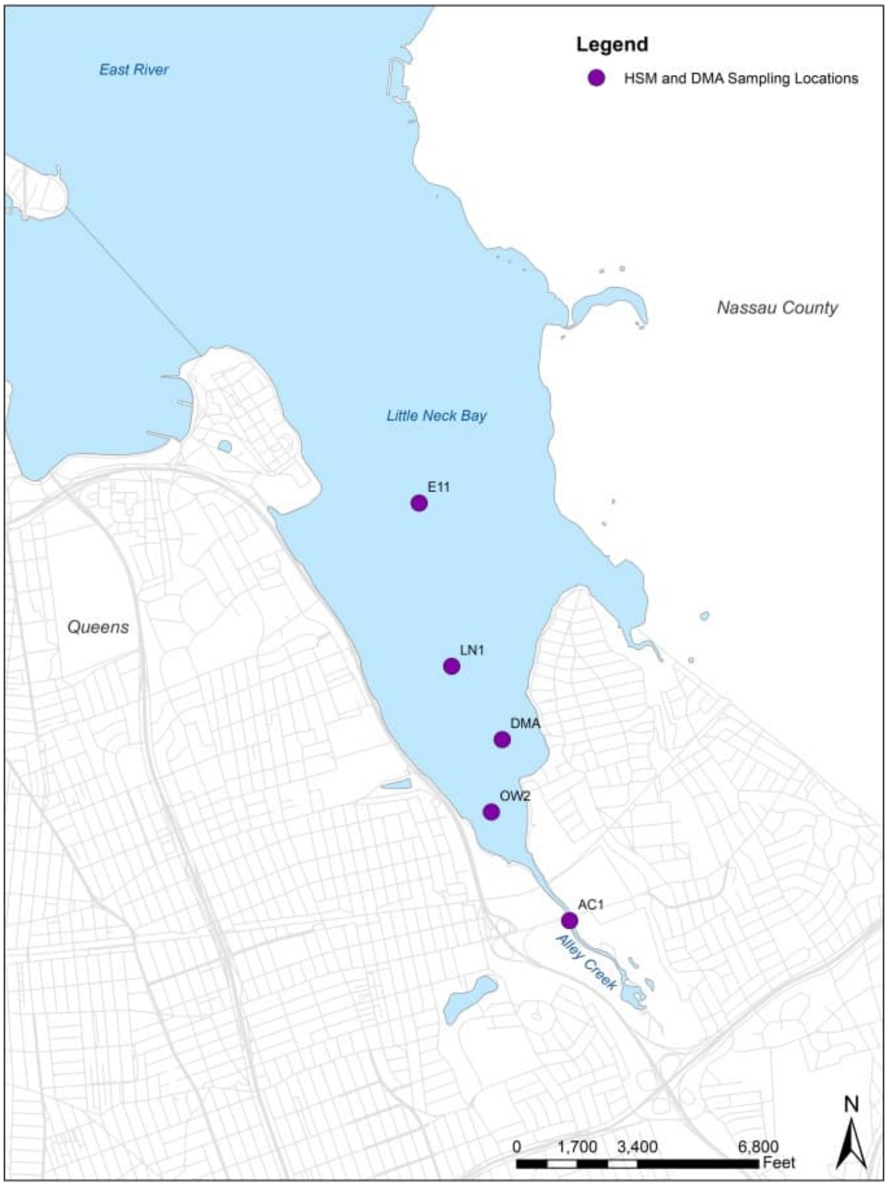


Figure 4-6. HSM and DMA Stations in Alley Creek and Little Neck Bay

Table 4-1. Calculated 10-year Bacteria Attainment in Alley Creek for Baseline Conditions and the Recommended Plan

Location	Percent Attainment with Criteria							
	Baseline				Recommended Plan			
	Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(3)		Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(3)	
	Recreational Season(1)	Annual			Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
AC1	93%	87%	53%	9%	98%	90%	59%	10%

Notes:

(1) The Recreational Season is from May 1st through October 31st.
(2) *Enterococcus* Criteria do not apply to Alley Creek. Attainment with these criteria is shown for informational purposes only.
(3) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤110 cfu/100mL.

Table 4-2. Calculated 10-year Bacteria Attainment in Littleneck Bay for Baseline Conditions and the Recommended Plan

Location	Percent Attainment with Criteria							
	Baseline				Recommended Plan			
	Class SB Fecal Coliform Criteria		Coastal Recreational Waters *Enterococcus* for Recreational Season(1)(3)		Class SB Fecal Coliform Criteria		Coastal Recreational Waters *Enterococcus* for Recreational Season(1)(3)	
	Recreational Season(1)	Annual			Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
OW2	N/A(2)	98%	91%	25%	100%	97%	92%	29%
LN1	N/A(2)	99%	95%	51%	100%	99%	97%	62%
E11	100%	100%	99%	75%	100%	100%	99%	80%
DMA	100%	100%	95%	49%	100%	100%	97%	62%

Notes:
(1) The Recreational Season is from May 1st through October 31st.
(2) Recreational season fecal coliform attainment was not developed at these stations for this LTCP.
(3) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤110 cfu/100mL.

Table 4-3. Model Calculated DO Attainment for Alley Creek and Little Neck Bay Stations for Baseline Conditions and the Recommended Plan (2008 Rainfall)

Station	Percent Annual Average Attainment			
	Baseline		Recommended Plan	
	Alley Creek Class I (≥4.0 mg/L)			
AC1	98%		98%	
	Little Neck Bay Class SB[3]			
	Acute[1] (≥3.0 mg/L)	Chronic[2] (≥4.8 mg/L)	Acute[1] (≥3.0 mg/L)	Chronic[2] (≥4.8 mg/L)
OW2	100%	100%	100%	100%
LN1	100%	93%	100%	93%
E11	100%	94%	100%	94%

Notes:
(1) Acute standard (never less than).
(2) Chronic standard based on daily average. See Table 2-5 in Section 2 for further details on the DO criteria.
(3) DO attainment values presented in the LTCP have been updated to reflect the current water quality criteria.

4.3.b Westchester Creek

4.3.b.1 WWFP Projects

The following summarizes the cost-effective grey projects currently being implemented for Westchester Creek based on the WWFP recommendations.

- Weir modifications to relief structures CSO-29 and CSO-29A
- Pugsley Creek parallel relief sewer

The total cost of the grey infrastructure projects under construction is $126M.

4.3.b.2 Approved LTCP Recommended Plan

The following summarizes the Recommended Plan from the June 2014 Westchester Creek LTCP that was approved by DEC on August 1, 2017.

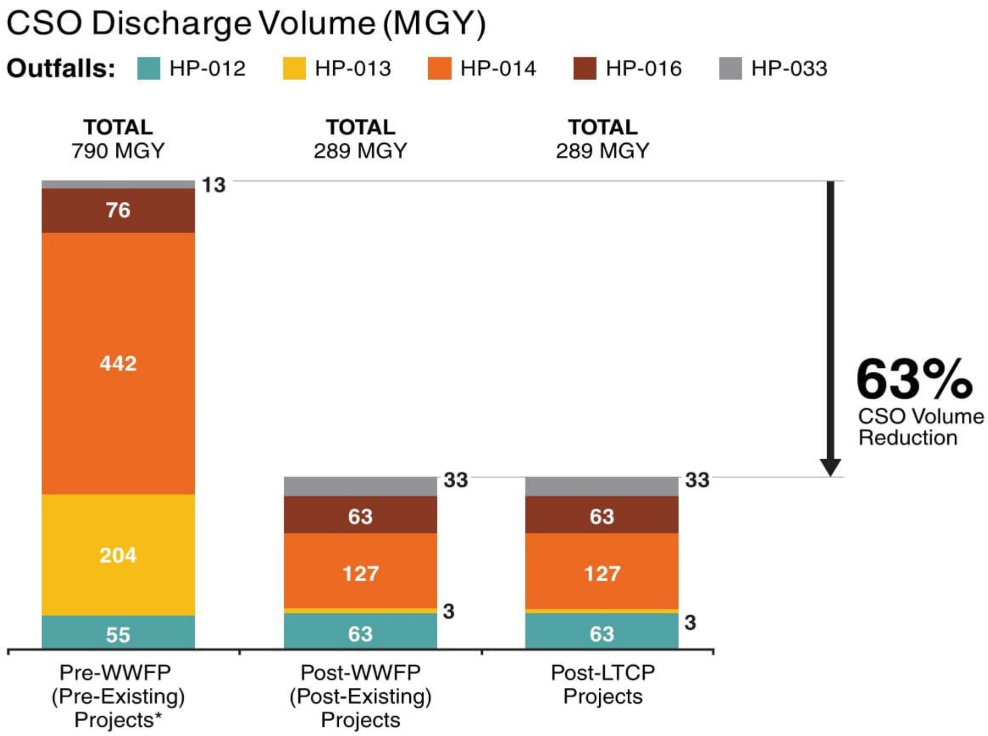
- **Description:** The cost-effective grey projects from the WWFP implemented in Westchester Creek were demonstrated to result in attainment of the monthly geometric mean fecal coliform criterion during the recreational season (May 1st through October 31st) in Westchester Creek. Therefore, no additional projects were recommended in the LTCP.

4.3.b.3 Benefits to Westchester Creek

Figure 4-7 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-7, the cost-effective grey projects (post WWFP) resulted in a 501 MGY (63 percent) reduction in the annual CSO volume to Westchester Creek.

4.3.b.4 Water Quality Standards Attainment

At the time that the Westchester Creek LTCP was submitted, the water quality classification for Westchester Creek was Class I. That classification has not changed, but the water quality criteria associated with that classification have changed. For Westchester Creek, the previous water quality criteria for bacteria included a fecal coliform monthly geometric mean of ≤2,000 cfu/100mL, assessed on an annual basis. The current criterion is for a fecal coliform monthly geometric mean of ≤200 cfu/100mL. Westchester Creek is a non-coastal tributary, so the *Enterococci* criteria for coastal primary contact recreational waters do not apply to Westchester Creek.



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Figure 4-7. Benefits to Westchester Creek

Table 4-4 presents the percent attainment with the current Class I water quality criteria for bacteria at Stations WC1, WC2, WC3, and E13 in Westchester Creek for Baseline Conditions and the Recommended Plan, for the 10-year simulation (2002 to 2011). Also shown in Table 4-4 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and the percent attainment with *Enterococcus* criteria. The *Enterococcus* criteria do not apply to Westchester Creek, and are shown for informational purposes only.

Table 4-5 presents the annual percent attainment with the applicable DO criteria for the Westchester Creek stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-4 and Table 4-5 are shown in Figure 4-8.

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Table 4-4. Calculated 10-year Bacteria Attainment in Westchester Creek for Baseline Conditions and the Recommended Plan

Location	Percent Attainment with Criteria			
	Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(3)	
	Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
WC2	95%	93%	88%	25%
WC1	98%	95%	90%	29%
WC3	98%	97%	95%	39%
E13	100%	100%	99%	77%

Notes:
(1) The Recreational Season is from May 1st through October 31st.
(2) *Enterococcus* Criteria do not apply to Westchester Creek. Attainment with these criteria is shown for informational purposes only.
(3) *Enterococcus* attainment has been updated from values presented in the LTCP.

Table 4-5. Model Calculated DO Attainment for Westchester Creek Stations for Baseline Conditions and the Recommended Plan (2008 Rainfall)

Station	Percent Annual Average Attainment
	Class I ≥4.0 mg/L
WC2	80%
WC1	97%
WC3	99%
E13	99%

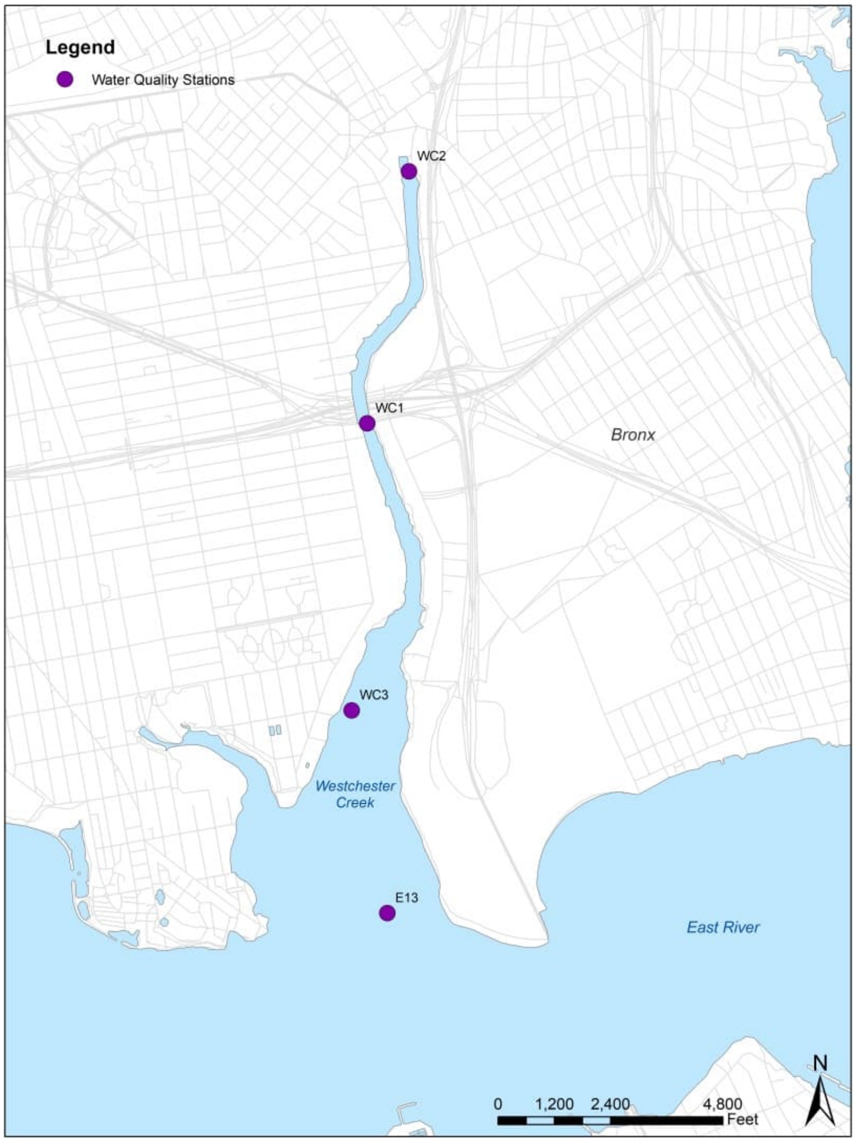

Figure 4-8. Water Quality Stations in Westchester Creek

4.3.c Hutchinson River

4.3.c.1 WWFP Projects

No grey infrastructure projects were planned or implemented in the Hutchinson River as a result of the previous CSO facilities planning or the 2012 Order on Consent. Other work completed in the Hunts Point system included Hunts Point WRRF headworks improvements. The cost of that work was $3M.

4.3.c.2 Approved LTCP Recommended Plan

The ~~following summarizes the~~ Recommended Plan from the September 2014 Hutchinson River LTCP that was approved by DEC on March 7, 2017 included seasonal disinfection with dichlorination, floatables control, and construction of an extension of Outfall HP-024. The initial size and length of the conduit in the LTCP Approved Plan would have provided about 0.7 MG of storage capacity to provide contact time for disinfection. As this project proceeded to design, enhancements were made to size the new conduit to convey and provide floatables control for up to 300 MGD of flow and the conduit was also sized to account for future projected sea level rise. As a result, the revised conduit configuration would have provided a volume of about 1.3 MG.

Following additional evaluations during the design process, further modifications to the LTCP Approved Plan were identified to eliminate both the chlorination and dechlorination facilities and upsize the conduit to provide 2.8 MG of CSO Storage in conjunction with providing floatables control for up to 300 MGD of flows entering the new conduit. The revised project was projected to result in about a 20% reduction in CSO discharges on an annual basis and about a 50% reduction in floatables (almost 100% at HP-024) into the Hutchinson River. These proposed modifications would achieve a similar bacterial reduction as required by the waste load allocation and provide for better floatables control along with year-round CSO reductions. A Consent Order Modification Request to revise the Recommended Plan for the Hutchinson River was approved by DEC on March 20, 2023, with revised project completion milestones. The following summarizes the approved revised project:

Description: ~~Seasonal disinfection with dechlorination, floatables control, and construction of an extension of~~ 2.8 MG Storage Conduit with Floatables Control for Outfall HP-024 (Figure 4-9)

- ~~**Probable bid cost presented in the LTCP:** $90M (June 2014 dollars)~~

- **Current total project cost, including engineering, escalated to the midpoint of construction:** $204M

- **Current Completion Milestone*:** ~~2030~~ 2033

~~** Milestone dates may be subject to revision by DEC based on additional facility planning.*~~

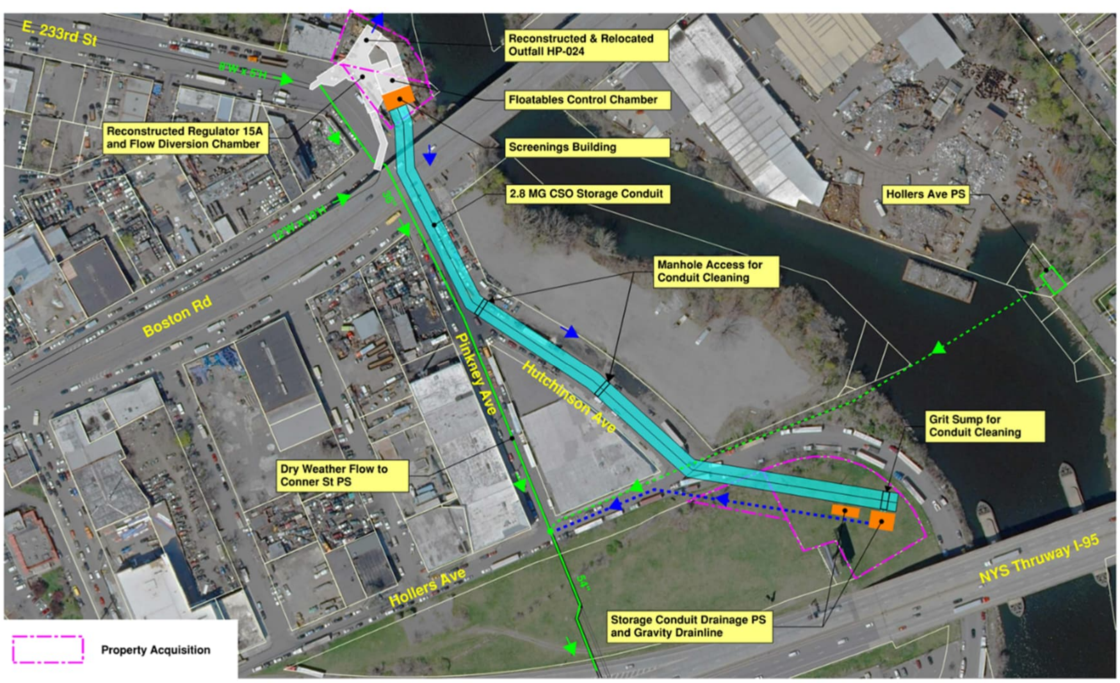

Figure 4-9. CSO Outfall HP-024 ~~Extension~~ Storage

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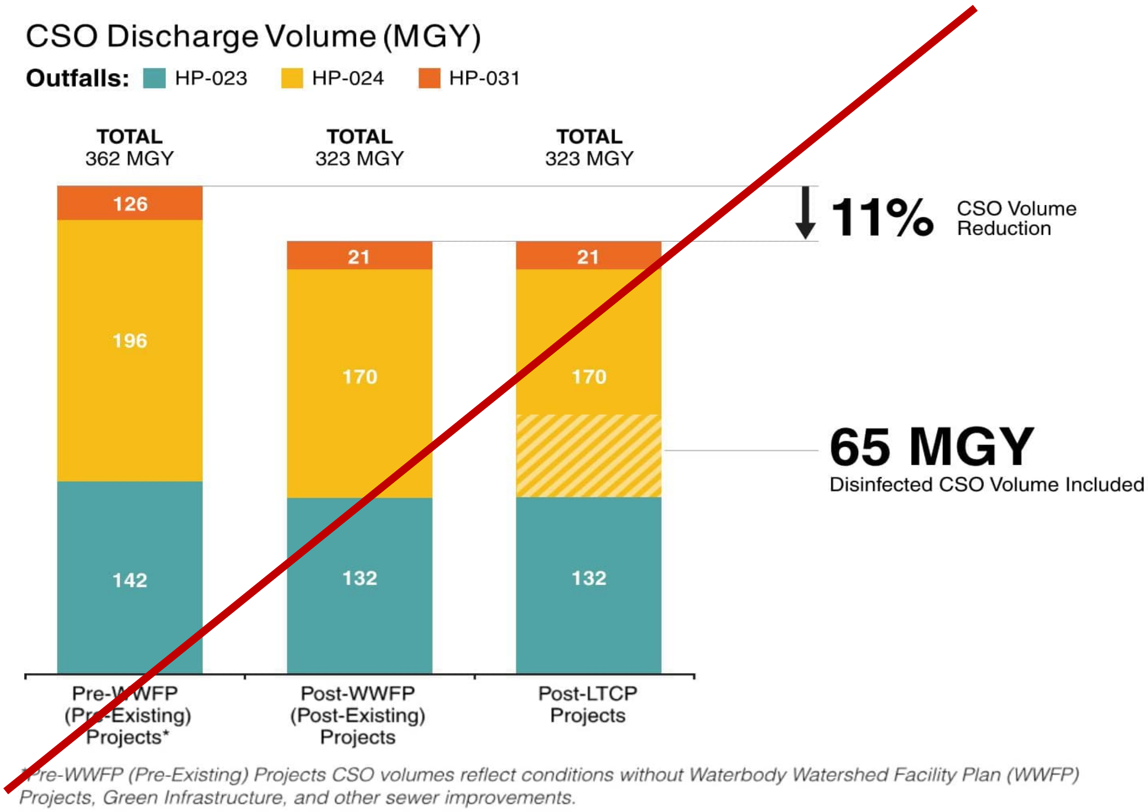
4.3.c.3 Benefits and Challenges of Implementing the Recommended Plan for Hutchinson River

Figure 4-10 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-10, the cost-effective grey projects (post WWFP) resulted in a ~~39~~ 21 MGY (~~11~~ 6 percent) reduction in the annual CSO volume to the Hutchinson River (note: the LTCP Baseline Conditions CSO volume was revised based on updated information developed during the design). The LTCP Recommended Plan provides an additional 50 MGY reduction, for an overall 20% reduction from the pre-WWFP condition ~~does not change the volume of CSO discharged, but will provide disinfection for 65 MG of the remaining 323 MG of discharge~~, based on the Typical Year rainfall. ~~The disinfection will be applied during the recreational season (May 1st through October 31st).~~ Additional benefits include the following:

- City owned properties and road rights-of-way are potentially available for siting of facilities.
- Elimination of the disinfection and dichlorination systems greatly simplifies the operational requirements of the facility. ~~DEP staff are familiar with the procedures for safe handling and use of sodium hypochlorite and sodium bisulfite through its application at each of the City's WRRFs.~~
- Storage provides a year-round benefit in terms of CSO reduction compared to seasonal disinfection.



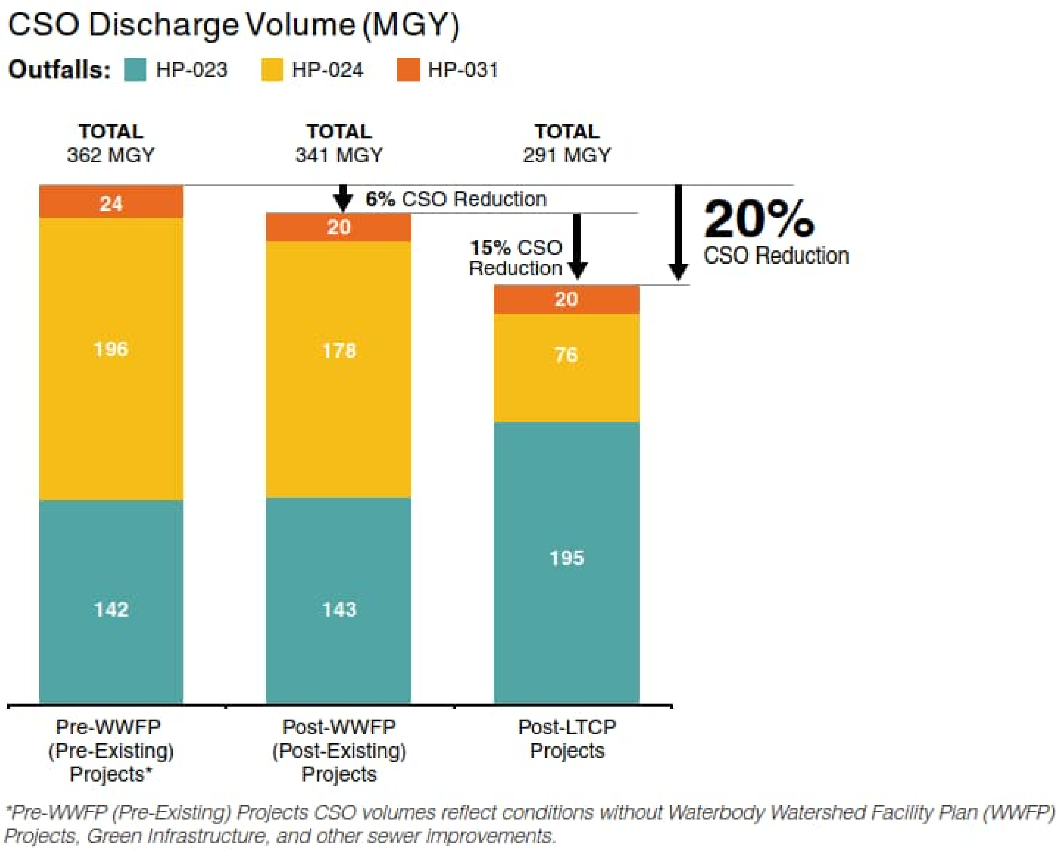


Figure 4-10. Benefits to Hutchinson River

~~While seasonal disinfection is a cost-effective approach to reduce the pathogen loads from the remaining CSO discharges to the Hutchinson River by an additional 20 percent, there are several construction and operational challenges that must be overcome. The challenges and associated risks are as follows:~~

- ~~Chemical feed facilities for chlorination and dechlorination will need to be constructed and maintained at multiple locations.~~
- ~~Site acquisition for the necessary facilities will be challenging.~~
- ~~To address the highly variable flow conditions, an extremely high degree of system automation and sophistication will be required to operate the disinfection system.~~
- ~~There is a risk that overdosing to overcome operational complexities and achieve anticipated permit limits for pathogens may make it difficult to achieve the chlorine residual permit limits.~~
- ~~Thorough flushing of the chemical feed lines will be required after each storm event to minimize the risk of crystallization of the chemicals and the formation of blockages within the feed lines.~~

~~The siting challenges may affect the project cost and schedule if site acquisition becomes problematic. Operational challenges are significant and additional assessment and study is required to fully develop the best treatment alternative for the variable CSO entering this facility. DEP will seek to address these challenges during design through the provision of technical enhancements in the form of additional design and operational criteria. DEP may also need to consider evaluating alternative technologies in consultation with DEC.~~

4.3.c.4 Water Quality Standards Attainment

At the time that the Hutchinson River LTCP was submitted, the water quality classification for the Hutchinson River was Class SB. That classification has not changed. The water quality criteria for bacteria includes a fecal coliform monthly geometric mean of ≤200 cfu/100mL, assessed on an annual basis. The Hutchinson River is a non-coastal tributary, so the *Enterococci* criteria for coastal primary contact recreational waters do not apply to the Hutchinson River.

Table 4-6 presents the percent attainment with the current Class SB water quality criteria for bacteria at Stations HR-01 to ~~HR-09~~ HR-06 in the Hutchinson River for the updated Baseline Conditions and the Recommended Plan, for the 10-year simulation (2002 to 2011). Also shown in Table 4-6 is the percent attainment with ~~an annual fecal coliform geometric mean of 200 cfu/100mL, and percent attainment with~~ *Enterococcus* criteria. The *Enterococcus* criteria do not apply to the Hutchinson River, and are shown for informational purposes only. The attainment percentages for fecal coliform bacteria in Table 4-6 are based on an assumption that the water quality of the Hutchinson River flowing into NYC from Westchester County is in compliance with water quality standards. Refer to the Hutchinson River LTCP for further discussion of the impact of pollutant loads from Westchester County, and the total maximum daily load calculations for the Hutchinson River.

Table 4-7 presents the annual percent attainment with the applicable DO criteria for the Hutchinson River stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-6 and Table 4-7 are shown in Figure 4-11.

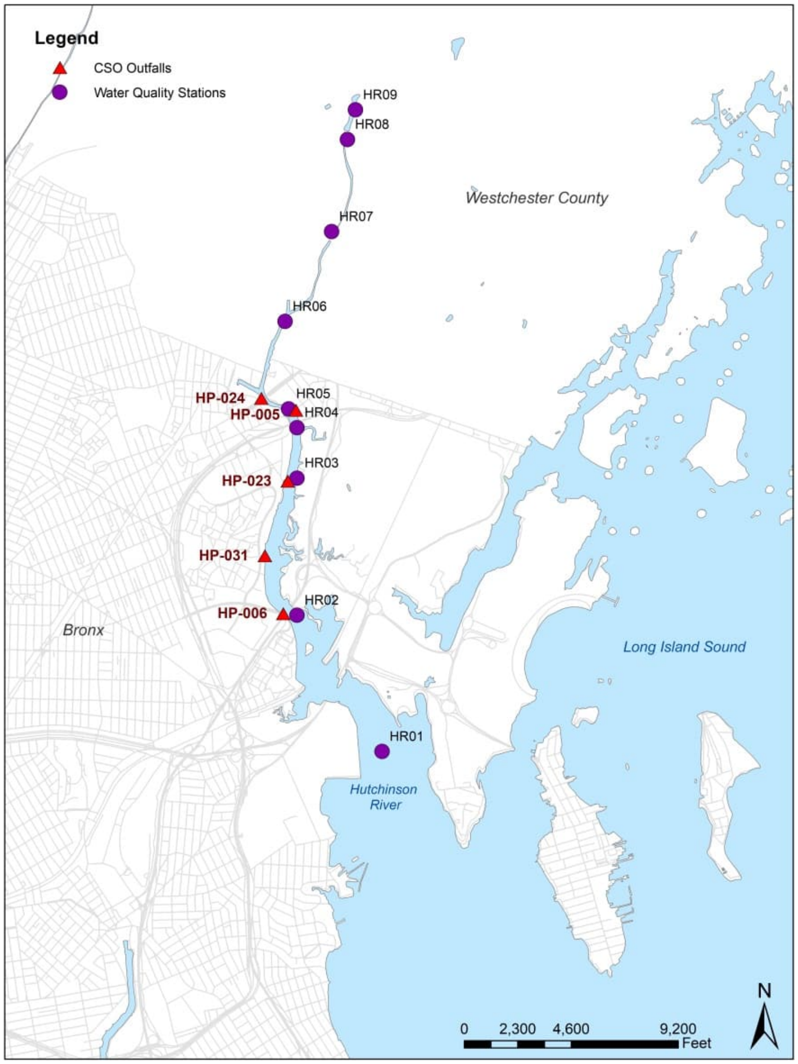


Figure 4-11. Water Quality Stations in the Hutchinson River

Table 4-6. Calculated 10-year Bacteria Attainment in Hutchinson River for Baseline Conditions and the Recommended Plan

Location	Percent Attainment with Criteria							
	Baseline				Recommended Plan			
	Class SB Fecal Coliform Criteria[1]		*Enterococcus* Criteria for Recreational Season[~~1~~ 2][~~2~~ 3][4][~~5~~][6]		Class SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season[~~1~~ 2][~~2~~ 3][4] [~~5~~][6]	
	Recreational Season[~~1~~ 2]	Annual			Recreational Season[1]	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
~~HR-09[4]~~	~~N/A[3]~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~
~~HR-08[4]~~	~~N/A[3]~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~
~~HR-07[4]~~	~~N/A[3]~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~	~~0%~~
HR-06[~~4~~5]	100% ~~N/A[3]~~	98% ~~74%~~	47%	3%	100% ~~92%~~	98% ~~77%~~	46% ~~48%~~	2% ~~3%~~
HR-05	98% ~~N/A[3]~~	96% ~~81%~~	58% ~~57%~~	5%	100% ~~95%~~	98% ~~84%~~	58% ~~61%~~	3% ~~5%~~
HR-04	100% ~~N/A[3]~~	98% ~~89%~~	71%	7% ~~9%~~	100% ~~95%~~	98% ~~90%~~	71% ~~74%~~	6% ~~10%~~
HR-03	98% ~~N/A[3]~~	96% ~~89%~~	76%	10%	100% ~~97%~~	98% ~~91%~~	76% ~~78%~~	7% ~~12%~~
HR-02	100% ~~N/A[3]~~	98% ~~93%~~	87% ~~86%~~	14% ~~15%~~	100% ~~97%~~	98% ~~94%~~	87% ~~89%~~	12% ~~15%~~
HR-01	100% ~~N/A[3]~~	100%	99%	65% ~~60%~~	100%	100%	99%	68% ~~66%~~

Notes:

(1) Fecal coliform criteria attainment based on model run with WQ from Westchester County is in attainment.
(~~1~~ 2) The Recreational Season is from May 1st through October 31st.
(~~2~~ 3) *Enterococcus* Criteria do not apply to Hutchinson River. Attainment with these criteria is shown for informational purposes only.
(~~3~~4) ~~10-year recreational season fecal coliform attainment was not developed for this LTCP.~~ For *Enterococcus* modeling, no adjustments were made to the loadings from Westchester County.
(~~4~~5) Monitoring station~~s~~ HR-06 ~~through HR-09 are~~ is located along a segment of the Hutchinson River in Westchester County.
(~~5~~6) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤110 cfu/100mL.

Table 4-7. Model Calculated DO Attainment for Hutchinson River Stations for Baseline Conditions and the Recommended Plan (2008 Rainfall)

Station	Percent Annual Average Attainment			
	Baseline		Recommended Plan	
	Class SB		Class SB	
	Chronic ≥4.8 mg/L(1)	Acute ≥3.0 mg/L(2)	Chronic ≥4.8 mg/L(1)	Acute ≥3.0 mg/L(2)
HR-09(3)	100%	100%	100%	100%
HR-08(3)	100%	100%	100%	100%
HR-07(3)	97%	100%	98%	100%
HR-06(3)	60%	83%	73%	95%
HR-05	70%	92%	78%	97%
HR-04	79%	96%	90%	99%
HR-03	92%	99%	97%	100%
HR-02	98%	99%	98%	100%
HR-01	97%	99%	98%	100%

Notes:
(1) Chronic standard based on daily average. See Table 2-5 in Section 2 for further details on the DO criteria.
(2) Acute standard (never less than).
(3) Monitoring stations HR-06 through HR-09 are located along a segment of the Hutchinson River in Westchester County.

4.3.d Flushing Creek

4.3.d.1 WWFP Projects

The following summarizes the cost-effective grey projects implemented for Flushing Creek based on the WWFP recommendations.

- The 43 MG Flushing Bay CSO Retention Facility
- The Corona Avenue Vortex Facility

The total cost of the constructed grey infrastructure projects was $363M.

4.3.d.2 Approved LTCP Recommended Plan

The following summarizes the Recommended Plan from the December 2014 Flushing Creek LTCP that was approved by DEC on March 7, 2017.

- **Description:** Seasonal disinfection with dechlorination of the discharge from the existing Flushing Bay CSO Retention Facility and Diversion Chamber 5 for CSO Outfall TI-010 (Figure 4-12); seasonal disinfection with dechlorination at Outfall TI-011 (Figure 4-13); and floatables control
- **Probable bid cost presented in the LTCP:** $56M (October 2014 dollars)
- **Current total project cost, including engineering, escalated to the midpoint of construction:** $89M
- **Current Completion Milestone*:** 2025

  ***** Milestone dates may be subject to revision by DEC based on additional facility planning.

4.3.d.3 Benefits and Challenges of Implementing the Recommended Plan for Flushing Creek

Figure 4-14 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-14, the cost-effective grey projects (post WWFP) resulted in a 1,212 MGY (50 percent) reduction in the annual CSO volume to Flushing Creek. The LTCP Recommended Plan does not change the volume of CSO discharged but will provide disinfection for 584 MG of the remaining 1,201 MG of discharge, based on the Typical Year rainfall. The disinfection will be applied during the recreational season (May 1st through October 31st). Additional benefits include the following:

- Application of disinfection to existing tanks and outfalls reduces neighborhood construction impacts.
- City owned properties and road-rights-of-way are potentially available for siting of facilities.
- DEP staff are familiar with the procedures for safe handling and use of sodium hypochlorite and sodium bisulfite through its application at each of the City's WRRFs.

Figure 4-12. Seasonal Disinfection at Flushing Bay CSO Retention Facility and Diversion Chamber 5

Figure 4-13. Seasonal Disinfection at CSO Outfall TI-011

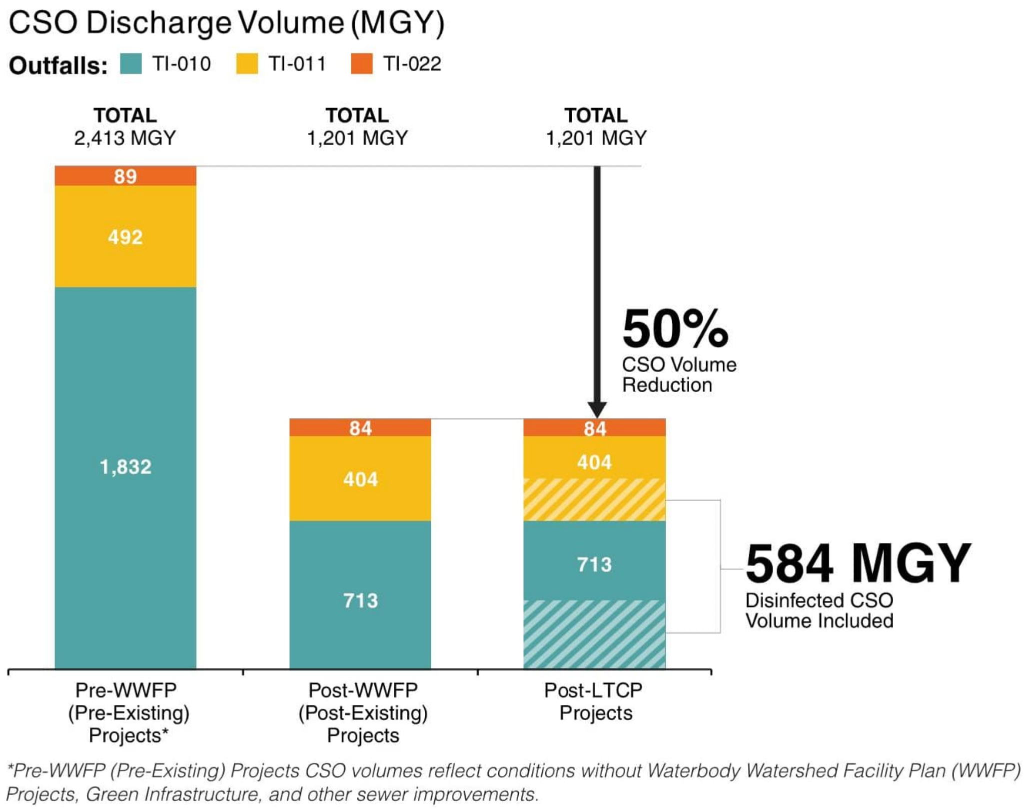


Figure 4-14. Benefits to Flushing Creek

While seasonal disinfection is a highly cost-effective approach to reduce the pathogen loads from the remaining CSO discharges to Flushing Creek by an additional 49 percent, several construction and operational challenges must be overcome. The challenges and associated risks are as follows:

- The existing retention facility is currently operated remotely but will require staffing during wet-weather events to monitor and maintain the disinfection facilities.
- The existing odor control facilities at the CSO retention facilities will need to be modified to provide a dual purpose of disinfection and odor control.
- Chemical feed facilities for chlorination and dechlorination will need to be constructed and maintained at multiple locations for TI-010 and TI-011.
- For TI-011, several sewers connect to the trunk sewer downstream of the disinfectant feed resulting in highly variable flow conditions from event to event.
- For TI-010, disinfectant will be introduced to multiple sewers entering the CSO retention facility resulting in variable flow conditions within each sewer barrel during overflow events.
- To address the highly variable flow conditions, an extremely high degree of system automation and sophistication will be required to operate the disinfection systems for TI-010 and TI-011.

- There is a risk that overdosing to overcome operational complexities and achieve anticipated permit limits for pathogens may make it difficult to achieve the chlorine residual permit limits.

- Thorough flushing of the chemical feed lines will be required after each storm event to minimize the risk of crystallization of the chemicals and the formation of blockages within the feed lines.

The siting challenges may affect the project cost and schedule if site acquisition becomes problematic. Operational challenges are significant and additional assessment and study is required to fully develop the best treatment alternative for the variable CSO entering this facility. DEP will seek to address these challenges during design through additional testing and the provision of design and operational criteria within the bid documents and facility O&M manuals to minimize these risks. DEP may also need to consider evaluating alternative technologies in consultation with DEC.

4.3.d.4 Water Quality Standards Attainment

At the time that the Flushing Creek LTCP was submitted, the water quality classification for Flushing Creek was Class I. That classification has not changed, but the water quality criteria associated with that classification has changed. For Flushing Creek, the previous water quality criteria for bacteria included a fecal coliform monthly geometric mean of ≤2,000 cfu/100mL, assessed on an annual basis. The current criterion is for a fecal coliform monthly geometric mean of ≤200 cfu/100mL. Flushing Creek is a non-coastal tributary, so the *Enterococcus* criteria for coastal primary contact recreational waters do not apply to Flushing Creek.

Table 4-8 presents the percent attainment with the current Class I water quality criteria for bacteria at Stations OW-03 to OW-06 in Flushing Creek for Baseline Conditions and the Recommended Plan, for the 10-year simulation (2002 to 2011). Also shown in Table 4-8 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and the percent attainment with *Enterococcus* criteria. The *Enterococcus* criteria do not apply to Flushing Creek and are shown for informational purposes only.

Table 4-9 presents the annual percent attainment with the applicable DO criteria for Flushing Creek stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-8 and Table 4-9 are shown in Figure 4-15.

Table 4-8. Calculated 10-year Bacteria Attainment in Flushing Creek for Baseline Conditions and the Recommended Plan

Location	Percent Attainment with Criteria							
	Baseline				Recommended Plan			
	Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(3)		Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(3)	
	Recreational Season(1)	Annual			Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
OW-3	62%	39%	45%	3%	78%	67%	69%	7%
OW-4	68%	43%	55%	3%	82%	67%	79%	9%
OW-5	74%	48%	59%	5%	90%	75%	85%	12%
OW-6	78%	53%	62%	6%	92%	75%	93%	26%

Notes:

(1) The Recreational Season is from May 1st through October 31st.
(2) *Enterococcus* Criteria do not apply to Flushing Creek. Attainment with these criteria is shown for informational purposes only.
(3) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤130 cfu/100mL.

Table 4-9. Model Calculated DO Attainment for Flushing Creek Stations for Baseline Conditions and the Recommended Plan (2008 Rainfall)

Station	Percent Annual Average Attainment Class I ≥4.0 mg/L	
	Baseline	Recommended Plan
OW-3	85%	85%
OW-4	88%	88%
OW-5	91%	91%
OW-6	96%	96%

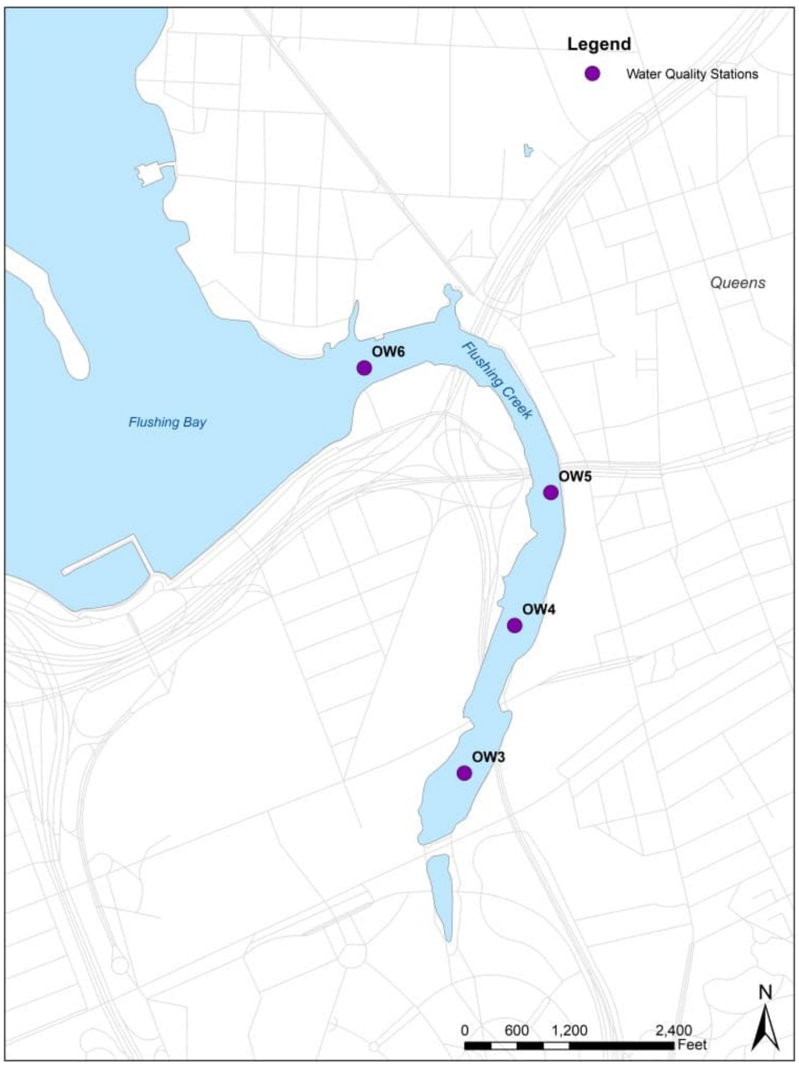


Figure 4-15. Water Quality Stations in Flushing Creek

4.3.e Bronx River

4.3.e.1 WWFP Projects

The following summarizes the cost-effective grey projects implemented for the Bronx River based on the WWFP recommendations.

- Hunts Point WRRF Headworks Upgrades
- Floatables Control Facilities for Outfalls HP-004, HP-007 and HP-009.

The total cost of the constructed grey infrastructure projects was $46M.

4.3.e.2 Approved LTCP Recommended Plan

The following summarizes the Recommended Plan from the June 2015 Bronx River LTCP that was approved by DEC on March 7, 2017.

- **Description:** Hydraulic relief sewers for Outfalls HP-007 and HP-009, and a bending weir with underflow baffle for Outfall HP-011 (Figure 4-16)
- **Probable bid cost presented in the LTCP:** $110M (February 2015 dollars)
- **Current total project cost, including engineering, escalated to the midpoint of construction:** $122M
- **Current Completion Milestone*:** 2026

  ***** *Milestone dates may be subject to revision by DEC based on additional facility planning.*

4.3.e.3 Benefits and Challenges of Implementing the Recommended Plan for the Bronx River

Figure 4-17 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-17, the cost-effective grey projects (post WWFP) resulted in a 44 MGY (9 percent) reduction in the annual CSO volume to the Bronx River. The LTCP Recommended Plan results in an additional 169 MG (37 percent) reduction in annual CSO volume.

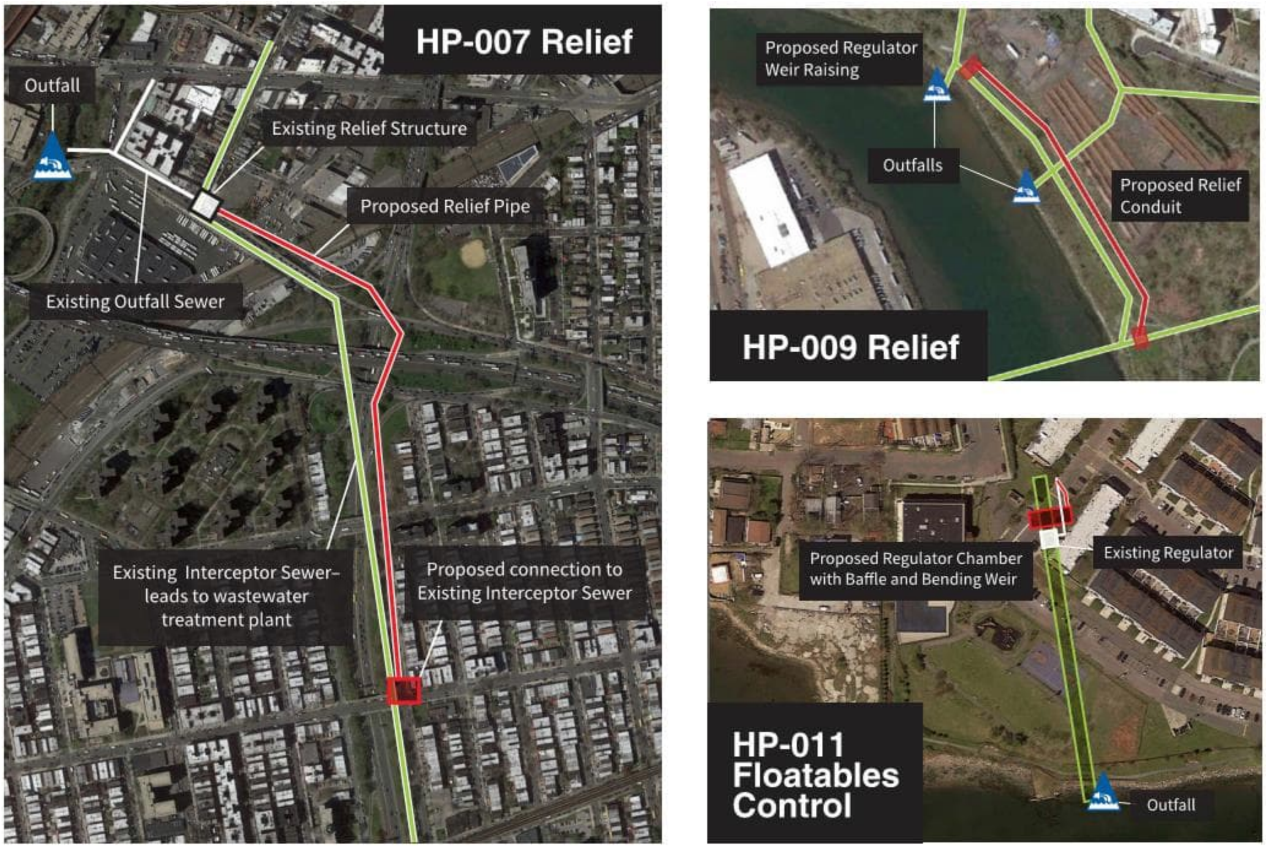


Figure 4-16. Hydraulic Relief at CSO Outfalls HP-007 and HP-009 and Floatables Control at CSO Outfall HP-011

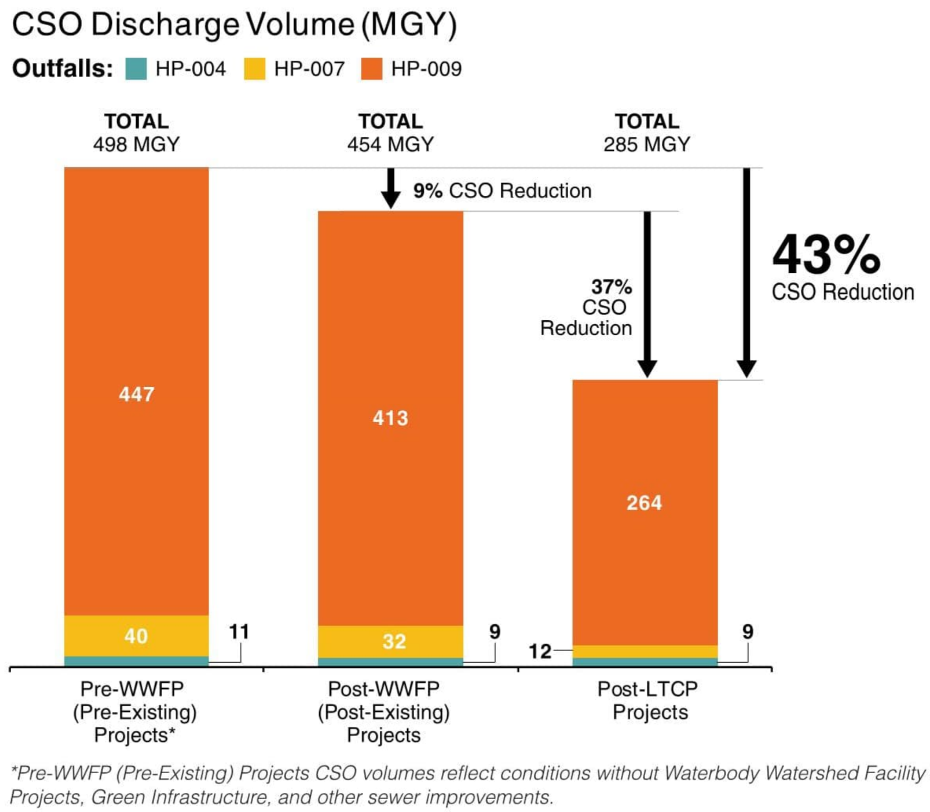


Figure 4-17. Benefits to Bronx River

Overall, from the pre-WWFP conditions to the LTCP Recommended Plan, the total annual CSO volume reduction is 213 MG (43 percent). Additional benefits include:

- The underflow baffle provides floatables control for remaining CSO discharges at Outfall HP-011 to complement the CSO capture benefits of the bending weir in Regulator HP-5.
- Reduced operation and maintenance of the bending weir and underflow baffle in comparison to netting facilities.
- Less neighborhood disruption in comparison to other CSO control alternatives.

While the Recommended Plan is a highly cost-effective approach to reducing the remaining CSO discharges to the Bronx River by an additional 37 percent, there are some construction and operational challenges that must be considered. The challenges and associated risks are as follows:

- Bending weir settings at Regulator HP-5 must balance between maximizing CSO capture while preventing upstream hydraulic impacts.
- Limited space is available within highway medians and traffic islands of the Bronx River Parkway for siting of microtunneling shafts and staging areas for construction of the HP-007 relief sewer.

- Construction of the relief sewer for HP-009 requires removal of mature trees and vegetation along the shoreline and within wetlands.
- While CSO discharges are reduced from HP-007, CSO discharges are increased at downstream Outfalls HP-009 (Bronx River) and HP-011 (East River).

DEP will seek to address these challenges during design through the provision of design and operational criteria.

4.3.e.4 Water Quality Standards Attainment

At the time that the Bronx River LTCP was submitted, the water quality classification for the freshwater reach of the river was Class B, and the saltwater reach was Class I. Those classifications have not changed, but the water quality criteria associated with the Class I saltwater reach has changed. For the freshwater reach of the Bronx River, the water quality criteria for bacteria includes a fecal coliform monthly geometric mean of ≤200 cfu/100mL, assessed on an annual basis. For the saltwater reach, the previous water quality criteria for bacteria included a fecal coliform monthly geometric mean of ≤2,000 cfu/100mL, assessed on an annual basis. The current criterion is for a fecal coliform monthly geometric mean of ≤200 cfu/100mL. The Bronx River is a non-coastal tributary, so the *Enterococcus* criteria for coastal primary contact recreational waters do not apply to the Bronx River.

Table 4-10 presents the percent attainment with the current Class B water quality criteria for bacteria at Stations BR-1 to BR-4, and the Class I water quality criteria for bacteria at Stations BR-5 to BR-9 in the Bronx River for Baseline Conditions and the Recommended Plan. Also shown in Table 4-10 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and the percent attainment with *Enterococcus* criteria. The *Enterococcus* criteria do not apply to the Bronx River, and are shown for informational purposes only.

Table 4-11 presents the annual percent attainment with the applicable DO criteria for the Bronx River stations in the saline reach of the river based on 2008 rainfall and the Recommended Plan.

The locations of the sampling stations referenced in Table 4-10 and Table 4-11 are shown in Figure 4-18.

Table 4-10. Calculated 10-year Bacteria Attainment in Bronx River for Baseline Conditions and the Recommended Plan

Location(1)			Percent Attainment with Criteria							
			Baseline				Recommended Plan			
			Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(2)(3)(5)		Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(2)(3)(5)	
			Recreational Season(2)(6)	Annual			Recreational Season(2)	Annual		
			Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
BR-1	Fresh Water Class B	Non-tidal	100%	100%	100%	22%	100%	100%	100%	22%
BR-2			100%	100%	100%	22%	100%	100%	100%	22%
BR-3			93%	93%	99%	14%	93%	93%	99%	14%
BR-4(4)		Tidal	80%	83%	59%	3%	80%	83%	82%	10%
BR-5	Saline Class I		87%	83%	59%	3%	87%	83%	84%	10%
BR-6			95%	80%	76%	7%	98%	90%	95%	30%
BR-7			95%	83%	79%	9%	98%	90%	95%	36%
BR-8			95%	85%	81%	13%	98%	90%	94%	40%
BR-9			100%	94%	95%	50%	100%	96%	97%	58%

Notes:

(1) The Class B freshwater stations are not affected by the Bronx River CSOs, which are all located in the saline section of the Bronx River.
(2) The Recreational Season is from May 1st through October 31st.
(3) *Enterococcus* Criteria do not apply to the Bronx River. Attainment with these criteria is shown for informational purposes only.
(4) BR-4 is located south of the dam and north of Tremont Avenue and is therefore located in the freshwater portion of the Bronx River but is also tidally influenced.
(5) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤130 cfu/100mL.
(6) The baseline conditions recreational season attainment with fecal coliform criteria has been updated from the LTCP, which did not provide 10-year results for the baseline conditions recreational season.

Table 4-11. Model Calculated DO Attainment for the Bronx River Saline Stations for Baseline Conditions and the Recommended Plan (2008 Rainfall)

Station		Percent Annual Average Attainment Class I ≥4.0 mg/L	
		Baseline Conditions	Recommended Plan
BR-5	Saline (Class I)	99%	99%
BR-6		95%	95%
BR-7		97%	97%
BR-8		99%	99%
BR-9		98%	98%

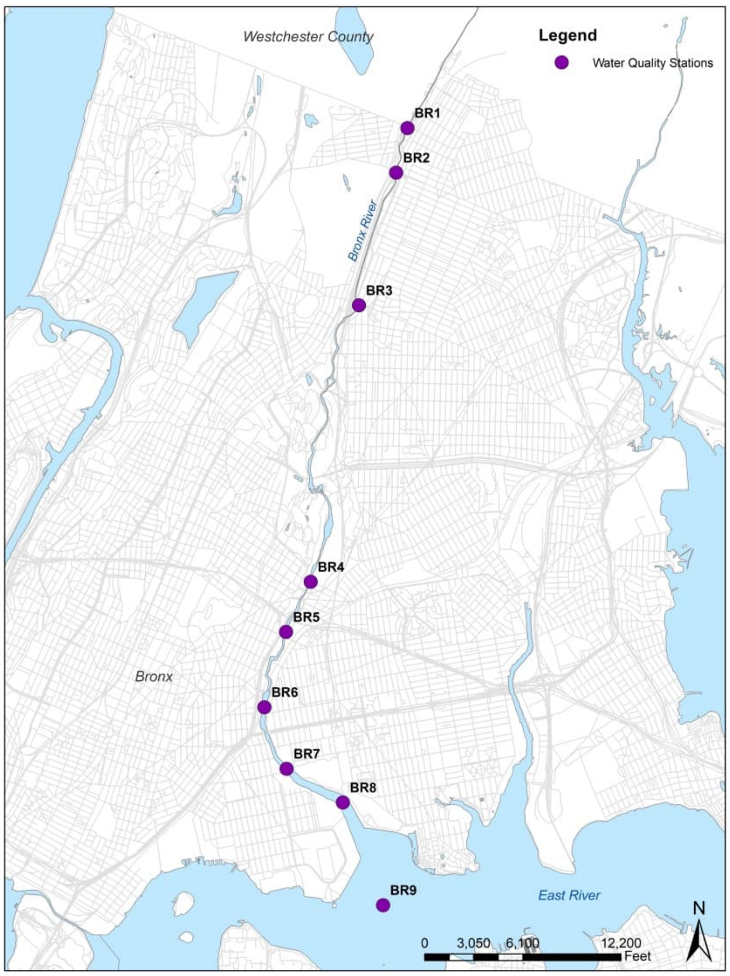


Figure 4-18. Water Quality Stations in the Bronx River

4.3.f Gowanus Canal

4.3.f.1 WWFP Projects

The following summarizes the cost-effective grey projects implemented for Gowanus Canal based on the WWFP recommendations.

- Restoration of the Gowanus flushing tunnel
- Reconstruction of the Gowanus Pumping Station

The total cost of the constructed grey infrastructure projects was $198M.

4.3.f.2 Approved LTCP Recommended Plan

The cost-effective grey projects from the WWFP implemented in Gowanus Canal were demonstrated to result in attainment of WQS in Gowanus Canal. Therefore, no additional projects were recommended in the LTCP to meet CWA requirements.

4.3.f.3 Projects to Meet Superfund Requirements

- **Description:** Through the Superfund process, two CSO storage tanks were determined to be required in order to meet Superfund requirements. The LTCP demonstrated that these tanks would further improve water quality in Gowanus Canal, but were not necessary to meet WQS. The two storage tanks determined to be required under the Superfund Program were an 8 MG storage tank for Outfall RH-034, and a 4 MG storage tank for Outfall OH-007 (Figure 4-19).
- **Probable bid cost:** $720M
- **Current total project cost, including engineering, escalated to the midpoint of construction:** $1,322M

4.3.f.4 Benefits to Gowanus Canal

Figure 4-20 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the storage tanks associated with the Superfund Program. As indicated in Figure 4-20, the cost-effective grey projects (post WWFP) resulted in a 208 MGY (44 percent) reduction in the annual CSO volume to Gowanus Canal. The storage tanks proposed under the Superfund Program result in an additional 148 MG (56 percent) reduction in annual CSO volume. Overall, from the pre-WWFP conditions to the Superfund recommendation, the total annual CSO volume reduction is 356 MG (76 percent).

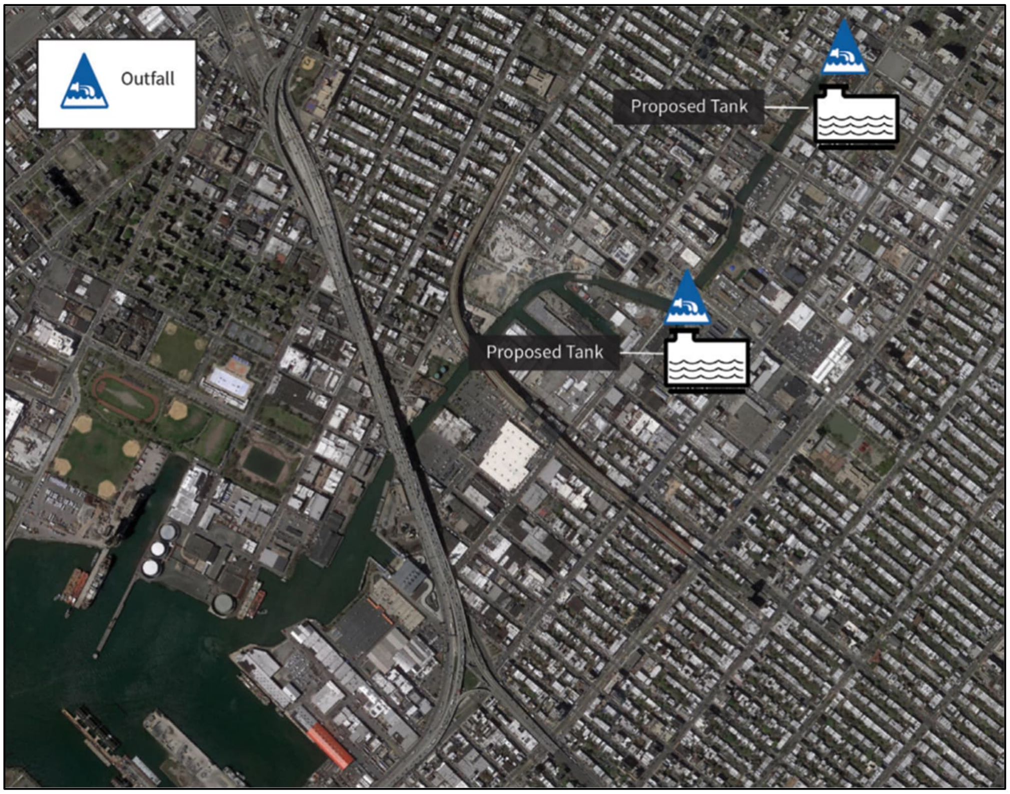


Figure 4-19. Elements of the Superfund Plan
(8MG Tank at RH-034 and 4MG Tank at OH-007)

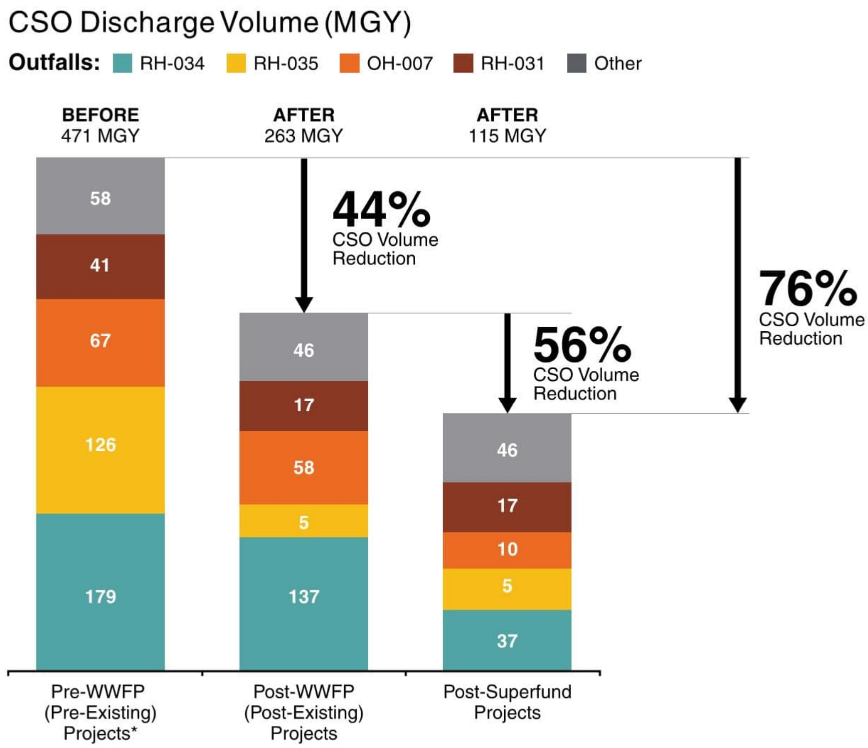
4.3.f.5 Water Quality Standards Attainment

At the time that the Gowanus Canal LTCP was submitted, the water quality classification for Gowanus Canal was Class SD. That classification has not changed, but the water quality criteria associated with that classification have changed. Previously, Class SD waters had no numerical criteria for bacteria. The current Class SD criterion is for a fecal coliform monthly geometric mean of ≤200 cfu/100mL. Gowanus Canal is a non-coastal tributary, so the *Enterococcus* criteria for coastal recreational waters do not apply to Gowanus Canal.

Table 4-12 presents the percent attainment with the current Class SD water quality criteria for bacteria at the water quality stations in Gowanus Canal for Baseline Conditions and with the storage tanks proposed under the Superfund Program, for the 10-year simulation (2002 to 2011). Also shown in Table 4-12 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and the percent attainment with *Enterococcus* criteria. The *Enterococcus* criteria do not apply to Gowanus Canal, and are shown for informational purposes only.

Table 4-13 presents the annual percent attainment with the applicable DO criteria for Gowanus Canal stations for Baseline Conditions and with the storage tanks proposed under the Superfund Program, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-12 and Table 4-13 are shown in Figure 4-21.



**Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

Figure 4-20. Benefits to Gowanus Canal

Table 4-12. Calculated 10-year Bacteria Attainment in Gowanus Canal for Baseline Conditions and with the Storage Tanks Proposed under the Superfund Program

Location	Percent Attainment with Criteria							
	Baseline				Storage Tanks Proposed under the Superfund Program			
	Class SD Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(3)		Class SD Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(3)	
	Recreational Season(1)	Annual			Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
GC-1	100%	98%	99%	70%	100%	98%	100%	92%
GC-2	100%	99%	99%	75%	100%	99%	100%	92%
GC-3	100%	100%	99%	75%	100%	100%	100%	92%
GC-4	100%	100%	99%	74%	100%	100%	100%	91%
GC-5	100%	100%	99%	67%	100%	100%	100%	91%
GC-6	100%	98%	93%	37%	100%	98%	100%	90%
GC-7	100%	98%	94%	39%	100%	98%	100%	90%

Notes:

(1) The Recreational Season is from May 1st through October 31st.
(2) *Enterococcus* Criteria do not apply to Gowanus Canal. Attainment with these criteria is shown for informational purposes only.
(3) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤130 cfu/100mL

Table 4-13. Model Calculated DO Attainment for Gowanus Canal Stations with Storage Tanks Proposed under the Superfund Program (2008 Rainfall)

Station	Percent Annual Average Attainment Class SD ≥3.0 mg/L	
	Baseline Conditions	Storage Tanks Proposed under the Superfund Program
GC-1	100%	100%
GC-2	100%	100%
GC-3	100%	100%
GC-4	100%	100%
GC-5	100%	100%
GC-6	98%	100%
GC-7	99%	100%

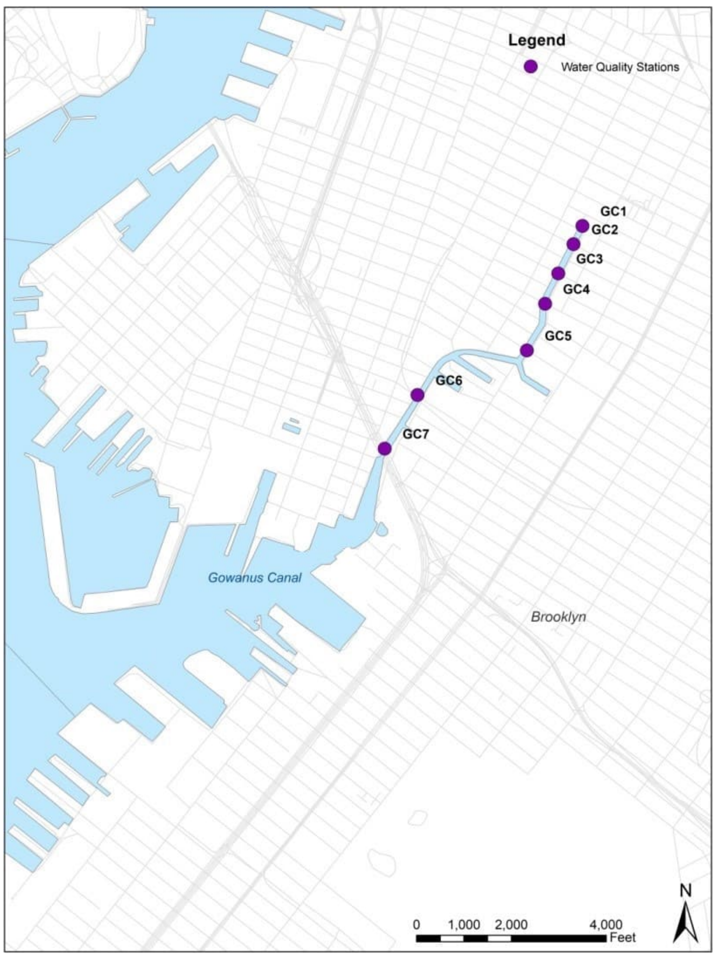


Figure 4-21. Water Quality Stations in Gowanus Canal

4.3.g Coney Island Creek

4.3.g.1 WWFP Projects

The following summarizes the cost-effective grey projects implemented for Coney Island Creek based on the WWFP recommendations.

- Upgrade of the Avenue V Pumping Station
- New wet-weather force main

The total cost of the grey infrastructure projects under construction is $197M.

4.3.g.2 Approved LTCP Recommended Plan

The following summarizes the Recommended Plan from the June 2016 Coney Island Creek LTCP that was approved by DEC on April 4, 2018.

- **Description:** The cost-effective grey projects from the WWFP implemented in Coney Island Creek were demonstrated to result in attainment of the Class I water quality standards in Coney Island Creek. Therefore, no additional projects were recommended in the LTCP.

4.3.g.3 Benefits to Coney Island Creek

Figure 4-22 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-22, the cost-effective grey projects (post WWFP) resulted in a 160 MGY (68 percent) reduction in the annual CSO volume to Coney Island Creek.

4.3.g.4 Water Quality Standards Attainment

At the time that the Coney Island Creek LTCP was submitted, the water quality classification for Coney Island Creek was Class I. That classification has not changed, but the water quality criteria associated with that classification have changed. For Coney Island Creek, the current water quality criteria for bacteria is a fecal coliform monthly geometric mean of ≤200 cfu/100mL, assessed on an annual basis Coney Island Creek is a non-coastal tributary, so the *Enterococcus* criteria for coastal primary contact recreational waters do not apply to Coney Island Creek.

Table 4-14 presents the percent attainment with the current Class I water quality criteria for bacteria at Stations CI-1 to CI-7 in Coney Island Creek for Baseline Conditions and the Recommended Plan, for the 10-year simulation (2002 to 2011). Also shown in Table 4-14 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and the percent attainment with *Enterococcus* criteria. The *Enterococcus* criteria do not apply to Coney Island Creek and are shown for informational purposes only.

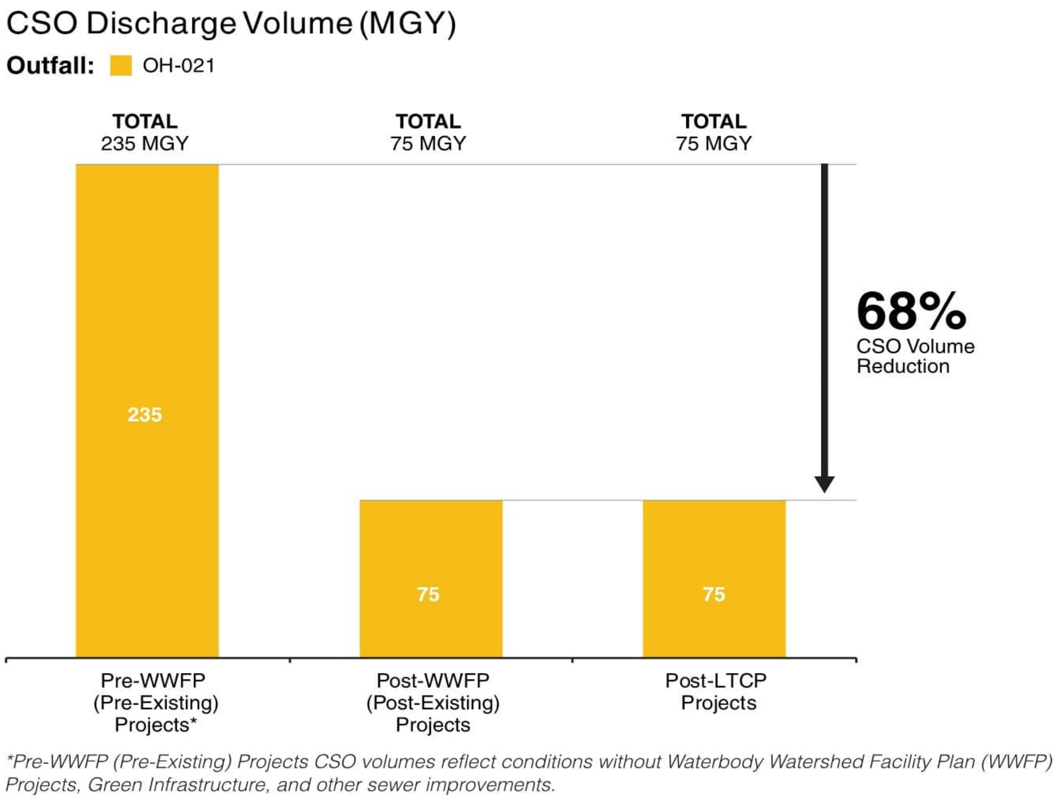


Figure 4-22: Benefits to Coney Island Creek

Table 4-15 presents the annual percent attainment with the applicable DO criteria for the Coney Island Creek stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-14 and Table 4-15 are shown in Figure 4-23.

Table 4-14. Calculated 10-year Bacteria Attainment in Coney Island Creek for Baseline Conditions and the Recommended Plan

Location	Percent Attainment with Criteria			
	Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(3)	
	Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90^{th} Percentile ≤130 cfu/100mL
CI-1	93%	57%	53%	3%
CI-2	93%	56%	54%	3%
CI-3	98%	65%	67%	5%
CI-4	100%	90%	84%	17%
CI-5	100%	91%	85%	19%
CI-6	100%	100%	100%	77%
CI-7	100%	100%	99%	67%

Notes:

(1) The Recreational Season is from May 1^{st} through October 31^{st}.
(2) *Enterococcus* Criteria do not apply to Coney Island Creek. Attainment with these criteria is shown for informational purposes only.
(3) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤130 cfu/100mL.

Table 4-15. Model Calculated DO Attainment for Coney Island Creek Stations for Baseline Conditions and the Recommended Plan (2008 Rainfall)

Station	Percent Annual Average Attainment
	Class I ≥4.0 mg/L
CI-1	90%
CI-2	95%
CI-3	96%
CI-4	98%
CI-5	99%
CI-6	99%
CI-7	99%

Figure 4-23. Water Quality Stations in Coney Island Creek

4.3.h Flushing Bay

4.3.h.1 WWFP Projects

The following summarizes the cost-effective grey projects implemented for Flushing Bay based on the WWFP recommendations.

- Divert Low Lying Sewers to the Low Level Interceptor and Raise Weir in Regulator BB-02
- Modifications to Regulators BB-04, BB-05, BB-06, BB-09 and BB-10
- Dredging and restoration of select areas of Flushing Bay

The total cost of the constructed grey infrastructure projects was $71M.

4.3.h.2 Approved LTCP Recommended Plan

The following summarizes the Recommended Plan from the December 2016 Flushing Bay LTCP that was approved by DEC on March 7, 2017.

- **Description:** 25 MG CSO storage tunnel with dewatering pumping station to capture overflows from CSO Outfalls BB-006 and BB-008 (Figure 4-24)

- **Probable bid cost presented in the LTCP:** $829M (February 2016 dollars)

- **Current total project cost, including engineering, escalated to the midpoint of construction:** $1,471M

- **Current Completion Milestone*:** 2035

  ***** *Milestone dates may be subject to revision by DEC based on ~~additional facility planning~~ approval of engineering design report per September 2022 Consent Order Modification.*

Figure 4-24. 25 MG CSO Storage Tunnel (Outfalls: BB-006 and BB-008)

4.3.h.3 Benefits and Challenges of Implementing the Recommended Plan for Flushing Bay

Figure 4-25 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-25, the cost-effective grey projects (post WWFP) resulted in a 347 MGY (19 percent) reduction in the annual CSO volume to Flushing Bay. The LTCP Recommended Plan results in an additional 747 MG (51 percent) reduction in annual CSO volume. Overall, from the pre-WWFP conditions to the LTCP Recommended Plan, the total annual CSO volume reduction is 1,094 MG (61 percent). Additional benefits include:

- Pump back will be discharged at the Bowery Bay WRRF eliminating the risk of re-deposition of solids along the interceptor as experienced with current CSO retention facilities.
- Trenchless construction methods can significantly reduce the extent of neighborhood disturbance associated with the construction of the storage tunnel and CSO diversion conduits.
- The tunnel alignment minimizes property acquisition requirements through the use of road rights-of-way and City owned properties.

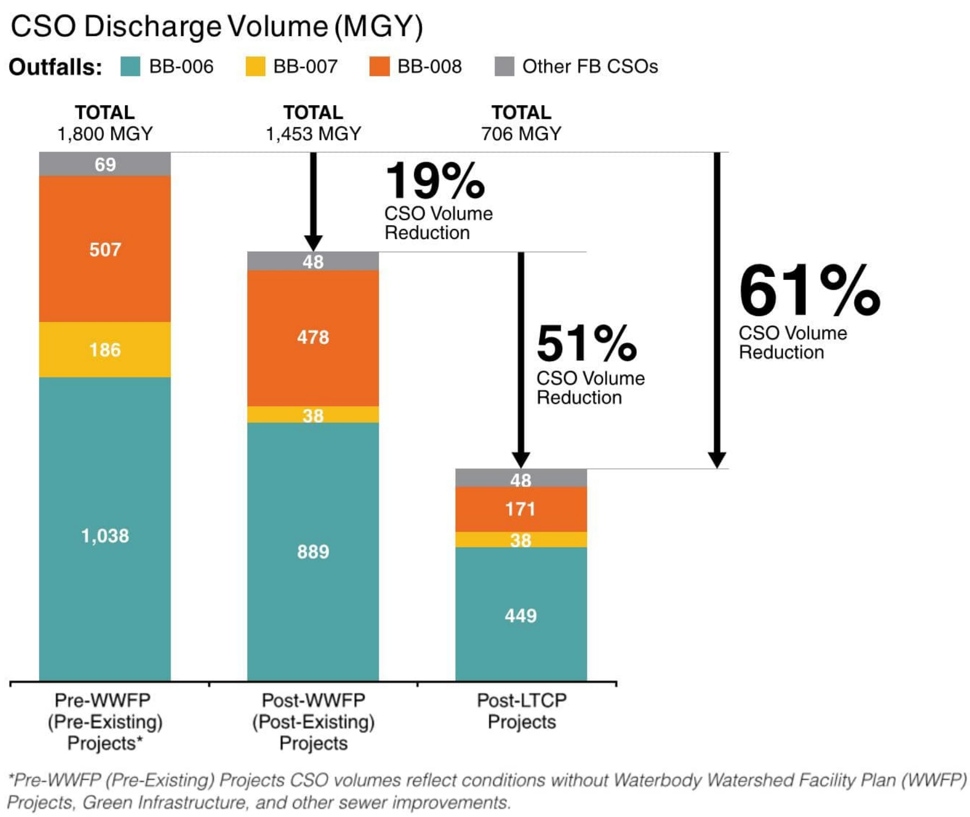


Figure 4-25. Benefits to Flushing Bay

While the Recommended Plan is a cost-effective approach to reducing the remaining CSO discharges to Flushing Bay by an additional 51 percent, a number of construction and operational challenges must be considered. The challenges and associated risks include the following:

- Construction of the dewatering pump station site will require either modification of the long term lease with the PANYNJ or acquisition of private property.
- As a result of past uses, the available sites for the dewatering pump station may require some level of environmental cleanup prior to construction.
- The tunnel and dewatering pump station will be at depths in the range of 100 to 150 feet and require more complex confined space entry for operation and maintenance.
- A portion of the proposed route of the tunnel will overlap with the proposed route for the LaGuardia Airport Access Improvement Project (AirTrain), which will connect the Airport to the NYCT Subway 7 Line and the Port Washington Branch of the LIRR commuter rail. The Federal Aviation Administration (FAA) released the Draft Environmental Impact Statement (DEIS) for this project in August 2020.
- Construction of the tunnel will require protection of existing utilities, highway infrastructure and building foundations.
- Mixed soils conditions require detailed geotechnical investigations and will require the development of a geotechnical baseline report to define geotechnical conditions and precautionary measures.
- Maintenance of regulator and outfall performance throughout construction.
- Hydraulic evaluations of the diversion chambers, diversion sewers, tunnel, and dewatering pump station will be necessary to address performance under a wide range of hydraulic conditions and to address air release and to reduce the risk of hydraulic surge conditions.
- Design of the tunnel and appurtenances to minimize sediment deposition and cleaning.
- The timing for design and construction of the recommended plan needs to be evaluated in light of affordability considerations and other large construction projects proceeding in and around the City, including the AirTrain and Superfund mandated CSO control projects.

DEP will seek to address these challenges during design through the provision of design and operational criteria.

4.3.h.4 Water Quality Standards Attainment

At the time that the Flushing Bay LTCP was submitted, the water quality classification for Flushing Bay was Class I. That classification has not changed. The water quality criteria for bacteria include a fecal coliform monthly geometric mean of ≤200 cfu/100mL, assessed on an annual basis. Flushing Bay is a non-coastal tributary, so the *Enterococcus* criteria for coastal primary contact recreational waters do not apply to Flushing Bay.

Table 4-16 presents the percent attainment with the current Class I water quality criteria for bacteria at the water quality stations in Flushing Bay for Baseline Conditions and the Recommended Plan. Also shown in Table 4-16 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and the percent attainment with *Enterococcus* criteria. The *Enterococcus* criteria do not apply to Flushing Bay and are shown for informational purposes only. In reviewing Table 4-16, it should be noted that in the Flushing Bay LTCP, the Baseline Conditions attainment of fecal coliform criteria was only assessed for the 2008 typical year, while the Recommended Plan was assessed using the 10-year simulation. The 2008 typical year Baseline Conditions attainment is not directly comparable to the 10-year Recommended Plan attainment.

Table 4-17 presents the annual percent attainment with the applicable DO criteria for Flushing Bay stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-16 and Table 4-17 are shown in Figure 4-26.

Table 4-16. Calculated 10-year Bacteria Attainment in Flushing Bay for Baseline Conditions and the Recommended Plan

Location		Percent Attainment with Criteria							
		Baseline				Recommended Plan			
		Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)		Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)	
		Recreational Season(1)	Annual			Recreational Season(1)	Annual		
		Monthly Geometric Mean ≤200 cfu/100mL(3)	Monthly Geometric Mean ≤200 cfu/100mL(3)	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
OW-7	Inner Flushing Bay	100%	100%	93%	16%	100%	100%	99%	61%
OW-7A		100%	100%	92%	12%	100%	100%	99%	55%
OW-7B		100%	100%	88%	11%	100%	100%	99%	58%
OW-7C		100%	100%	88%	12%	100%	100%	99%	60%
OW-8		100%	100%	93%	17%	100%	100%	98%	56%
OW-9		100%	100%	96%	22%	100%	100%	99%	66%
OW-10	Outer Flushing Bay	100%	100%	97%	35%	100%	100%	99%	71%
OW-11		100%	100%	99%	66%	100%	100%	100%	86%
OW-12		100%	100%	98%	45%	100%	100%	100%	75%
OW-13		100%	100%	98%	47%	100%	100%	100%	74%
OW-14		100%	100%	99%	71%	100%	100%	100%	79%
OW-15		100%	100%	99%	56%	100%	100%	100%	77%

Notes:
(1) The Recreational Season is from May 1st through October 31st.
(2) *Enterococcus* Criteria do not apply to Flushing Bay. Attainment with these criteria is shown for informational purposes only.
(3) Values for Baseline Conditions fecal coliform attainment are for 2008 rainfall only, not the 10-year simulation. The 10-year simulation fecal coliform attainment was not developed for Baseline Conditions for this LTCP. Attainment for 2008 is not directly comparable to the 10-year simulation attainment.
(4) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤130 cfu/100mL.

Table 4-17. Model Calculated DO Attainment for Flushing Bay Stations with Recommended Plan (2008 Rainfall)

Station		Percent Annual Average Attainment Class I ≥4.0 mg/L	
		Baseline Conditions	Recommended Plan
OW-7	Inner Flushing Bay	100%	100%
OW-7A		100%	100%
OW-7B		100%	100%
OW-7C		100%	100%
OW-8		100%	100%
OW-9		100%	100%
OW-10	Outer Flushing Bay	99%	99%
OW-11		99%	99%
OW-12		99%	99%
OW-13		99%	99%
OW-14		97%	97%
OW-15		98%	98%

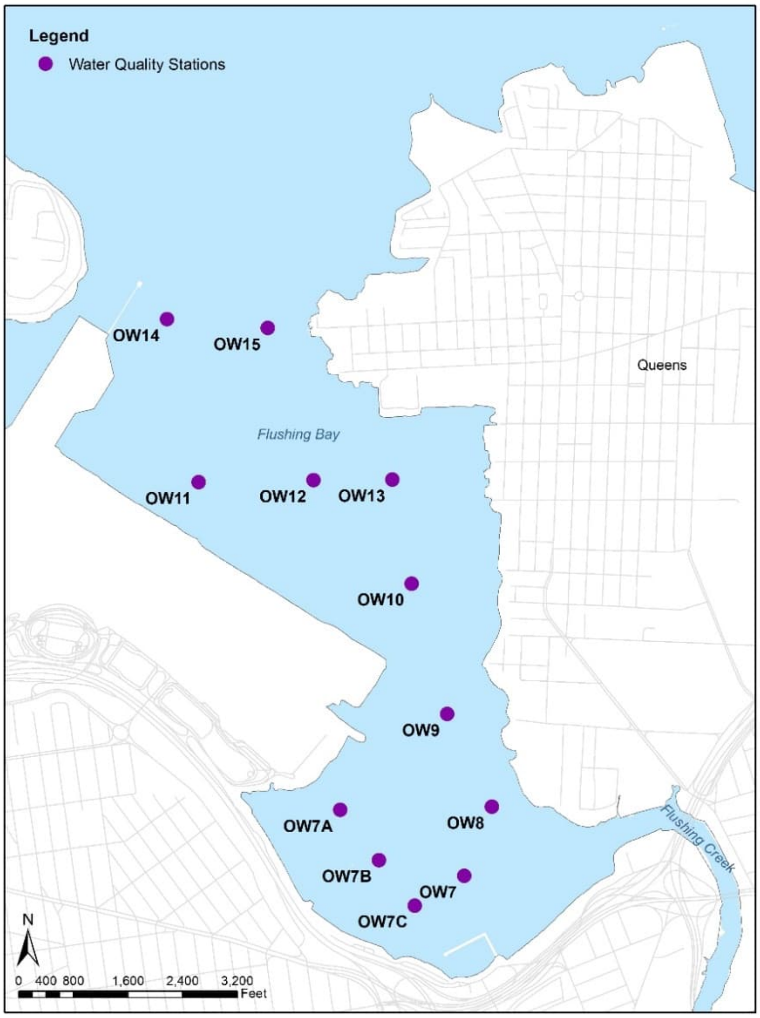


Figure 4-26. Water Quality Stations in Flushing Bay

4.3.i Newtown Creek

4.3.i.1 WWFP Projects

The following summarizes the cost-effective grey projects implemented for Newtown Creek based on the WWFP recommendations.

- Sewer system improvements including bending weirs and floatables control at Regulators NCB-01, NCB-02, NCQ-01, and BB-L4.
- Upgrade of the Brooklyn/Queens Pumping Station main sewage pumps, headworks upgrades and odor control.
- In-stream aeration in the Upper English Kills, Lower English Kills, East Branch and Dutch Kills.

The total cost of the constructed grey infrastructure projects was $262M.

4.3.i.2 Approved LTCP Recommended Plan

The following summarizes the Recommended Plan from the June 2017 Newtown Creek LTCP that was approved by DEC on June 27, 2018.

- **Description:** 39 MG CSO storage tunnel to capture overflows from Outfalls NCB-015, NCB-083, and NCQ-077, and 26 MGD expansion of the Borden Avenue Pumping Station to reduce overflows at Outfall BB-026 (Figure 4-27)

- **Probable bid cost presented in the LTCP:** $597M (February 2017 Dollars)

- **Current total project cost, including engineering, escalated to the midpoint of construction:** $2,401M

- **Current Completion Milestones*:** 2029 for the Borden Avenue Pumping Station Expansion, 2042 for the 39 MG CSO Storage Tunnel

  ***** Milestone dates may be subject to revision by DEC based on additional facility planning.

4.3.i.3 Benefits and Challenges of Implementing the Recommended Plan for Newtown Creek

Figure 4-28 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-28, the cost-effective grey projects (post WWFP) resulted in a 295 MGY (20 percent) reduction in the annual CSO volume to Newtown Creek. The LTCP Recommended Plan results in an additional 707 MG (61 percent) reduction in annual CSO volume. Overall, from the pre-WWFP conditions to the LTCP Recommended Plan, the total annual CSO volume reduction is 1,002 MG (69 percent). Additional benefits include:

- For the long tunnel alignment options, pump back will be discharged at the Newtown Creek WRRF eliminating the risk of re-deposition of solids along the interceptor as experienced with current CSO retention facilities.

- Trenchless construction methods significantly reduce the extent of neighborhood disturbance associated with the construction of the storage tunnel and CSO diversion conduits.

- The tunnel alignment minimizes property acquisition requirements through the use of the creek corridor, road rights-of-way and City owned properties.

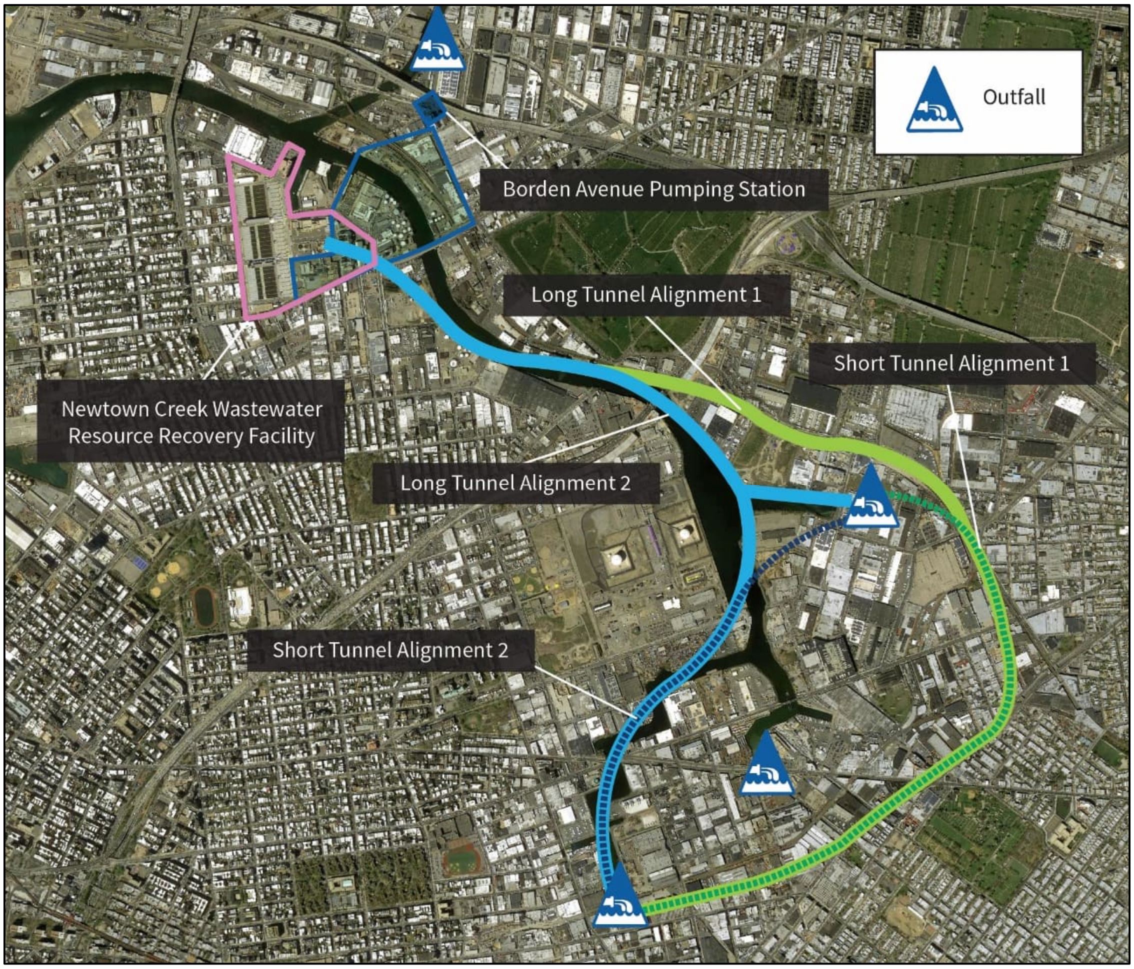
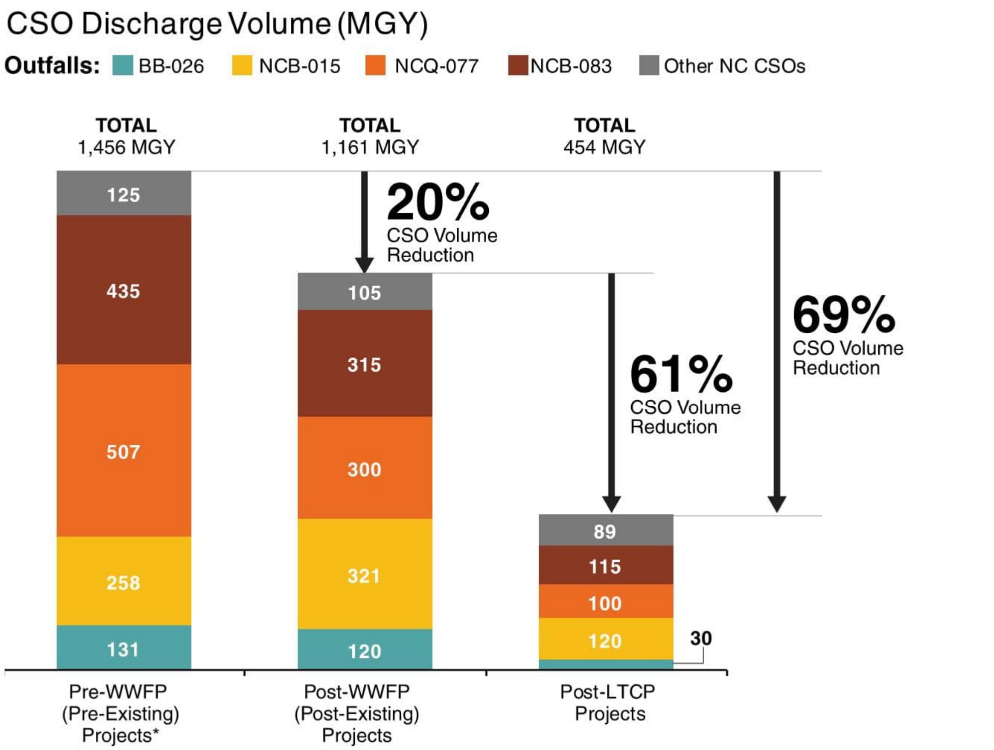


Figure 4-27. 26 MGD Borden Avenue Pumping Station Expansion and 39 MG CSO Storage Tunnel

Figure 4-28. Benefits to Newtown Creek



***Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.*

While the Recommended Plan is a cost-effective approach to reducing the remaining CSO discharges to Newtown Creek by an additional 61 percent, a number of construction and operational challenges must be considered. The challenges and associated risks include the following:

- Construction of the dewatering pump station site could require relocation of sanitation department facilities or acquisition of private property.
- As a result of past uses, the available sites for the dewatering pump station may require some level of environmental cleanup prior to construction.
- For the short tunnel alignments, there is a risk of deposition of sediment in the interceptor from dewatering operations similar to what is currently experienced at existing CSO retention facilities.
- The tunnel and dewatering pump station will be at depths in excess of 300 feet and require more complex confined space entry equipment for accessing these facilities to perform operations and maintenance.
- Construction of the tunnel will require protection of existing utilities, highway infrastructure and building foundations.

- While the tunnel will be bored in rock, shafts and CSO diversion sewers will be constructed in a range of mixed soils and groundwater conditions that must be addressed in the geotechnical baseline report.
- Maintenance of regulator and outfall performance throughout construction.
- Hydraulic evaluations of the diversion chambers, diversion sewers, tunnel and dewatering pump station will be necessary to address performance under a wide range of hydraulic conditions and to address air release and to reduce the risk of hydraulic surge conditions.
- Design of the tunnel and appurtenances to minimize sediment deposition and cleaning.

DEP will seek to address these challenges during design through the provision of design and operational criteria.

4.3.i.4 Water Quality Standards Attainment

At the time that the Newtown Creek LTCP was submitted, the water quality classification for Newtown Creek was Class SD. That classification has not changed. The bacteria criteria for Class SD waters includes a fecal coliform monthly geometric mean of ≤200 cfu/100mL, assessed on an annual basis.

Newtown Creek is a non-coastal tributary, so the *Enterococcus* criteria for coastal recreational waters do not apply to Newtown Creek.

Table 4-18 presents the percent attainment with the current Class SD water quality criteria for bacteria at the water quality stations in Newtown Creek for Baseline Conditions and the Recommended Plan, for the 10-year simulation (2002 to 2011). Also shown in Table 4-18 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and the percent attainment with *Enterococcus* criteria. The *Enterococcus* criteria do not apply to Newtown Creek, and are shown for informational purposes only. In reviewing Table 4-18, it should be noted that in the Newtown Creek LTCP, the Baseline Conditions attainment of fecal coliform criteria was only assessed for the 2008 typical year, while the Recommended Plan was assessed using the 10-year simulation. The 2008 typical year Baseline Conditions attainment is not directly comparable to the 10-year Recommended Plan attainment.

Table 4-19 presents the annual percent attainment with the applicable DO criteria for Newtown Creek stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-18 and Table 4-19 are shown in Figure 4-29.

Table 4-18. Calculated 10-year Bacteria Attainment in Newtown Creek for Baseline Conditions and the Recommended Plan

Location		Percent Attainment with Criteria							
		Baseline				Recommended Plan			
		Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)		Class I Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)	
		Recreational Season(1)	Annual			Recreational Season(1)	Annual		
		Monthly Geometric Mean ≤200 cfu/100mL(3)	Monthly Geometric Mean ≤200 cfu/100mL(3)	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
NC4	Main Channel	100%	75%	89%	20%	93%	90%	94%	35%
NC5		100%	75%	87%	15%	93%	90%	93%	25%
NC6	Dutch Kills	83%	50%	81%	14%	93%	88%	92%	27%
NC7	Main Channel	100%	75%	86%	16%	93%	90%	94%	26%
NC8		83%	50%	86%	16%	93%	90%	94%	28%
NC9		83%	50%	85%	14%	93%	90%	94%	26%
NC10	Maspeth Creek	67%	42%	77%	11%	92%	89%	94%	31%
NC11	English Kills	67%	42%	65%	5%	92%	89%	87%	13%
NC12	East Branch	67%	42%	46%	3%	88%	83%	78%	8%
NC13	English Kills	67%	42%	66%	7%	92%	89%	87%	14%
NC14		67%	42%	50%	3%	83%	83%	78%	7%

Notes:
1. (1) The Recreational Season is from May 1st through October 31st.
2. (2) *Enterococcus* Criteria do not apply to Newtown Creek. Attainment with these criteria is shown for informational purposes only.
3. (3) Values for Baseline Conditions fecal coliform attainment are for 2008 rainfall only, not the 10-year simulation. The 10-year simulation fecal coliform attainment was not developed for Baseline Conditions for this LTCP. Attainment for 2008 is not directly comparable to the 10-year simulation attainment.
4. (4) The *Enterococcus* criteria have been updated from the original LTCP, which presented attainment with a 30-day GM of ≤30 cfu/100mL and a 30-day STV of ≤130 cfu/100mL.

Table 4-19. Model Calculated DO Attainment for Newtown Creek Stations for Baseline Conditions and the Recommended Plan (2008 Rainfall) – Aeration System Operational

Station		Percent Annual Average Attainment Class SD ≥3.0 mg/L	
		Baseline Conditions	Recommended Plan
Main Channel	NC4	100%	100%
	NC5	100%	100%
Dutch Kills	NC6	98%	99%
Main Channel	NC7	100%	100%
	NC8	100%	100%
	NC9	99%	100%
Maspeth Creek	NC10	96%	100%
English Kills	NC11	95%	100%
East Branch	NC12	95%	100%
English Kills	NC13	94%	100%
	NC14	90%	97%

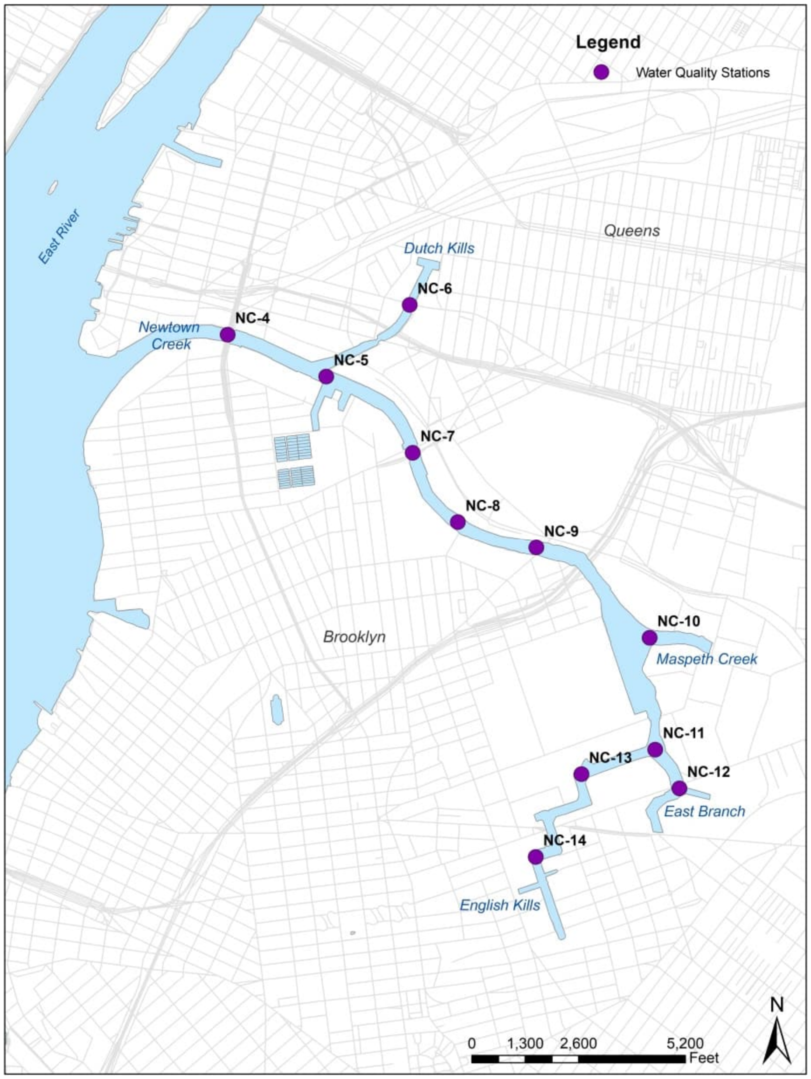


Figure 4-29. Water Quality Stations in Newtown Creek

4.3.j Jamaica Bay and Tributaries

4.3.j.1 WWFP Projects

The following summarizes the cost-effective grey projects implemented for Jamaica Bay and Tributaries based on the WWFP recommendations.

- Spring Creek Auxiliary WRRF Upgrade
- 50 MG Paerdegat Basin CSO Facility (30 MG tank and 20 MG in-line storage)
- 26th Ward WRRF wet-weather stabilization

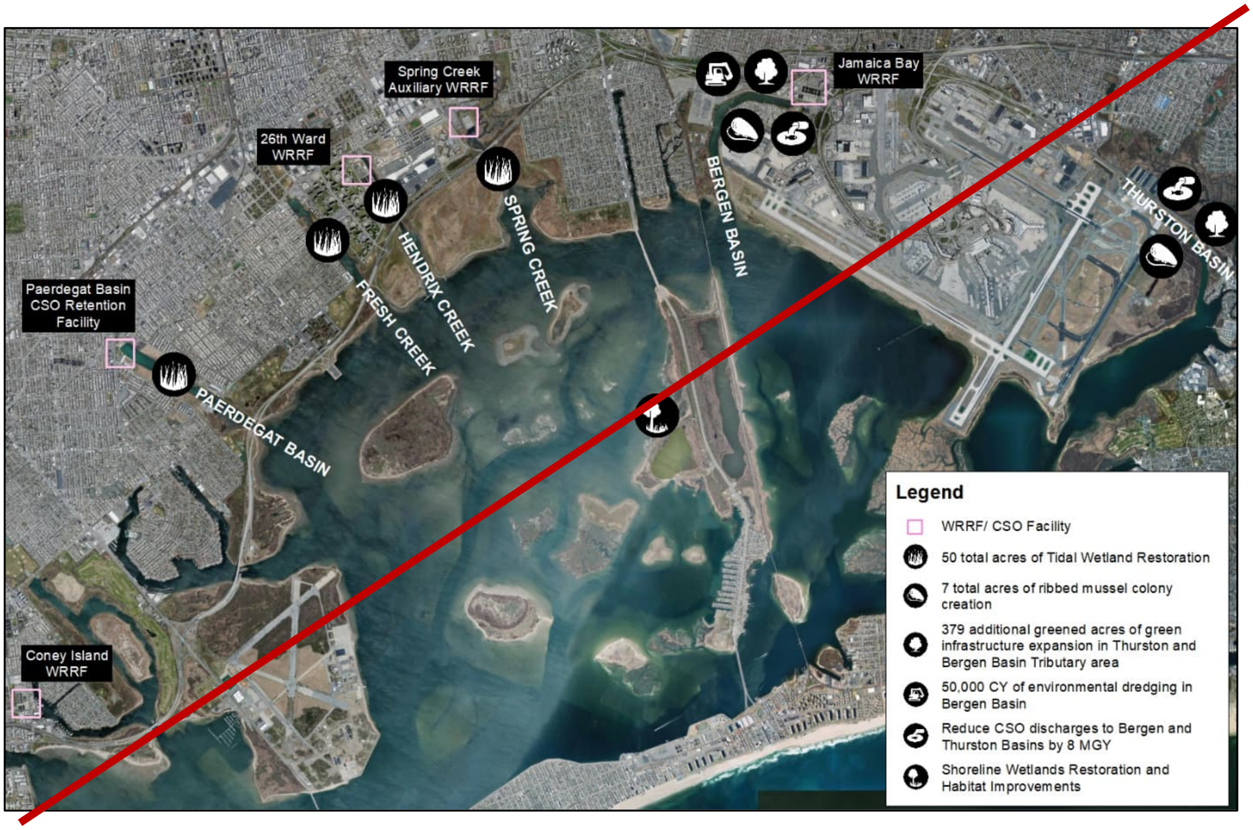
- 26th Ward WRRF sewershed sewer cleaning and high level storm sewers
- New sewer parallel to the west interceptor and Bergen Basin lateral sewer
- Hendrix Creek and Paerdegat Basin dredging
- Warnerville Pumping Station and forcemain
- Shellbank Basin de-stratification
- Regulator improvements including automation of JA-02 and bending weirs at JA-03, JA-06 and JA-14

The total cost of the constructed grey infrastructure projects was $1,100M.

4.3.j.2 LTCP Recommended Plan

The following summarizes the Recommended Plan from the June 2018 Jamaica Bay and Tributaries LTCP as updated by the January 2023 Supplemental Documentation. This LTCP ~~is currently under review~~ was approved by DEC in January 2023.

- **Description:** ~~GI expansion in Bergen and Thurston Basin watersheds;~~ ribbed mussel colony creation in Bergen and Thurston Basins; environmental dredging in Bergen Basin; and wetlands and Marsh Island Restoration in ~~tidal wetland restoration in Spring Creek, Hendrix Creek, Fresh Creek, Paerdegat Basin and~~ Jamaica Bay and certain tributaries (Figure 4-30)
- **Probable bid cost presented in the LTCP Supplemental Documentation:** ~~$310M~~ $141M (~~June 2018~~ 2022 Dollars)
- **Current total project cost, including engineering, escalated to the midpoint of construction:** ~~$579M~~ $230M
- **Current Completion Milestone:** 2040 ~~LTCP schedule shows 14 years from DEC approval of the LTCP. Since the LTCP has not yet been approved, this pending date is not yet a Milestone~~.


Spring Creek Auxiliary WRRF
26th Ward WRRF
Jamaica Bay WRRF
Paerdegat Basin CSO Retention Facility
Coney Island WRRF
SPRING CREEK
HENDRIX CREEK
FRESH CREEK
PAERDEGAT BASIN
BERGEN BASIN
THURSTON BASIN
Legend
WRRF/ CSO Facility
50 total acres of Tidal Wetland Restoration
7 total acres of ribbed mussel colony creation
379 additional greened acres of green infrastructure expansion in Thurston and Bergen Basin Tributary area
50,000 CY of environmental dredging in Bergen Basin
Reduce CSO discharges to Bergen and Thurston Basins by 8 MGY
Shoreline Wetlands Restoration and Habitat Improvements

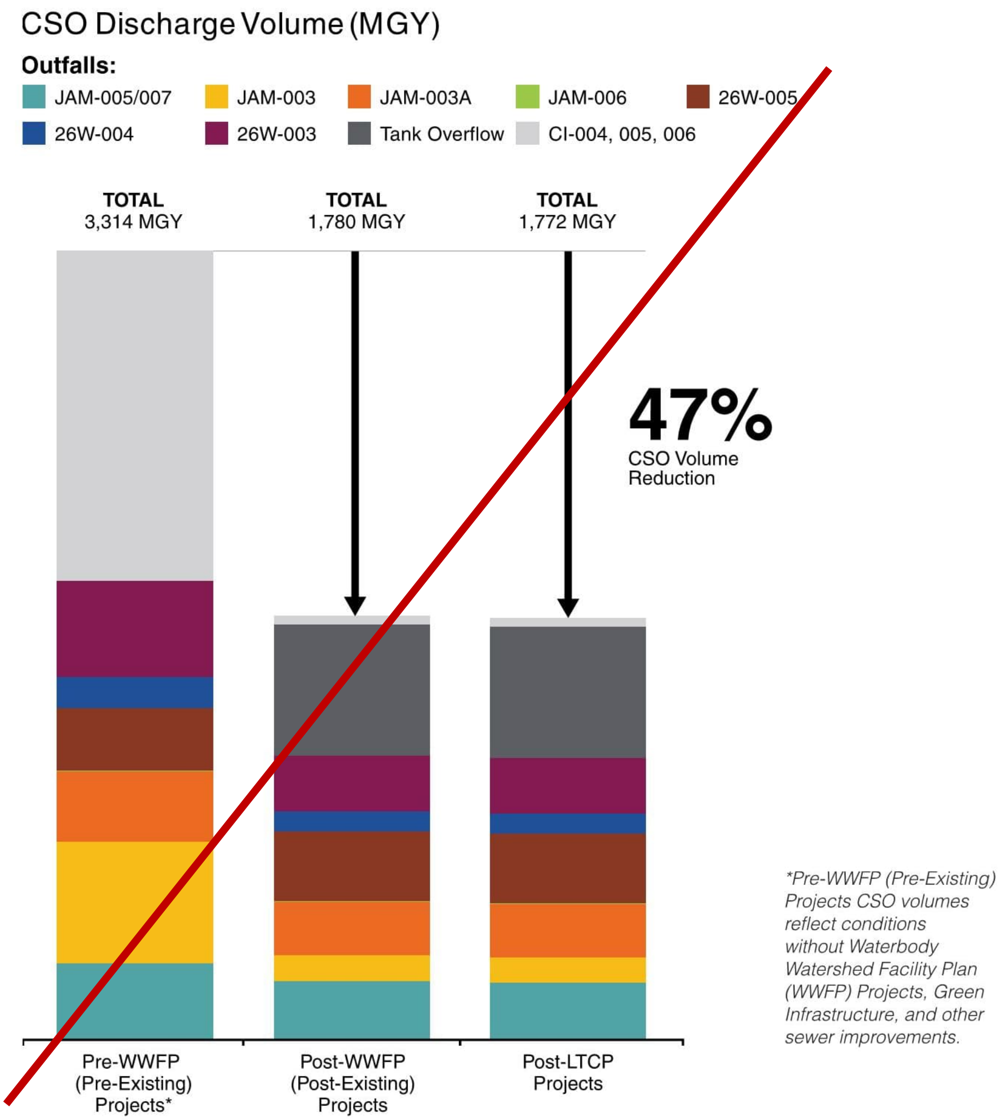
**Will be cost sharing with USACE*

Figure 4-30. Elements of the LTCP

4.3.j.3 Benefits and Challenges of Implementing the Recommended Plan for Jamaica Bay and Tributaries

Figure 4-31 presents the reductions in CSO volume associated with the WWFP cost-effective grey projects and the LTCP Recommended Plan. As indicated in Figure 4-31, the cost-effective grey projects (post WWFP) resulted in a ~~1,534~~ 1,745 MGY (~~46~~ 49 percent) reduction in the annual CSO volume to the

tributaries to Jamaica Bay. The LTCP Recommended Plan does not change the CSO volume from the LTCP Baseline Conditions. ~~results in an additional 8 MG reduction in annual CSO volume. Overall, from~~


CSO Discharge Volume (MGY)
Outfalls:
JAM-005/007
JAM-003
JAM-003A
JAM-006
26W-005
26W-004
26W-003
Tank Overflow
CI-004, 005, 006
TOTAL 3,314 MGY
TOTAL 1,780 MGY
TOTAL 1,772 MGY
47%
CSO Volume Reduction
Pre-WWFP (Pre-Existing) Projects*
Post-WWFP (Post-Existing) Projects
Post-LTCP Projects
*Pre-WWFP (Pre-Existing) Projects CSO volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements.

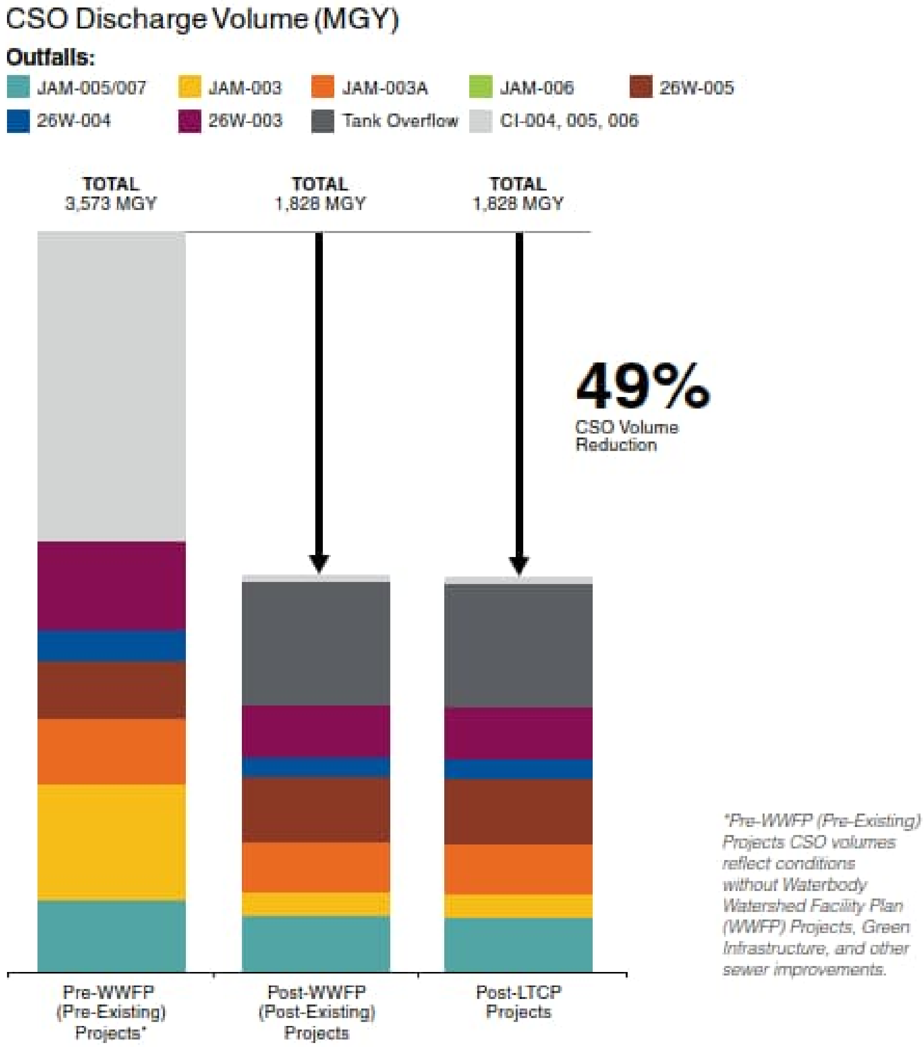


Figure 4-31. Benefits to Jamaica Bay and Tributaries

~~the pre-WWFP conditions to the LTCP Recommended Plan, the total annual CSO volume reduction is 1,542 MG (47 percent).~~ ~~Additional b~~ Benefits of the Recommended Plan include:

- ~~The Green Infrastructure will continue to provide water quality benefits as the sewer system transitions from combined to separate sewers upon implementation of the Southeast Queens Buildout Program.~~

- Tidal wetland restoration enhances fish and wildlife habitat, as well as filters direct drainage.

- Environmental dredging will remove sediments that contribute to historical odor issues at the head end of Bergen Basin.

- Ribbed mussels enhance aquatic and wildlife habitats and provide continuous filtration of pathogens and other contaminants within waterways regardless of the contributing source.

While the Recommended Plan is a cost-effective approach to improving conditions in Jamaica Bay and its tributaries ~~reducing the remaining CSO discharges to Bergen and Thurston Basins by an additional 15 MG~~, a number of construction and maintenance challenges must be considered. The challenges and associated risks include the following:

- Coordination with airport security for performance of work in Bergen and Thurston Basins.

- Maintenance of access to airport fuel transfer docks during performance of environmental dredging and installation of ribbed mussels.

- Potential impacts of chlorine residual from Jamaica WRRF effluent on Bergen Basin ribbed mussel installations.

- ~~Coordination of the siting of green infrastructure with the Southeast Queens Buildout, Downtown Jamaica Facilities Planning and other ongoing programs where planning and design of sewer routes are still being developed.~~

DEP will seek to address these challenges during planning and design. Laboratory and scaled field applications will be performed to verify ribbed mussel performance and identify the design criteria to be used in preparing construction documents. Maintenance manuals will also be prepared for each of the environmental projects to minimize these risks and maximize their long term performance.

4.3.j.4 Water Quality Standards Attainment

At the time that the Jamaica Bay and Tributaries LTCP was submitted, the water quality classification for the tributaries was Class I, and the classification for Jamaica Bay was Class SB. Those classifications have not changed, but the water quality criteria associated with Jamaica Bay has changed. The fecal coliform bacteria criteria for Class I and SB remains as a monthly geometric mean of ≤200 cfu/100mL, assessed on an annual basis.

However, Jamaica Bay is now classified as a coastal primary contact recreational waterbody, so the bacteria criteria also include a 30-day *Enterococcus* geometric mean of ≤35 cfu/100mL, and a 30-day 90^{th} percentile limit of ≤130 cfu/100mL. The tributaries to Jamaica Bay are non-coastal tributaries, so the *Enterococci* criteria for coastal primary contact recreational waters do not apply to the Jamaica Bay tributaries.

Table 4-20 presents the percent attainment with the current Class I and Class SB water quality criteria for fecal coliform at the water quality stations in Jamaica Bay and Tributaries for the Recommended Plan, for the 10-year simulation (2002 to 2011). Also shown in Table 4-20 is the percent attainment with an annual fecal coliform geometric mean of 200 cfu/100mL, and percent attainment with *Enterococcus* criteria. The *Enterococcus* criteria apply to Jamaica Bay, but do not apply to the tributaries, where they are shown for informational purposes only.

Table 4-21 presents the annual percent attainment with the applicable DO criteria for the Jamaica Bay tributaries stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall. Table 4-22 presents the annual percent attainment with the applicable DO criteria for the Jamaica Bay stations for Baseline Conditions and the Recommended Plan, based on 2008 rainfall.

The locations of the sampling stations referenced in Table 4-20, Table 4-21 and Table 4-22 are shown in Figure 4-32.

Table 4-20. Calculated 10-year Bacteria Attainment in Jamaica Bay and Tributaries for the Recommended Plan

Location	Percent Attainment with Criteria							
	Baseline Conditions				Recommended Plan			
	Class I/SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)		Class I/SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)	
	Recreational Season(1)	Annual			Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
Thurston Basin								
TBH1(3)	88%	77%	65%	5%	88%	77%	65%	5%
TBH3(3)	93%	89%	84%	11%	93%	89%	84%	11%
TB9(3)	95%	91%	89%	14%	95%	91%	89%	14%
TB10(3)	100%	98%	95%	24%	100%	98%	95%	24%
TB11	100%	100%	100%	87%	100%	100%	100%	87%
TB12	100%	100%	100%	96%	100%	100%	100%	96%
Bergen Basin								
BB5(3)	72%	57%	29%	0%	72%	57%	29%	0%
BB6(3)	93%	89%	69%	6%	93%	89%	69%	6%
BB7(3)	100%	100%	93%	14%	100%	100%	93%	14%
BB8	100%	100%	100%	57%	100%	100%	100%	57%
Spring Creek								
SP1	100%	100%	100%	78%	100%	100%	100%	78%

with

Table 4-20. Calculated 10-year Bacteria Attainment in Jamaica Bay and Tributaries for the Recommended Plan

Location	Percent Attainment with Criteria							
	Baseline Conditions				Recommended Plan			
	Class I/SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)		Class I/SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)	
	Recreational Season(1)	Annual			Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
SP2	100%	100%	100%	94%	100%	100%	100%	94%
Hendrix Creek								
HC1	98%	99%	98%	33%	98%	99%	98%	32%
HC2	100%	100%	98%	38%	100%	100%	98%	38%
HC3	100%	100%	100%	71%	100%	100%	100%	71%
Fresh Creek								
FC1	93%	85%	98%	16%	93%	85%	98%	16%
FC2	100%	98%	98%	17%	100%	98%	98%	17%
FC3	100%	100%	100%	51%	100%	100%	100%	51%
FC4	100%	100%	100%	92%	100%	100%	100%	92%
Paerdegat Basin								
PB2	95%	97%	96%	28%	95%	97%	96%	28%
PB3	100%	100%	100%	69%	100%	100%	100%	69%

Table 4-20. Calculated 10-year Bacteria Attainment in Jamaica Bay and Tributaries for the Recommended Plan

Location	Percent Attainment with Criteria							
	Baseline Conditions				Recommended Plan			
	Class I/SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)		Class I/SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)	
	Recreational Season(1)	Annual			Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
Jamaica Bay (Northern Shore)								
J10	100%	100%	100%	85%	100%	100%	100%	85%
J3	100%	100%	100%	97%	100%	100%	100%	97%
J9a	100%	100%	100%	92%	100%	100%	100%	92%
J8	100%	100%	100%	92%	100%	100%	100%	92%
J7	100%	100%	100%	57%	100%	100%	100%	57%
JA1	100%	100%	100%	86%	100%	100%	100%	86%
Jamaica Bay (Inner Bay)								
J2	100%	100%	100%	98%	100%	100%	100%	98%
J12	100%	100%	100%	97%	100%	100%	100%	97%
J14	100%	100%	100%	100%	100%	100%	100%	100%
J16	100%	100%	100%	99%	100%	100%	100%	99%

Table 4-20. Calculated 10-year Bacteria Attainment in Jamaica Bay and Tributaries for the Recommended Plan

Location	Percent Attainment with Criteria							
	Baseline Conditions				Recommended Plan			
	Class I/SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)		Class I/SB Fecal Coliform Criteria		*Enterococcus* Criteria for Recreational Season(1)(2)(4)	
	Recreational Season(1)	Annual			Recreational Season(1)	Annual		
	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	Monthly Geometric Mean ≤200 cfu/100mL	30-day Geometric Mean ≤35 cfu/100mL	30-day 90th Percentile ≤130 cfu/100mL
Jamaica Bay (Rockaway Shore)								
J1	100%	100%	100%	100%	100%	100%	100%	100%
J5	100%	100%	100%	100%	100%	100%	100%	100%

Notes:
(1) The Recreational Season is from May 1st through October 31st.
(2) *Enterococcus* Criteria apply to stations in Jamaica Bay, but not to the stations in the tributaries. Attainment with these criteria in the tributaries is shown for informational purposes only.
(3) Monitoring station is located in a portion of the waterbody where unauthorized access is prohibited by JFK Airport security and/or a physical barrier.
(4) *Enterococcus* attainment has been updated from values presented in the LTCP.

Table 4-21. Model Calculated DO Attainment for Jamaica Bay Tributaries Stations for Baseline Conditions and the Recommended Plan (2008 Rainfall)

	Annual Attainment (%) Tributaries – Class I ≥4.0 mg/L	
Station	**Baseline Conditions**	**Recommended Plan**
Thurston Basin		
TBH1(1)	90%	90%
TBH3(1)	90%	90%
TB9(1)	92%	92%
TB10(1)	92%	92%
TB11	97%	97%
TB12	99%	99%
Bergen Basin		
BB5(1)	89%	89%
BB6(1)	95%	95%
BB7(1)	99%	99%
BB8	100%	100%
Spring Creek		
SP1	99%	99%
SP2	100%	100%
Hendrix Creek		
HC1	94%	94%
HC2	98%	98%
HC3	100%	100%
Fresh Creek		
FC1	99%	99%
FC2	100%	100%
FC3	100%	100%
FC4	100%	100%
Paerdegat Basin		
PB2	99%	99%
PB3	100%	100%

Note:
(1) Monitoring station is located in a portion of the waterbody where unauthorized access is prohibited by JFK Airport security and/or a physical barrier.

Table 4-22. Model Calculated DO Attainment for Jamaica Bay Stations with Recommended Plan (2008 Rainfall)

Station	Annual Attainment (%) Jamaica Bay - Class SB			
	Baseline Conditions		Recommended Plan	
	Acute(1) (≥3.0 mg/L)	Chronic(2) (≥4.8 mg/L)	Acute(1) (≥3.0 mg/L)	Chronic(2) (≥4.8 mg/L)
Jamaica Bay (Northern Shore)				
J10	100%	100%	100%	100%
J3	100%	100%	100%	100%
J9a	100%	100%	100%	100%
J8	100%	100%	100%	100%
J7	100%	100%	100%	100%
JA1	100%	99%	100%	99%
Jamaica Bay (Inner Bay)				
J2	100%	100%	100%	100%
J12	100%	100%	100%	100%
J14	100%	100%	100%	100%
J16	100%	100%	100%	100%
Jamaica Bay (Rockaway Shore)				
J1	100%	100%	100%	100%
J5	100%	100%	100%	100%

Notes:
(1) Acute standard (never less than).
(2) Chronic standard based on daily average. See Table 2-5 in Section 2 for further details on the DO criteria.

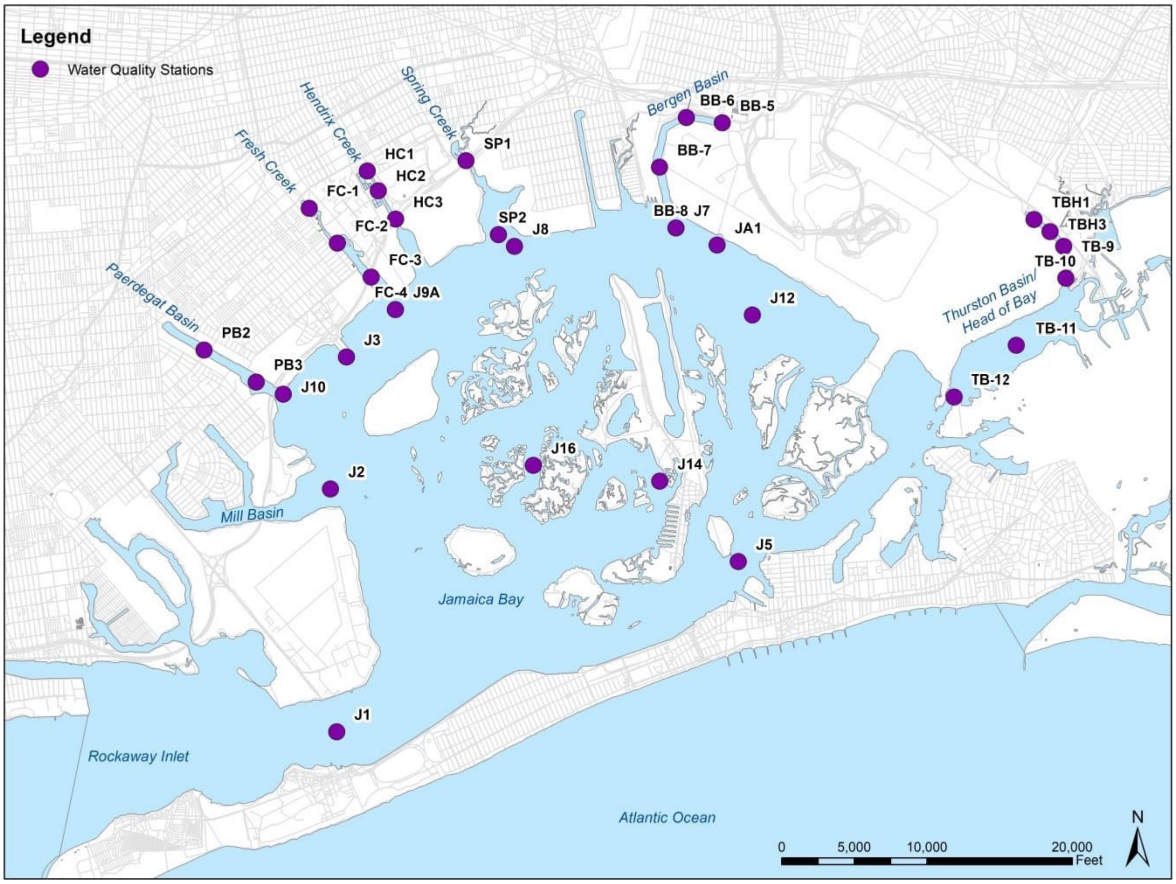


Figure 4-32. Water Quality Stations in Jamaica Bay and Tributaries

4.4 Post-Construction Monitoring

Since no CSO-specific grey infrastructure projects were implemented for outfalls discharging to the Citywide/Open Waters, a post-construction compliance monitoring (PCM) program specific to the Citywide/Open Waters waterbodies has not been implemented. However, ongoing sampling has been conducted over many years in the Citywide/Open Waters waterbodies as part of DEP's Harbor Survey Monitoring (HSM) and Sentinel Monitoring (SM) programs. A PCM program for the Recommended Plan from the Citywide/Open Waters LTCP is expected to consist of two basic components:

1. Receiving water data collection in Citywide/Open Waters using existing DEP HSM and SM stations; and

2. Modeling the collection system and receiving waters to characterize water quality using the existing InfoWorks ICM™ (IW) and LTCP Regional Model (LTCPRM), respectively.

AECOM with Hazen

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

The HSM and SM sampling programs have been collecting data from stations in the Harlem River, Hudson River, East River, New York Harbor, Arthur Kill, and Kill Van Kull Stations for many years. Current HSM and SM sampling stations that would be used for the PCM in the Citywide/Open Waters include the following:

- Harlem River – One HSM station (H3); four SM stations (S54 to S57)
- Hudson River – Six HSM stations (N1, NR1, N3B, N3C, N4, and N5); seven SM stations (S47 to S53)
- East River – Eight HSM stations (E2, E4, E6, E7, E8, E12, E13, and E14); 12 SM stations (S3, S4, S8, S9, S10, S11, S16, S17, S58, S63, S65, and S67)
- New York Harbor – Seven HSM stations (N6-N9, K5A, K6, and GB1); nine SM stations (S18, S19, S39-S44, and S73)
- Arthur Kill/Kill Van Kull – Five HSM stations (K1-K5); five SM stations (S45, S69-S72)

Figure 4-33 shows the locations of the PCM Stations in the Citywide/Open Waters waterbodies. Sampling at the stations shown in Figure 4-33 is typically scheduled monthly in the non-recreational season (November 1st through April 31st) and weekly in the recreational season (May 1st through October 31st). Measured parameters relating to receiving water quality at these stations include: dissolved oxygen, fecal coliform, *Enterococci*, chlorophyll 'a', and Secchi depth. With the exception of *Enterococci*, NYC has used these parameters for decades to identify historical and spatial trends in water quality throughout New York Harbor. The PCM program measures dissolved oxygen and chlorophyll 'a' at surface and bottom depths; the remaining parameters are measured at the surface only.

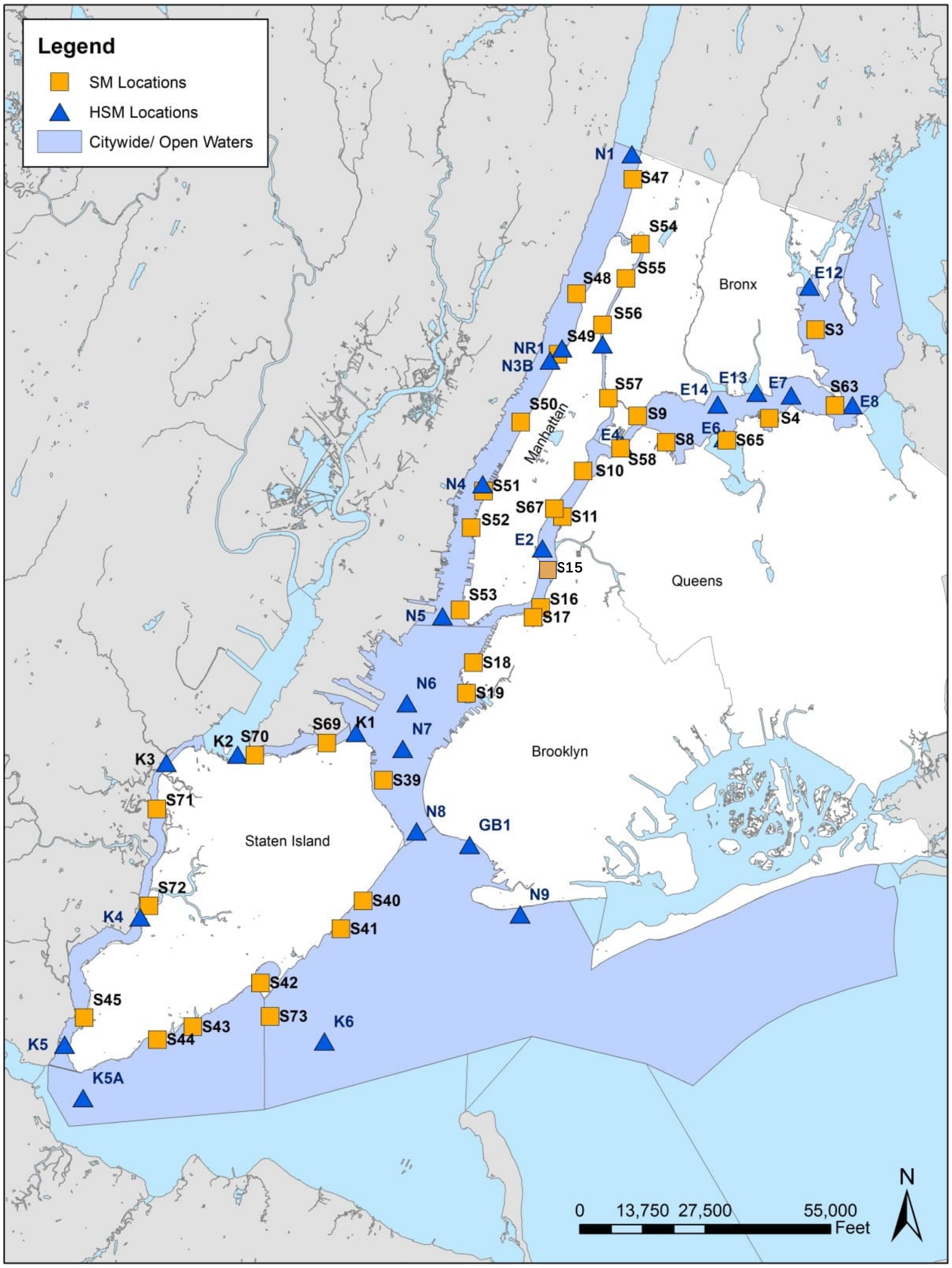


Figure 4-33. HSM and SM Sampling Locations in Citywide/Open Waters Waterbodies

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

No CSO facilities currently discharge directly to the Citywide/Open Waters waterbodies, and no new CSO storage/treatment facilities are proposed under the Citywide/Open Waters LTCP.

4.4.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). For waterbodies where no additional CSO controls are proposed, affirmation of water quality projections would still 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 relation to the water quality goals.

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

Given the uncertainty associated with potentially widely varying precipitation conditions, rainfall analysis is an essential component of the PCM. For the Citywide/Open Waters waterbodies, the most representative long term rainfall data record is available from the National Weather Service's JFK Airport gauge. Rain data for each calendar year of the PCM program will be compared to the 10-year model period (2002 –2011) and to the JFK 2008 rain data used for alternative evaluations. Statistics, including number of storms, duration, total annual and monthly depths, and peak intensities, will be used to classify the particular reporting year as wet or dry relative to the JFK 2008 Typical Year rainfall. Radar rainfall data may be used to supplement the analysis where evidence exists of large spatial variations in rainfall.

The reporting year will be modeled utilizing the existing IW/LTCPRM 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.

Attachment E

Revised Section 5 Green Infrastructure

5.0 GREEN INFRASTRUCTURE

5.1 NYC Green Infrastructure Program (GI Program)

The New York City Green Infrastructure Program (GI Program) was initiated to manage stormwater to reduce CSOs in NYC and to provide resiliency and other co-benefits to local communities. More details on the overall program elements and GI Program status are described in the *Green Infrastructure Annual Report* published every April 30th. These reports can be found at www.nyc.gov/dep/greeninfrastructure.

In January 2011, DEP launched the GI Program and committed $1.5B in funding through 2030 to implement green infrastructure on public property. Current program funding commitments are at $~~1.6~~ 1.8B in capital and $~~27~~ 70M in expense in combined sewer areas. Expense funding is largely to support research, monitoring and modeling efforts and Resilient NYC Partners, DEP's innovative contract to retrofit private properties with green infrastructure. The GI Program is tasked with accomplishing the program goals through planning, design and construction, research and development on performance and operations, and modeling evaluations. In addition to its primary objective to improve water quality, the GI Program will yield climate change resiliency resulting in co-benefits including: improved air quality; urban heat island mitigation; carbon sequestration; and biodiversity co-benefits, including increased urban habitat for pollinators and wildlife.

5.2 Citywide Coordination and Implementation

DEP works directly with its partner agencies on retrofit projects within right-of-way (streets and sidewalks), and with public schools, public housing, parks, and other NYC-owned property within the combined sewer area. 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 to implement right-of-way (ROW) and public property retrofit projects. The New York City Economic Development Corporation (EDC) and the Department of Design and Construction (DDC) also manage design and construction contracts for several area-wide contracts in conjunction with DEP. DEP has developed design standards for ROW GI Practices and is developing additional GI standards to address various field conditions and restrictions. The GI Program is also developing on-site GI standards to retrofit City-owned properties. These standards include porous pavement, rain gardens, retention systems, and synthetic turf.

5.2.a Community Engagement

Stakeholder participation is critical to the success of the GI Program. 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, civic organizations, and other NYC agencies.

DEP maintains a public webmap that shows the status of GI assets (Final Design, In Construction, or Constructed). The map allows users to easily access and view information on the GI Program in their neighborhoods. DEP's website hosts all GI Program reports and materials, including standard designs and procedures for ROW GI Practices at www.nyc.gov/dep/greeninfrastructure.

DEP has print materials targeted at certain aspects of the GI Program. For instance, an informational brochure describing the site selection and construction processes for ROW includes frequently asked questions and explains the co-benefits of GI. This brochure is distributed to residents during early design stages when DEP staff is working in the field locating potential GI locations. In addition, DEP has expanded its GI design tool box and incorporated new infiltration basin designs with grass and concrete tops (Figure 5-1) to provide a better fit for different land uses (commercial, industrial, mixed use) for maintenance and to also accommodate constraints raised by residents such as special parking permits.

Figure 5-1. GI Asset Types

DEP also notifies abutting property owners in advance of ROW GI construction projects. In each contract area, DEP and its partner agencies provide construction liaison staff to be present during construction. Contact information for the construction liaison is affixed to door hangers should property owners wish to contact DEP with concerns during construction.

As part of its ongoing outreach efforts, DEP continues its presentations to elected officials and other civic and environmental organizations about upcoming construction schedules.

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

DEP's Green Infrastructure Annual Reports, due annually on April 30th, contain updated information on completed projects throughout the City and in the Citywide/Open Waters LTCP waterbodies (Harlem River, Hudson River, East River, New York Bay, and Kill Van Kull/Arthur Kill). These Annual Reports can be found on DEP's website (www.nyc.gov/dep/greeninfrastructure). Note the GI Annual Reports refer to the Citywide/Open Waters LTCP watershed as "East River/Open Waters." In addition, Quarterly Progress Reports are posted on DEP's 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 GI Program applies an adaptive management approach to demonstration and pilot projects, based on information collected and evaluated from lessons learned in the field and performance monitoring results. For more information on DEP's 2009-2012 green infrastructure pilots, see the 2013 Annual Report on DEP's website (www.nyc.gov/dep/greeninfrastructure).

Neighborhood Demonstration Area Projects

The CSO Order included design, construction, and monitoring milestones for three Neighborhood Demonstration Area Projects (Demonstration Projects). DEP completed construction of GI practices within a total of 66 acres of tributary area in the Hutchinson River, Newtown Creek, and Jamaica Bay CSO watersheds. DEP monitored these GI practices to study the benefits of GI application on a neighborhood scale and from a variety of techniques. While DEP's early pilot projects provided 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 multiple installations within identified small tributary drainage areas. The data collected from each of the three Demonstration Areas enhanced DEP's understanding of the benefits of GI relative to runoff control and resulting CSO reduction and were used in the development of the 2016 Performance Metrics Report. DEP submitted a Post Construction Monitoring (PCM) Report to DEC in August 2014 and, after responding to DEC comments, submitted an updated PCM Report in January 2015. The PCM Report can be found on DEP's website (www.nyc.gov/dep/greeninfrastructure).

5.3.b Public Projects

In coordination with NYC agencies and non-profit partners, DEP continues to identify, design, and construct public property GI retrofit projects. Detailed information on project status, the site selection, and design processes for public property retrofit projects can be found in the Green Infrastructure Annual Reports on DEP's website (www.nyc.gov/dep/greeninfrastructure).

5.3.c Other Private Projects (Grant Program)

DEP continues to develop and encourage incentives for GI projects within privately owned property, primarily through the Green Infrastructure Grant Program. DEP also launched ~~is launching~~ a new, innovative ~~Private Property Retrofit Incentive Program which was anticipated to start in 2020 that will~~ contract designed to substantially scale-up investments in GI on private property. ~~The program initiation is expected to be delayed due to the Covid-19 pandemic. DEP is currently assessing the schedule impacts which is unknown at the time of this publication.~~ In 2022 DEP announced its first project under the program, which will fund a green infrastructure retrofit at Green-Wood Cemetery in Brooklyn.

~~The program utilizes a third-party administrator who is responsible for identifying the most cost-effective properties, 50,000 square feet or larger, to retrofit with GI and retrofitting them for a flat-rate incentive payment. This approach allows the administrator the flexibility to aggregate and bid projects in the most~~

~~cost-effective manner. The goal for this program is 200 greened acres in five years.~~ More information on the grant program and ~~future private incentive program~~ Resilient NYC Partners can be found in the Green Infrastructure Annual Reports on DEP's website (www.nyc.gov/dep/greeninfrastructure).

5.3.d Projected vs. Monitoring Results

For projected and monitored results, see the 2016 Green Infrastructure Performance Metrics Report and Appendices, which are available on DEP's website (www.nyc.gov/dep/greeninfrastructure).

5.4 Future Green Infrastructure in the Watershed

5.4.a Relationship Between Stormwater Capture and CSO Reduction

The 2016 Green Infrastructure Performance Metrics Report and Appendices (Performance Metrics Report), which are available on DEP's website (www.nyc.gov/dep/greeninfrastructure), created equivalency rates, as outlined in the CSO Order. The equivalency rates developed in the Performance Metrics Report incorporated data from existing and planned GI practices implemented by 2015, which primarily included retention-based rain gardens (formerly called bioswales) using site-specific information in order to model them as individual, distributed assets. By contrast, the equivalency rate for the projected 2030 GI implementation utilized a lumped modeling approach to estimate the future projects where GI asset specifics such as location, technology type, and design details are currently unknown.

To summarize the relationship between stormwater capture and CSO reduction, DEP has included two equivalency rates based on the 1.5 percent GI implementation rate that are defined as: (a) "Stormwater capture to CSO reduction ratio;" and (b) "Million gallons of CSO eliminated on an annual basis per acre (Ac) of impervious area managed by GI." The relationship between stormwater capture and CSO reduction varies based on the types of GI practices installed, watershed, and sewer system characteristics.

5.4.b Opportunities for Cost-Effective CSO Reduction Analysis

The level of GI anticipated to be implemented through 2030 in the Citywide/Open Waters LTCP waterbodies, and the resulting anticipated CSO reduction, are described in Section 5.4.c below.

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

Waterbody-specific implementation rates for GI are estimated based on the best available information from known subsurface conditions, zoning and land use data, availability of publicly-owned properties, as well as modeling efforts, WWFPs, and CSO outfall tier data (current as of the LTCP report date).

The following criteria were applied to prioritize CSO tributary areas to determine waterbody-specific GI implementation rates:

- Water Quality Standards;
- Cost-effective grey investments; and
- Additional considerations:
  - Background water quality conditions
  - Public concerns and demand for recreational uses

- Site-specific limitations (i.e., groundwater, bedrock, soil types, etc.)
- Additional planned CSO controls not captured in WWFPs or the CSO Order (i.e., high level storm sewers [HLSS]).

The overall goal for this prioritization is to apply implementation rates that allow DEP to saturate priority watersheds with GI in order to cost-effectively maximize benefits based on the specific opportunities and field conditions in the watersheds of the Citywide/Open Waters LTCP waterbodies.

Green Infrastructure Baseline Implementation Rate – Citywide/Open Waters LTCP (or "East River/Open Waters" as referred to in the GI Annual Report)

As of April 2022 ~~March 2020~~, DEP has ~~constructed or is in construction on~~ reported 1,486 ~~900~~ GI assets that manage 539 ~~195~~ greened acres in the watershed. GI assets include ROW practices, public property retrofits, and GI implementation on private properties. In addition, thousands of additional assets are currently in design or pending construction. ~~All built and planned GI assets are projected to result in a CSO volume reduction of approximately 912 MGY by 2030, based on the 2008 baseline rainfall condition.~~

For the Citywide/Open Waters LTCP, the baseline reduction includes projects in the implementation areas as listed in Table 5-1:

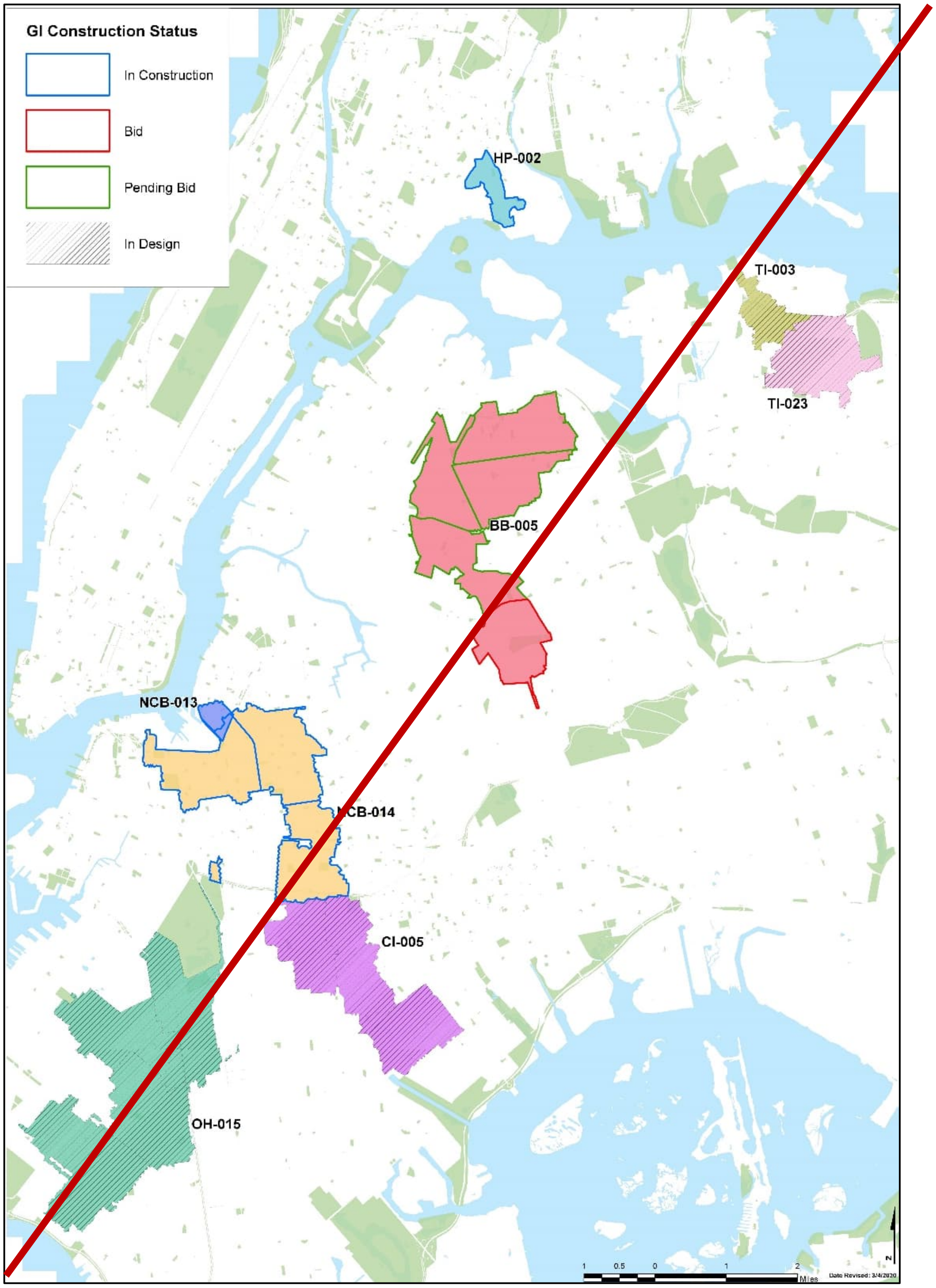
Table 5-1. GI Implementation Areas

Implementation Area	Description
ROW GI Implementation	~~Figure 5-2~~ DEP's interactive public green infrastructure map available online nyc.gov/dep/gimap shows the ROW GI contract areas within the East River/ Open Waters area. Within these contract areas, DEP is designing and constructing thousands of ROW GI assets including rain gardens, infiltration basins, ~~and~~ stormwater green streets, and porous pavement.
Public Property GI Retrofits	DEP is working with partner agencies to construct GI within schools, parks, NYCHA housing and on other publicly-owned property such as NYPD and Taxi and Limousine Commission property. Current public property retrofits within Citywide/Open Waters LTCP waterbodies are shown in the East River/Open Waters watershed ~~map in the 2019 GI Annual Report~~ in the online public map.
Private Property GI Incentives	Through its Green Infrastructure Grant Program, DEP has funded GI on private property. Most recently, to align with new DEP incentives and elements of the Climate Mobilization Act of 2019, DEP has shifted the focus of the Green Infrastructure Grant Program to green roof retrofits. DEP ~~is~~ also launched~~ing a new Private Property Retrofit Incentive Program this year~~ Resilient NYC Partners which will target 200 greened acres on properties 50,000 square feet or larger. Green infrastructure projects funded within private property in Citywide/Open Waters LTCP waterbodies are shown in the East River/Open Waters watershed ~~map in the 2019 GI Annual Report~~ in the online public map.
New and Redevelopment Stormwater Regulations	DEP ~~is~~ updated~~ing~~ and streamlined~~ing~~ its policy for stormwater management within new and redevelopment projects through promulgation of the ~~a~~ new Unified Stormwater Rule in February of 2022. The policies will result in greater retention of stormwater on-site and more strict release rates for stormwater going into the City's combined sewers, therefore providing more effective CSO reduction. Due to the watershed's

Table 5-1. GI Implementation Areas

Implementation Area	Description
	size and how new and redevelopment is concentrated in the City, future stormwater controls resulting from new and redevelopment projects will eventually generate the majority of CSO reduction attributed to green infrastructure within the Citywide/Open Waters LTCP waterbodies.
Tibbetts Brook Daylighting ~~and Van Cortlandt Lake Improvements~~	CSO reductions from the Tibbetts Brook Daylighting ~~and Van Cortlandt Lake Improvements~~ Project are included in Citywide/Open Waters LTCP waterbodies GI baseline reduction. See Section 5.4.d for details on this project.
Stormwater Recovery and Reuse	DEP is also embarking on two new stormwater recovery and reuse projects in the Citywide/Open Waters LTCP waterbodies that provide a synergistic approach to demand management and CSO reduction goals – the Central Park Jackie Onassis Reservoir Recirculation Project and the Prospect Park Valve Replacement Project. In addition to reducing potable demand, these projects also reduce discharge to the combined sewer system.

As more information on feasibility, development and redevelopment rates, and as individual GI projects progress, DEP will continue to report on the progress of these GI implementation areas in the Citywide/Open Waters LTCP waterbodies through its GI Annual Reports, which are published on DEP's website annually on April 30th.



~~Figure 5-2. ROW Green Infrastructure Contract Areas for Citywide/Open Waters LTCP Waterbodies~~

5.4.d Tibbetts Brook Daylighting ~~and Van Cortland Lake Improvements Project~~

Tibbetts Brook originates in Yonkers and flows through Van Cortlandt Park in the Bronx before discharging into ~~Van Cortlandt Lake~~ Hester and Pierro's Mill Pond. Since the early 1900s, the stream has been diverted from ~~Van Cortlandt Lake~~ Hester and Pierro's Mill Pond through an 8'-0" diameter tunnel that connects to a combined sewer flowing to the Wards Island WRRF. During wet-weather events, overflows from the combined sewer system discharge to the Harlem River at an outfall on W. 192nd Street. (referred to as WI-056), which, volumetrically, is one of the largest CSO discharge points in New York City.

The original route of Tibbetts Brook split into two streams at what is today W. 237th Street. One branch ran along what is now Tibbett Avenue and another ran along what is currently a railroad ROW along the Major Deegan Expressway. With commuter rail service on the ROW discontinued in 1958 and freight service eliminated in the late 1980s, proposals to daylight Tibbetts Brook within the ROW have existed since the 1990s. In ~~conjunction~~ parallel ~~with~~ to the construction of an open channel, or stream daylighting, DEP and New York City Department of Parks & Recreation (DPR) ~~propose~~ intend to create a greenway providing a landscaped bike path and pedestrian walkway, which will be called the Putnam Greenway. The name pays respect to the New York and Putnam Railroad, the original owners of the ROW. Acquisition of property rights or easements that would be required are under review and discussion with relevant property owners.

Figure 5-3 shows the approximately 1.5-mile route of the proposed project~~, including a 1-mile long segment of open channel and two smaller segments of underground pipes, depending on the acquisition of privately owned easements~~. The proposed project ~~has two~~ components include ~~: (1) Van Cortlandt Lake~~ Hester and Pierro's Mill Pond improvements for additional dynamic storage; ~~and (2)~~ Baseflow daylighting of Tibbetts Brook via a water conveyance system. Baseflow daylighting could include additional storm flow of up to ~~31~~ 38 cfs (24 MGD) which, in combination with ~~Van Cortlandt Lake~~ Hester and Pierro's Mill Pond improvements, could provide a reduction in annual CSO volume of up to ~~228~~ 215 to 220 MG.

DEP ~~had~~ also evaluated full flow daylighting of Tibbetts Brook. This alternative, however, was eliminated due to the three large sewer crossings which are located along the proposed route of the open channel at Van Cortlandt Park South, W. 233rd Street and W. 225th Street ~~(Figure)~~. The crossings are located just below the surface with thick top slabs which were likely designed to support the railroad tracks. Rerouting the sewer crossings is not feasible. Based on the existing geometry of the crossings at Van Cortlandt Park South and W. 233rd Street, reconfiguration of those crossings to provide additional cover is not possible. The proposed project includes an open channel constructed on top of ~~these~~ the Van Cortlandt Park South and W. 233rd Street crossings with up to four feet of fill ~~(Figure)~~ and a retaining wall along the eastern edge of the ROW next to the Major Deegan Expressway. The ~~sewer crossing at~~ open channel enters a pipe south of W. 233rd Street, and the pipe crosses over the W. 225th Street sewer crossing ~~could potentially be reconfigured~~.

To minimize disruption to the existing weir structure in Hester and PIerro's Mill Pond, a new side weir is planned to be installed to ~~Van Cortlandt Park, an underground pipe would convey flow from the lake to the upstream end of the proposed project (Figure). The pipe would connect to the existing 8'-0" diameter tunnel that runs between Van Cortlandt Lake and the Broadway Sewer. An underground diversion structure would~~ send dry-weather flow and a portion of the wet-weather flow to the daylighted section south of the pond, while flows above the design flow rate of the open channel would continue to the Broadway Sewer. Historically, the route south of W. 225th Street, had anticipated to return underground before crossing under railroad tracks owned by Metro North to discharge to the Harlem River (Figure 5-4). However, since the Metro North MTA tracks are live, the currently preferred option is to connect to an existing regulator (Regulator WI-67) located east of the tracks and routing flow through Outfall WI-056 where the connection would be made downstream of the regulator's tide gates and would include an additional flap gate to prevent the backup of combined sewage into the daylighting system. This option provides the least impacts to the natural environment, is more cost effective, and will help keep the project on schedule. ~~Alternatively, a new~~

~~pipe could be microtunneled under the Metro North tracks and connected to a new outfall point. Detailed engineering analyses need to be performed to provide more details on final configurations.~~

The proposed action would reroute flow into Van Cortlandt Lake from its current path through the Broadway sewer to a daylighted stream along the former CSX right-of-way, from which it would discharge directly to the Harlem River, reducing combined sewer overflows from Outfall WI-056 by the volumes shown below.

Closed Channel
Open Channel

Summary of Alternatives

Alternative	CSO Reduction (MG/year)	New Siphons	Maintenance Requirements	Safety Requirements	Constructability Concerns	Open Channel Flow (cfs)	Channel Dimensions: Open Channel Cross Section
Base Flow Daylighting | w/ Van Cortlandt Lake Improvements	156 | 202	No	Low	Low	Medium	Up to 14	3' / 12'
Base Flow Daylighting w/ Van Cortlandt Lake Improvements and Additional Storm Flow	228	No	Low	Low/Moderate	Medium	Up to 31	3.5' / 12'

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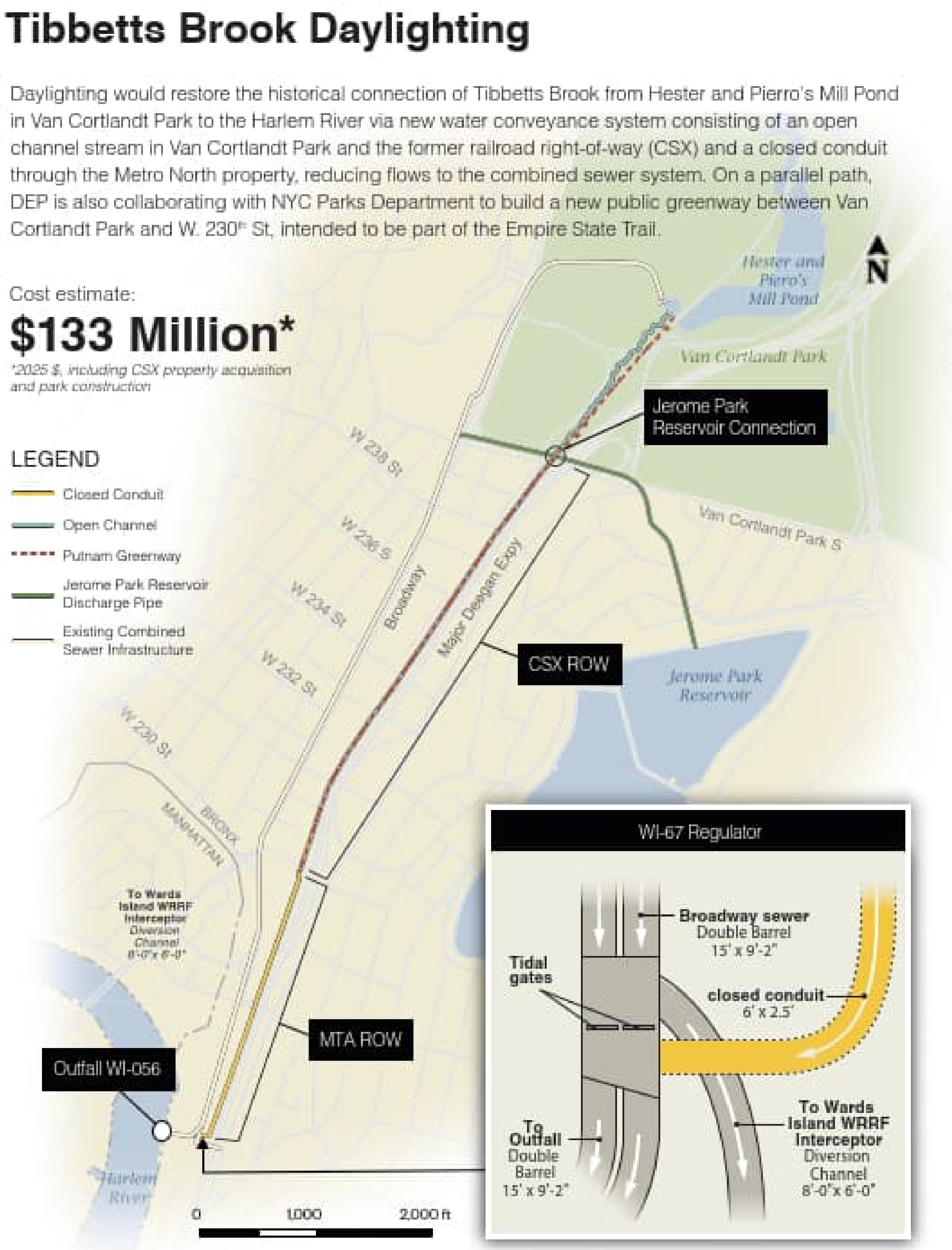
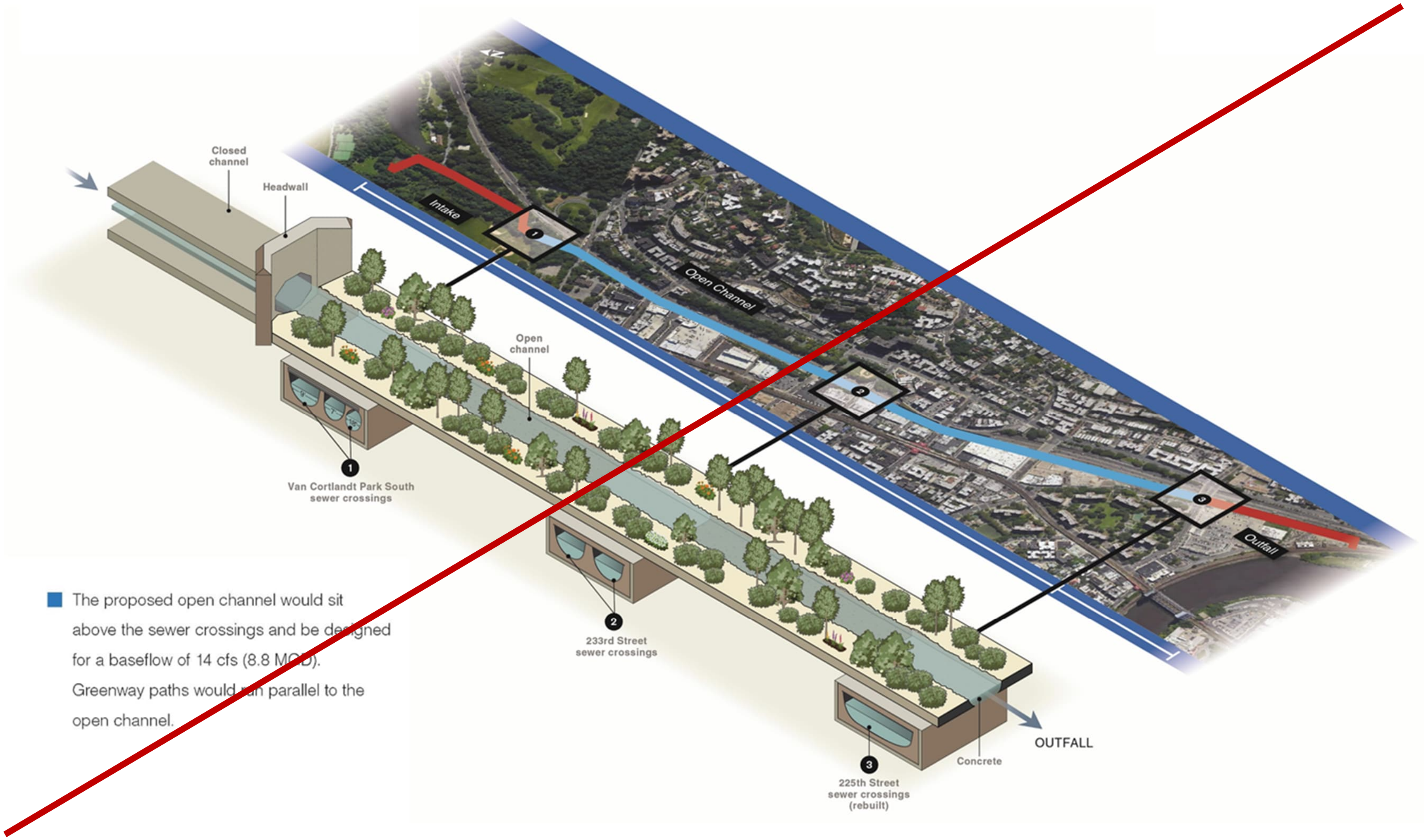
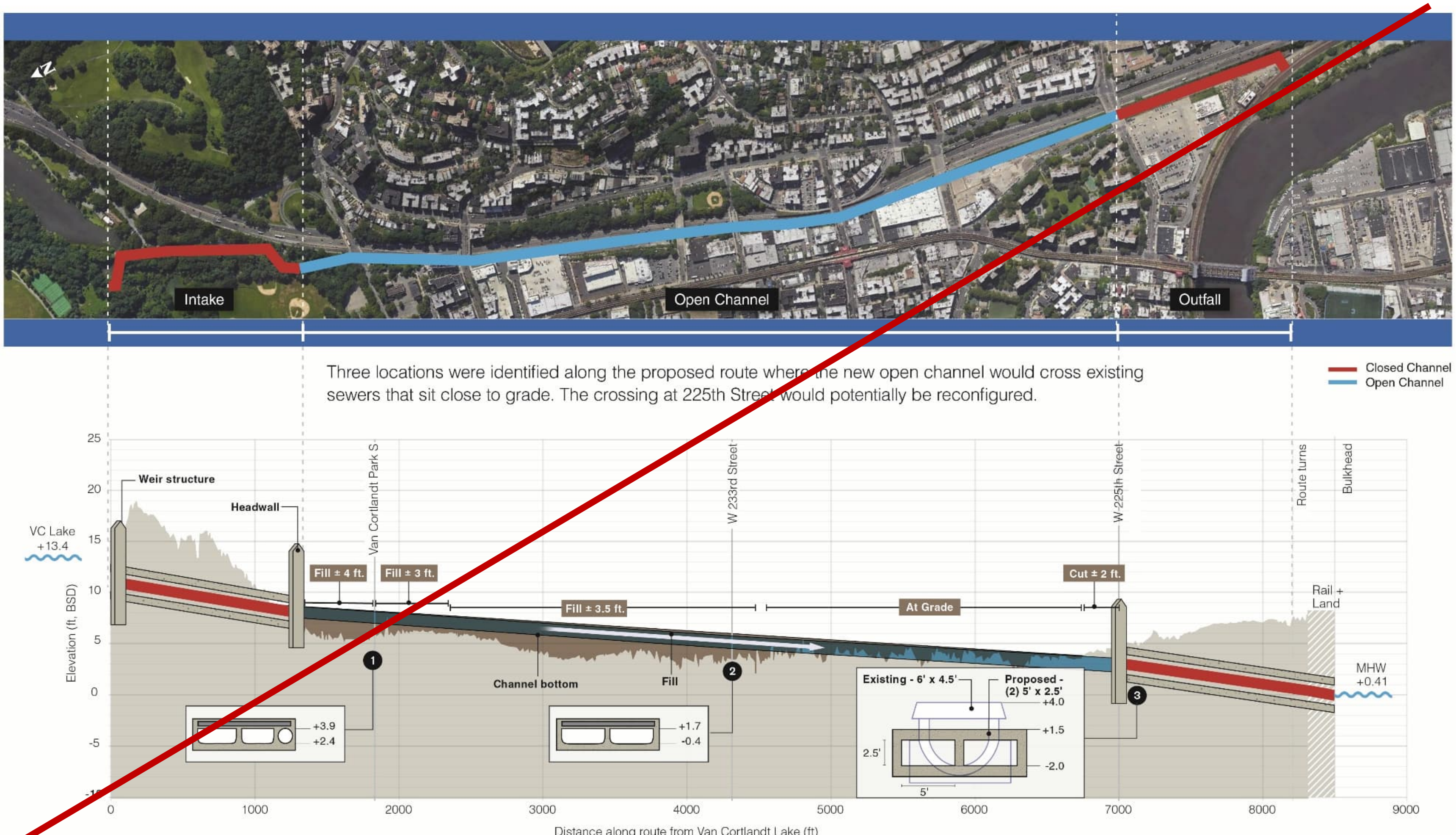


Figure 5-3. Daylighting Alternatives ~~Considered~~ for Tibbetts Brook

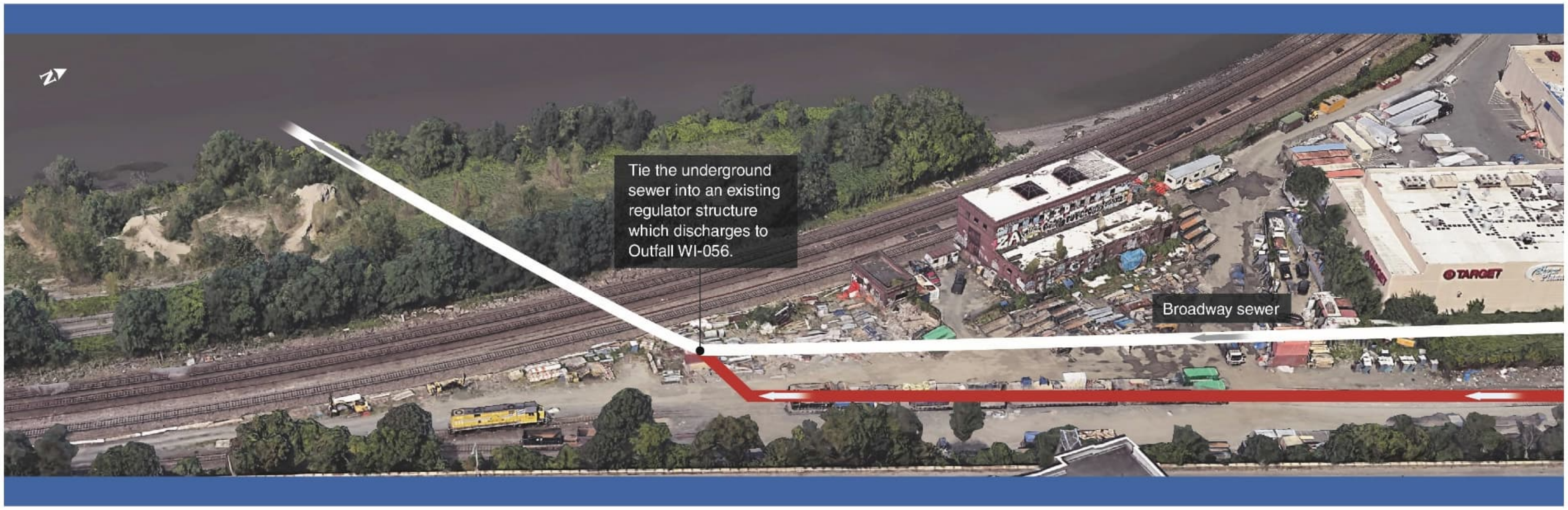


~~**Figure 5-4. Location of Sewer Crossings along the Proposed Route of Tibbetts Brook Daylighting**~~



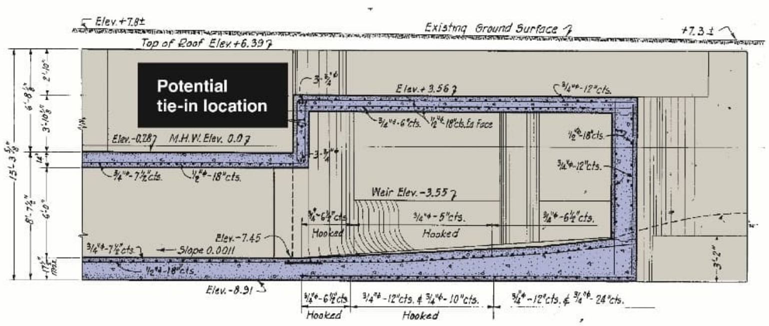
~~**Figure 5-5. Proposed Cut and Fill along Daylighted Route**~~

~~**Figure 5-6. Upstream Connection to Flow from Van Cortlandt Lake**~~



The channel would return to an underground sewer and discharge to the Harlem River.

The new sewer will tie into the tide gate chamber of Regulator 67, downstream of the tide gates and discharge through Outfall WI-056



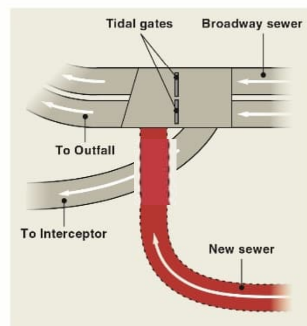


Figure 5-4. Proposed Piped Connection to Outfall at the Downstream End of the Daylighted Section

~~Based on the space available along the ROW and the restrictions imposted by the existing sewer crossings, the~~ The proposed configuration of the Tibbetts Brook Daylighting Project is as described in ~~on the second row of~~ Figure 5-3. This configuration would include a V-shaped open channel sized to convey a peak flow of 38 cfs (24 MGD) ~~31~~ MGD, which would allow for approximately ~~17~~ 10 MGD of wet-weather flow above the base dry-weather flow rate of 14 MGD. This alternative, in conjunction with improvements to ~~Van Cortlandt Lake,~~ Hester and Pierro's Mill Pond would result in a reduction of approximately ~~228~~ 215 to 220 MGY of CSO to the Harlem River. ~~The Van Cortlandt Lake improvements would include modifying the existing downstream dam structure to allow for dynamic storage in the lake during wet-weather, along with constructing a new dam structure between Van Cortlandt Lake and the Upper Basin so that the Upper Basin water level would not be affected by the dynamic storage in the Van Cortlandt Lake.~~

Attachment F

Revised Section 8 Evaluation of Alternatives

8.0 EVALUATION OF ALTERNATIVES

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

This section contains the following information:

- Process for developing and evaluating CSO control alternatives that reduce CSO discharges and improves water quality (Section 8.1).
- CSO control alternatives and initial screening applicable to all of the five Citywide/Open Waters waterbodies (Section 8.2).
- CSO control alternatives development and evaluation for each of the five Citywide/Open Waters waterbodies (Sections 8.3 to 8.7). Within each of these sections, information is presented related to:
    - Initial evaluation of alternatives and identification of alternatives retained for more detailed cost/performance analysis
    - Estimated costs and CSO reductions achieved by the retained alternatives
    - Cost-performance relationships and level of attainment of water quality standards for the retained alternatives
    - Selection of the preferred alternative for each waterbody
- Summary of the overall Recommended Plan for the Citywide/Open Waters waterbodies (Section 8.8)

The water quality standards applicable to the Citywide/Open Waters waterbodies vary with the waterbody classifications, which include coastal primary recreational Class SB, non-coastal Class SB, Class I, and Class SD. As presented in Section 6.3, Table 6-11, all waterbodies were assessed for attainment with fecal coliform bacteria criteria. *Enterococcus* criteria are applicable only to the Class SB coastal recreational waters and were therefore assessed only for those waterbodies. The level of attainment with DO criteria associated with the appropriate waterbody classification was also assessed.

8.1 Considerations for LTCP Alternatives under the Federal CSO Control Policy

This LTCP addresses the water quality objectives of the CWA and the New York State Environmental Conservation Law. As required by the 2012 CSO Order, 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) must be prepared. A UAA is the mechanism to examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State. If deemed necessary, the UAA would assess compliance with the next higher classification that the State would consider in adjusting WQS and developing waterbody-specific criteria. The remainder of Section 8.1 presents general considerations for developing the LTCP in accordance with the CSO Control Policy, and a description of the process for evaluating the alternatives.

8.1.a Performance

To determine the influence of control of NYC CSOs on the attainment of WQ Criteria, a Performance Gap Analysis was performed. For this analysis, NYC CSO loads were modeled as eliminated, but all other sources of discharge to the waterbodies remained, including NYC stormwater discharges, and loadings from outside of NYC reflective of current conditions. The results of the analysis for each of the Citywide/Open Waters waterbodies are summarized in Section 6.3, and below in Table 8.1-1. As indicated in Table 8.1-1, the Hudson, Harlem and East Rivers, and New York Bay are all in attainment with the fecal coliform Water Quality Criteria under Baseline Conditions, so no attainment gap exists between Baseline Conditions and the condition with No NYC CSO Loads. For Kill Van Kull and the Class SD reach of Arthur Kill north of the Outerbridge Crossing Bridge, annual attainment of the fecal coliform criteria ranges from approximately 60 to 100 percent under Baseline Conditions, and 63 to 100 percent with No NYC CSO Loads. For the Class I section of Arthur Kill south of the Outerbridge Crossing Bridge, annual attainment of the fecal coliform criteria at Station K5 was 93 percent under both Baseline Conditions and No NYC CSO Loads. Thus, control of NYC CSOs has no impact on the attainment of the fecal coliform Water Quality Criteria in Arthur Kill or Kill Van Kull, indicating that impairments to water quality are due to sources other than NYC CSOs.

The Class SB coastal recreational waters of Long Island Sound east of the Throgs Neck Bridge are in attainment with the applicable *Enterococcus* Water Quality Criteria under Baseline Conditions, indicating no attainment gap. The Upper and Lower New York Bay are in attainment with the 30-day geomean *Enterococcus* criteria under Baseline Conditions, but portions of the Bay along the Brooklyn shoreline are not in attainment with the 90^{th} Percentile STV *Enterococcus* criteria under Baseline Conditions. Attainment with the 90^{th} Percentile STV *Enterococcus* criteria in that area ranges from 50 to 100 percent under Baseline Conditions. With No NYC CSO Loads, the Brooklyn shoreline of New York Bay is generally in compliance with the 30-day STV *Enterococcus* criteria. The area around Station K5A, near the southwestern tip of Staten Island, remains under 70 percent attainment with the 30-day STV *Enterococcus* criteria under the No NYC CSO Loads modeling scenario, indicating that the non-attainment in that area is driven by sources other than NYC CSOs.

Water Quality Criteria for dissolved oxygen are attained on an annual average basis in each of the Citywide Open Waters with the exception of the Class I portion of Arthur Kill and in an area of New York Bay off the southwest corner of Staten Island, where no NYC CSO discharges exist. For the Class I reach of Arthur Kill south of the Outerbridge Crossing, attainment of the DO criteria at Station K5 was 93 percent for both Baseline Conditions and No NYC CSO Loads. Similarly, attainment of the Class SB daily average criteria at Station K5A of the southwest corner of Staten Island was 89 percent for both Baseline Conditions and No NYC CSO Loads. Thus, control of NYC CSOs has no impact on the attainment of the dissolved oxygen Water Quality Criteria in Arthur Kill or New York Bay near Station K5A, indicating that impairments to water quality in those areas are due to sources other than NYC CSOs.

Table 8.1-1. Summary of Water Quality Gap Analysis

Waterbody	WQS Classification	Attainment with Criteria[1]							
		Fecal Coliform Monthly GM≤200 CFU/100mL[2]		*Enterococcus* 30-day GM≤35 cfu/100mL[3]		*Enterococcus* 30-day STV≤130 cfu/100mL[3]		DO Annual Average Attainment[4]	
		Baseline	No NYC CSO Loads	Baseline	No NYC CSO Loads	Baseline	No NYC CSO Loads	Baseline	No NYC CSO Loads
Harlem River	Class I	Yes	Yes	N/A	N/A	N/A	N/A	Yes	Yes
Hudson River (North of Harlem River)	Class SB	Yes	Yes	N/A	N/A	N/A	N/A	Yes	Yes
Hudson River (South of Harlem River)	Class I	Yes	Yes	N/A	N/A	N/A	N/A	Yes	Yes
Long Island Sound (East of Throgs Neck Bridge)	Class SB Coastal Primary Recreational	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
East River (between Whitestone Bridge and Throgs Neck Bridge)	Class SB	Yes	Yes	N/A	N/A	N/A	N/A	Yes	Yes
East River (West of Whitestone Bridge)	Class I	Yes	Yes	N/A	N/A	N/A	N/A	Yes	Yes
New York Bay	Class SB Coastal Primary Recreational	Yes	Yes	Yes	Yes	No	Yes[5]	No[6]	No[6]
Arthur Kill/Kill Van Kull (South of Outerbridge Crossing Bridge)	Class I	No[6]	No[6]	N/A	N/A	N/A	N/A	No[6]	No[6]

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Table 8.1-1. Summary of Water Quality Gap Analysis

Waterbody	WQS Classification	Attainment with Criteria[1]							
		Fecal Coliform Monthly GM≤200 CFU/100mL[2]		*Enterococcus* 30-day GM≤35 cfu/100mL[3]		*Enterococcus* 30-day STV≤130 cfu/100mL[3]		DO Annual Average Attainment[4]	
		Baseline	No NYC CSO Loads	Baseline	No NYC CSO Loads	Baseline	No NYC CSO Loads	Baseline	No NYC CSO Loads
Arthur Kill (North of Outerbridge Crossing Bridge)	Class SD	**No[6]**	**No[6]**	N/A	N/A	N/A	N/A	**Yes**	**Yes**
Kill Van Kull	Class SD	**No[6]**	**No[6]**	N/A	N/A	N/A	N/A	**Yes**	**Yes**

Notes:

* *Enterococcus* criteria are not applicable to these waterbodies. Attainment with criteria is presented for informational purposes

(1) "**Yes**" means ≥95% attainment with the criteria. "**No**" means <95% attainment with the criteria. Attainment based on 10-year model simulation.

(2) Assessed on an annual basis.

(3) Assessed on a recreational season (May 1st through October 31st) basis. *Enterococcus* criteria apply only to coastal primary recreational waters. N/A = Not applicable.

(4) DO criteria:

  a. Class SB acute ≥3 mg/L; chronic ≥ range of 3 to 4.8 mg/L (see Section 6 for more details on Class SB chronic criteria)

  b. Class I ≥4 mg/L

  c. Class SD ≥3 mg/L

(5) All but a few shoreline grid cells and the area around Station K5A off the southwest end of Staten Island are in compliance with the 30-day STV *Enterococcus* criteria. None of these locations are near NYC CSOs.

(6) The load component analysis in Section 6 demonstrated that the non-attainment is driven by sources from outside of NYC.

The evaluations concluded that for the Hudson River, Harlem River, and East River/Long Island Sound, the waterbodies are in attainment with the applicable bacteria and DO Water Quality Criteria under Baseline Conditions, and thus no further CSO control would be needed to meet WQS. For Arthur Kill and Kill Van Kull, a condition of No NYC CSOs would not be sufficient to meet the applicable bacteria Water Quality Criteria, in part because Arthur Kill already has no direct NYC CSO discharges, but also indicative that other sources are driving the non-attainment of WQS. A model run was conducted for Baseline Conditions with all pollutant loads from outside of NYC zeroed out. This run indicated that with only CSO and stormwater discharges from NYC, Arthur Kill, and Kill Van Kull would be in full attainment with the Existing WQ Criteria for bacteria (fecal coliform). Thus, the remaining NYC CSO loads would not preclude attainment of the WQ Criteria for bacteria if the other sources were controlled.

For the Upper and Lower New York Bay, the applicable fecal coliform monthly GM criteria are met on an annual basis and the *Enterococcus* 30-day GM criteria are achieved on a recreational season basis under Baseline Conditions. However, attainment with the *Enterococcus* 30-day STV criteria is less than 95 percent during the recreation season. The modeled condition with No NYC CSO Loads would bring the *Enterococcus* 30-day STV criteria attainment to greater than 95 percent, indicating that the non-attainment with the STV element of the *Enterococcus* criteria under Baseline Conditions is driven by NYC CSO sources.

As a result of the generally high level of attainment with applicable WQ Criteria under Baseline Conditions, the CSO control alternatives evaluations focused primarily on system optimization measures. These optimization measures prioritized high-frequency CSO discharges and CSOs located near public access points along the waterbodies. The alternatives evaluations also considered the level of CSO control necessary to achieve the DEC goal for a time to recovery of less than 24 hours after a wet-weather event. Consistent with the CSO Control Policy, alternatives to provide a range of 25, 50, 75, and 100 percent CSO control (based on the 2008 typical year rainfall) were also evaluated. Given the extremely high cost of these CSO control alternatives and the limited potential benefit in terms of improvement in attainment of WQS, these alternatives were only developed to a conceptual level, sufficient to assess general dimensions and order-of-magnitude costs.

Table 8.1-2 provides a summary of the storage volume required to achieve 25, 50, 75, and 100 percent CSO capture in the 2008 typical year for each of the Citywide/Open Waters waterbodies. For each case, the percent CSO control was estimated based upon the 2008 Typical Year.

Table 8.1-2. Summary of Storage Volume Required for 25, 50, 75, and 100 Percent CSO Control for Citywide/Open Waters Waterbodies

Waterbody	Storage Volume Required (MG)			
	25% CSO Control(1)	50% CSO Control(1)	75% CSO Control(1)	100% CSO Control(1)
Harlem River	21	130	197	277
Hudson River	14	79	114	142
East River/Long Island Sound	52	367	526	740
Upper/Lower New York Bay	22	156	253	361
Kill Van Kull	2.5	6.8	15	30
Total	**112**	**739**	**1,105**	**1,550**

Note:
(1) Level of CSO control based on 2008 typical year rainfall.

Figure 8.1-1 shows a plot of the required volumes for the Citywide/Open Waters waterbodies for 50, 75, and 100 percent CSO control for the 2008 typical year.

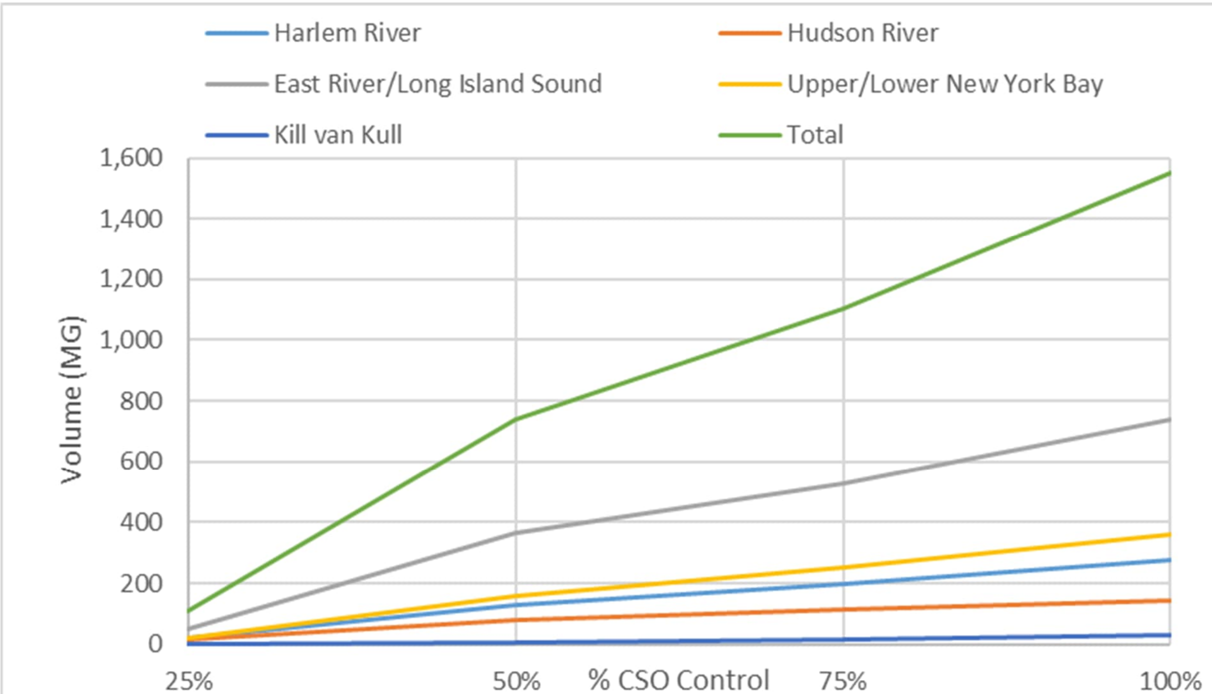

Figure 8.1-1. Required Storage Volume for 25, 50, 75 and 100 Percent CSO Control for each of the Citywide/Open Waters Waterbodies

8.1.b Impact on Sensitive Areas

In developing LTCP alternatives, special effort is made to minimize the impact of construction, to protect existing sensitive areas, and to enhance water quality in sensitive areas. As described in Section 2.0, sensitive areas as defined by the CSO Control Policy within the Citywide/Open Waters waterbodies included the Class SB waters of Hudson River north of the Harlem River, East River/Long Island Sound east of the Whitestone Bridge, and New York Bay. Each of the Citywide/Open Waters waterbodies was also identified as “waters with threatened or endangered species and their habitat.”

8.1.c Cost

Cost estimates for the alternatives were computed using a costing tool based on parametric costing data. This approach provides an 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 2019 dollars.

For the LTCP alternatives, Probable Bid Cost (PBC) was used as the estimate of the construction cost. Annual operation and maintenance costs were then used to calculate the total or net present worth (NPW) over the projected useful life of the project. In general, a lifecycle of 100 years and an interest rate of 3.0 percent were assumed resulting in a Present Worth Factor of 31.599.

To quantify costs and benefits, alternatives were compared based on reductions of both CSO discharge volume and bacteria loading against the total cost of the alternative. These costs were then used to plot the performance and attainment curves. A pronounced inflection point appearing in the resulting graphs, the so-called knee-of-the-curve point, suggests a potential cost-effective alternative for further consideration. In theory, this would reflect the alternative that achieves the greatest appreciable water quality improvements per unit of cost. However, cost/performance or cost/attainment curves do not always identify a distinct "knee," and if an alternative does fall on a distinct "knee," it may not necessarily be the preferred alternative. The final, or preferred, alternative must be capable of improving water quality in a fiscally responsible and affordable manner to properly allocate resources across the overall citywide LTCP program and DEP's larger capital improvement program (see Section 9 for discussion of affordability analysis). These monetary considerations also must be balanced with non-monetary factors, such as construction impacts, 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
- Constructability

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

Several site-specific factors were considered to evaluate an alternative's constructability, including available space, neighborhood assimilation, impact on parks and green space, and overall practicality of installing and 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 impacts as well as costs.

8.1.e Cost-Effective Expansion

All alternatives evaluated were sized to handle the CSO volumes based on the 2008 typical year rainfall and 2040 design year dry-weather flows, 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 could 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 allows adjustment of the design of future phases based on the performance of already-constructed phases. Lessons learned during operation of current facilities can be incorporated into the design of future facilities. However, phased construction also exposes the local community to a longer construction period. Where applicable, for those alternatives that could be expanded, the LTCP took into account the ease of expansion, 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 address additional pollutant parameters or more stringent discharge limits strengthens the case for application of that technology.

8.1.f Long Term Phased Implementation

Recommended LTCP implementation steps associated with the preferred alternative are typically structured in a way that makes them adaptable to change by expansion and modification resulting from possible new regulatory and/or local drivers at the time of implementation of the LTCP alternative. If applicable, the project(s) would be implemented over a multi-year schedule. Because of this, permitting and approval requirements must be identified prior to selection of the alternative. With the exception of GI, which is assumed to occur on both private and public property, most of the CSO grey technologies target municipally owned property and right-of-way-acquisitions. DEP will work closely with other NYC agencies and, as necessary, with NYS, to provide proper coordination with other government entities.

8.1.g Other Environmental Considerations

DEP has considered minimizing impacts on the environment and surrounding neighborhoods during construction. These impacts could potentially include traffic, site access issues, park and wetland disruption, noise pollution, air quality, and odor emissions. Potential environmental impacts will be identified with the selection of the preferred plan and communicated to the public. The specific details on mitigation of the identified concerns and/or impacts, such as erosion control measures and the re-routing of traffic, would be addressed later as part of a pre-construction environmental assessment.

8.1.h Community Acceptance

As described in Section 7, DEP is committed to involving the public, regulators, and other stakeholders throughout the planning process. Community acceptance of the Recommended Plan is essential to its success. As such, DEP uses the LTCP public participation process to present the scope of the LTCP, background, newly collected data, WQS and the development and evaluation of alternatives to the public and to solicit its support and feedback. The Citywide/Open Waters LTCP is intended to improve water quality, and public health and safety are its priorities. The goal of raising awareness of and access to waterbodies was also considered throughout the alternative analysis. Several CSO control measures, such as GI, have been shown to enhance communities while increasing local property values. As such, the benefits of GI were considered in the formation of the baseline and the final Recommended Plan.

8.1.i Methodology for Ranking Alternatives

The multi-step evaluation process DEP used to develop the Citywide/Open Waters LTCP included the following:

1. Evaluated benchmarking scenarios, including baseline and 100 percent CSO control, to establish a range of CSO controls within the Citywide/Open Waters sewersheds for consideration. The results of this step were described in Section 6.
2. Used baseline conditions to prioritize the CSO outfalls for possible controls.
3. Developed a list of promising CSO control measures for further evaluation based in part on the prioritized CSO list.

4. Established levels of intermediate CSO control that provide a range between baseline and 100 percent CSO control for the receiving water quality simulations that were conducted.
5. Conducted a series of workshops with DEP staff from April through June 2019, to work through the evaluation of system optimization measures using the Optimizer software and the InfoWorks model.
6. Held meetings with DEP and DEC staff on February 26, June 28 (conference call), and August 8, 2019, to review progress on the development and evaluation of CSO control alternatives.
7. Conducted a meeting with DEP staff on July 22, 2019, to prepare for the Inter-Bureau Alternatives Workshop.
8. Conducted an Inter-Bureau Alternatives Workshop at DEP on July 25, 2019, to solicit input on the alternatives under consideration, and to select a shortlist of retained alternatives.
9. Conducted a workshop with DEP Bureau of Wastewater Treatment staff on November 20, 2019, to review the retained optimization alternatives.
10. Held meeting with DEP and DEC staff on December 3, 2019, to review the retained alternatives.

Consistent with the approach used for the previous LTCPs submitted to DEC under this program, the alternatives development and evaluation process started with a range of different potential CSO control technologies. This initial "toolbox" was organized into categories that included Source Control, System Optimization, CSO Relocation, Water Quality/Ecological Enhancement, Treatment and Storage. Specific CSO control measures considered under each category were as follows:

Source Control

- Additional Green Infrastructure
- High Level Storm Sewers

System Optimization

- Regulator Modification
- Parallel Interceptor/Sewer
- Bending Weirs or Control Gates
- Pumping Station Expansion/Optimization

CSO Relocation

- Gravity Flow Redirection to Other Watersheds
- Pumping Station Modification
- Flow Redirection with Conduit/Tunnel and Pumping

Water Quality/Ecological Enhancement

- Floatables Control
- Environmental Dredging
- Wetland Restoration and Daylighting

Treatment

- Outfall Disinfection
- Retention Treatment Basin
- High-Rate Clarification
- WRRF Expansion

Storage

- In-System/Outfall
- Tank
- Tunnel

As noted above, due to the generally high level of attainment with applicable WQ Criteria under Baseline Conditions, the CSO control alternatives evaluations focused primarily on system optimization measures. In addition, consistent with the CSO Control Policy, alternatives to provide a range of 25, 50, 75, and 100 percent CSO control (in the 2008 typical year) were also evaluated. However, each of the technologies listed above was initially considered for potential applicability to the Citywide/Open Waters waterbodies. Some of the technologies could be screened out for all waterbodies without further evaluation, based on general system knowledge. Other technologies required varying levels of analysis to assess feasibility before getting screened out. The screening process was iterative and was conducted in coordination with DEP staff through the various workshops described above.

Figure 8.1-2 presents a graphical representation of the CSO control alternatives toolbox. This figure shows all of the technologies listed above, color-coded to indicate whether the technology was considered for ongoing implementation under other programs, was screened out based on various levels of evaluation, or was carried forward as a retained alternative for evaluation using the cost/performance curves. Further discussion of the technologies within each of these categories is presented below.

<table>
<tr><td>Source Control</td><td colspan="2">Green Infrastructure</td><td colspan="3">Storm Sewers</td></tr>
<tr><td>System Optimization</td><td>Regulator Modifications</td><td>Parallel Interceptor / Sewer</td><td>Bending Weirs Control Gates</td><td>Pump Station Optimization</td><td>Pump Station Expansion</td></tr>
<tr><td>CSO Relocation</td><td>Gravity Flow Redirection to Other Watersheds</td><td>Pumping Station Modification</td><td colspan="3">Flow Redirection with Conduit/Tunnel and Pumping</td></tr>
<tr><td>Water Quality / Ecological Enhancement</td><td>Floatables Control</td><td>Environmental Dredging</td><td colspan="3">Wetland Restoration & Daylighting</td></tr>
<tr><td>Satellite Treatment</td><td>Outfall Disinfection</td><td colspan="2">Retention Treatment Basin (RTB)</td><td colspan="2">High-Rate Clarification (HRC)</td></tr>
<tr><td>Centralized Treatment</td><td colspan="5">WRRF Expansion</td></tr>
<tr><td>Storage</td><td colspan="2">In-System</td><td>Tank</td><td colspan="2">Tunnel</td></tr>
</table>

Ongoing Projects	Evaluated but Screened Out	**Retained Alternatives**

Figure 8.1-2. Matrix of CSO Control Measures for Citywide Open Waters

AECOM with Hazen

8.1.i.1 Ongoing Projects

Technologies under this category are not specifically recommended as part of this LTCP, but may continue to be implemented in parts of the Citywide/Open Waters sewersheds as part of other DEP programs and initiatives.

- *Additional Green Infrastructure (GI):* As noted in Section 5, the planned and implemented GI in the Citywide/Open Waters sewersheds included in the Citywide/Open Waters Baseline Conditions is projected to result in a CSO volume reduction of approximately 912 MGY, based on the 2008 typical rainfall year. The GI assets generally consist of right-of-way (ROW) practices, public property retrofits, and GI implementation on private properties. DEP is also developing a new stormwater program which is expected to provide additional CSO and stormwater load reductions in Open Waters above and beyond the GI baseline conditions and timeframe. More details on the program development and associated proposed legislation are included in Section *5*.
- *High Level Storm Sewers:* DEP has typically employed high level storm sewers (HLSS) – i.e., the removal of public right-of-way runoff from streets and sidewalks – only where localized flooding problems have occurred, rather than as a CSO control measure. While HLSS can reduce CSO volumes, the resultant increase in stormwater discharge can negate the benefit of the CSO reduction in terms of attainment of WQS. In addition, construction of HLSS is relatively expensive, and results in extensive construction-period disruptions and impacts in the location of the work. For these reasons, HLSS was not carried forward as a retained alternative. However, as localized drainage level-of-service issues arise, DEP will continue to evaluate HLSS as a means of improving drainage level-of-service on a site-specific basis.

8.1.i.2 Technologies Evaluated but Screened Out

Technologies under this category were not carried forward as retained alternatives. The reasons for screening these technologies out are summarized below.

- *Pumping Station Optimization/Expansion/Modification:* The system optimization evaluations described further below identified pumping stations that could potentially impact CSO discharges to the Citywide/Open Waters waterbodies, and where appropriate, evaluated the impact of potential changes to the pump station operation/capacity on CSOs. Previously submitted LTCPs evaluated the impacts of pumping station modifications on CSOs that discharge to the various tributary waterbodies. In the Port Richmond system, construction of needed renovations to the Hannah Street Pumping Station is expected to commence in 2021, and expansion of the pumping station had been evaluated in the East River/Open Waters WWFP. In addition, the Hannah Street Bypass alternative described further below would maximize the capacity of the downstream interceptor and reduce flow to the Hannah Street Pumping Station. Potential modifications to other pumping stations were not found to significantly improve CSO performance and were therefore not evaluated further.
- *Flow Redirection with Conduit/Tunnel and Pumping.* The concept behind this technology is to relocate CSO flow to a less-sensitive receiving water, using a combination of tunnels and/or near-surface conduits and pumping. This approach would typically be considered where a CSO outfall is located upstream along a confined tributary, and the CSO could potentially be relocated to a larger, less-sensitive waterbody where the CSO loads could be more readily diluted and dispersed. Since this LTCP addresses the larger waterbodies where strong currents and rapid

dilution already takes place, and adjacent waterbodies were not considered to be "less sensitive," this technology was not considered further.

- *Environmental Dredging*: This technology would typically be considered in locations were solids deposition at the end of a CSO outfall creates adverse aesthetic conditions in the waterbody. No such locations were identified for the Citywide/Open Waters CSOs, and therefore environmental dredging was not considered further.
- *Outfall Disinfection*: This technology would be considered in locations where a relatively long, large-diameter outfall exists, and CSO bacteria loads are contributing to non-attainment of WQS. For the Citywide/Open Waters sewersheds, the interceptor systems tend to run adjacent to the shorelines, resulting in relatively short distances between the CSO regulators and the ends of the outfall pipes. In addition, as described above, the gap analysis indicated that the only location where NYC CSOs were clearly tied to non-attainment of WQS was along the Brooklyn shoreline in New York Bay, where the 30-day STV *Enterococcus* criteria are not met under Baseline Conditions (although the 30-day Enterococcus geometric mean criteria are met). None of the outfalls downstream of the CSO regulators along the Brooklyn shoreline are long enough to make outfall disinfection practical. For these reasons, outfall disinfection was not considered further.
- *Retention/treatment Basin*: Retention/treatment basins are tanks that store CSO volume up to the capacity of the tank, then provide sedimentation and disinfection treatment for volumes in excess of the storage capacity. Given the size of the major outfalls discharging to the Citywide/Open Waters waterbodies, a single retention/treatment basin would likely require at least two acres of land and would cost in the hundreds of millions of dollars to construct. Multiple retention/treatment basins would be required to provide even 50 percent capture for the waterbodies. As described further below, tunnel storage is being assessed as a means to provide 25, 50, 75, and 100 percent capture of the CSOs to the Citywide/Open Waters waterbodies in the 2008 typical year. Therefore, retention/treatment basins were not considered further.
- *WRRF Expansion*: For each of the WRRFs in the Citywide/Open Waters sewersheds, modeling evaluations were conducted to assess the impact on CSO reduction of increasing the capacity of the WRRFs by 25, 50, 75, and 100 percent. This initial screening assessment was intended to identify if further investigation into the siting needs and costs for such expansion would be beneficial from the perspective of CSO reduction. In many cases, the benefit of expanding the WRRF capacity would be limited by the capacity of the collection system to convey additional wet-weather flow to the plant. In addition, significant space constraints at the WRRF sites limit the ability to expand existing plant processes. For these reasons, WRRF expansion was not evaluated further.
- *In-System Storage*: As noted above, most of the Open Waters outfalls were relatively short, so opportunities for significant storage in existing outfalls were limited.

The evaluation of retained CSO control measures applicable to all of the Open Waters waterbodies is described in Section 8.2, while the subsequent subsections present the evaluation of retained alternatives specific to each of the individual Open Waters waterbodies.

8.2 CSO Control Alternatives Applicable to All of the Citywide/Open Waters Waterbodies

Of the CSO control technologies indicated as "Retained" in the Toolbox presented in Figure 8.1-2 above, DEP's programmatic approach to floatables control would be considered similarly applicable in each of the Open Waters waterbodies.

Stormwater runoff can transport trash and debris from urban areas into local waterbodies. Once waterborne, these materials are referred to as "floatables." The City relies on many existing programs to control trash and debris stemming from its combined and storm sewers. Public education, outreach, involvement and participation are important parts of the City's efforts to control floatables. A variety of programs encourage the public to help manage trash and debris, including a suite of stewardship programs (e.g., Parks Community Clean-ups) and 311, which enables New Yorkers to report to the City dirty conditions they observe. Other key programs include street sweeping, catch basin hooding and maintenance, catch basin inspection and cleaning, and booming and netting to catch materials that could potentially discharge via an outfall.

The components of the existing program include the following:

Rules and Regulations Enforcement – The Department of Sanitation of New York (DSNY) patrols all areas including commercial, industrial, manufacturing, and residential blocks daily and issues notices of violation for failure of property owners to maintain their properties in conformance with the applicable rules and regulations for littering and illegal dumping.

Public Education, Outreach, and Stewardship – The City has multiple education and outreach programs that target litter and floatables. Table 8.2-1 summarizes these programs.

Table 8.2-1. Summary of Litter and Floatables Education, Outreach, and Stewardship Programs

Controls	Responsible Agencies	Description
Adopt-a-Bluebelt	DEP	DEP invites local organizations to keep their catch basins clear of debris.
Adopt-a-Catch Basin	DEP	DEP invites local organizations to keep their catch basins clear of debris.
Shoreline and Bluebelt Clean-ups	DEP	DEP organizes, supports, and sponsors various shoreline cleanup events throughout NYC.
NYC Park Stewardship	DPR	DPR coordinates volunteer opportunities that enable volunteers to help restore natural areas, care for street trees, clean and beautify parks, and monitor wildlife. These activities can include the care and restoration of natural areas through removal of invasive plants and floatable debris along coastlines.
Adopt-a-Highway/Greenway	DOT	DOT invites sponsors to adopt highway or greenway segments to perform litter removal and beautification.
Adopt-a-Basket	DSNY	DSNY invites local businesses or community groups to monitor and maintain local litter baskets.
Community Clean-ups	DSNY	DSNY supports local community groups and block associations in their volunteer efforts to keep their

Table 8.2-1. Summary of Litter and Floatables Education, Outreach, and Stewardship Programs

Controls	Responsible Agencies	Description
		neighborhoods clean through local block and street area clean-ups by offering free loans of cleanup tools and equipment.
311	Various Agencies	311 enables the public to report issues, such as heavily littered streets or clogged catch basins, which are referred to the appropriate agency for inspection and follow-up.
Agency Websites and Social Media	Various Agencies	Various agencies provide educational information on webpages and through outreach campaigns which aim to improve cleanliness and aesthetics of City streets, beaches and the harbor.
Clean Streets = Clean Beaches	DEP, DSNY	The City distributes educational literature, places posters, and conducts events to raise awareness of litter and floatables issues.

DEP Catch Basin Hooding, Inspection, and Maintenance Program – DEP administers a catch basin inspection, hooding, and maintenance program, which helps prevent trash and debris from reaching waterbodies. DEP is responsible for approximately 148,000 catch basins, which are regularly inspected, and if necessary, cleaned and repaired, in both the combined sewer and MS4 areas.

Catch Basin Marking – Catch basins are marked with a medallion or stamp to inform the public that the catch basin drains directly to local waterbodies and that nothing should be dumped into them.

End-of-Pipe and In-Water Containment Systems – DEP operates and maintains a number of end-of-pipe/in-water controls that intercept floatables from combined and separate sewer systems. DEP also operates specialized skimmer vessels (Figure 8.2-1) that collect floatables from these booms and/or form surface waters.

DEP Bluebelt Program – This program preserves natural drainage corridors such as streams and ponds and optimizes them through the design and construction of stormwater controls to filter stormwater before it empties into the New York Harbor.

Public Litter Baskets – DSNY services over 23,500 litter baskets to encourage pedestrians to properly dispose of trash. Through the Adopt-A-Basket Program, DSNY invites local businesses or community groups to monitor local litter baskets and replace bags when they are nearly full to minimize the risk of overflow between scheduled pickups.

Street Sweeping – DSNY utilizes about 435 mechanical broom trucks (Figure 8.2-1) and 185 mechanical brooms to remove street litter before it can enter the sewer system. Each week, the boom trucks cover about 9,700 miles of roadway along their scheduled routes.

Figure 8.2-1. Examples of Mechanical Broom Truck and Skimmer Vessel

SAFE Disposal Events and Special Waste Drop-off Sites – DSNY hosts SAFE (Solvents, Automotive, Flammables, and Electronics) Disposal Events throughout the year in all five boroughs to help residents properly dispose of waste that cannot be thrown out with regular household waste.

Zero Waste – In 2015, the City released OneNYC which includes commitments to sustainability and sending zero waste to landfills by 2030. The initiatives to reduce waste all serve to reduce the sources of floatables.

Business Improvement Districts (BIDs) – BIDs are geographical areas where local stakeholders oversee and fund the maintenance, improvement, and promotion of their commercial district which often includes supplemental sanitation services such as litter removal and litter basket maintenance. In 2017, there were more than 70 BIDs in operation, providing sanitation services to 4,000 block faces and servicing nearly 6,000 waste receptacles.

Park Maintenance – DPR works closely with several groups to promote park stewardship, including litter removal from parks and other DPR properties. Each year it organizes numerous events including beach clean-ups, community garden maintenance, and regular litter removal activities.

Media Campaigns – From 2015 to 2018, the City implemented three public education media campaigns. The BYO (Bring Your Own) Campaign encourages New Yorkers to live a less disposable lifestyle by using reusable bags, mugs, and bottles. The Don't Trash Our Waters Campaign was launched to raise public awareness of the connection between trash, litter and water quality. DSNY partnered with DPR and the New York Knicks for #TalkTrashNewYork, an anti-litter campaign promoting clean streets, sidewalks, beaches, and parks across NYC.

The City also made recent progress on item bans and fees that can reduce the prevalence and persistence of floatables.

Styrofoam Ban. As of January 1, 2019, New York City stores, food service establishments, and mobile food commissaries were no longer permitted to offer, sell, or possess single-use foam food containers. Enforcement of this ban began July 1, 2019.

Executive Order on Single-Use Plastic. In April 2019, Mayor de Blasio signed an Executive Order (EO) that ended the direct City purchase of unnecessary single-use plastics in favor of compostable or recyclable alternatives. This EO is expected to reduce NYC carbon emissions, decrease plastic pollution, and reduce risks to wildlife.

Paper Bag Fee. In 2019 New York State passed the Bag Waste Reduction Law making New York State one of eight States in the country to implement a plastic-bag ban. In 2019, the New York City Council approved a five-cent paper bag fee to complement the ban. Three cents of the fee will go to the State Environmental Protection Fund and the other two cents will go toward the production of reusable bags. The fee and ban encourage New Yorkers to use reusable bags, reducing the number of single-use bags that might end up in the environment. The New York State ban follows the City's 2016 NYC Carryout Bag Law, which sought to impose a fee of at least five cents on all carryout merchandise bags.

Evaluation of Existing Programs

As part of past initiatives to reduce floatables citywide, DEP has assessed many floatables control technologies and estimated the efficiency of those used in NYC. Additionally, the City continually evaluates litter and floatables conditions in NYC through several ongoing monitoring programs.

DEP has conducted various field studies to estimate the removal efficiency of various floatables controls as part of its previous Citywide Comprehensive Floatables Facility Planning Project. Based on these studies, DEP developed estimates of the removal rates for current practices, including street sweeping, catch basin hooding, end-of-pipe netting, booming and skimming operations, and combined-sewage treatment capture at WRRFs. The total capture efficiency is approximately 96 percent for citywide floatables originating from street litter. In addition to the past studies that evaluated the efficiency of various controls, the City has several ongoing monitoring programs to help assess trash and debris conditions. The Street Cleanliness Program visually monitors trends in street and sidewalk litter, on a monthly basis throughout the City. In tandem, DEP monitors floatables in waterbodies and on beaches citywide through its Floatables Monitoring Program which utilizes visual ratings to document floatables levels at monitoring sites throughout NYC (Figure 8.2-2). Visual ratings collected by DEP staff through the Harbor Survey Program are supplemented by citizen scientists who conduct similar inspections through the Volunteer Survey Program.

Figure 8.2-2. Floatables Monitoring Program Sites

DEP also monitors the volume of floatable materials recovered through booms, nets, and open water skimming. This information is reported in the Annual CSO BMP Report and is summarized in Figure 8.2-3. The quantity of floatables reaching the in-water containment system has decreased by about 75% over the last decade.

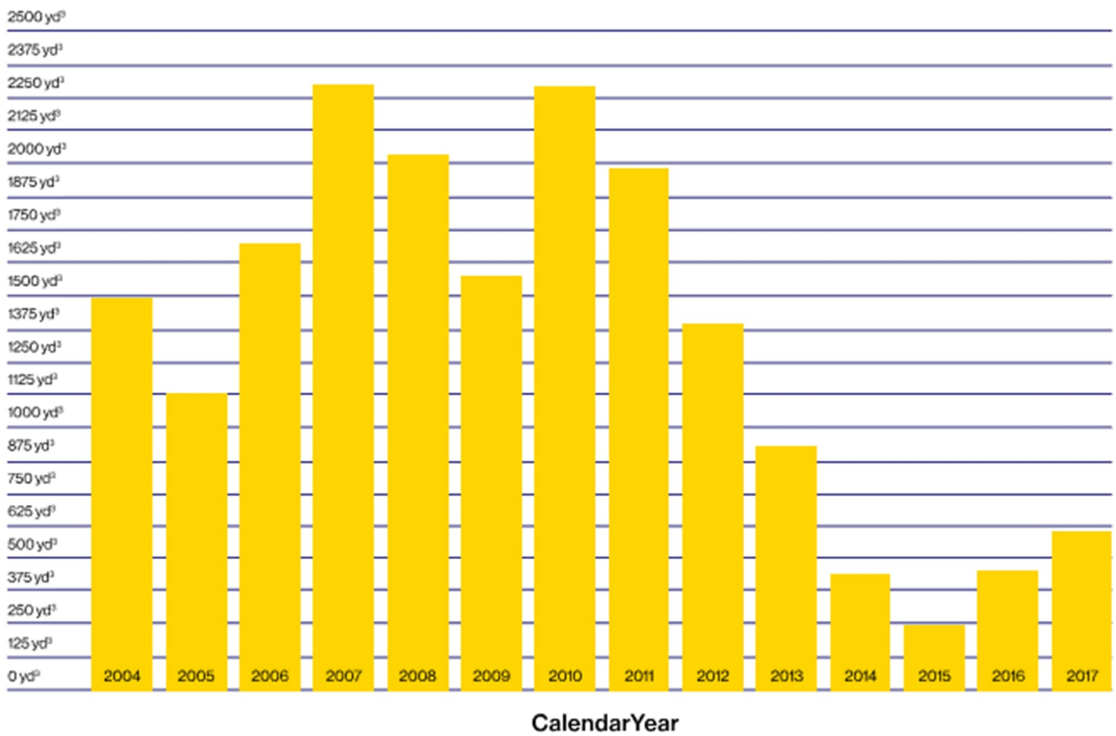

Figure 8.2-3. Total Floatables Collected by Boom and Skim Program

Measurable Goals and Program Assessment

The City has established measurable goals and utilizes these measures to detail the status of each goal through their annual reporting. The City's MS4 Permit requires an Annual Effectiveness Assessment in each Annual Report. The City is continuing to refine and update the measurable goals to allow for better quantification and accurate representation of the effectiveness of each measure.

The City's litter and floatables control programs are highly effective in preventing litter, trash, and floatable materials from entering surrounding waterbodies. The City continues to evaluate technologies and approaches to further improve upon its current successes and document performance in their annual CSO and MS4 BMP reports.

8.3 CSO Control Alternatives for Harlem River

As shown in Section 6, WQS for bacteria and dissolved oxygen are met in the Harlem River under Baseline Conditions. Therefore, attainment of WQS was not a factor in evaluating CSO control alternatives for the Harlem River. Rather, the focus was on evaluating alternatives for cost-effective reduction of CSO activations and volume. The CSO control alternatives that passed the initial screening phase and were retained for the Harlem River generally fell within the categories of system optimization and tunnel storage. System optimization alternatives covered the categories of fixed weirs, parallel interceptor/sewer, bending weirs or control gates, and gravity flow redirection to other watersheds. The storage tunnel alternatives, used to assess 25, 50, 75 and 100 percent CSO capture in the 2008 typical year, also included high-rate clarification for the dewatering flows from the tunnels. Storage tanks were not evaluated due to the number of outfalls to be captured and the general lack of available sites of sufficient size for storage tanks. Each CSO control measure was initially evaluated on three of the key considerations described in Section 8.1: (1) benefits, as expressed by level of CSO control and WQS attainment; (2) costs; and (3) challenges, such as siting and operations. Using this methodology, the retained CSO control measures listed in Section 8.1 were evaluated on a cost-performance basis and used to develop the basin-wide alternatives.

As described in Section 5 above, the Tibbetts Brook Daylighting project is included in the LTCP Baseline Conditions. The system optimization and storage tunnel alternatives were evaluated assuming the CSO reduction and system hydraulic benefits derived from the Tibbetts Brook Daylighting project would be in place. The Citywide/Open Waters Baseline Conditions also include implementation of the Recommended Plans from the LTCPs for the tributary waterbodies previously submitted to DEC under this program, as well as other grey infrastructure projects implemented as part of earlier planning programs. Those projects are summarized in Section 4.

The following sections present the evaluations of the system optimization and tunnel storage alternatives for the Harlem River.

8.3.a System Optimization Alternatives

The approach to the initial identification and evaluation of system optimization alternatives for the Harlem River using the Optimatics Optimizer software was presented in Section 3. As described in Section 3, the Optimizer software was configured to prioritize monitored regulators discharging outside the period of critical wet-weather events, high-discharge frequency regulators, and regulators discharging in proximity to official and publicly-identified public access points (kayak launches/marinas).

The optimization alternatives for outfalls to the Harlem River associated with the North River WRRF collection system were evaluated independently from the outfalls associated with the Wards Island WRRF collection system, as the two systems are hydraulically independent. However, the North River WRRF system also includes combined sewer outfalls discharging to the Hudson River, and the Wards Island WRRF includes outfalls that discharge to the Hudson River, Bronx Kill, and East River. Thus, the Harlem River optimization alternatives associated with the North River WRRF system needed to be considered in conjunction with alternatives for the Hudson River outfalls associated with the North River WRRF system, and Harlem River optimization alternatives associated with the Wards Island WRRF system needed to be considered in conjunction with alternatives for the Hudson River, Bronx Kill and East River outfalls associated with the Wards Island WRRF system.

The sections below present the evaluations of Harlem River optimization alternatives associated with the North River and Wards Island WRRF collections systems, respectively.

8.3.a.1 System Optimization for Harlem River Outfalls in the North River WRRF System

Table 8.3-1 summarizes the CSO outfalls and associated regulators tributary to the Harlem River from the North River WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.3-1. Table 8.3-2 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits (“BMP Regulator”)
- A “Key Regulator” as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet of) a public access location
- Regulators that activated more than average for the waterbody

Table 8.3-1. Harlem River CSO Outfalls/Regulators Associated with the North River WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
NR-008	N-14	19.2	34				✓
NR-009	N-13	1.7	20				✓
NR-010	N-10, N-11, N-12	9.3	18				✓
NR-016	N-4	1.1	6			✓	
NR-017	N-3	25.5	17	✓			✓
NR-018	N-1	0.1	1			✓	
NR-007	N-15	0.9	10			✓	

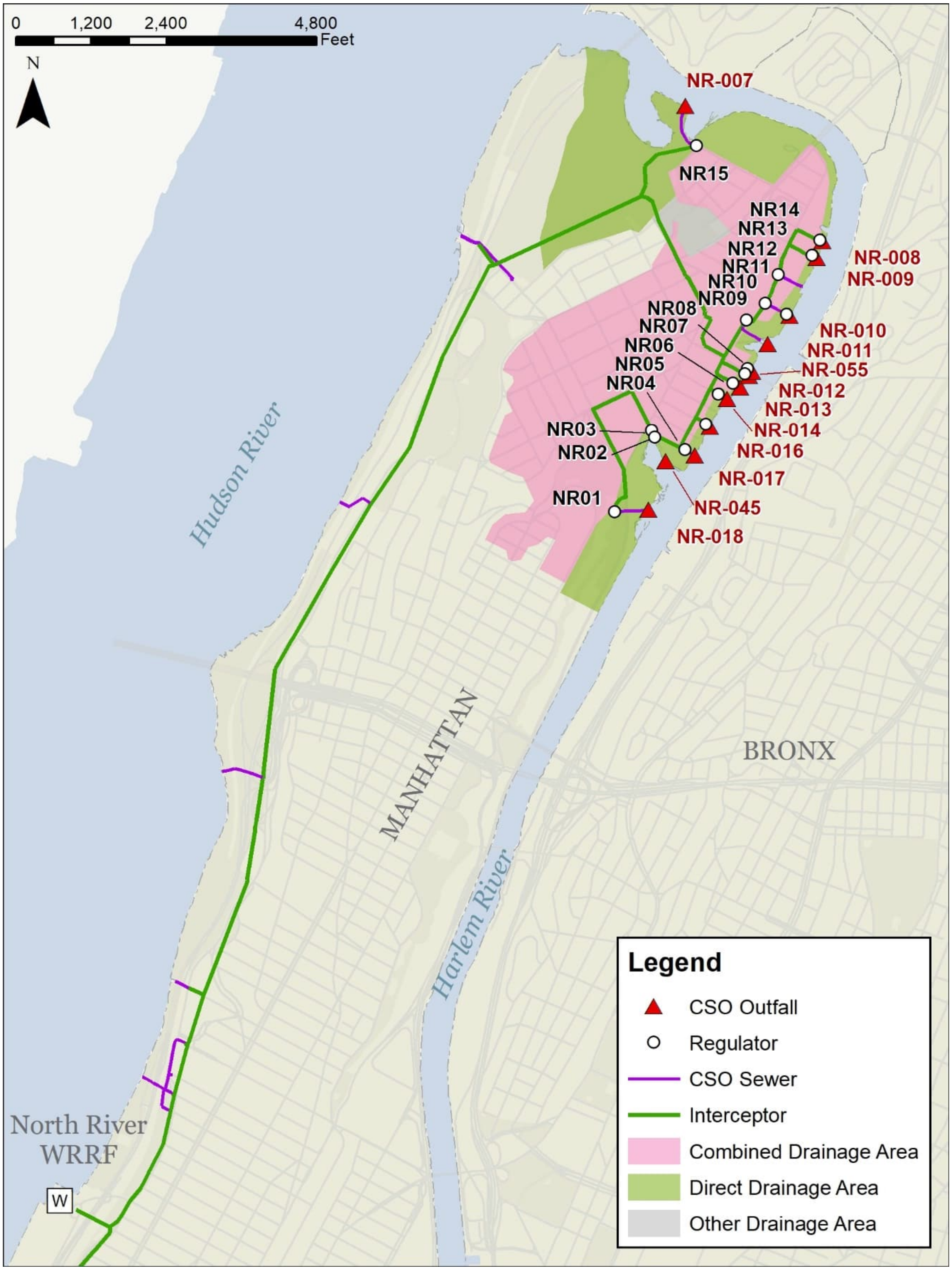

Figure 8.3-1. CSO Outfalls/Regulators Tributary to Harlem River from the North River WRRF System

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full North River WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line (hydraulic grade line) elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The North River WRRF is located along the Henry Hudson Parkway south of Hudson Riverbank State Park. The collection system primarily serves the western shoreline and northern tip of Manhattan. The southern interceptor begins at West 12th Street generally follows Route 9A and Riverside Boulevard in a northerly direction towards the WRRF. The northern interceptor sewer parallels the Harlem River at its upstream end, crosses Manhattan along Isham Street and then bends to the south along the Henry Hudson Parkway (Route 9A) to the WRRF. A total of 55 regulators divert flow to the interceptors with 51 outfalls discharging to the Hudson River (38 CSOs) and Harlem River (13 CSOs).

- The WRRF collection system is relatively shallow (<10 feet of cover) at the upstream end of the interceptor, but ranges from 15 to 25 feet of cover for most of the interceptor paralleling the Harlem River.

- Regulators contributing to CSO outfalls discharging to the Harlem River generally activate between 6 to 34 times during the typical year with a total average annual overflow volume (AAOV) of 75 MGY.

- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating that the portion of the system along the Harlem River is highly sensitive to hydraulic grade line impacts.

- The Optimizer modeling identified multiple alternatives that included modifications to the regulators located along the Harlem River resulting in varying degrees of improved capture and hydraulic performance. The most optimal alternatives from the Optimizer modeling were evaluated in more detail using InfoWorks runs for the 2008 typical year. AAOV reductions of approximately 20 percent and activation frequency reductions of approximately 40 percent were predicted for the better performing alternatives.

- The strong performance improvement was a result of the components of the alternatives that included up-sizing of interceptor and branch interceptor connections. These modifications allowed more flow to be conveyed to the WRRF without adversely affecting the peak hydraulic grade line.

- While CSO volume and activations increased at two regulators downstream of the system optimization, the reductions at other regulators associated with the system optimization measures resulted in a net reduction in CSO discharge volume and frequency of activation to the Harlem River.

Another consideration for assessing the optimization of the North River outfalls tributary to the Harlem River was the planned up-zoning throughout Inwood north of Thayer Street. The re-zoning was enacted for the purposes of promoting development of thousands of affordable housing units, encourage economic development that benefits the local community and development of additional open space to improve community access to the Harlem River. As projects develop and advance, traffic, sewer and water improvements will be performed throughout the sewershed. In addition to the re-zoning, DEP is evaluating alternatives for the elimination of Regulators NR-09, 10, and 12 associated with Outfalls NR-010 and 011. These regulators and associated outfalls are located within the MTA's 207th Street Train Yard Facility and are difficult to access for performance of routine inspections and maintenance.

Sewer modifications planned for both of these projects are in the early planning stages and routing is not currently available. For the purposes of simulating the proposed up-zoning in the optimization evaluations, re-routing of the main interceptor and up-sizing the branch interceptors serving Regulators NR-14 (CSO-008) and NR-13 (CSO-009) were included in the Optimizer model. In addition, installation of a new regulator to replace Regulator NR-10 and re-routing of the branch interceptor along 10th Avenue was included in the Optimizer model to simulate elimination of regulators associated with CSOs NR-010 and NR-011. The assumed interceptor modifications associated with these planned projects are illustrated in Figure 8.3-2.

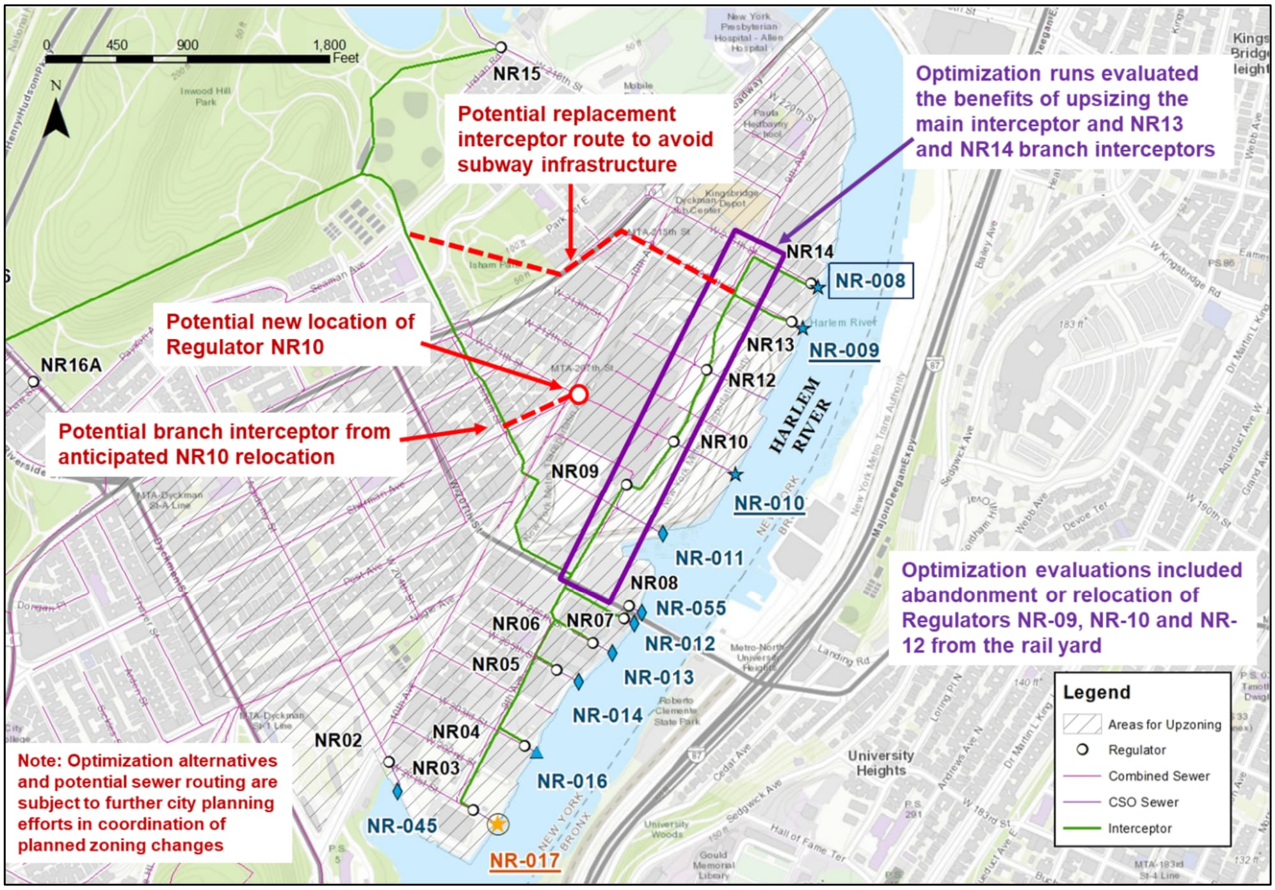

Figure 8.3-2. Potential Interceptor Upgrades Assumed for Optimization Evaluations

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<u>Follow-up Evaluations Based on Full InfoWorks Model</u>

The most promising optimization alternatives coming out of the Optimizer evaluations are summarized in Table 8.3-2. These alternatives were further analyzed in more detail using the full North River WRRF system InfoWorks model. The resulting impacts of Alternatives HAR-1 and HAR-2 on peak hydraulic grade line in the 5-year storm are summarized in Figure 8.3-3 and Figure 8.3-4, respectively. The annual CSO volume and frequency for these optimization alternatives are summarized in Table 8.3-3 and estimated probable bid costs and construction/implementation considerations are summarized in Table 8.3-4.

Table 8.3-2. Harlem River Optimization Components for Retained Alternatives

Outfall	Regulator	Components	
		HAR-1	HAR-2
NR-007	NR-15		
NR-008	NR-14		
NR-009	NR-13		
NR-017	NR-03		
AAOV Reduction		16 MGY	15 MGY
Probable Bid Cost		$ 36M	$ 31M

<u>KEY</u>

Increase Orifice Size

Raise Weir

Replace Branch Interceptor

Upsize Main Interceptor

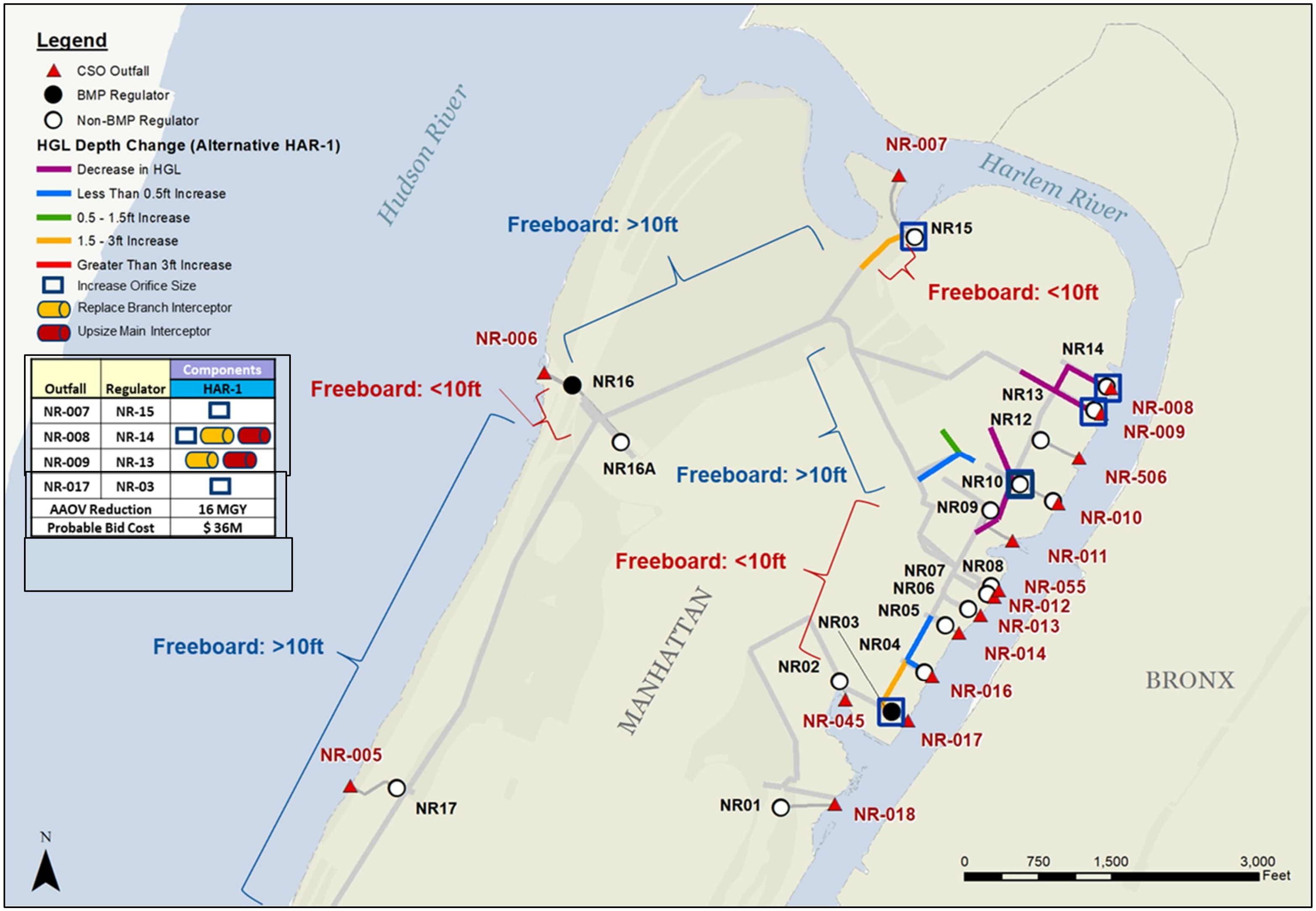

Figure 8.3-3. Hydraulic Grade Line Impacts of Alternative HAR-1 vs. Baseline Conditions, 5-Year Storm

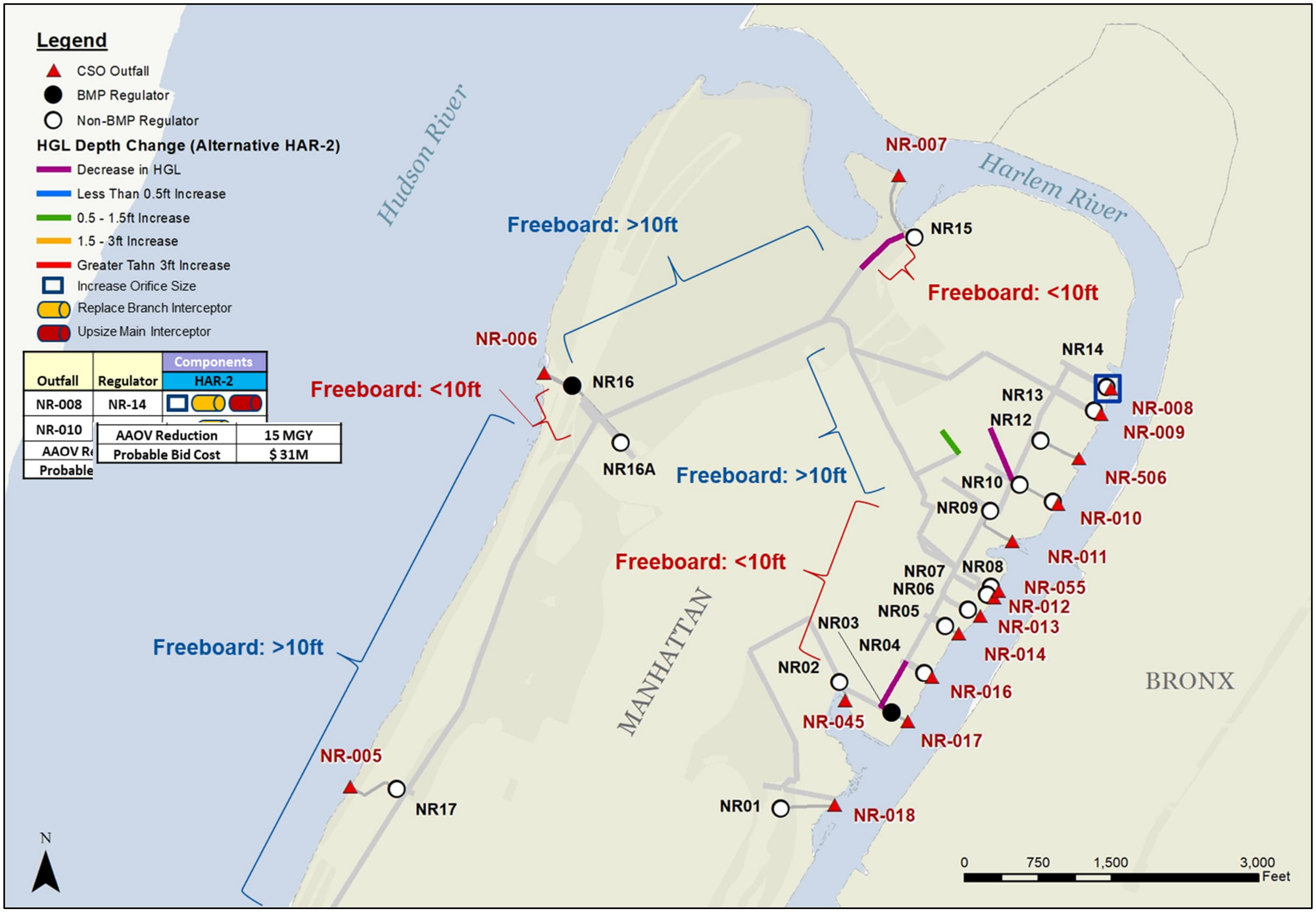

Figure 8.3-4. Hydraulic Grade Line Impacts of Alternative HAR-2 vs. Baseline Conditions, 5-Year Storm

Table 8.3-3. Summary of Performance of North River Optimization Alternatives for Harlem River

		Baseline Conditions Typical Year		Alternative HAR-1[2]		Alternative HAR-2[3]	
Outfall[1]	Regulator	Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
NR-008	N-14	19.2	34	7.0	11	7.2	10
NR-009	N-13	1.7	20	1.3	6	0.6	6
NR-010	N-10,11,12	9.3	18	4.2	7	4.1	7
NR-016	N-4	1.1	6	1.3	8	1.1	7
NR-017	N-3	25.5	17	24	15	26.3	18
NR-045	N-2	12.5	15	11.8	12	12.5	15
NR-018	N-1	0.1	1	0.1	1	0.1	1
NR-007	N-15	0.9	10	0.5	7	0.9	10
Total		74.9	152	55.2	100	57.5	104

Notes:

(1) Outfalls and regulators with negligible impacts to Annual CSO Volume and Activations are not included in this table.

(2) HAR-1 reduces CSO volume to the Harlem River by 20 MGY, but increases CSO volume to the Hudson River by 5 MGY, resulting in a net reduction of 15 MGY. Total activations of Harlem River CSOs are reduced by 52 per year, while Hudson River CSO activations are increased by 1 per year.

(3) HAR-2 reduces CSO volume to the Harlem River by 17 MGY, but increases CSO volume to the Hudson River by 4 MGY, resulting in a net reduction of 13 MGY. Total activations of Harlem River CSOs are reduced by 48 per year, while Hudson River CSO activations are not impacted.

Table 8.3-4. Summary of Cost and Implementation Considerations for North River Optimization Alternatives for Harlem River

Alternative	Probable Bid Cost ($M)	Implementation Considerations
HAR-1	$36M	• Net reduction in CSO is 15 MGY. • Projected to reduce CSO by 20 MGY to the Harlem River with a 5 MGY increase in CSO to the Hudson River.
HAR-2	$31M	• Net reduction in CSO is 13 MGY. • Projected to reduce CSO by 17 MGY to the Harlem River with a 4 MGY increase in CSO to the Hudson River.

Given the potential reduction in CSO activation frequency and volume associated with the relatively modest costs for Alternatives HAR-1 and HAR-2, both alternatives were retained for further consideration.

8.3.a.2 System Optimization for Harlem River Outfalls in the Wards Island WRRF System

Table 8.3-5 summarizes the CSO outfalls and associated regulators tributary to the Harlem River (including the Bronx Kill) from the Wards Island WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.3-5. Table 8.3-5 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits (“BMP Regulator”)
- A “Key Regulator” as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet of) a public access location
- Regulators that activated more than average for the waterbody

Another consideration for assessing the optimization of the Wards Island outfalls tributary to the Harlem River was the planned up-zoning in East Harlem to accommodate the Department of City Planning’s Mandatory Inclusionary Housing (MIH) Program would be applied. The zoning changes allows for greater density on Park Avenue, Lexington Avenue, Third Avenue, Second Avenue and East 116th Street to provide income restricted housing for a portion of the units in any new development. The increase in zoning densities is located between regulators WIM-24 through WIM-30 near the point at which the interceptor crosses under the Harlem River from Manhattan to Randall’s Island. While dry-weather flows are anticipated with the up-zoning, impacts to wet-weather flow are expected to be negligible and have no impact on the optimization evaluations.

<u>Findings/Observations from Optimizer Evaluations</u>

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Wards Island WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Wards Island WRRF collection system serves the east side of Manhattan and western Bronx. The Manhattan interceptor parallels the Harlem River Drive, while the Bronx Interceptor generally follows the Major Deegan Expressway. A total of 75 regulators divert flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to the Hudson River (3 CSOs), Harlem River (50 CSOs), Bronx Kill (3 CSOs), and East River (19 CSOs). The interceptor sewers convey flow to the Wards Island WRRF located to the south and east of Randall's Island Park.

- The WRRF collection system is relatively shallow (<10 feet of cover) at the upstream ends of each interceptor, but ranges from 15 to 25 feet of cover for most of the interceptor paralleling the Harlem River.

- Baseline Conditions include daylighting of Tibbetts Brook which is projected to reduce CSO discharges to the Harlem River by 228 MGY.

- Regulators contributing to CSO outfalls discharging to the Harlem River activate between 16 to 58 times during the typical year with a total average annual overflow volume (AAOV) of 1,824 MGY.

- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the system is highly sensitive to hydraulic grade line impacts.

- The Optimizer modeling identified multiple alternatives that included modifications to as many as 25 regulators that resulted in varying degrees of improved capture and hydraulic performance. The most optimal alternatives from the Optimizer modeling were evaluated in more detail using InfoWorks runs for the 2008 typical year. However, these runs indicated that limited reductions in AAOV (<1.5%) and activation frequency (<2.5%) were predicted for the better performing alternatives.

- The limited performance improvement was a result of a combination of hydraulic grade line sensitivities and hydraulic balancing. In this system, increasing flow to the interceptor system tended to create adverse impacts on the hydraulic grade line, potentially increasing the risk of flooding. Also, since the system was generally running full during wet-weather, alternatives that reduced CSO at one location tended to result in offsetting increases at other locations.

Table 8.3-5. Harlem River CSO Outfalls/Regulators Associated with the Wards Island WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
WIM-038	WI-38	11.0	29	✓			
WIM-045	WI-45	34.1	37	✓			✓
WIM-046	WI-46	123.0	43	✓		✓	✓
WIM-047	WI-47	18.3	47				✓
WIM-048	WI-48	11.1	48				✓
WIM-050	WI-50	15.7	41				✓
WIM-051	WI-51	21.7	37	✓			✓
WIM-052	WI-52	44.5	45	✓			✓
WIB-056	WI-67	582.0	44	✓	✓		✓
WIB-057	WI-66	124.0	41	✓		✓	✓
WIB-058	WI-65	31.3	29				✓
WIB-060	WI-62	285.4	35	✓			✓
WIB-062	WI-60A	147.0	38	✓		✓	✓
WIB-065	WI-57	0.2	28			✓	
WIB-068	WI-53	17.2	5	✓	✓		
WIB-075	WI-58	68.0	27	✓			
WIB-076	WI-76	58.5	42				✓
WIB-077	WI-75	81.2	38				✓
WIB-078	WI-74	34.5	41				✓

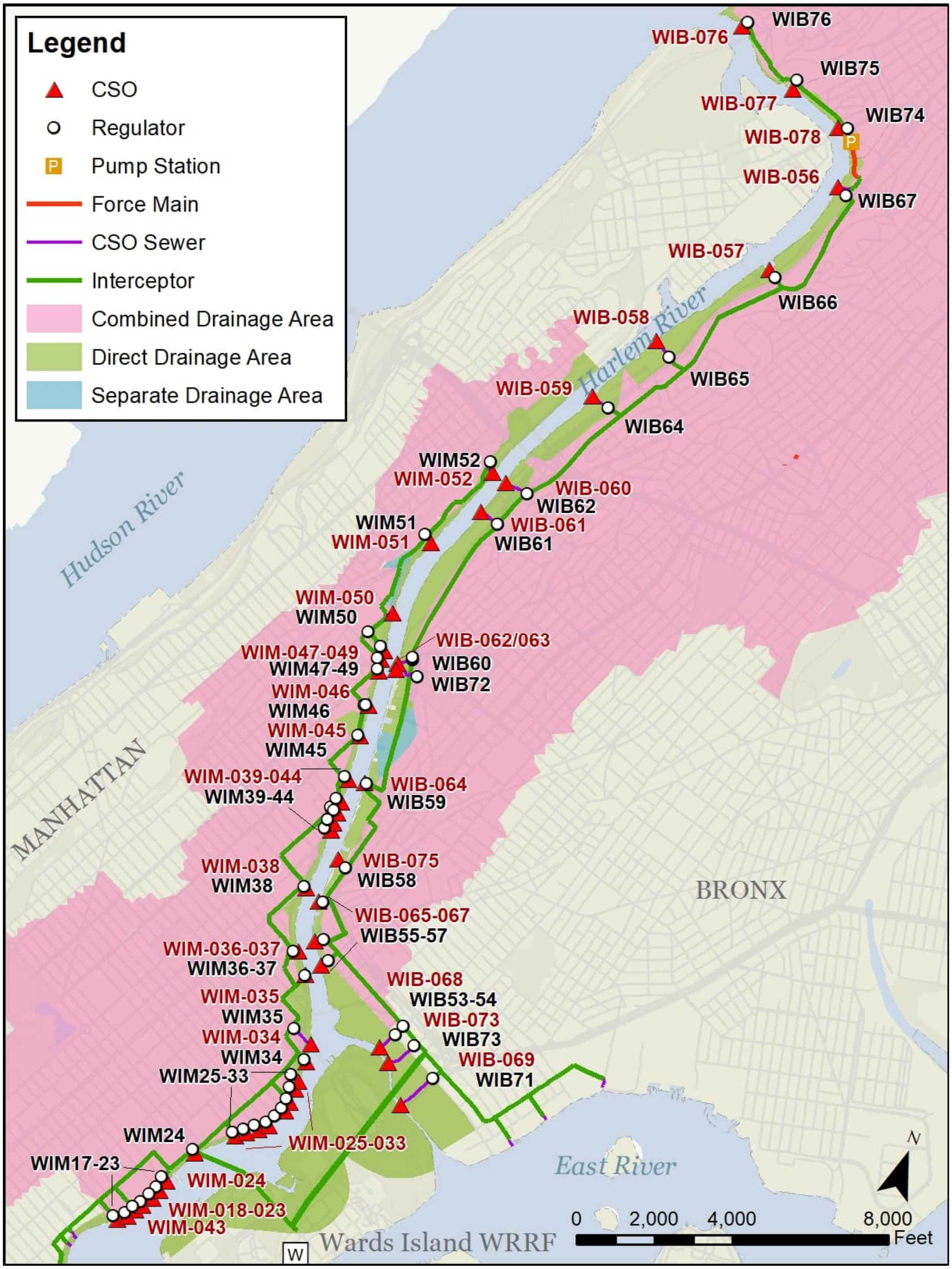

Figure 8.3-5. CSO Outfalls/Regulators Tributary to Harlem River from the Wards Island WRRF System

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Follow-up Evaluations Based on Full InfoWorks Model

No retained alternatives were identified from the initial Optimization runs due to hydraulic grade line impacts that increased the potential risk of flooding, while providing negligible reductions in CSO volume and activations along the Harlem River. In an effort to reduce the hydraulic grade line impacts associated with system optimization, an evaluation of bending weirs was performed for select regulator sites using the InfoWorks model. The results of the evaluation are summarized in Table 8.3-6.

Initial evaluations reviewed regulator sites for suitability based upon manufacturer installation and operational constraints. Mean high tide elevations were reviewed in comparison to the existing weir crest to identify regulator sites where installation of a bending weir would be suitable based upon weir submergence limitations set by the manufacturers. Two sites within the Wards Island collection system were identified where the mean high tide did not exceed an elevation of the existing regulator weir crest. InfoWorks model runs were then performed to determine whether the 5-year design storm hydraulic grade line for Baseline Conditions could be matched to achieve DEP design criteria. Available record drawings were reviewed for each regulator site to assess constructability.

Installation of a bending weir is not recommended at Regulator WI-62 as it was found to increase the hydraulic grade line of the upstream collector sewer as much as 72 inches during a 5-year design storm. Constructability issues were also identified. The existing regulator weir is located within a tunnel that was constructed within bedrock. Stairway access to the weir is provided within an adjacent shaft. Insufficient space is available within the existing access shaft to accommodate the bending weir counter-weight system, requiring an additional chamber to be constructed to a depth of 70 feet within bedrock adjacent to the existing tunnel. The depth of the tunnel would require special provisions to address confined space entry requirements for the frequent access necessary for proper operation and maintenance of the bending weir mechanical systems. In addition, construction next to adjacent structures in bedrock can be very risky and require costly measures to protect existing structures from being damaged during excavation. In consideration of the hydraulic performance and constructability risks, installation of a bending weir at this site is not recommended.

Regulator WI-60A is located adjacent to an exit ramp from the Major Deegan Expressway north of the Macombs Dam Bridge. The regulator chamber is about 23 feet deep and located in relatively steeply sloped right-of-way green space to the west of the exit ramp. There is space adjacent to the existing regulator to accommodate the counter-weight chamber. InfoWorks modeling projects a 7 MGY reduction in CSO volume with hydraulic grade line impacts in excess of 12 inches during the 5-year design storm along collector sewers upstream of the regulator. In consideration of the relatively small CSO reductions, hydraulic grade line impacts and accessibility for maintenance, installation of a bending weir at Regulator WI-60A was not retained for further consideration.

Table 8.3-6. Summary of Bending Weir Evaluations

Outfall	Regulator	Mean High Tide Below Weir Crest	Achieves 5-year Design Storm hydraulic grade line Criteria	Constructability and O&M Concerns	Retained Alternative
WIB-060	WI-62	✓	Increases of 12" to 72"	Bedrock, deep, access limitations	Not recommended
WIB-061	WI-60A	✓	Increases of 6" to 15"	✓	Not recommended

8.3.b Storage Tunnel Alternatives for 25/50/75/100 Percent CSO Control

Conceptual storage tunnel alternatives were developed to model potential 25, 50, 75, and 100 percent control of the annual CSO volume discharged to the Harlem River in the 2008 Typical Year. The approach to sizing and layout of the storage tunnel alternatives was as follows:

- For the 50-percent CSO control tunnel, the Typical Year annual overflow volume of each CSO outfall to the Harlem River was reviewed and combinations of outfalls were identified where capture of 100 percent of the CSO from those outfalls would approximately match 50 percent of the total CSO volume from all outfalls to the Harlem River.
- The locations of these outfalls were then assessed in relation to the length and diameter of tunnel needed to capture the outfalls.
- Based on DEP expertise, a combination of outfalls was selected that provided reasonable tunnel length/diameter to provide 50-percent volume capture.
- A similar approach was taken for the 75-percent CSO control tunnel.
- For the 25-percent CSO control tunnel, the 50-percent CSO tunnel was downsized until the volume of storage provided would result in approximately 25-percent CSO control.
- For the 100-percent CSO control tunnel, it was assumed that every CSO outfall to the Harlem River that was predicted to be active in the 2008 Typical Year would be tied into the tunnel. Where multiple outfalls were located in close proximity to each other, it was assumed that a near-surface consolidation conduit would be provided to a single drop shaft.
- For each storage tunnel alternative, the dewatering rate required to dewater the storage tunnel within 24 hours was compared to the available dry-weather flow capacity in the WRRF closest to the downstream end of the tunnel. If insufficient dry-weather flow capacity was available at the

WRRF to accept the additional dewatering flows, a high-rate clarification wet-weather flow treatment system with disinfection was added to the alternative to treat the dewatered flow.

- A detailed siting assessment was not conducted, so the specific locations of various features of the tunnel alternatives (mining shaft, TBM removal shaft, drop shafts, dewatering pump station, dewatered flow treatment facility, near-surface diversion structures/connection conduits) were not identified.

The main features of the 25, 50, 75, and 100-percent CSO control storage tunnels modeling scenarios for the Harlem River are summarized in Table 8.3-7. Figure 8.3-6 to Figure 8.3-8 present conceptual layouts of the storage tunnel alternatives.

Table 8.3-7. Summary of 25, 50, 75, and 100-Percent CSO Control Alternatives for Harlem River

Alternative	HAR-3	HAR-4	HAR-5	HAR-6
Level of CSO Control(1)	**25%**	**50%**	**75%**	**100%**
Length (mi.)	5.4	5.4	6.0	6.0
Diameter (ft.)	11	28	32	39
Volume (MG)	20	130	190	269
Outfalls Captured	• WIB-056 • WIB-057 • WIB-060	• WIB-056 • WIB-057 • WIB-060	• WIM-046 • WIB-056 • WIB-057 • WIB-060 • WIB-062 • WIB-068 • WIB-075 • WIB-076 • WIB-077	All CSO Outfalls to Harlem River (62 Total)
Net CSO Volume Reduction (MGY)	476	991	1,486	1,899
Wet Weather Flow Treatment Facility Capacity for Dewatering Flow (MGD)	20	130	190	269
Estimated Probable Bid Cost(2)	$800M	$1,900M	$3,200M	$8,000M

Notes:
(1) Modeled annual percent CSO reduction based on the 2008 Typical Year.
(2) 2019 dollars.

The 25 percent and 50 percent capture tunnels would start from a mining shaft located in the vicinity of the Wards Island WRRF, and run generally under or along the shoreline of the Harlem River north to a TBM retrieval shaft/drop shaft in the vicinity of Outfall WIB-056 (Figure 8.3-6). Additional drop shafts would be provided in the vicinity of Outfalls WIB-057 and WIB-060. The 75 percent capture tunnel would follow a similar route, but would extend further north in the vicinity of outfalls WIB-076 and WIB-077, and would capture the additional outfalls listed in Table 8.3-7 (Figure 8.3-7). The 100 percent CSO control tunnel would run along a route similar to the 75 percent capture tunnel. Multiple near-surface consolidation conduits would be provided to convey flow from adjacent outfalls to common drop shafts, and the tunnels would capture all of the CSO from all of the Harlem River CSO outfalls in the 2008 typical year (Figure 8.3-8).

The closest WRRF to the mining shaft for the tunnel storage alternatives would be the Wards Island WRRF. However, a dedicated wet-weather high-rate treatment facility would be necessary for the treatment of the CSO retained in the storage tunnel.

While these alternatives provide relatively high levels of CSO control, the significant challenges to implementation include:

- Very high implementation cost
- Limited siting availability for shafts, dewatering pumping station, dewatering flow treatment facility
- Long implementation period
- Significant and prolonged construction impacts (truck traffic, noise, dust) for surface consolidation sewers due to the large number of drop shafts necessary to divert CSO to the tunnel
- Negligible improvement in the annual attainment of applicable water quality standards
- Construction impacts and likelihood of utility conflicts for near-surface diversion structures and connecting conduits

Despite these challenges, these alternatives were retained in order to provide an assessment of a range of levels of CSO control for the Harlem River, in accordance with the CSO Control Policy and the Clean Water Act guidance.

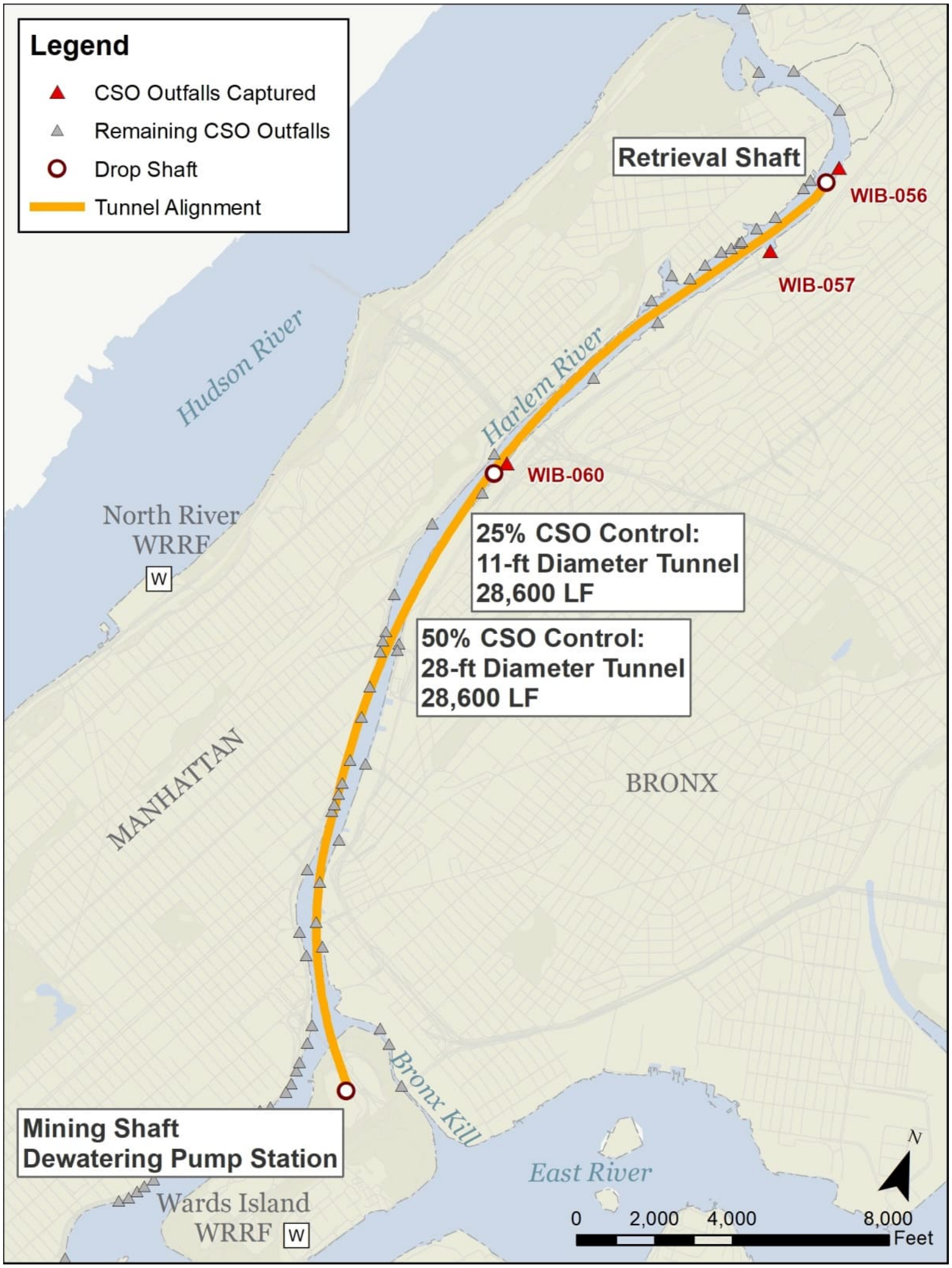

Figure 8.3-6. Conceptual Layout for 25% and 50% Control Storage Tunnels for Harlem River

Figure 8.3-7. Conceptual Layout for 75% Control Storage Tunnel for Harlem River

Figure 8.3-8. Conceptual Layout for 100% Control Storage Tunnel for Harlem River

8.3.c Summary of Retained Alternatives for Harlem River

The goal of the previous evaluations was to develop a list of retained CSO control measures for the Harlem River. These CSO control measures, whether individually or in combination, form the basis of basin-wide alternatives to be assessed using more rigorous cost-performance and cost-attainment analyses. Table 8.3-8 lists all of the CSO control measures originally identified in the "Alternatives Toolbox" shown above in Figure 8.1-2, and identifies whether the CSO control measure was retained for further analysis. The reasons for excluding the non-retained CSO control measures from further consideration are also noted in the table.

Table 8.3-8. Summary of CSO Control Measure Screening for Harlem River

Control Measure	Category	Retained for Further Analysis?	Remarks
Additional GI Build-out	Source Control	NO(1)	Planned GI build-out in the watershed is included in the baseline. It is unlikely that additional sites will be identified due to site constraints in publicly owned properties.
High Level Storm Sewers	Source Control	NO(1)	No cost-effective opportunities identified
Regulator Modifications	System Optimization	YES	Incorporated into optimization alternatives HAR-1, HAR-2
Parallel Interceptor Sewer	System Optimization	YES	Incorporated into optimization alternatives HAR-1, HAR-2.
Bending Weirs/Control Gates	System Optimization	NO	Only two potentially feasible locations were predicted to have adverse hydraulic grade line impacts.
Pumping Station Optimization	System Optimization	NO	Limited benefit in terms of CSO reduction.
Pumping Station Expansion	System Optimization	NO	Limited benefit in terms of CSO reduction.
Gravity Flow Redirection to Other Watersheds	CSO Relocation	YES	Optimization Alternatives HAR-1 and HAR-2 shift some CSO volume between Harlem and Hudson River
Pumping Station Modification	CSO Relocation	NO	No cost-effective opportunities identified.
Flow Redirection with Conduit and Pumping	CSO Relocation	NO	No cost-effective opportunities identified.
Floatables Control	Floatables Control	YES	Programmatic floatables control will be applied and expanded citywide.
Environmental Dredging	Water Quality/ Ecological Enhancement	NO	No specific locations of CSO sediment mounding identified.
Wetland Restoration and Daylighting	Water Quality/ Ecological Enhancement	NO(2)	Tibbetts Brook Daylighting project is included in the baseline conditions. No additional daylighting opportunities were identified.
Outfall Disinfection	Treatment: Satellite	NO	Not feasible due to short length of outfalls.

Table 8.3-8. Summary of CSO Control Measure Screening for Harlem River

Control Measure	Category	Retained for Further Analysis?	Remarks
Retention/Treatment Basins	Treatment: Satellite	NO	Significant siting constraints and very high costs. Tunnel storage covers 25/50/75/100 percent CSO control alternatives.
High-Rate Clarification	Treatment: Satellite	YES	Incorporated into the storage tunnel alternatives for treatment of captured CSO during tunnel dewatering.
WRRF Expansion	Centralized Treatment	NO	Insufficient space available. Limited benefit compared to potential cost.
In-System Storage (Outfalls)	Storage	NO	Negligible levels of CSO control due to short outfalls.
Off-line Storage (Tanks)	Storage	NO	Significant siting constraints and very high costs. Tunnel storage covers 50/75/100 percent CSO control alternatives.
Off-line Storage (Tunnels)	Storage	YES	Tunnel storage alternatives HAR-3, HAR-4 and HAR-5 cover 25/50/75/100 percent CSO control.

Notes:
(1) Additional GI and HLSS are considered to be ongoing programs that will continue to be implemented system-wide outside of the LTCP program.
(2) Tibbetts Brook daylighting was evaluated, but the project has been incorporated into the baseline conditions.

As shown, the retained CSO control measures include system optimization measures, tunnel storage (with high-rate clarification for dewatering flows), and programmatic floatables control. Wetland restoration and daylighting were evaluated as part of the Tibbetts Brook project, which is incorporated into the baseline conditions.

8.3.d CSO Volume and Loading Reductions for Retained Alternatives for Harlem River

Table 8.3-9 summarizes the projected performance of the retained Harlem River alternatives in terms of annual CSO volume and fecal coliform load reduction, based on the 2008 Typical Year. These data are plotted on Figure 8.3-9. In all cases, the predicted reductions shown are relative to the baseline conditions using 2008 JFK rainfall as described in Section 6. The baseline assumptions were described in detail in Section 6 and include the implementation of the grey infrastructure projects from the approved WWFPs, the Recommended Plans from the previously submitted LTCPs, and the projected level of GI identified in Section 5.

Table 8.3-9. Summary of Model Predicted Performance for Retained Harlem River Alternatives

Alternative	Annual Performance Based on 2008 Typical Year				
	Remaining CSO Volume (MGY) (1)	Frequency of Overflow (2)	Additional CSO Volume to Other Waterbodies (MGY) (3)	Net CSO Volume Reduction (%)	Net Fecal Coliform Reduction (%)
Baseline Conditions	1,899	58	-	-	-
HAR-1. Optimization of Regulators Associated with Outfalls NR-007, 008, 009, 010 and 017	1,880	58	4	<1	<1
HAR-2. Optimization of Regulators Associated with Outfalls NR-008, and 010	1,882	58	4	<1	<1
HAR-3. Tunnel Storage for 25% CSO Control (20 MG Capacity)	1,423	58	0	25	25
HAR-4. Tunnel Storage for 50% CSO Control (130 MG Capacity)	908	58	0	52	52
HAR-5. Tunnel Storage for 75% CSO Control (190 MG Capacity)	413	58	0	78	78
HAR-6. Tunnel Storage for 100% CSO Control (269 MG Capacity)	0	0	0	100	100

Notes:
(1) Remaining CSO includes all discharges to the Harlem River and Bronx Kill from the North River and Wards Island WRRF Collection Systems.
(2) Frequency of overflow is based upon the most frequently active CSO outfall.
(3) Additional CSO volume to other waterbodies accounts for increases at other CSO outfalls in response to the implementation of a CSO control alternative. Net CSO volume reduction and net fecal coliform reduction account for any additional CSO discharge to other waterbodies.

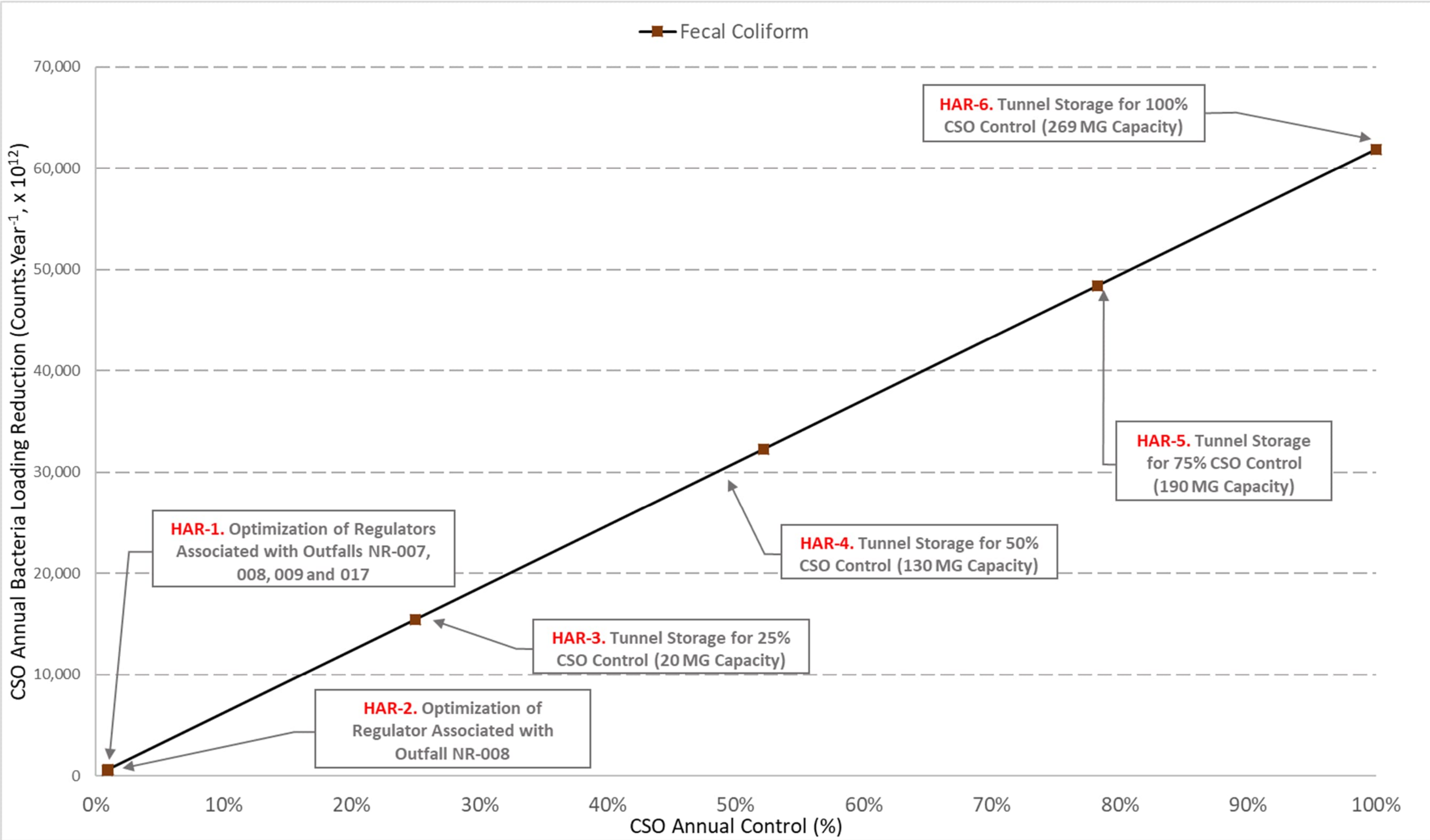

Figure 8.3-9. Untreated CSO Volume Reductions (as Percent CSO Annual Control) vs. Annual CSO Bacteria Loading Reduction (2008 Typical Year)

Because the retained alternatives for the Harlem River provide volume reduction and not treatment, the predicted bacteria loading reductions of the alternatives are very closely aligned with their projected CSO volume reductions.

8.3.e Cost Estimates for Harlem River Retained Alternatives

Evaluation of the retained alternatives requires cost estimation. The methodology for developing these costs is dependent upon the type of technology and its O&M requirements. The construction costs were developed as PBC and the total NPW costs were determined by adding the estimated PBC to the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 100-year life cycle. Design, construction management, and land acquisition costs are not included in the cost estimates. All costs are in 2019 dollars and are considered Level 5 cost estimates by AACE International with an accuracy of -50 percent to +100 percent.

8.3.e.1 Alternative HAR-1. Optimization of Regulators Associated With Outfalls NR-007, 008, 009, and 017.

Costs for Alternative HAR-1 include planning-level estimates of the costs to optimize the performance of Regulators NR-15, NR-14, NR-13 and NR-03 associated with Outfalls NR-007, NR-008, NR-009, and NR-017 respectively. A description of the optimization components is provided in Section 8.3.a.1 and summarized in Table 8.3-2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HAR-1 is $37M as shown in Table 8.3-10.

Table 8.3-10. Estimated Costs for Alternative HAR-1

Item	2019 Cost ($ Million)
Probable Bid Cost	$36
Annual O&M Cost	$1
Net Present Worth	$37

8.3.e.2 Alternative HAR-2. Optimization of Regulators Associated With Outfall NR-008.

Costs for Alternative HAR-2 include planning-level estimates of the costs to optimize the performance of Regulator NR-14 associated with Outfall NR-008. A description of the optimization components is provided in Section 8.3.a.1 and summarized in Table 8.3-2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HAR-2 is $32M as shown in Table 8.3-11.

Table 8.3-11. Estimated Costs for Alternative HAR-2

Item	2019 Cost ($ Million)
Probable Bid Cost	$31
Annual O&M Cost	$1
Net Present Worth	$32

8.3.e.3 Alternative HAR-3. Tunnel Storage for 25 Percent CSO Control

Costs for Alternative HAR-3 include planning-level estimates of the costs for a CSO storage tunnel sized for 25 percent CSO control in the 2008 typical year. A description of the tunnel alternative components is provided in Section 8.3.b and summarized in Table 8.3-7. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HAR-3 is $1,000M as shown in Table 8.3-12.

Table 8.3-12. Estimated Costs for Alternative HAR-3

Item	2019 Cost ($ Million)
Probable Bid Cost	$800
Annual O&M Cost	$5
Net Present Worth	$1,000

8.3.e.4 Alternative HAR-4. Tunnel Storage for 50 Percent CSO Control

Costs for Alternative HAR-4 include planning-level estimates of the costs for a CSO storage tunnel sized for 50 percent CSO control in the 2008 typical year. A description of the optimization components is provided in Section 8.3.b and summarized in Table 8.3-7. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HAR-4 is $2,200M as shown in Table 8.3-13.

Table 8.3-13. Estimated Costs for Alternative HAR-4

Item	2019 Cost ($ Million)
Probable Bid Cost	$1,900
Annual O&M Cost	$9
Net Present Worth	$2,200

8.3.e.5 Alternative HAR-5. Tunnel Storage for 75 Percent CSO Control

Costs for Alternative HAR-5 include planning-level estimates of the costs for a CSO storage tunnel sized for 75 percent CSO control in the 2008 typical year. A description of the optimization components is provided in Section 8.3.b and summarized in Table 8.3-7. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HAR-5 is $3,500M as shown in Table 8.3-14.

Table 8.3-14. Estimated Costs for Alternative HAR-5

Item	2019 Cost ($ Million)
Probable Bid Cost	$3,200
Annual O&M Cost	$11
Net Present Worth	$3,500

8.3.e.6 Alternative HAR-6. Tunnel Storage for 100 Percent CSO Control.

Costs for Alternative HAR-6 include planning-level estimates of the costs for a CSO storage tunnel sized for 100 percent CSO control in the 2008 typical year. A description of the optimization components is provided in Section 8.3.b and summarized in Table 8.3-7. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HAR-6 is $8,400M as shown in Table 8.3-15.

Table 8.3-15. Estimated Costs for Alternative HAR-6

Item	2019 Cost ($ Million)
Probable Bid Cost	$8,000
Annual O&M Cost	$14
Net Present Worth	$8,400

The cost estimates of these retained alternatives are summarized below in Table 8.3-16 and are then used in the development of the cost-performance and cost-attainment plots presented in Section 8.3.f.

Table 8.3-16. Estimated Costs of Retained Alternatives

Alternative	PBC(1) ($ Million)	Annual O&M Cost ($ Million/Year)	Total Net Present Worth(2) ($ Million)
HAR-1. Optimization of Regulators Associated with Outfalls NR-007, 008, 009 and 017	$36	$1	$37
HAR-2. Optimization of Regulator Associated with Outfall NR-008	$31	$1	$32
HAR-3. Tunnel Storage for 25% CSO Control (21 MG Capacity)	$800	$5	$1,000
HAR-4. Tunnel Storage for 50% CSO Control (132 MG Capacity)	$1,900	$9	$2,200
HAR-5. Tunnel Storage for 75% CSO Control (202 MG Capacity)	$3,200	$11	$3,500
HAR-6. Tunnel Storage for 100% CSO Control (291 MG Capacity)	$8,000	$14	$8,400

Notes:
(1) The Probable Bid Cost (PBC) for the construction contract based upon 2019 dollars.
(2) The Net Present Worth (NPW) is based upon a 100-year service life for tunnels and is calculated by multiplying the annual O&M cost by a present worth of 31.599 and adding this value to the PBC.

8.3.f Cost-Benefit Curves for Retained Alternatives

The final step of the analysis is to evaluate the cost-effectiveness of the basin-wide retained alternatives based on their NPW and projected impact on CSO loadings and attainment of applicable WQS. Section 8.3.f.1 below presents plots of cost versus CSO volume and bacteria load reduction (Cost-Performance

Curves), and Section 8.3.g.2 below presents plots of cost versus percent attainment with WQS for selected points along the Harlem River (Cost-Attainment Curves).

8.3.f.1 Cost-Performance Curves

Cost-performance curves were developed by plotting the costs of the retained alternatives against their predicted level of CSO control, both in terms of CSO volume reduction, and in bacteria load reduction. In each case, a best-fit cost curve was developed based on those alternatives judged most cost-effective for a defined level of CSO control as estimated by IW modeling for the 2008 typical year rainfall. Figure 8.3-10 presents a plot of CSO volume reduction versus NPW for the retained alternatives, while Figure 8.3-11 plots the cost of the alternatives against fecal coliform loading reductions.

8.3.g Cost-Attainment Curves

This section evaluates the relationship of the costs of the retained alternatives versus their expected level of attainment of bacteria Primary Contact WQ Criteria as modeled using the LTCPRM water quality model for the 2008 Typical Year simulation. As indicated in Section 6, based on the 10-year WQ simulations for the Harlem River, the Existing WQ Criteria (Class I) for fecal coliform are met at least 95 percent of the time under baseline conditions. As a result, implementation of any of the retained alternatives described above, including the 100 percent CSO capture tunnel, results in nominal improvement in the percent attainment of Existing WQ Criteria (Class I) for fecal coliform. Cost-attainment plots are presented below for two locations along the Harlem River: LTCP sampling Station HA-2, near the northern end of the Harlem River (Figure 8.3-12), and LTCP sampling Station HA-4, located approximately midway between the northern and southern ends of the Harlem River (Figure 8.3-13). The locations of these stations are shown in Figure 8.3-17 below. The plots show NPW versus percent attainment with the Existing WQ Criteria (Class I) for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis. Cost-attainment plots for any other WQ modeling cell along the Harlem River would look similar to Figure 8.3-12 and Figure 8.3-13.

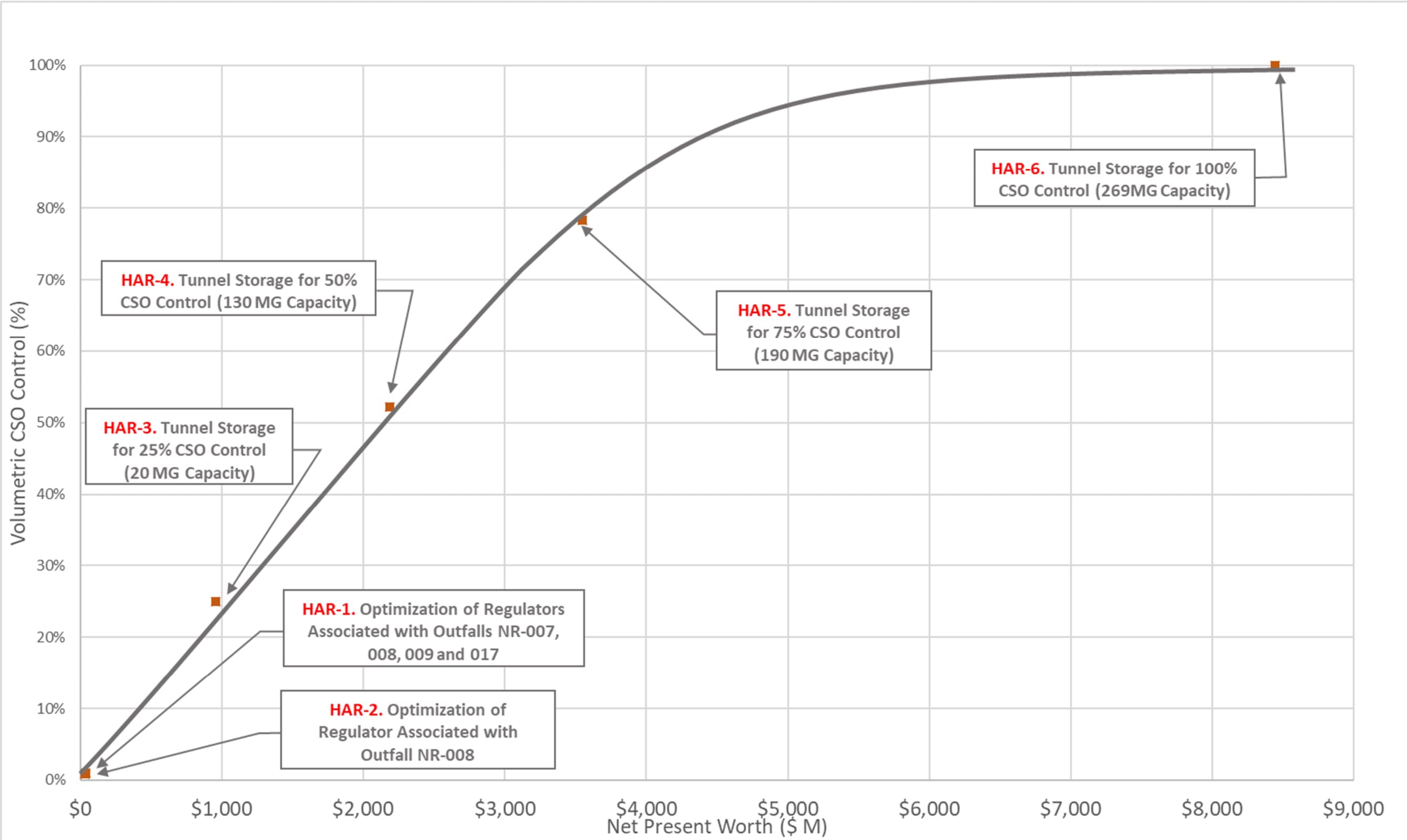

Figure 8.3-10. Cost vs. CSO Control (2008 Typical Year)

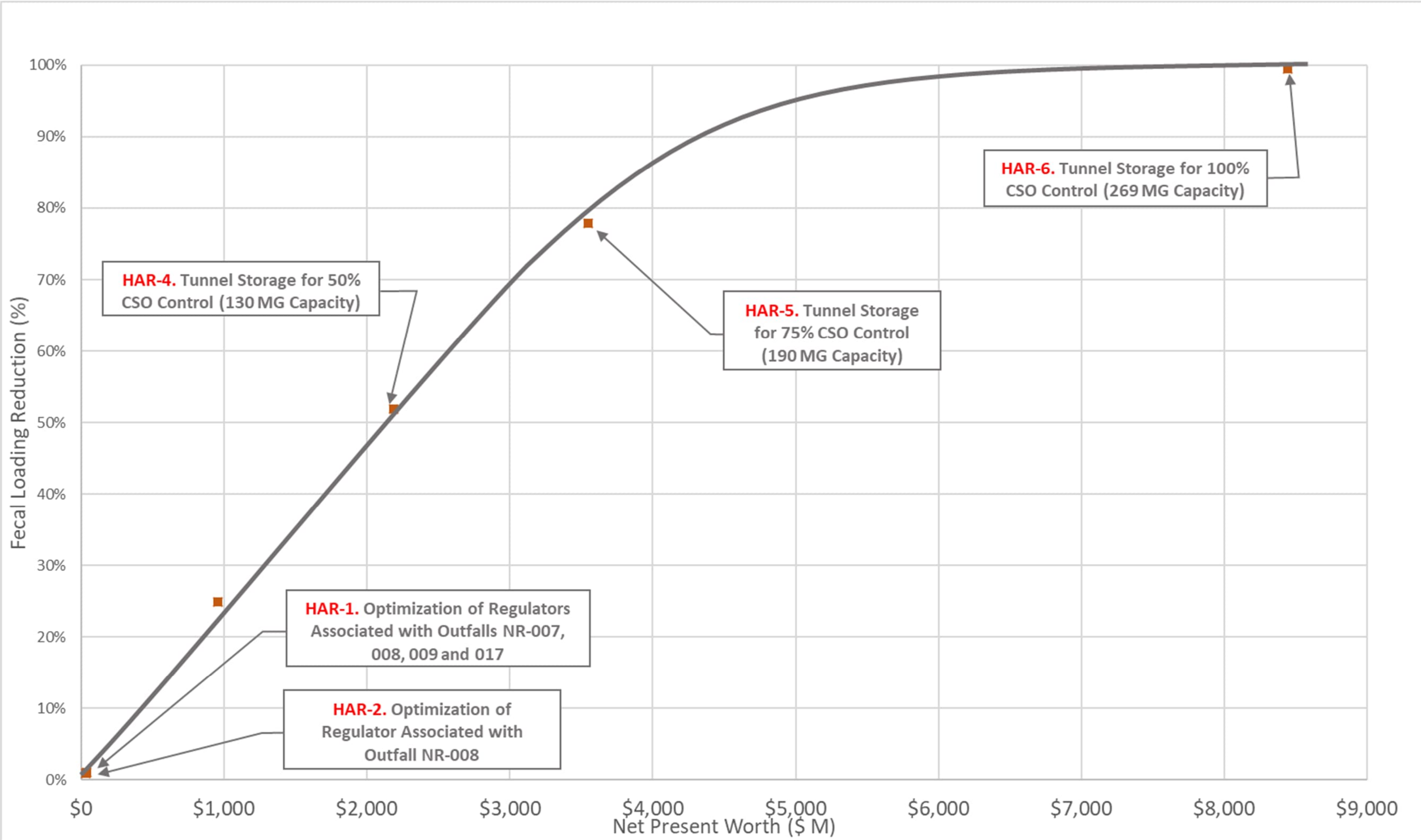

Figure 8.3-11. Cost vs. Fecal Coliform Loading Reduction (2008 Typical Year)

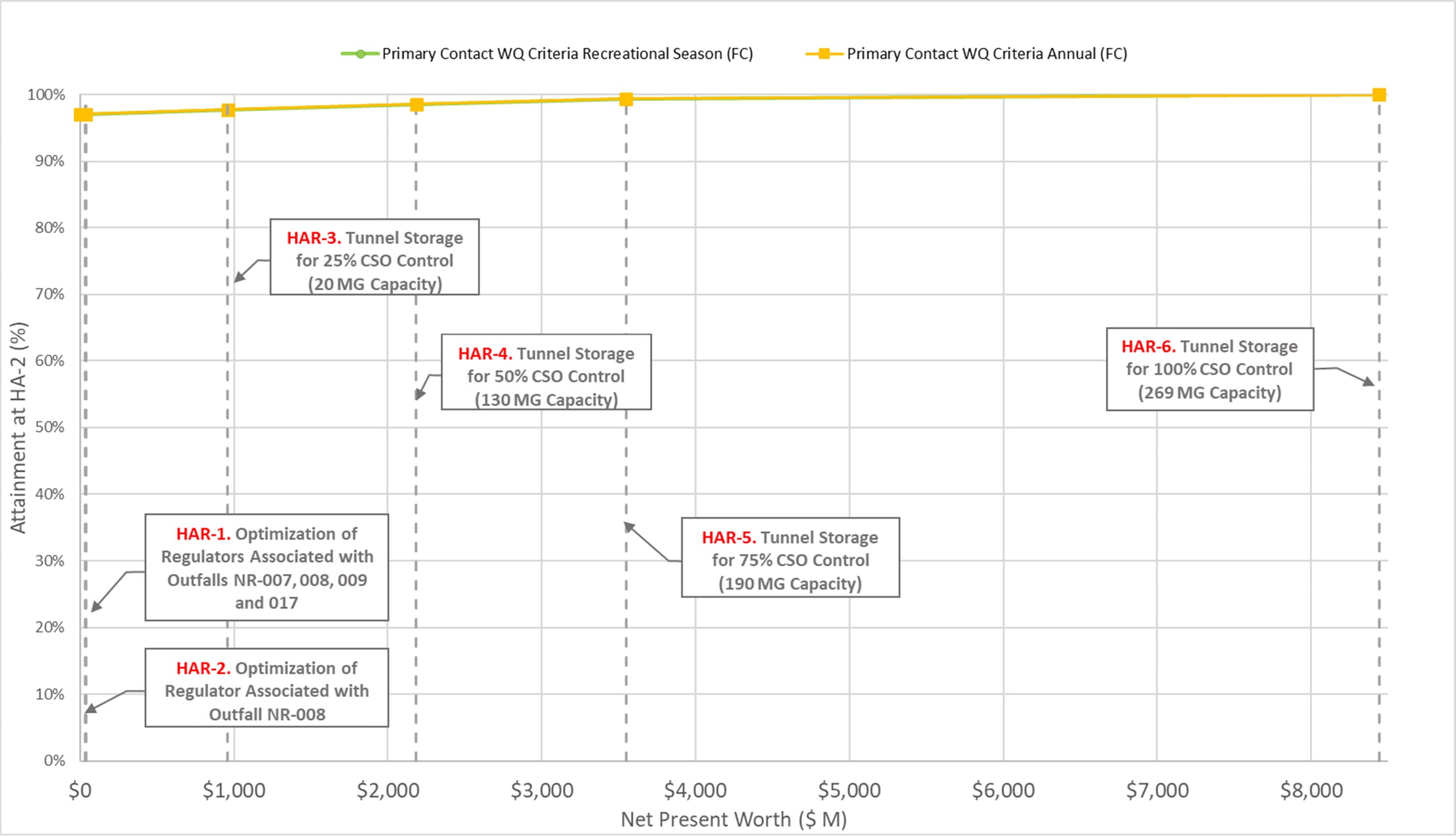

Figure 8.3-12. Cost vs. Bacteria Attainment at Station HA-2

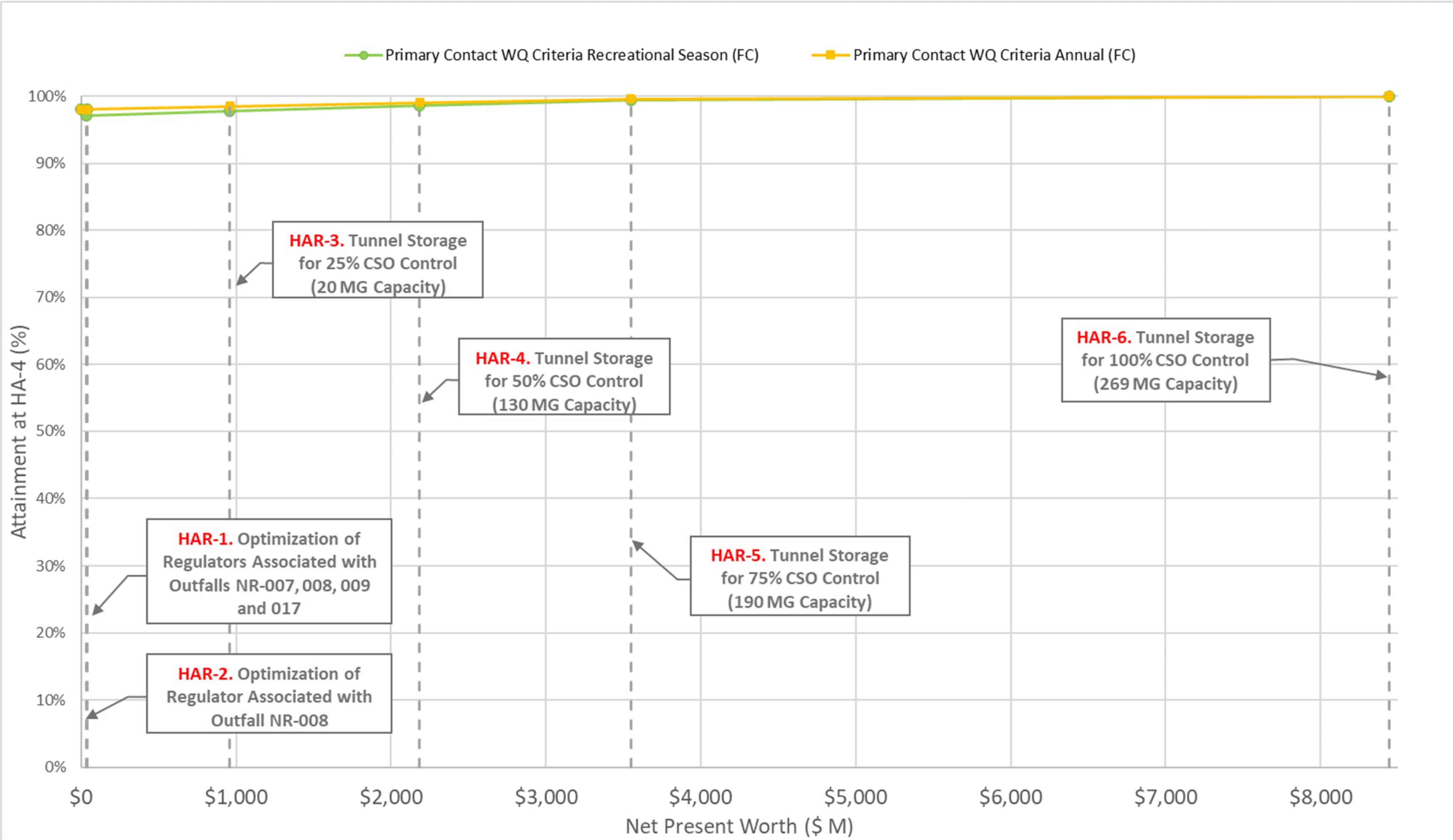

Figure 8.3-13. Cost vs. Bacteria Attainment at Station HA-4

8.3.h Conclusion on Preferred Alternative

The selection of the preferred alternative for the Harlem River is based on multiple considerations including public input, environmental and water quality benefits, and projected costs. The two optimization alternatives described above, HAR-1 and HAR-2, would provide a nominal reduction in CSO volume to the Harlem River for a cost of $36M and $31M, respectively. These alternatives, however, are contingent on the re-routing of the branch interceptor along 10th Avenue that is being considered as part of up-zoning modifications in the Inwood area. Since the timing and configuration of this work is uncertain, and the costs associated with Alternatives HAR-1 and HAR-2 are high relative to the net volume of CSO reduced, these optimization alternatives are not recommended. These alternatives could potentially be re-considered in the future as part of the overall improvements being considered for the Inwood area.

The CSO storage tunnel alternatives would provide a range of levels of CSO reduction to the Harlem River, but the costs associated with those alternatives are very high. Since the level of attainment with the Existing WQ Criteria for bacteria is greater than 95 percent at all WQ model cells in the Harlem River (see Figure 6-2 in Section 6), the high costs associated with the storage tunnel alternatives would not significantly change the already-high level of attainment with the WQ Criteria. Section 9 presents affordability issues and impacts on disadvantaged communities that would come into play if the CSO program costs were to further significantly increase. For these reasons, the CSO storage tunnel alternatives are not recommended.

As described in Section 5, the Tibbetts Brook Daylighting project to be implemented under the GI program will reduce CSO volume to the Harlem River by 228 MGY. Although this project is considered to be part of the Baseline Conditions, the volume reduction is significant, regardless of which program the projected is counted under. This project will also reduce energy consumption at the Wards Island WRRF by reducing dry-weather pumping and treatment requirements as a result of diverting the dry-weather brook flow direction to the Harlem River.

In summary, no new CSO projects are recommended for the Harlem River. Water quality improvements will continue to be achieved through implementation of the Tibbetts Brook Daylighting projects under the GI program, as well as other GI projects and ongoing programmatic floatables control activities. While the annual volume of CSO remaining in the Harlem River is acknowledged to remain relatively high, the time-to-recovery analysis presented further below demonstrates that the duration of impact of the remaining CSOs is relatively low.

Figure 8.3-14 presents a mosaic of the level of attainment with the Existing WQ Criteria for bacteria in the Harlem River on an annual basis, and Figure 8.3-15 shows the level of attainment for the recreational season (May 1st through October 31st). Figure 8.3-16 presents the level of attainment with the Existing WQ Criteria for DO on an average annual basis.

Table 8.3-17 presents the highest calculated monthly fecal coliform GM at LTCP sampling locations and waterbody access locations in the Harlem River during the 10-year period on an annual basis and during the recreational season (May 1st through October 31st), for the Recommended Plan. Table 8.3-17 also presents the percent of time that the fecal coliform monthly GM criterion of 200 cfu/100mL would be attained over the 10-year simulation period. The locations of the stations and supplemental model output locations listed in Table 8.3-17 are shown on Figure 8.3-17.

Figure 8.3-14. Harlem River Fecal Coliform Annual Attainment, Recommended Plan, 10-Year Simulation

Figure 8.3-15. Harlem River Fecal Coliform Recreational Season Attainment, Recommended Plan, 10-Year Simulation

Figure 8.3-16. Harlem River DO Annual Attainment, Recommended Plan, 2008 Typical Year Simulation

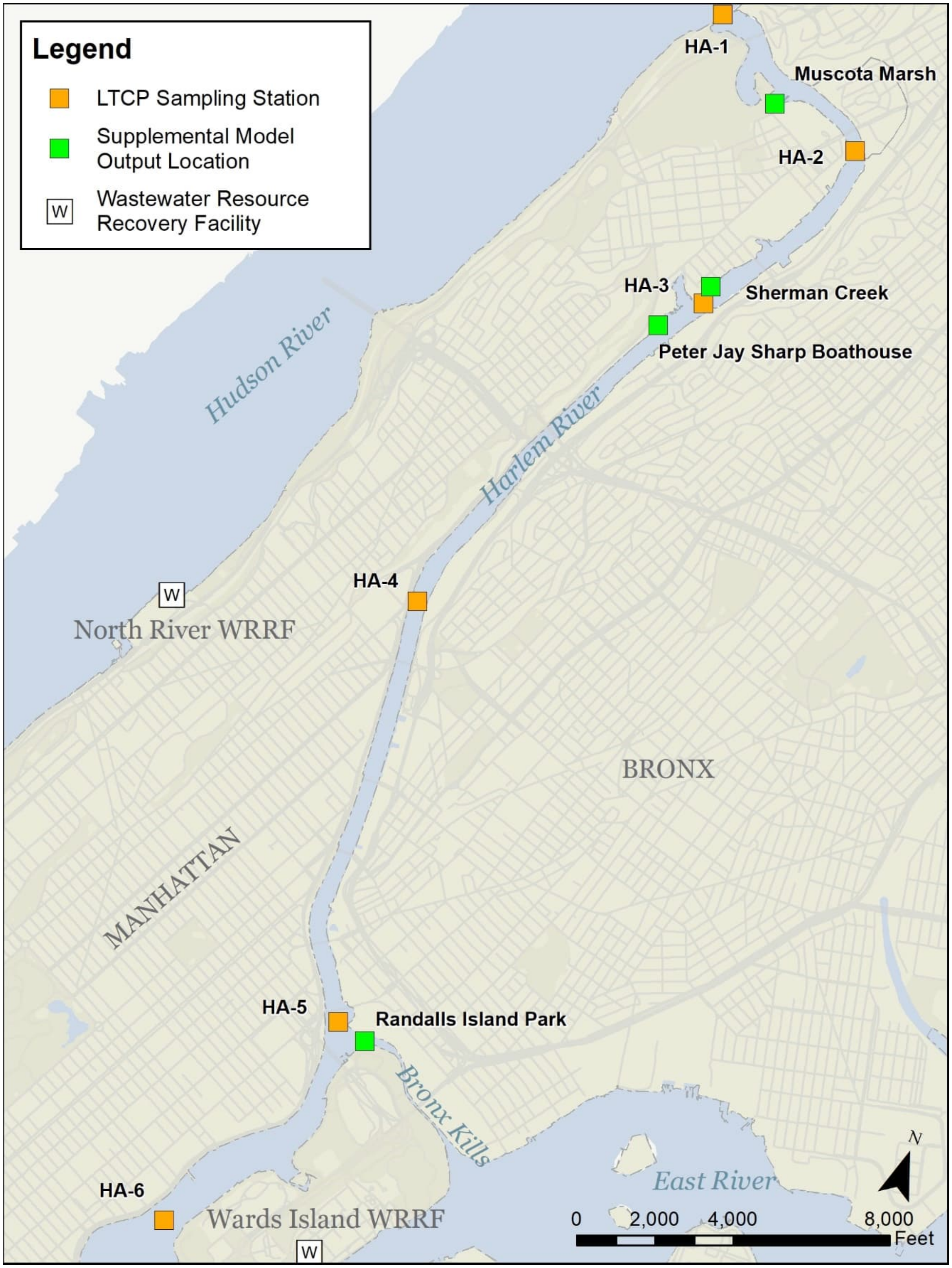

Figure 8.3-17. Sampling Stations and Supplemental Model Output Locations on the Harlem River

Table 8.3-17. Model Calculated 10-Year Baseline Fecal Coliform Maximum Monthly GM and Percent Attainment of WQ Criteria for Harlem River Recommended Plan

Description	Maximum Monthly Fecal Coliform GMs (cfu/100mL)		% Attainment (GM ≤200 cfu/100mL)	
	Annual	Recreational Season(1)	Annual	Recreational Season(1)
Harlem River (Class I)				
HAR-1	280	196	98%	100%
HAR-2	445	303	97%	97%
HAR-3	484	296	97%	97%
HAR-4	618	308	97%	97%
HAR-5	769	326	98%	98%
HAR-6	360	150	99%	100%
Muscota Marsh	363	243	98%	98%
Sherman Creek	480	295	97%	97%
Sharp Boathouse	526	312	97%	97%
Randall's Island Park	503	451	97%	97%

Note:
(1) The recreational season is from May 1st through October 31st.

Table 8.3-18 presents the average annual attainment of DO criteria for the 2008 typical year for the Recommended Plan at LTCP sampling locations in the Harlem River.

Table 8.3-18. 2008 Annual Average DO Attainment for Harlem River, Recommended Plan

Class I 2008 Annual Attainment (%) (Entire Water Column)	
Station	**Instantaneous (≥4.0 mg/L)**
Harlem River	
HAR-1	99.9%
HAR-2	100%
HAR-3	100%
HAR-4	100%
HAR-5	100%
HAR-6	100%

8.3.i Use Attainability Analysis

The CSO Order requires that a UAA be included in an LTCP "where existing WQS do not meet the Section 101(a)(2) goals of the CWA, or where the proposed alternative set forth in the LTCP will not achieve existing WQS or the Section 101(a)(2) goals." The UAA shall "examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State." The UAA process specifies that States can remove a designated use that is not an existing use if the scientific assessment can demonstrate that attaining the designated use is not feasible for at least one of six reasons:

1. Naturally occurring loading concentrations prevent the attainment of the use; or
2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or
5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

As part of the LTCP, elements of a UAA, including the six conditions presented above, will be used to determine if changes to the designated use are warranted, considering a potential adjustment to the designated use classification as appropriate.

As noted in previous sections, with the implementation of the preferred alternative, the Harlem River is predicted to meet the Existing WQ fecal coliform bacteria criterion of 200 cfu/100mL on an annual basis based on both the 2008 Typical Year rainfall and the 10-year continuous simulation. The Class I DO criteria are also predicted to be achieved for the preferred alternative. Therefore, a Use Attainability Analysis is not needed for the Harlem River.

8.3.j Time to Recovery

As noted above, the Harlem River is a Class I waterbody, with best uses identified as secondary contact recreation and fishing, and the applicable Water Quality Criteria for fecal coliform bacteria are based on a monthly geometric mean. However, to gain insight into the shorter-term impacts of wet-weather sources of bacteria, DEP has performed an analysis to assess the amount of time following the end of a rainfall event required for the Harlem River to recover and return to fecal coliform concentrations less than 1,000 cfu/100mL.

The analyses consisted of examining the WQ model-calculated bacteria concentrations in the Harlem River for recreational periods (May 1st through October 31st) abstracted from 10 years of model simulations. For the Harlem River, the JFK Airport rainfall data was compared against water quality model bacteria results for the 10 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. The chosen target threshold concentration was 1,000 cfu/100mL for fecal coliform. The various rainfall events were then placed into rain event size “bins” ranging from less than 0.1 inch to greater than 1.5 inches. Only rain events that reached the target threshold concentrations before the beginning of the next storm were included. The median time to recovery for each bin at each water quality station was calculated.

Table 8.3-19 presents the median time to recovery for the Recommended Plan for the Harlem River, for the storms in the greater than 1.0 to 1.5 inch rainfall bin, which includes the 90th percentile event. In other words, this rainfall bin covers approximately 90 percent of the rain events that would occur in an average year. Values are presented at the LTCP sampling stations, and the waterbody access locations.

DEC has advised that it seeks to have a time to recovery of less than 24 hours, and this target has been consistent in the previously approved LTCPs. As indicated in Table 8.3-19, under the Recommended Plan, none of the stations assessed had a median time to recovery greater than ten hours, and six of the ten locations had median times to recovery of 4 hours or less, indicating a quick recovery following greater than 90 percent of the storms.

Table 8.3-19. Harlem River Time to Recovery, Fecal Coliform, Recommended Plan

Location	Median Time to Recovery (hours) Fecal Coliform Threshold (1,000 cfu/100mL)(1)
HAR-1	2
HAR-2	3
HAR-3	4
HAR-4	6.5
HAR-5	6
HAR-6	0(2)
Muscota Marsh	2
Sherman Creek	4
Sharp Boathouse	5
Randall’s Island Park	9.5

Notes:

(1) Median time-to-recovery values presented for storms from the 10-year simulation, recreational seasons, in the size range of >1.0 to 1.5-inches of rainfall, which includes the 90th percentile rain event.

(2) Median time to recovery of “0” means that the average concentration across the water column never reached the 1,000 cfu/100mL threshold at the referenced station for more than half of the storms within the 1 to-1.5 inch rainfall bin assessed.

8.3.k Recommended LTCP Elements to Meet Water Quality Goals for Harlem River

The actions identified in this LTCP include:

- DEP will continue to implement the Green Infrastructure Program, including the Tibbetts Brook Daylighting project, and programmatic floatables control activities for the Harlem River.
- The Recommended Plan is predicted to achieve compliance with the Current WQ Criteria for bacteria on an annual basis based on both the 2008 Typical Year rainfall and the 10-year continuous simulation. The Class I DO criteria are also predicted to be achieved on an annual average basis for the Recommended Plan. As a result, a UAA is not required as part of this LTCP.
- DEP will establish with the DOHMH through public notification a wet-weather advisory during the recreational season (May 1st through October 31st), informing the public which recreational activities are not recommended in the Harlem River at that time. The LTCP includes a recovery time analysis that can be used to establish the duration of the wet-weather advisory for public notification.

DEP is committed to improving water quality in this waterbody, which will be advanced by the improvements and actions identified in this LTCP. These identified actions have been balanced with input from the public and awareness of the cost to the residents of NYC.

8.4 CSO Control Alternatives for Hudson River

As shown in Section 6, WQS for bacteria and dissolved oxygen are met in the Hudson River under Baseline Conditions. Therefore, attainment of WQS was not a factor in evaluating CSO control alternatives for the Hudson River. Rather, the focus was on evaluating alternatives for cost-effective reduction of CSO activations and volume. The CSO control alternatives that passed the initial screening phase and were retained for the Hudson River generally fell within the categories of system optimization and tunnel storage. System optimization alternatives covered the categories of fixed weirs, parallel interceptor/sewer, bending weirs or control gates, and gravity flow redirection to other watersheds. The storage tunnel alternatives, used to assess 25, 50, 75, and 100 percent CSO capture in the typical year, also included high-rate clarification for the dewatering flows from the tunnels. Storage tanks were not evaluated due to the number of outfalls and the general lack of available sites of sufficient size for storage tanks. Each control measure was initially evaluated on three of the key considerations described in Section 8.1: (1) benefits, as expressed by level of CSO control and WQS attainment; (2) costs; and (3) challenges, such as siting and operations. Using this methodology, the retained control measures listed in Section 8.1 were evaluated on a cost-performance basis and used to develop the basin-wide alternatives.

The Citywide/Open Waters Baseline Conditions include implementation of the Recommended Plans from the LTCPs for the tributary waterbodies previously submitted to DEC under this program, as well as other grey infrastructure projects implemented as part of earlier planning programs. Those projects are summarized in Section 4.

The following sections present the evaluations of the system optimization and tunnel storage alternatives for the Hudson River.

8.4.a System Optimization Alternatives

The approach to the initial identification and evaluation of system optimization alternatives for the Hudson River using the Optimatics Optimizer software was presented in Section 3. As described in Section 3, the Optimizer software was configured to prioritize monitored regulators discharging outside the period of critical wet -weather events, high-discharge frequency regulators, and regulators discharging in proximity to official and publicly-identified public access points (kayak launches/marinas).

The optimization alternatives for outfalls to the Hudson River associated with the Wards Island, North River, and Newtown Creek WRRF collection systems were evaluated independently, as the three systems are hydraulically independent. However, the Wards Island WRRF includes: combined sewer outfalls that discharge to the Harlem River, Bronx Kill, and East River; the North River WRRF system also includes combined sewer outfalls discharging to the Harlem River; and the Newtown Creek WRRF system includes combined sewer outfalls that discharge to the East River. Thus, the Hudson River optimization alternatives associated with the North River WRRF system need to be considered in conjunction with alternatives for the Harlem River outfalls associated with the North River WRRF system. Hudson River optimization alternatives associated with the Wards Island WRRF system need to be considered in conjunction with alternatives for the Harlem River, Bronx Kill, and East River outfalls associated with the Wards Island WRRF systems. Hudson River optimization alternatives associated with the Newtown Creek WRRF system need to be considered in conjunction with alternatives for the East River.

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The sections below present the evaluations of Hudson River optimization alternatives associated with the Wards Island, North River and Newtown Creek WRRF collections systems, respectively.

8.4.a.1 System Optimization for Hudson River Outfalls in the North River WRRF System

Table 8.4-1 summarizes the CSO outfalls and associated regulators tributary to the Hudson River from the North River WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.4-1. Table 8.4-1 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits ("BMP Regulator")
- A "Key Regulator" as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet of) a public access location
- Regulators that activated more than average for the waterbody

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full North River WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The North River WRRF is located along the Henry Hudson Parkway south of Hudson Riverbank State Park. The collection system primarily serves the western shoreline and northern tip of Manhattan. The southern interceptor begins at West 12th Street generally following Route 9A and Riverside Boulevard in a northerly direction towards the WRRF. The northern interceptor sewer parallels the Harlem River at its upstream end, crosses Manhattan along Isham Street and then bends to the south along the Henry Hudson Parkway (Route 9A) to the WRRF. A total of 55 regulators divert flow to the interceptors with 52 outfalls discharging to the Hudson River (39 CSOs) and Harlem River (13 CSOs).
- The WRRF collection system is relatively shallow (<10 feet of cover) at the upstream ends of each interceptor, but ranges from 15 to 25 feet of cover for most of the interceptor paralleling the Hudson River.
- Regulators contributing to CSO outfalls discharging to the Hudson River generally activate between 1 to 21 times during the typical year with a total average annual overflow volume (AAOV) of 366 MGY.
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface near the southern end of the interceptor, indicating that it is highly sensitive to hydraulic grade line impacts. However, the balance of the interceptor sewer along the Hudson River reaches depths over 100 feet in some areas with freeboard greater than 25 feet. These deeper sections provide opportunities to store and convey additional flow from optimized regulators and branch interceptors.
- The Optimizer modeling identified multiple alternatives that included modifications to as many as 10 regulators resulting in varying degrees of improved capture and hydraulic performance. Upon

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performing InfoWorks runs for the 2008 typical year, limited reductions in AAOV (approximately 1-2%) and activation frequency (approximately 4-8%) were predicted for the better performing alternatives.

- The relatively limited performance improvement was a result of a combination of hydraulic grade line sensitivities and hydraulic balancing. In this system, increasing flow to the interceptor system tended to create adverse impacts on the hydraulic grade line, potentially increasing the risk of flooding. Also, since the system was generally running full during wet-weather, alternatives that reduced CSO at one location tended to result in offsetting increases at other locations. While the interceptor has available storage capacity during smaller storms, the rise in grade line during the 5-year storm in the shallower upstream reaches of the interceptor exceeds the level of acceptable risk.

Table 8.4-1. Hudson River CSO Outfalls/Regulators Associated with the North River WRRF

Outfall	Regulator	Baseline Conditions Typical Year		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
NR-006	N-16	35.7	18	✓	✓	✓	
NR-004	N-18	4.9	10	✓	✓		
NR-043	N-23	45.4	10	✓	✓		
NR-040	N-26A	44.7	21	✓			✓
NR-038	N-28	5.6	8	✓		✓	
NR-037	N-29	0.9	4			✓	
NR-046	N-29A	7.4	12	✓			
NR-035	N-31	6.5	18			✓	
NR-033	N-33	19.4	10	✓	✓		
NR-032	N-36	0.7	6			✓	
NR-031	N-38	2.1	8			✓	
NR-030	N-39, 40	4.9	12			✓	
NR-027	N-45	69.8	11	✓			
NR-026	N-46	13.9	19			✓	✓
NR-023	N-50	20.1	10	✓		✓	
NR-022	N-51	6.5	10			✓	

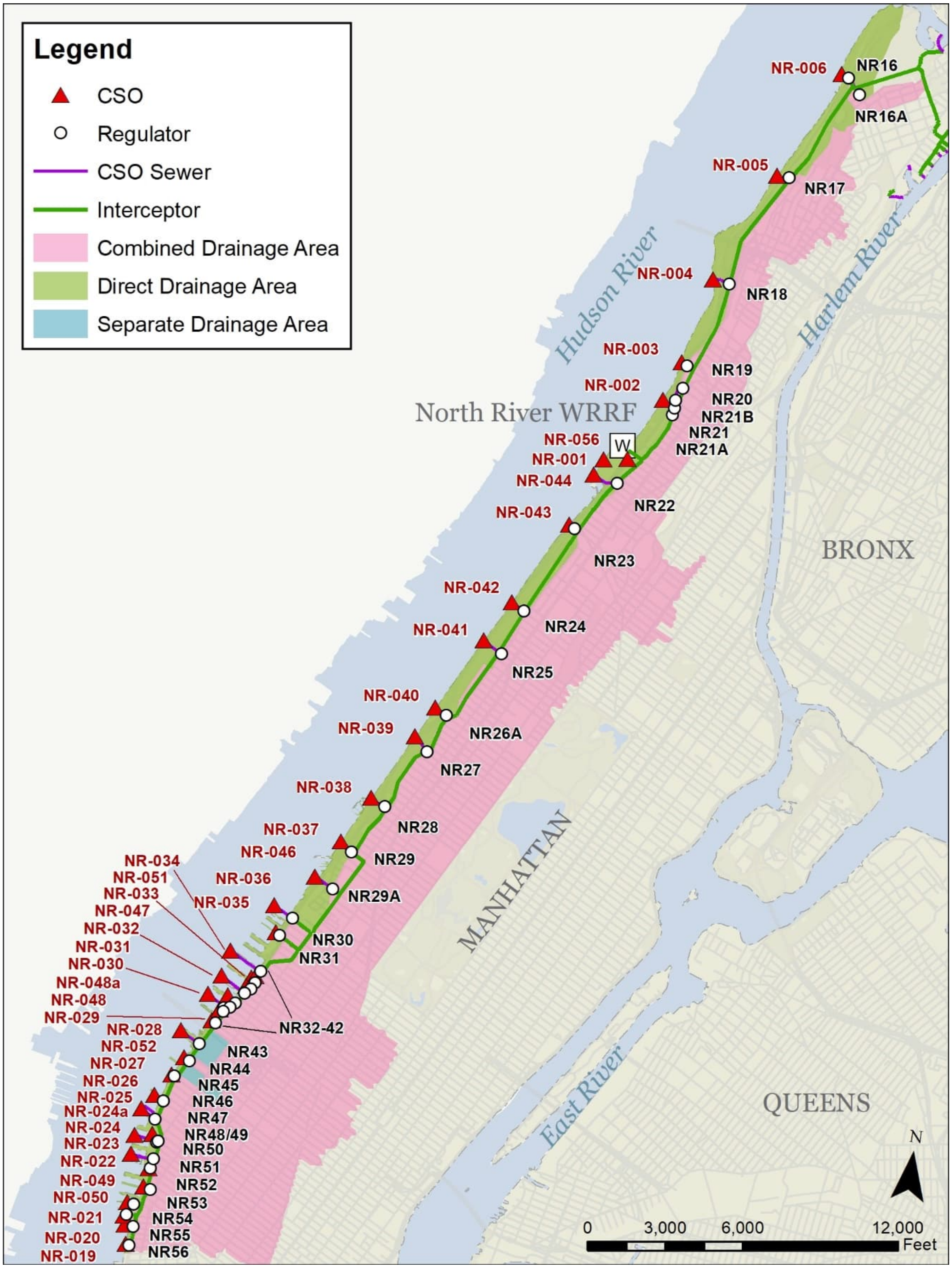

Figure 8.4-1. CSO Outfalls/Regulators Tributary to Hudson River from the North River WRRF System

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Follow-up Evaluations Based on Full InfoWorks Model

The most promising optimization alternatives coming out of the Optimizer evaluations are summarized in Table 8.4-2:

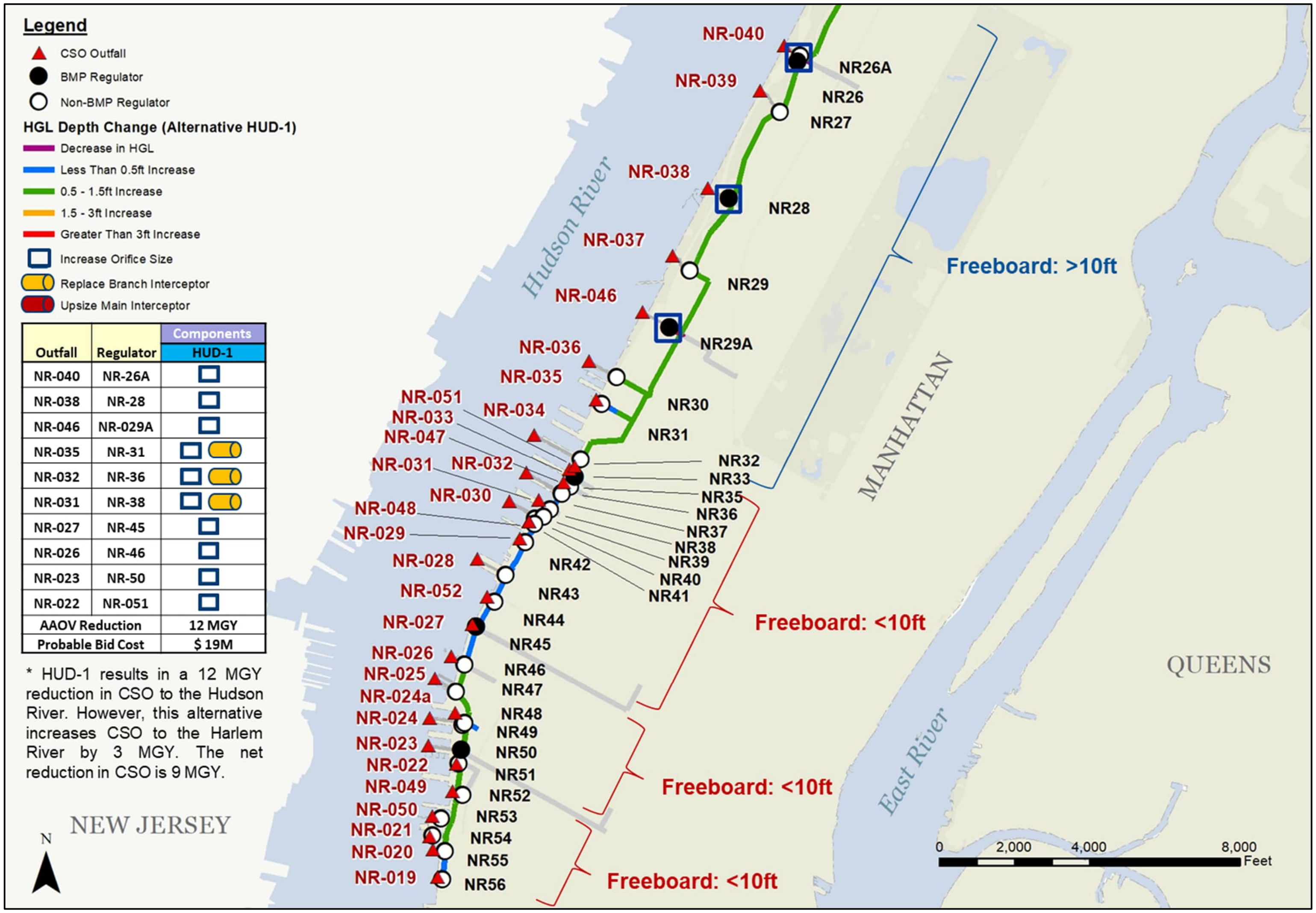
Table 8.4-2. Hudson River Optimization Components for Retained Alternatives

Outfall	Regulator	Components	
		HUD-1	HUD-2
NR-040	NR-26A	□	□
NR-038	NR-28	□	□
NR-046	NR-029A	□	□
NR-035	NR-31	□ ⬭	
NR-032	NR-36	□ ⬭	
NR-031	NR-38	□ ⬭	
NR-027	NR-45	□	
NR-026	NR-46	□	
NR-023	NR-50	□	
NR-022	NR-051	□	
AAOV Reduction		12 MGY	10 MGY
Probable Bid Cost		$ 19M	$ 3M

KEY

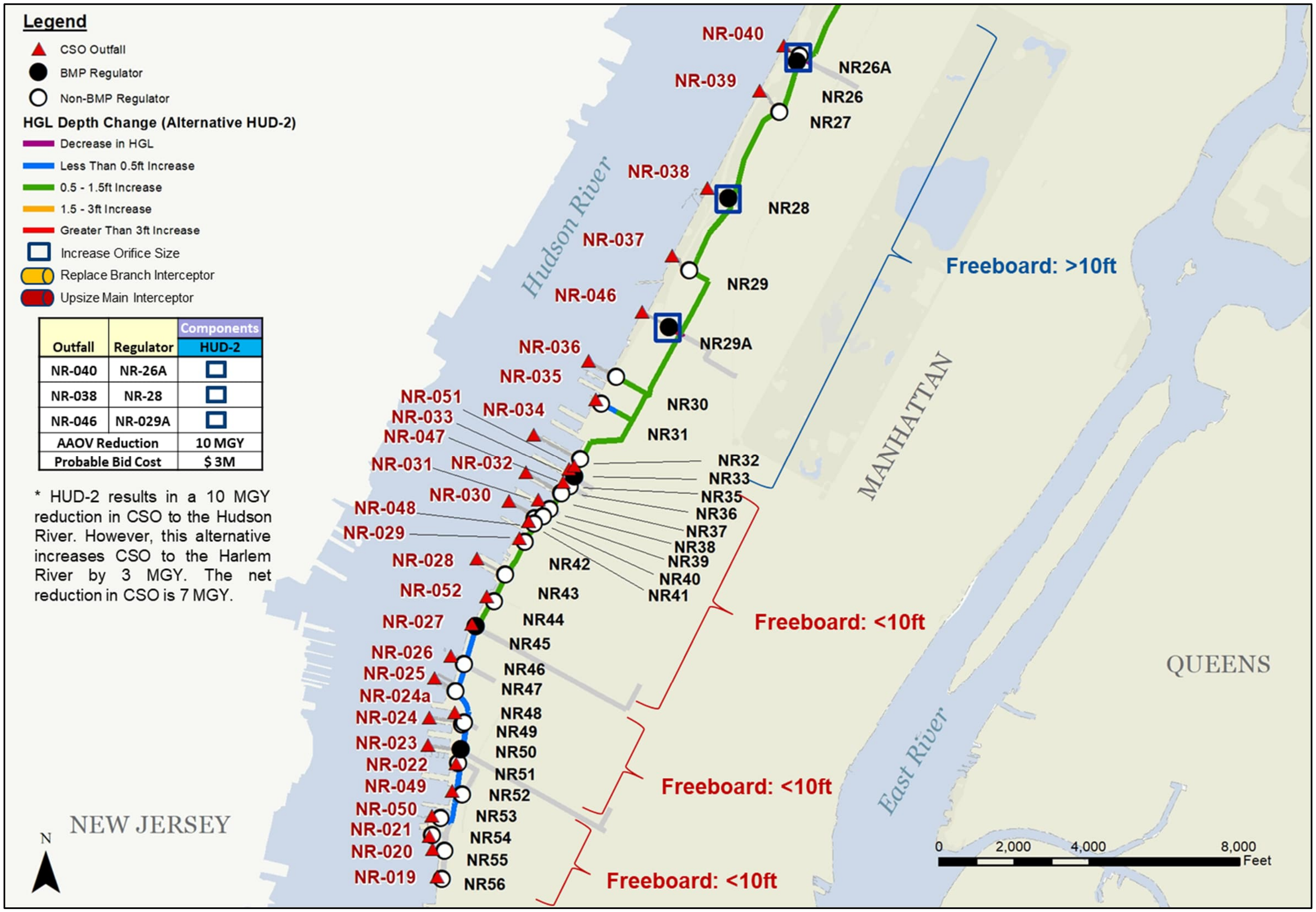
- □ Increase Orifice Size
- ⏢ Raise Weir
- ⬭ Replace Branch Interceptor
- ⬭ Upsize Main Interceptor

These alternatives were further analyzed in more detail using the full North River WRRF system InfoWorks model. The resulting impacts of Alternatives HUD-1 and HUD-2 on peak hydraulic grade line in the 5-year storm are summarized in Figure 8.4-2 and Figure 8.4-3, respectively. The annual CSO volume and frequency for these optimization alternatives are summarized in Table 8.4-3 and estimated probable bid costs and construction/implementation considerations are summarized in Table 8.4-4.



Outfall	Regulator	Components HUD-1
NR-040	NR-26A	Increase Orifice Size
NR-038	NR-28	Increase Orifice Size
NR-046	NR-029A	Increase Orifice Size
NR-035	NR-31	Increase Orifice Size; Replace Branch Interceptor
NR-032	NR-36	Increase Orifice Size; Replace Branch Interceptor
NR-031	NR-38	Increase Orifice Size; Replace Branch Interceptor
NR-027	NR-45	Increase Orifice Size
NR-026	NR-46	Increase Orifice Size
NR-023	NR-50	Increase Orifice Size
NR-022	NR-051	Increase Orifice Size
AAOV Reduction		12 MGY
Probable Bid Cost		$ 19M

Figure 8.4-2. Hydraulic Grade Line Impacts of Alternative HUD-1 vs. Baseline Conditions, 5-Year



Outfall	Regulator	Components HUD-2
NR-040	NR-26A	☐
NR-038	NR-28	☐
NR-046	NR-029A	☐
AAOV Reduction		10 MGY
Probable Bid Cost		$ 3M

Figure 8.4-3. Hydraulic Grade Line Impacts of Alternative HUD-2 vs. Baseline Conditions, 5-Year Storm

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Table 8.4-3. Summary of Performance of North River Optimization Alternatives for Hudson River

Outfall[(1)]	Regulator	Baseline Conditions Typical Year		Alternative HUD-1[(2)]		Alternative HUD-2[(3)]	
		Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
NR-006	N-16	35.7	18	38.6	18	38.3	18
NR-004	N-18	4.9	10	4.9	10	4.9	10
NR-043	N-23	45.4	10	51.0	11	50.7	11
NR-040	N-26A	44.7	21	32.1	12	12.8	9
NR-038	N-28	5.6	8	2.4	3	2.4	3
NR-037	N-29	0.9	4	1.1	5	1.1	5
NR-046	N-29A	7.4	12	0.6	1	0.6	1
NR-035	N-31	6.5	18	5.3	6	7.0	18
NR-033	N-33	19.4	10	21.2	10	21.7	10
NR-032	N-36	0.7	6	1.8	6	1.1	6
NR-031	N-38	2.1	8	3.8	6	2.5	8
NR-030	N-39, 40	4.9	12	5.5	12	5.5	12
NR-027	N-45	69.8	11	83.6	10	77.2	11
NR-026	N-46	13.9	19	9.3	10	14.9	19
NR-023	N-50	20.1	10	18.5	9	23.1	11
NR-022	N-51	6.5	10	6.9	10	7.4	12
Total		**366**	**400**	**354**	**363**	**356**	**385**

Notes:
(1) Outfalls and regulators with negligible impacts to Annual CSO Volume and Activations are not included in this table.
(2) HUD-1 reduces CSO volume to the Hudson River by 12 MGY, but increases CSO volume to the Harlem River by 3 MGY, resulting in a net reduction of 9 MGY. Total activations of Hudson River CSOs are reduced by 37 per year, while Harlem River CSO activations are increased by 5 per year.
(3) HUD-2 reduces CSO volume to the Hudson River by 10 MGY, but increases CSO volume to the Harlem River by 3 MGY, resulting in a net reduction of 7 MGY. Total activations of Hudson River CSOs are reduced by 15 per year, while Harlem River CSO activations are increased by 4 per year.

Table 8.4-4. Summary of Cost and Implementation Considerations for North River Optimization Alternatives for Hudson River

Alternative	Probable Bid Cost ($M)	Implementation Considerations
HUD-1	$19M	Net reduction in CSO is 9 MGY. Projected to reduce CSO by 12 MGY to the Hudson River with a 3 MGY increase in CSO to the Harlem River.
HUD-2	$3M	Net reduction in CSO is 7 MGY. Projected to reduce CSO by 10 MGY to the Hudson River with a 3 MGY increase in CSO to the Harlem River.

Given the relatively cost-effective potential reduction in CSO activation frequency and volume for Alternatives HUD-1 and HUD-2, both alternatives were retained for further consideration.

8.4.a.2 System Optimization for Hudson River Outfalls in the Wards Island WRRF System

Table 8.4-5 lists the CSO outfalls and associated regulators tributary to the Hudson River from the Wards Island WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.4-4. Table 8.4-5 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits (“BMP Regulator”)
- A “key regulator” as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet of) a public access location
- Regulators that activated more than average for the waterbody

Table 8.4-5. Hudson River CSO Outfalls/Regulators Associated with the Wards Island WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
WIB-053	WI-79	46.3	50				✓
WIB-054	WI-78	31.7	39				✓
WIB-055	WI-77	19.5	54				✓

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Wards Island WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Wards Island WRRF collection system serves the northeast side of Manhattan and western Bronx. The Manhattan interceptor parallels the Harlem River Drive, while the Bronx Interceptor initially parallels the Hudson River along Palisades Avenue, then bends eastward along the Harlem River and then to the south generally following the Major Deegan Expressway. A total of 75 regulators divert flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to the Hudson River (3 CSOs), Harlem River (50 CSOs), Bronx Kill (3 CSOs) and East River (19 CSOs). The interceptor sewers convey flow to the Wards Island WRRF located to the south and east of Randall's Island Park.
- The topography at the north end of the WRRF collection system is undulating and is served by three pumping stations (West 254th Street PS, West 248th Street PS and West 235th Street PS). A regulator is also located at each pumping station to control the peak wet-weather flows diverted to each pumping station.
- The sewers tributary to each regulator are relatively steep due to the topography. Depth of cover on the gravity sewers varies, ranging from relatively shallow (<10 feet of cover) to about 40 feet.
- Regulators contributing to CSO outfalls discharging to the Hudson River activate between 39 to 54 times during the typical year with a total AAOV of 98 MGY.
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface, indicating the system is highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified multiple alternatives that included modifications to as many as 25 regulators throughout the WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year, limited reductions in AAOV (<1.5%) and activation frequency (<2.5%) were predicted for the better performing alternatives.
- The limited performance improvement was a result of the hydraulic grade line sensitivities and the capacity of each pumping station.

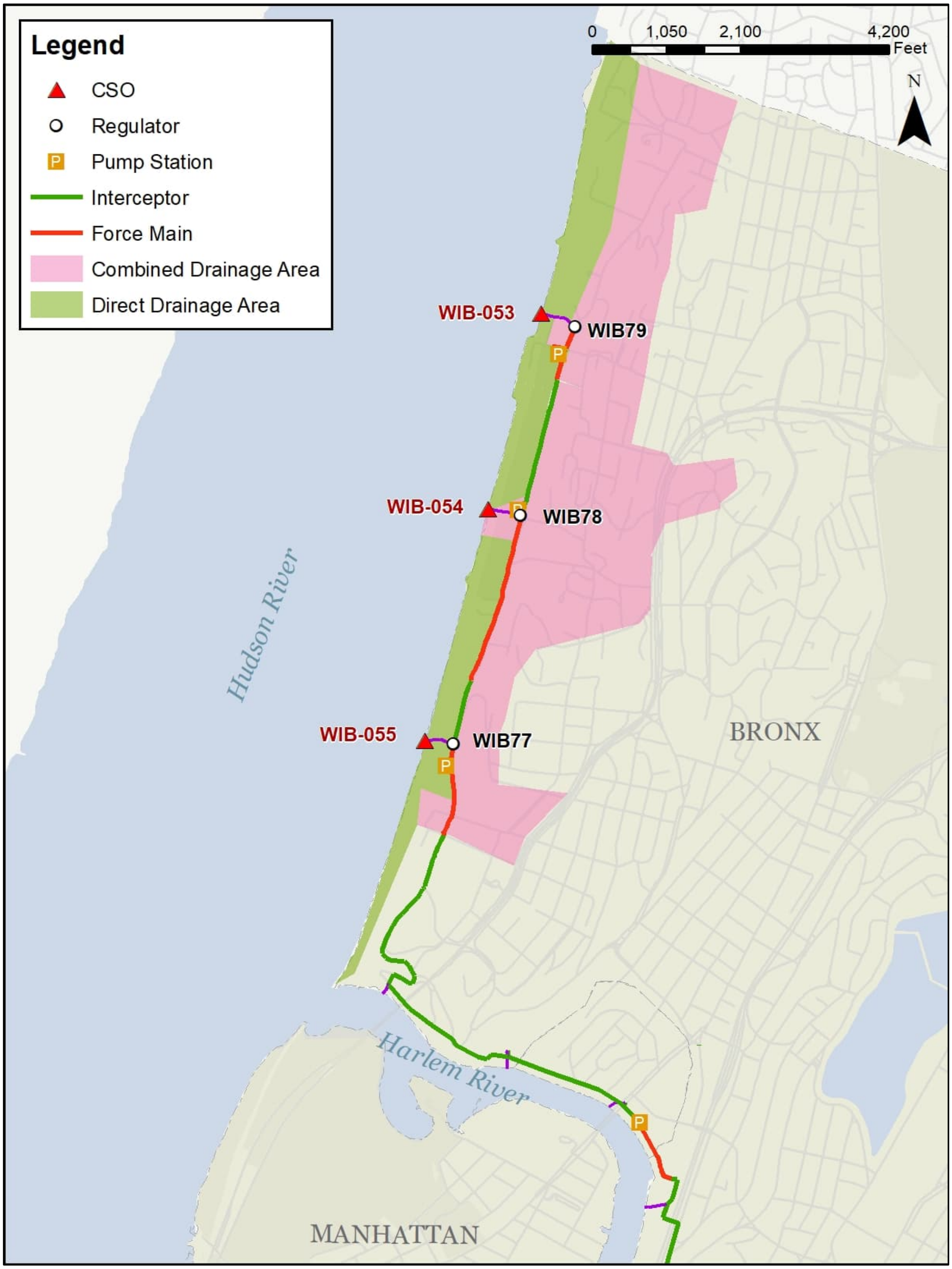

Figure 8.4-4. CSO Outfalls/Regulators Tributary to Hudson River from the Wards Island WRRF System

<u>Follow-up Evaluations Based on Full InfoWorks Model</u>

InfoWorks model runs were performed to evaluate the pumping station capacity upgrades necessary to reduce CSO volume and activation at each of the three pumping stations. Pumping station capacities were increased in 50-percent increments up to two times the existing pumping station capacity. Results of the analysis are summarized in Table 8.4-6. While volumes and frequencies were reduced at each of the outfalls associated with these pumping stations, the volumes and frequencies of overflow at downstream outfalls increased. The re-balancing of wet-weather flow within the interceptor system resulted in a transfer of CSO discharges from the Hudson River to the Harlem River. Upon looking at the total volume of CSO discharged during the 2008 typical year for each of these scenarios, the volumes were found to increase as the pumping station capacities were increased. As these alternatives produced no net reduction in CSO volume, they were eliminated from further consideration.

Table 8.4-6. Summary of Pumping Station Capacity Upgrade Evaluation for Wards Island WRRF System

Outfall	Regulator	Baseline Conditions		1.5X PS Capacity Increase		2.0X PS Capacity Increase	
		Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
W. 254th St. PS		**1.0 MGD**		**1.5 MGD**		**2.0 MGD**	
WI-053	WI-79	46.3	50	39.8	47	34.8	42
W. 248th St. PS		**2.9 MGD**		**4.3 MGD**		**5.8 MGD**	
WI-054	WI-78	31.7	39	24.3	34	19.2	29
W. 235th St. PS		**3.5 MGD**		**5.3 MGD**		**7.0 MGD**	
WI-055	WI-77	19.5	54	14.8	49	11.7	38
Total Hudson River		**97.5**	**143**	**78.9**	**130**	**65.7**	**109**
Impacted Downstream Regulators/Outfalls							
WI-076	WI-76	58.5	42	74.2	41	86.1	43
WI-077	WI-75	81.2	38	84.0	40	85.7	40
WI-078	WI-75	34.5	41	35.4	42	35.9	42
Total Harlem River		**174.2**	**121**	**193.6**	**123**	**207.7**	**125**
Total		**271.7**	**264**	**272.5**	**253**	**273.4**	**234**

8.4.a.3 System Optimization for Hudson River Outfalls in the Newtown Creek WRRF System

Table 8.4-7 summarizes the CSO outfalls and associated regulators tributary to the Hudson River from the Newtown Creek WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.4-5. Table 8.4-7 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits (“BMP Regulator”)
- A “key regulator” as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet of) a public access location
- Regulators that activated more than average for the waterbody

Table 8.4-7. Hudson River CSO Outfalls/Regulators Associated with the Newtown Creek WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
NCM-070	NCM-9	8.4	21				✓
NCM-071	NCM-6, 7	8.1	19				✓
NCM-072	NCM-5	9.2	12			✓	
NCM-074	NCM-3	10.9	15			✓	
NCM-075	NCM-2	77.8	21	✓		✓	✓
NCM-076	NCM-1	225.3	47	✓		✓	✓

Note:
(1) Outfalls and regulators with negligible impacts to Annual CSO Volume and Activations are not included in this table.

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Newtown Creek WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Manhattan part of the Newtown Creek WRRF collection system serves the southern end of Manhattan. The southern branch of the Manhattan interceptor starts in the vicinity of Outfall NCM-081, and runs south parallel to the Hudson River shoreline. The interceptor continues around the southern tip of Manhattan, then runs north parallel to the East River, to the Manhattan Pumping Station. The northern branch of the Manhattan Interceptor runs south from approximately East 71st Street, parallel to the East River shoreline, to the Manhattan Pumping Station. A total of 63 regulators divert flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to the Hudson River (9 CSOs), and East River (49 CSOs). The interceptor sewers convey flow to the Manhattan Pumping Station, where flow is pumped across the East River to the Newtown Creek WRRF.
- Depth of cover on the interceptor varies, ranging from relatively shallow (<10 feet of cover) at the upstream end to greater than 20 feet.
- Regulators contributing to CSO outfalls discharging to the Hudson River activate between 6 to 47 times during the typical year with a total AAOV of 370 MGY.
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the system is highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified multiple alternatives that included modifications to as many as 11 regulators throughout the Manhattan side of the WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year, limited reductions in AAOV (<3%) and activation frequency (<2%) were predicted for the better performing alternatives.
- The relatively limited performance improvement was a result of a combination of hydraulic grade line sensitivities and hydraulic balancing. In this system, increasing flow to the interceptor system tended to create adverse impacts on the hydraulic grade line, potentially increasing the risk of flooding. Also, since the system was generally running full during wet-weather, alternatives that reduced CSO at one location tended to result in offsetting increases at other locations. While the interceptor has available storage capacity during smaller storms, the rise in grade line during the 5-year storm into the shallower upstream reaches of the interceptor exceeds the level of acceptable risk.

Figure 8.4-5. CSO Outfalls/Regulators Tributary to Hudson River from the Newtown Creek WRRF System

Follow-up Evaluations Based on Full InfoWorks Model

As noted above, the best-performing alternatives coming out of the Optimizer evaluations resulted in very limited improvement in either CSO volumes or activations. When these alternatives were evaluated using the full InfoWorks model, these alternatives resulted in unacceptable increases in the peak hydraulic grade line in the upstream end of the interceptor during the 5-year storm. Therefore, these alternatives were not retained for further evaluation.

8.4.b Storage Tunnel Alternatives for 25/50/75/100 Percent CSO Control

Conceptual storage tunnel alternatives were developed to model potential 25, 50, 75, and 100 percent control of the annual CSO volume discharged to the Hudson River in the 2008 Typical Year. The approach to sizing and layout of the storage tunnel alternatives was as follows:

- For the 50 percent CSO control tunnel, the Typical Year annual overflow volume of each CSO outfall to the Hudson River was reviewed and combinations of outfalls were identified where capture of 100 percent of the CSO from those outfalls would approximately match 50 percent of the total CSO volume from all outfalls to the Hudson River.
- The locations of these outfalls were then assessed in relation to the length and diameter of tunnel needed to capture the outfalls.
- Based on DEP expertise, a combination of outfalls was selected that provided reasonable tunnel length/diameter to provide 50 percent CSO volume capture.
- A similar approach was taken for the 75 percent CSO control tunnel.
- For the 25 percent CSO control tunnel, the 50 percent CSO tunnel was downsized until the volume of storage provided would result in approximately 25 percent CSO control.
- For the 100 percent CSO control tunnel, it was assumed that every CSO outfall to the Hudson River that was predicted to be active in the 2008 Typical Year would be tied into the tunnel. Where multiple outfalls were located in close proximity to each other, it was assumed that a near-surface consolidation conduit would be provided to a single drop shaft.
- For each of these alternatives, the dewatering rate required to dewater the storage tunnel within 24 hours was compared to the available dry-weather flow capacity in the WRRF closest to the downstream end of the tunnel. If insufficient dry-weather flow capacity was available at the WRRF to accept the additional dewatering flows, a high-rate clarification wet-weather flow treatment system with disinfection was added to the alternative to treat the dewatered flow.
- A detailed siting assessment was not conducted, so the specific locations of various features of the tunnel alternatives (mining shaft, TBM removal shaft, drop shafts, dewatering pumping station, dewatered flow treatment facility, near-surface diversion structures/connection conduits) were not identified.

The main features of the 25, 50, 75, and 100 percent CSO control storage tunnels modeling scenarios for the Hudson River are summarized in Table 8.4-8. Figure 8.4-6 to Figure 8.4-9 present conceptual layouts of the storage tunnel alternatives.

Table 8.4-8. Summary of 25, 50, 75 and 100 Percent CSO Control Alternatives for the Hudson River

Alternative	HUD-3	HUD-4	HUD-5	HUD-6
Level of CSO Control(1)	**25%**	**50%**	**75%**	**100%**
Length (mi.)	2.3	7.0	10.9	14.8
Diameter (ft.)	14	19	18	18
Volume (MG)	14	79	114	142
Outfalls Captured	• NCM-075 • NCM-076	• NCM-075 • NMC-076 • NR-023 • NR-027 • NR-043	2 NCM outfalls and 15 NR outfalls	All CSO Outfalls to Hudson River (52 Total)
Net CSO Volume Reduction (MGY)	209	438	613	833
Wet-Weather Flow Treatment Facility Capacity for Dewatering Flow (MGD)	14	79	114	142
Estimated Probable Bid Cost(2)	$600M	$1,500M	$2,900M	$5,200M

Notes:
(1) Modeled annual percent CSO reduction based on the 2008 Typical Year.
(2) 2019 dollars.

The 25 percent CSO capture tunnel would capture overflow from Outfalls NCM-075 and NCM-076 (Figure 8.4-6). The distance between those outfalls is relatively short (approximately 2,000 feet). Therefore, a tunnel to provide 25-percent CSO capture would likely start at a mining shaft some distance north of Outfall NCM-076, and terminate at an equipment removal/drop shaft at Outfall NCM-075. For this exercise, the tunnel length was assumed to be approximately 12,000 feet long, which would result in a diameter of 14 feet. A shorter tunnel with larger diameter or a longer tunnel with smaller diameter could also be considered. The 50 percent CSO capture tunnel would start from a mining shaft located in the vicinity of Outfall NR-043, south of the North River WRRF, and run generally under or along the shoreline of the Hudson River south to a TBM retrieval shaft/drop shaft in the vicinity of Outfall NCM-075 (Figure 8.4-7). Additional drop shafts would be provided in the vicinity of Outfalls NCM-076, NR-023, and NR-027. The 75 percent CSO capture tunnel would follow a similar route, but would extend further north to the vicinity of Outfall NR-006, and would capture the additional outfalls listed in Table 8.4-8 (Figure 8.4-8). The mining shaft for this tunnel could be located near Outfall NR-006, or could be located near the North River WRRF, with the tunnel bored in both directions from that mining shaft. The 100 percent CSO control tunnel would run along a route similar to the 75 percent CSO capture tunnel, but would extend to Outfall NCM-071 in the south, and to Outfall WIB-053, north of the Harlem River (Figure 8.4-9). Multiple near-surface consolidation conduits would be provided to convey flow from adjacent outfalls to common drop shafts, and the tunnel would capture all of the CSO from all of the Hudson River CSO outfalls in the 2008 typical year.

The closest WRRF to the mining shaft for the tunnel storage alternatives would be the North River WRRF. However, a dedicated wet-weather high-rate treatment facility would be necessary for the treatment of the CSO retained in the storage tunnel.

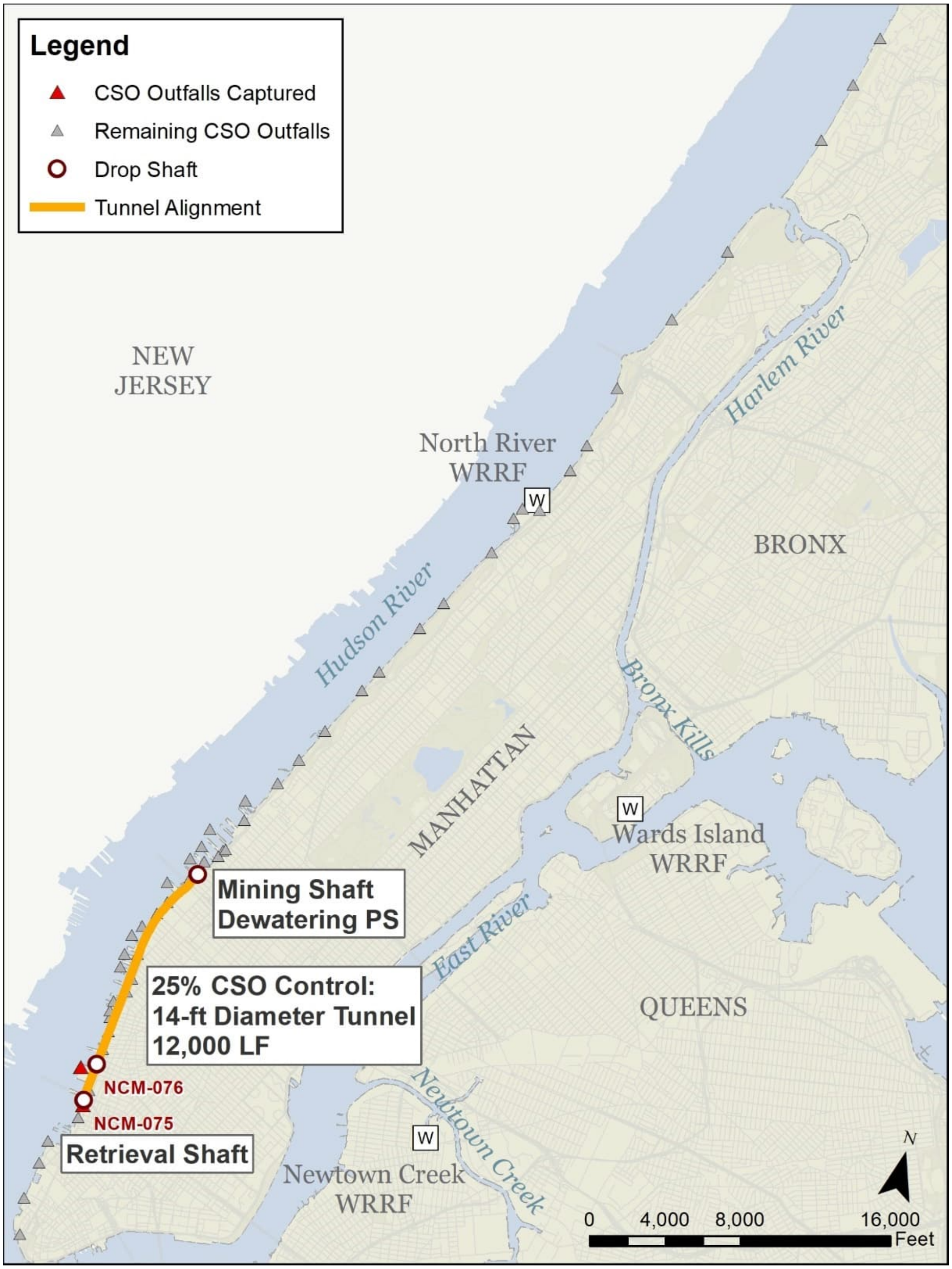

Figure 8.4-6. 25 Percent CSO Control Tunnel for Hudson River

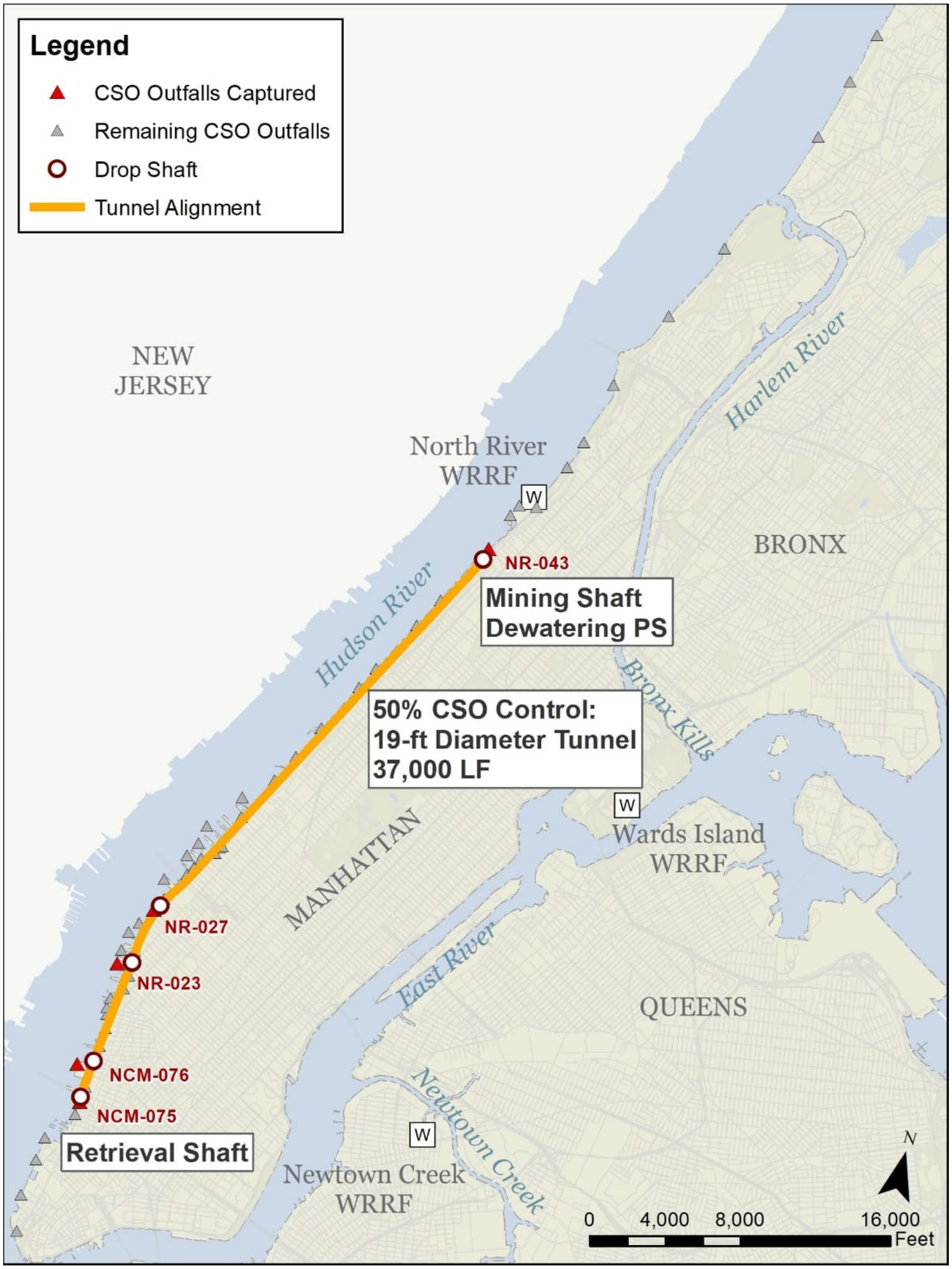

Figure 8.4-7. 50 Percent CSO Control Tunnel for Hudson River

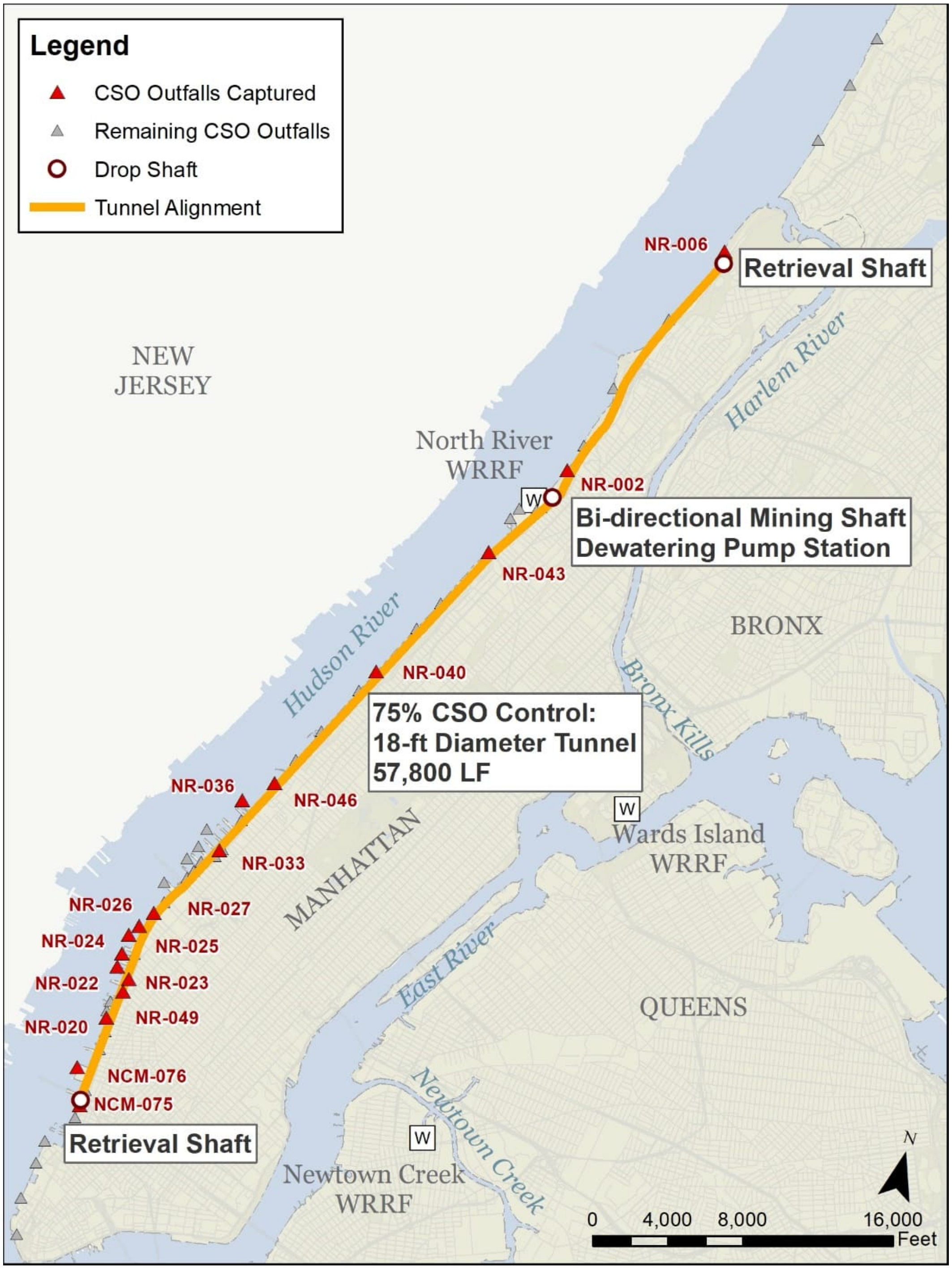

Figure 8.4-8. 75 Percent CSO Control Tunnel for Hudson River

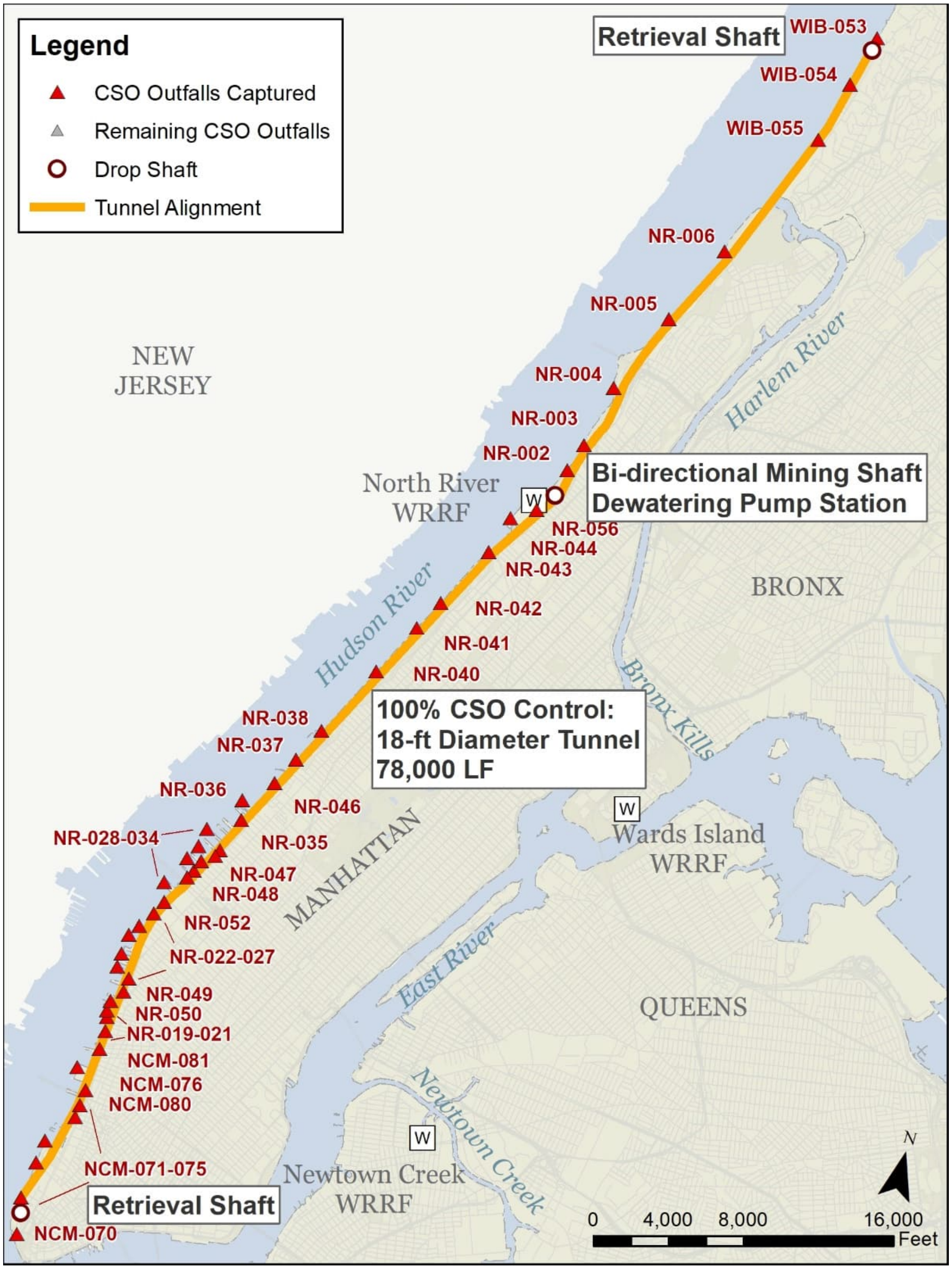

Figure 8.4-9. 100 Percent CSO Control Tunnel for Hudson River

Table 8.4-9. Summary of CSO Control Measure Screening for Hudson River

Control Measure	Category	Retained for Further Analysis?	Remarks
Additional GI Build-out	Source Control	NO(1)	Planned GI build-out in the watershed is included in the baseline. It is unlikely that additional sites will be identified due to site constraints in publicly owned properties.
High Level Storm Sewers	Source Control	NO(1)	No cost-effective opportunities identified
Regulator Modifications	System Optimization	YES	Incorporated into optimization alternatives HUD-1, HUD-2
Parallel Interceptor Sewer	System Optimization	YES	Incorporated into optimization alternatives HUD-1, HUD-2.
Bending Weirs/Control Gates	System Optimization	NO	No cost-effective or constructible site opportunities were identified
Pumping Station Optimization	System Optimization	NO	Limited benefit in terms of CSO reduction.
Pumping Station Expansion	System Optimization	NO	Limited benefit in terms of CSO reduction.
Gravity Flow Redirection to Other Watersheds	CSO Relocation	YES	Optimization Alternatives HUD-1 and HUD-2 shift some CSO volume between Harlem and Hudson River
Pumping Station Modification	CSO Relocation	NO	No cost-effective opportunities identified.
Flow Redirection with Conduit and Pumping	CSO Relocation	NO	No cost-effective opportunities identified.
Floatables Control	Floatables Control	YES	Programmatic floatables control will be applied and expanded Citywide
Environmental Dredging	Water Quality/ Ecological Enhancement	NO	No specific locations of CSO sediment mounding identified.
Wetland Restoration and Daylighting	Water Quality/ Ecological Enhancement	NO	No daylighting opportunities were identified.
Outfall Disinfection	Treatment: Satellite	NO	Not feasible due to short length of outfalls.
Retention/Treatment Basins	Treatment: Satellite	NO	Significant siting constraints and very high costs. Tunnel storage covers 25/50/75/100% CSO control alternatives.
High-Rate Clarification	Treatment: Satellite	YES	Incorporated into the storage tunnel alternatives for treatment of captured CSO during tunnel dewatering.
WRRF Expansion	Centralized Treatment	NO	Insufficient space available. Limited benefit compared to potential cost.
In-System Storage (Outfalls)	Storage	NO	Negligible levels of CSO control due to short outfalls.
Off-line Storage (Tanks)	Storage	NO	Significant siting constraints and very high costs. Tunnel storage covers 25/50/75/100% CSO control alternatives.
Off-line Storage (Tunnels)	Storage	YES	Tunnel storage alternatives HUD-3, HUD-4, HUD-5 and HUD-6 cover 25/50/75/100% CSO control.

Note:

(1) Additional GI and HLSS are considered to be ongoing programs that will continue to be implemented system-wide outside of the LTCP program.

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While these alternatives provide relatively high levels of CSO control, the significant challenges to implementation include:

- Very high implementation cost
- Limited siting availability for shafts, dewatering pumping station, dewatering flow treatment facility
- Long implementation period
- Significant and prolonged construction impacts (truck traffic, noise, dust) for surface consolidation sewers due to the large number of drop shafts necessary to divert CSO to the tunnel
- Negligible improvement in the annual attainment of applicable water quality standards
- Construction impacts and likelihood of utility conflicts for near-surface diversion structures and connecting conduits

Despite these challenges, these alternatives were retained in order to provide an assessment of a range of levels of CSO control for the Hudson River, in accordance with the CSO Control Policy and the Clean Water Act guidance.

8.4.c Summary of Retained Alternatives for Hudson River

The goal of the previous evaluations was to develop a list of retained control measures for the Hudson River. These control measures, whether individually or in combination, form the basis of basin-wide alternatives to be assessed using more rigorous cost-performance and cost-attainment analyses. Table 8.4-8 lists all of the control measures originally identified in the "Alternatives Toolbox" shown above in Table 8.4-9, and identifies whether the control measure was retained for further analysis. The reasons for excluding the non-retained control measures from further consideration are also noted in the table.

As shown, the retained control measures include system optimization measures, tunnel storage (with high-rate clarification for dewatering flows), and programmatic floatables control.

8.4.d CSO Volume and Loading Reductions for Retained Alternatives for Hudson River

Table 8.4-10 summarizes the projected performance of the retained Hudson River alternatives in terms of annual CSO volume and fecal coliform load reduction, based on the 2008 Typical Year. These data are plotted on Figure 8.4-10. In all cases, the predicted reductions shown are relative to the Baseline Conditions using 2008 JFK rainfall as described in Section 6. The baseline assumptions were described in detail in Section 6 and include the implementation of the grey infrastructure projects from the approved WWFPs, the Recommended Plans from the previously-submitted LTCPs, and the projected level of GI identified in Section 5.

Table 8.4-10. Hudson River Retained Alternatives Performance Summary (2008)

Alternative	Annual Performance Based on 2008 Typical Year				
	Remaining CSO Volume (MGY) (1)	Frequency of Overflow (2)	Additional CSO Volume to Other Waterbodies (MGY) (3)	Net CSO Volume Reduction (%)	Net Fecal Coliform Reduction (%)
Baseline Conditions	833	54	-	-	-
HUD-1. Optimization of Regulators Associated with Outfalls NR-022, 023, 026, 027, 031, 032, 035, 038, 040	821	54	3	1	1
HUD-2. Optimization of Regulators Associated with Outfalls NR-038, 040 and 046	823	54	3	1	1
HUD-3. Tunnel Storage for 25% CSO Control (14 MG Capacity)	624	54	0	25	25
HUD-4. Tunnel Storage for 50% CSO Control (79 MG Capacity)	395	54	0	53	53
HUD-5. Tunnel Storage for 75% CSO Control (114 MG Capacity)	220	54	0	74	74
HUD-6. Tunnel Storage for 100% CSO Control (142 MG Capacity)	0	0	0	100	100

Notes:

(1) Remaining CSO includes all discharges to the Hudson River from the Newtown Creek, North River, and Wards Island WRRF Collection Systems.

(2) Frequency of overflow is based upon the most frequently active CSO outfall.

(3) Additional CSO volume to other waterbodies accounts for increases at other CSO outfalls in response to the implementation of a CSO control alternative. Net CSO volume reduction and net fecal coliform reduction account for any additional CSO discharge to other waterbodies.

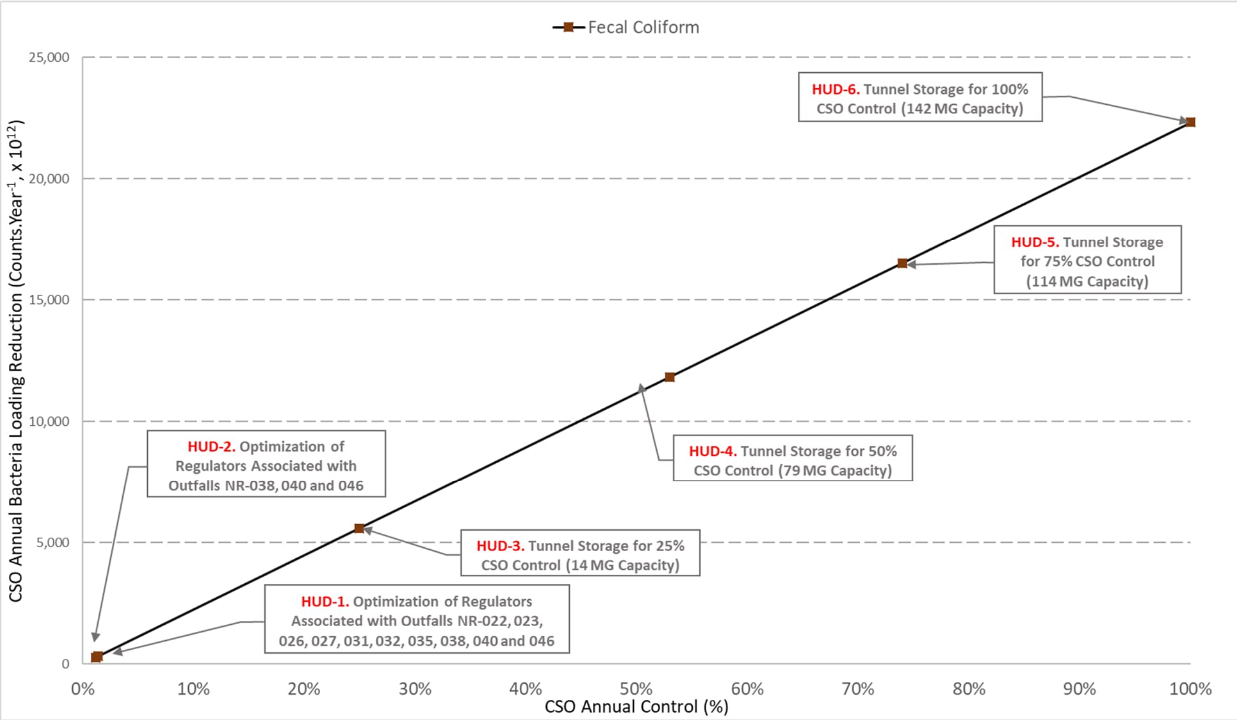

Figure 8.4-10. Untreated CSO Volume Reductions (as Percent CSO Annual Control) vs. Annual CSO Bacteria Loading Reduction (2008 Typical Year)

Because the retained alternatives for the Hudson River provide volume reduction and not treatment, the predicted bacteria loading reductions of the alternatives are very closely aligned with their projected CSO volume reductions.

8.4.e Cost Estimates for Hudson River Retained Alternatives

Evaluation of the retained alternatives requires cost estimation. The methodology for developing these costs is dependent upon the type of technology and its operation and maintenance (O&M) requirements. The construction costs were developed as Probable Bid Cost (PBC) and the total Net Present Worth (NPW) costs were determined by adding the estimated PBC to the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 100-year life cycle. Design, construction management, and land acquisition costs are not included in the cost estimates. All costs are in 2019 dollars and are considered Level 5 cost estimates by AACE International with an accuracy of -50 percent to +100 percent.

8.4.e.1 Alternative HUD-1. Optimization of Outfalls NR-022, NR-023, NR-026, NR-027, NR-031, NR-032, NR-035, NR-038, NR-040, NR-046.

Costs for Alternative HUD-1 include planning-level estimates of the costs to modify regulators associated with Outfalls NR-022, NR-023, NR-026, NR-027, NR-031, NR-032, NR-035, NR-038, NR-040, and NR-046 and reflect the description provided in Section 8.4.a. Site acquisition costs are not included. As this alternative is limited to modifications to regulator orifices and branch interceptor replacement, there is no impact to existing operation and maintenance costs. The total cost, expressed as NPW, for Alternative HUD-1 is $20M as shown in Table 8.4-11.

Table 8.4-11. Estimated Costs for Alternative HUD-1

Item	2019 Cost ($ Million)
Probable Bid Cost	$19
Annual O&M Cost	$0
Net Present Worth	$19

8.4.e.2 Alternative HUD-2. Optimization of Outfalls NR-038, NR-040, and NR-046.

Costs for Alternative HUD-2 include planning-level estimates of the costs to modify regulators associated with Outfalls NR-038, NR-040, and NR-046 and reflect the description provided in Section 8.4.a. Site acquisition costs are not included. As this alternative consists of modifications to the orifices in three existing regulators, there is no impact to existing operation and maintenance costs. The total cost, expressed as NPW, for Alternative HUD-2 is $3M as shown in Table 8.4-12.

Table 8.4-12. Estimated Costs for Alternative HUD-2

Item	2019 Cost ($ Million)
Probable Bid Cost	$3
Annual O&M Cost	$0
Net Present Worth	$3

8.4.e.3 Alternative HUD-3. Tunnel Storage for 25 Percent CSO Control

Costs for Alternative HUD-3 include planning-level estimates of the costs for a CSO storage tunnel sized for 25 percent CSO control. A description of the optimization components is provided in Section 8.4.b and illustrated in Table 8.4-9. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HAR-3 is $700M as shown in Table 8.4-13.

Table 8.4-13. Estimated Costs for Alternative HUD-3

Item	2019 Cost ($ Million)
Probable Bid Cost	$600
Annual O&M Cost	$5
Net Present Worth	$700

8.4.e.4 Alternative HUD-4. Tunnel Storage for 50 Percent CSO Control

Costs for Alternative HUD-4 include planning-level estimates of the costs for a CSO storage tunnel sized for 50 percent CSO control. A description of the optimization components is provided in Section 8.4.b and illustrated in Table 8.4-9. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HAR-3 is $1,700M as shown in Table 8.4-14.

Table 8.4-14. Estimated Costs for Alternative HUD-4

Item	2019 Cost ($ Million)
Probable Bid Cost	$1,500
Annual O&M Cost	$7
Net Present Worth	$1,700

8.4.e.5 Alternative HUD-5. Tunnel Storage for 75 Percent CSO Control

Costs for Alternative HUD-5 include planning-level estimates of the costs for a CSO storage tunnel sized for 75 percent CSO control. A description of the optimization components is provided in Section 8.4.b and illustrated in Table 8.4-9. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HUD-4 is $3,200M as shown in Table 8.4-15.

Table 8.4-15. Estimated Costs for Alternative HUD-5

Item	2019 Cost ($ Million)
Probable Bid Cost	$2,900
Annual O&M Cost	$8
Net Present Worth	$3,200

8.4.e.6 Alternative HUD-6. Tunnel Storage for 100 Percent CSO Control.

Costs for Alternative HUD-6 include planning-level estimates of the costs for a CSO storage tunnel sized for 100 percent CSO control. A description of the optimization components is provided in Section 8.4.b and illustrated in Table 8.4-9. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative HUD-5 is $5,000M as shown in Table 8.4-16.

Table 8.4-16. Estimated Costs for Alternative HUD-6

Item	2019 Cost ($ Million)
Probable Bid Cost	$5,200
Annual O&M Cost	$9
Net Present Worth	$5,500

The cost estimates of these retained alternatives are summarized below in Table 8.4-17 and are then used in the development of the cost-performance and cost-attainment plots presented in Section 8.4.f.

Table 8.4-17. Estimated Cost of Retained Alternatives for Hudson River

Alternative	PBC(1) ($ Million)	Annual O&M Cost ($ Million/Year)	Total Net Present Worth(2) ($ Million)
HUD-1. Optimization of Regulators Associated with Outfalls NR-022, 023, 026, 027, 031, 032, 035, 038, 040 and 046	$19	$0	$19
HUD-2. Optimization of Regulators Associated with Outfalls NR-038, 040 and 046	$3	$0	$3
HUD-3. Tunnel Storage for 25% CSO Control (14 MG Capacity)	$600	$5	$700
HUD-4. Tunnel Storage for 50% CSO Control (79 MG Capacity)	$1,500	$7	$1,700
HUD-5. Tunnel Storage for 75% CSO Control (114 MG Capacity)	$2,200	$8	$3,200
HUD-6. Tunnel Storage for 100% CSO Control (142 MG Capacity)	$5,200	$9	$5,500

Notes:
(1) The Probable Bid Cost (PBC) for the construction contract based upon 2019 dollars.
(2) The Net Present Worth (NPW) is based upon a 100-year service life for tunnels and is calculated by multiplying the annual O&M cost by a present worth of 31.599 and adding this value to the PBC.

8.4.f Cost-Benefit Curves for Retained Alternatives

The final step of the analysis is to evaluate the cost-effectiveness of the basin-wide retained alternatives based on their NPW and projected impact on CSO loadings and attainment of applicable WQS. Section 8.4.f.1 below presents plots of cost versus CSO volume and bacteria load reduction (Cost-Performance Curves), and Section 8.4.g below presents plots of cost versus percent attainment with WQS for selected points along the Hudson River (Cost-Attainment Curves).

8.4.f.1 Cost-Performance Curves

Cost-performance curves were developed by plotting the costs of the retained alternatives against their predicted level of CSO control, both in terms of CSO volume reduction, and in bacteria load reduction. In each case, a best-fit cost curve was developed based on those alternatives judged most cost-effective for a defined level of CSO control as estimated by IW modeling for the typical year rainfall (2008).

Figure 8.4-11 presents a plot of CSO volume reduction versus NPW for the retained alternatives, while Figure 8.4-12 plots the cost of the alternatives against fecal coliform loading reductions.

8.4.g Cost-Attainment Curves

This section evaluates the relationship of the costs of the retained alternatives versus their expected level of attainment of bacteria Primary Contact WQ Criteria as modeled using the LTCPRM water quality model for the 2008 Typical Year simulation. As indicated in Section 6, based on the 10-year WQ simulations for the Harlem River, the Existing WQ Criteria (Class I) for fecal coliform are met 100 percent of the time under Baseline Conditions. As a result, implementation of any of the retained alternatives described above, including the 100 percent CSO capture tunnel, results in no improvement in the percent attainment of Existing WQ Criteria (Class I) for fecal coliform. Cost-attainment plots are presented below for two locations along the Hudson River: LTCP sampling Station HD-2, located in the northern half of the River (Figure 8.4-13), and LTCP sampling Station HD-7, located in the southern half of the River (Figure 8.4-14). The locations of these stations are shown in Figure 8.4-18 below. The plots show NPW versus percent attainment with the Existing WQ Criteria (Class I) for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis. As indicated in the figures, attainment is 100 percent for all of the alternatives. Cost-attainment plots for any other WQ modeling cell along the Hudson River would look similar to Figure 8.4-14 and Figure 8.4-15.

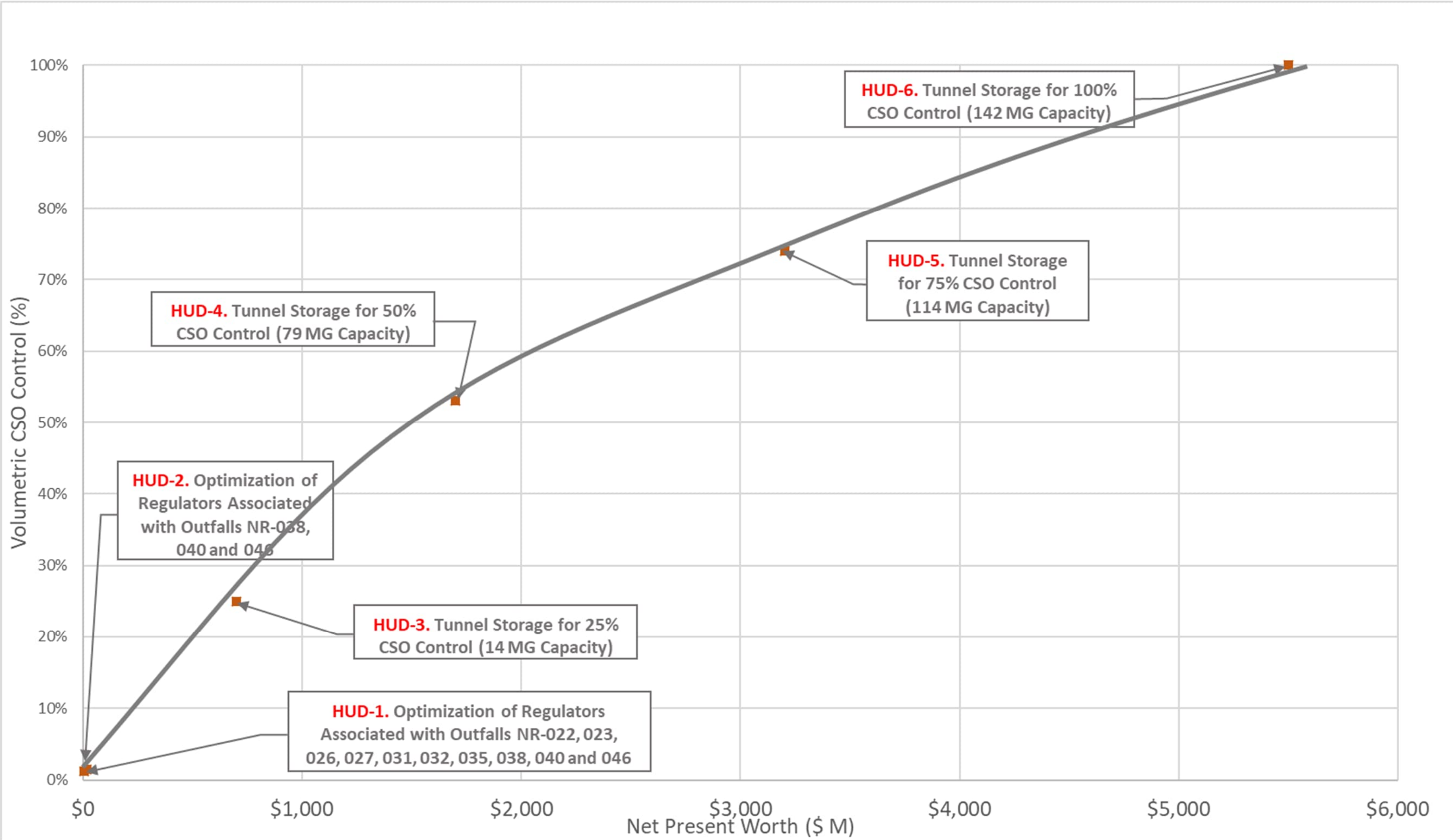

Figure 8.4-11. Cost vs. CSO Control (2008 Typical Year) for Hudson River

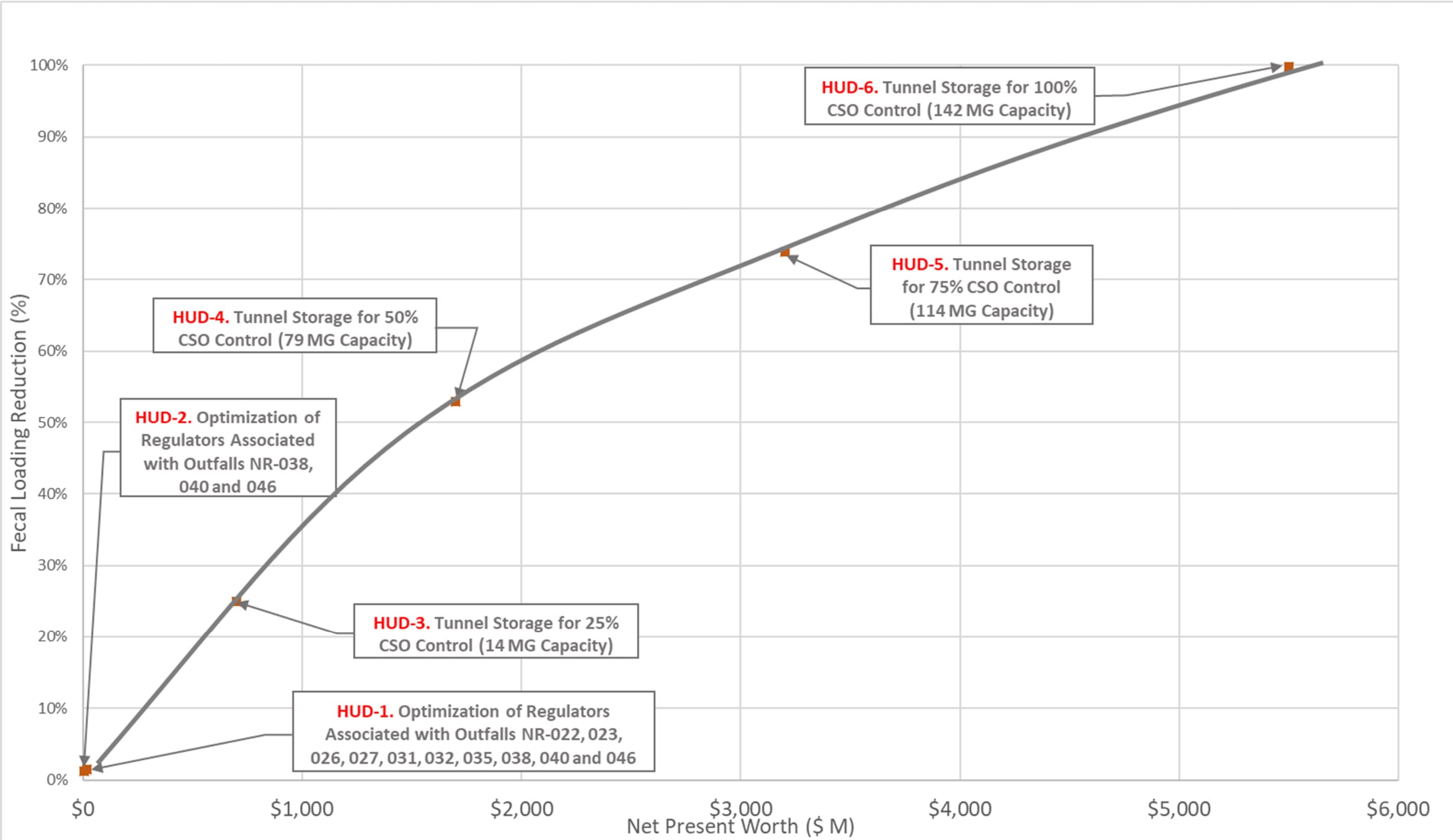

Figure 8.4-12. Cost vs. Fecal Coliform Loading Reduction (2008 Typical Year) for Hudson River

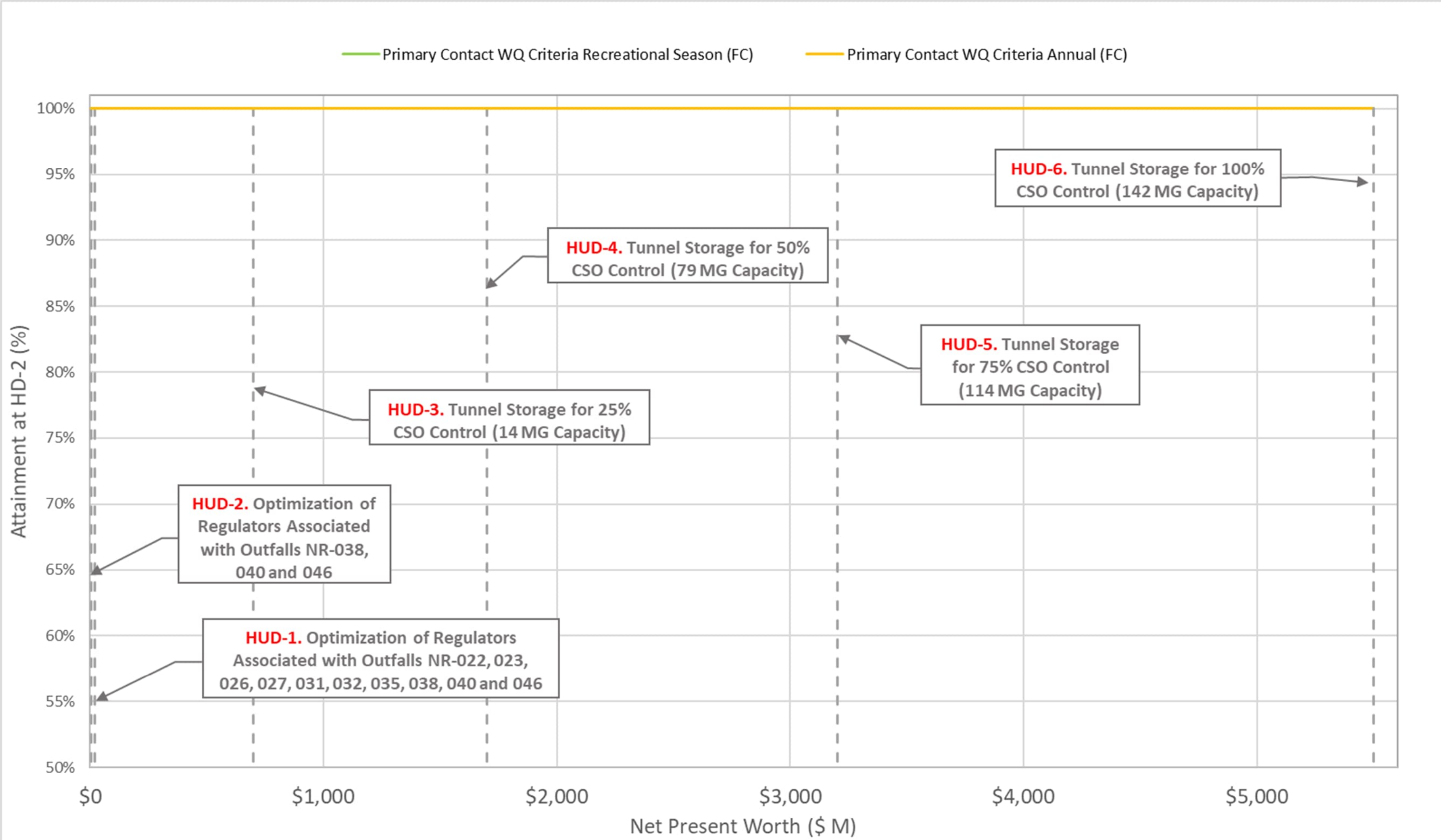

Figure 8.4-13. Cost vs. Bacteria Attainment at Station HD-2

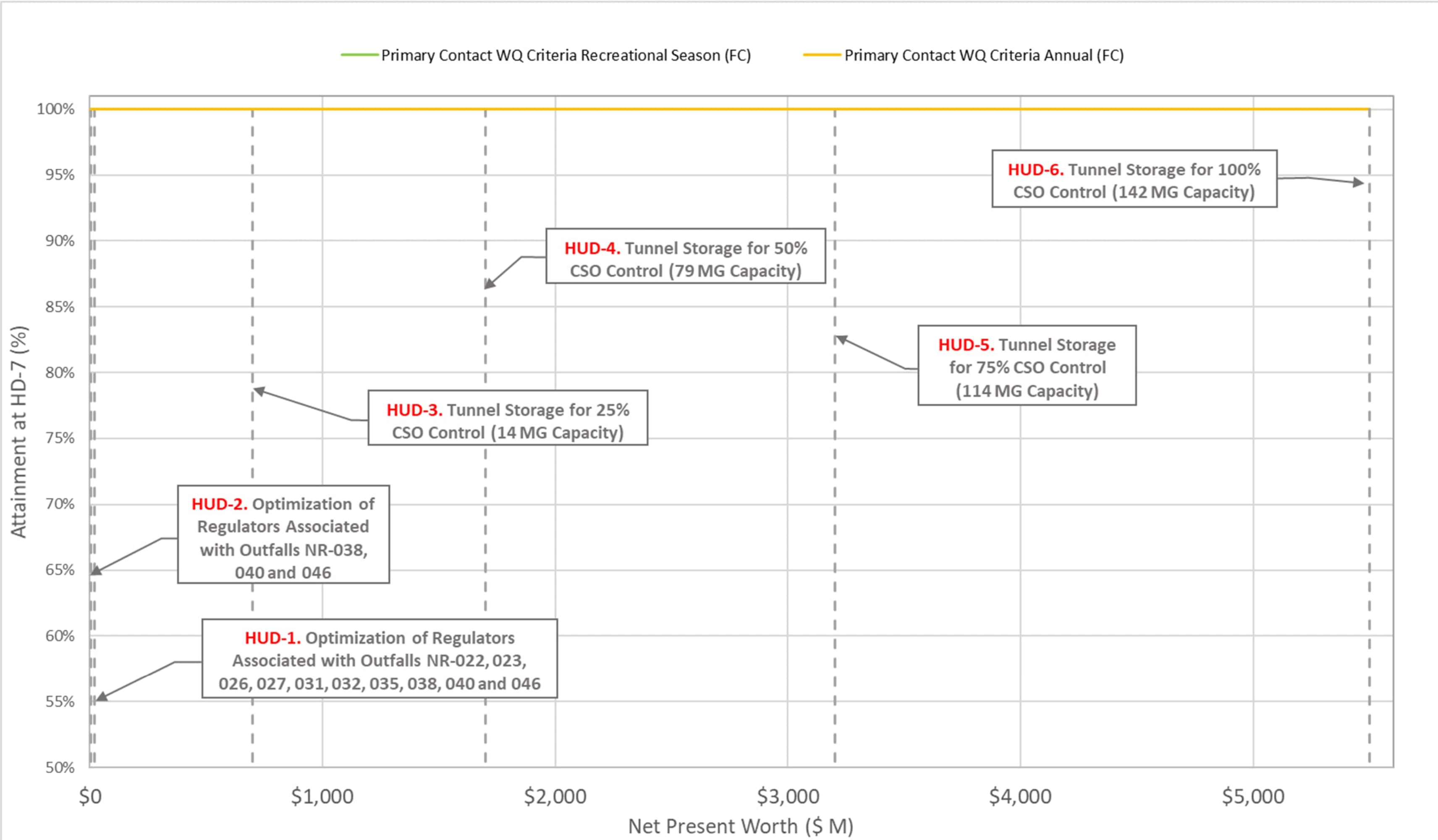

Figure 8.4-14. Cost vs. Bacteria Attainment at Station HD-7

8.4.h Conclusion on Preferred Alternative

The selection of the preferred alternative for the Hudson River is based on multiple considerations including public input, environmental and water quality benefits, and projected costs. A traditional knee-of-the-curve (KOTC) analysis is presented above. However, as described above and in Section 6, the Hudson River attains applicable water quality standards for fecal coliform and dissolved oxygen greater than 95 percent of the time under Baseline Conditions. The CSO storage tunnel alternatives would provide a range of levels of CSO reduction to the Hudson River, but the costs associated with those alternatives are very high, and those high-cost alternatives would not change the level of attainment of WQ criteria. Section 9 presents affordability issues and impacts on disadvantaged communities that would come into play if the CSO program costs were to further significantly increase. For these reasons, the CSO storage tunnel alternatives are not recommended.

Of the two optimization alternatives carried forward in the evaluation, HUD-2 was the more cost-effective based on CSO volume control, with a net CSO volume reduction of 7 MGY during the typical year and a PBC of $3M This cost does not include costs for land acquisition, design, and construction management. As this alternative consists of increasing the regulator orifice opening and involves no mechanical equipment, no additional operation and maintenance costs are associated with this alternative. Although Alternative HUD-1 had a slightly higher net CSO volume reduction (9 MGY), the PBC for HUD-1 was more than six times higher than the PBC for HUD-2. Therefore, HUD-2 was selected as the preferred alternative for inclusion in the Recommended Plan. While this project provides a relatively nominal reduction in CSO discharge, the project is consistent with DEP BMP practices for maximizing flow to the WRRF.

In summary, the following conclusions can be drawn from these analyses:

1. Under Baseline Conditions, fecal coliform standards attainment is projected to be 98 percent or greater at all Hudson River Stations annually and during the recreational season (May 31st through October 31st), while DO attainment is greater than 97 percent at all stations.
2. The most cost-effective alternative, based on the KOTC analysis approach, consistent with EPA's CSO Control Policy is Alternative HUD-2 which cost-effectively reduces CSO discharges with no impact to current collection system operation and maintenance practices.
3. The PCM will document the WQ improvements upon implementation of these projects.
4. While the annual volume of CSO remaining in the Hudson River is acknowledged to remain relatively high, the time to recovery analysis presented further below demonstrates that the duration of impact of the remaining CSOs is low.

Figure 8.4-15 presents a mosaic of the level of attainment with the Existing WQ Criteria for bacteria in the Hudson River on an annual basis, and Figure 8.4-16 presents the level of attainment for the recreational season (May 1st through October 31st). Figure 8.4-17 presents the level of attainment with the Existing WQ Criteria for DO on an average annual basis.

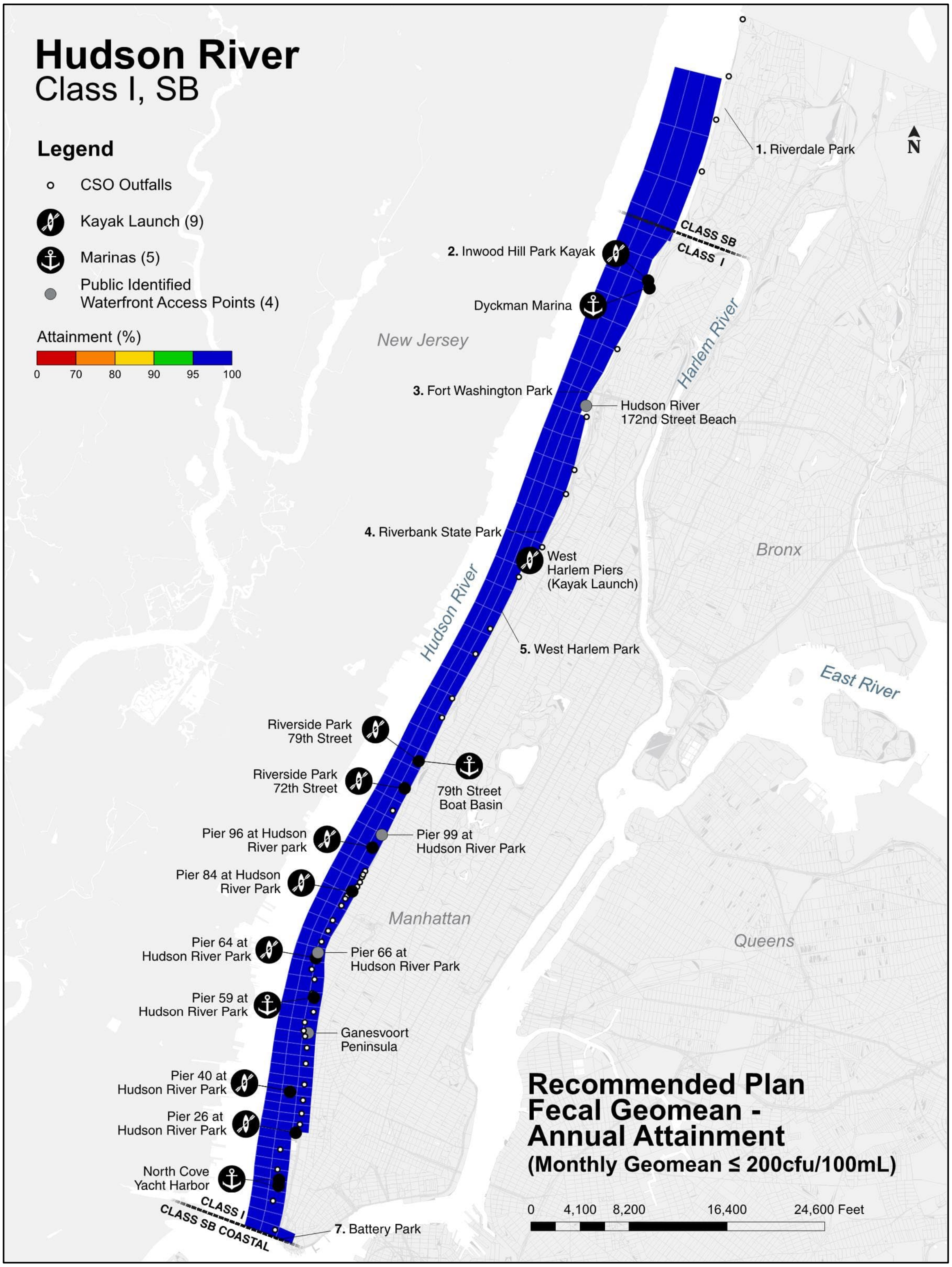

Figure 8.4-15. Hudson River Fecal Coliform – Recommended Plan Annual Attainment (10-year Runs)

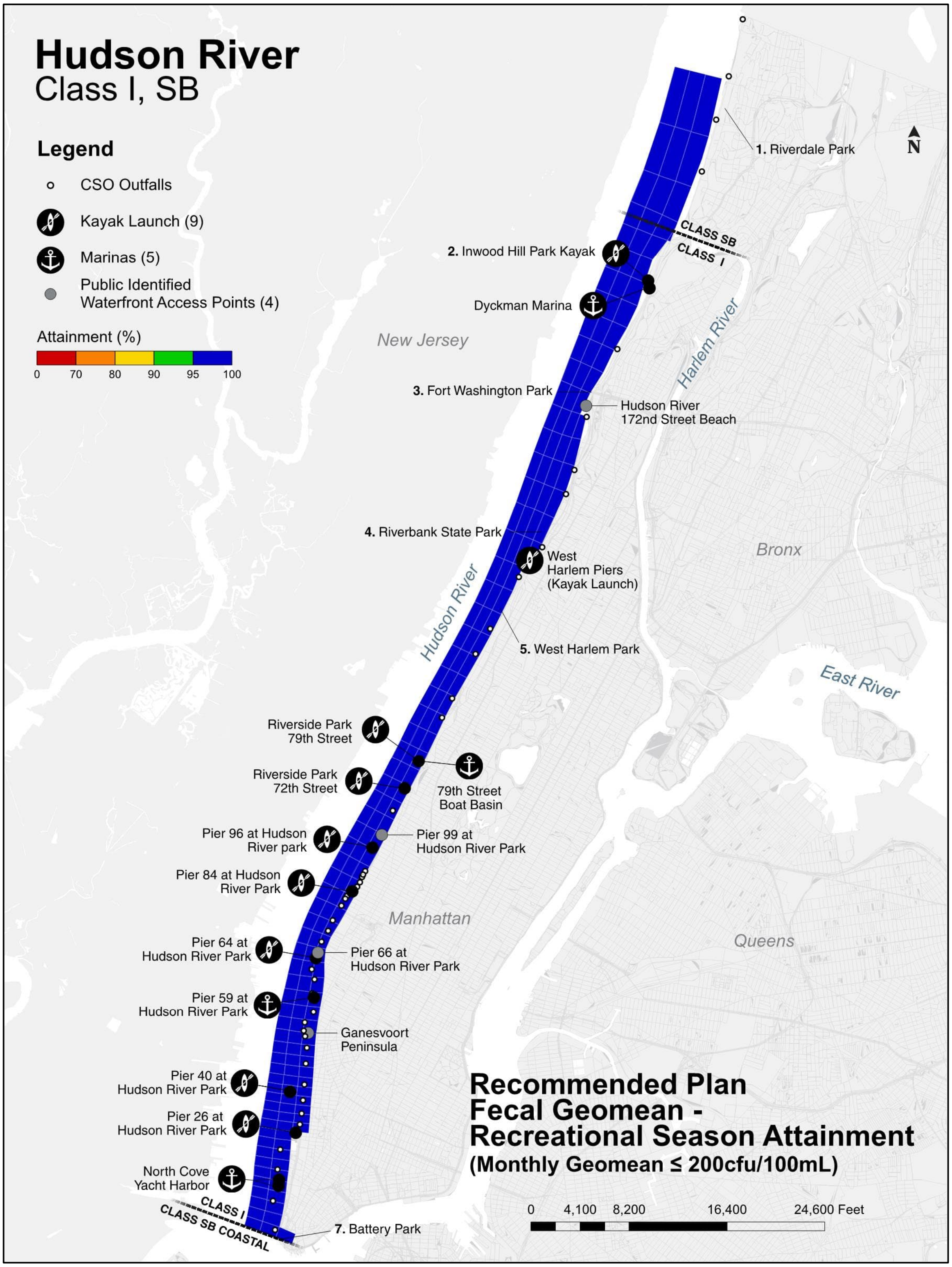

Figure 8.4-16. Hudson River Fecal Coliform – Recommended Plan Recreational Season Attainment (10-year Runs)

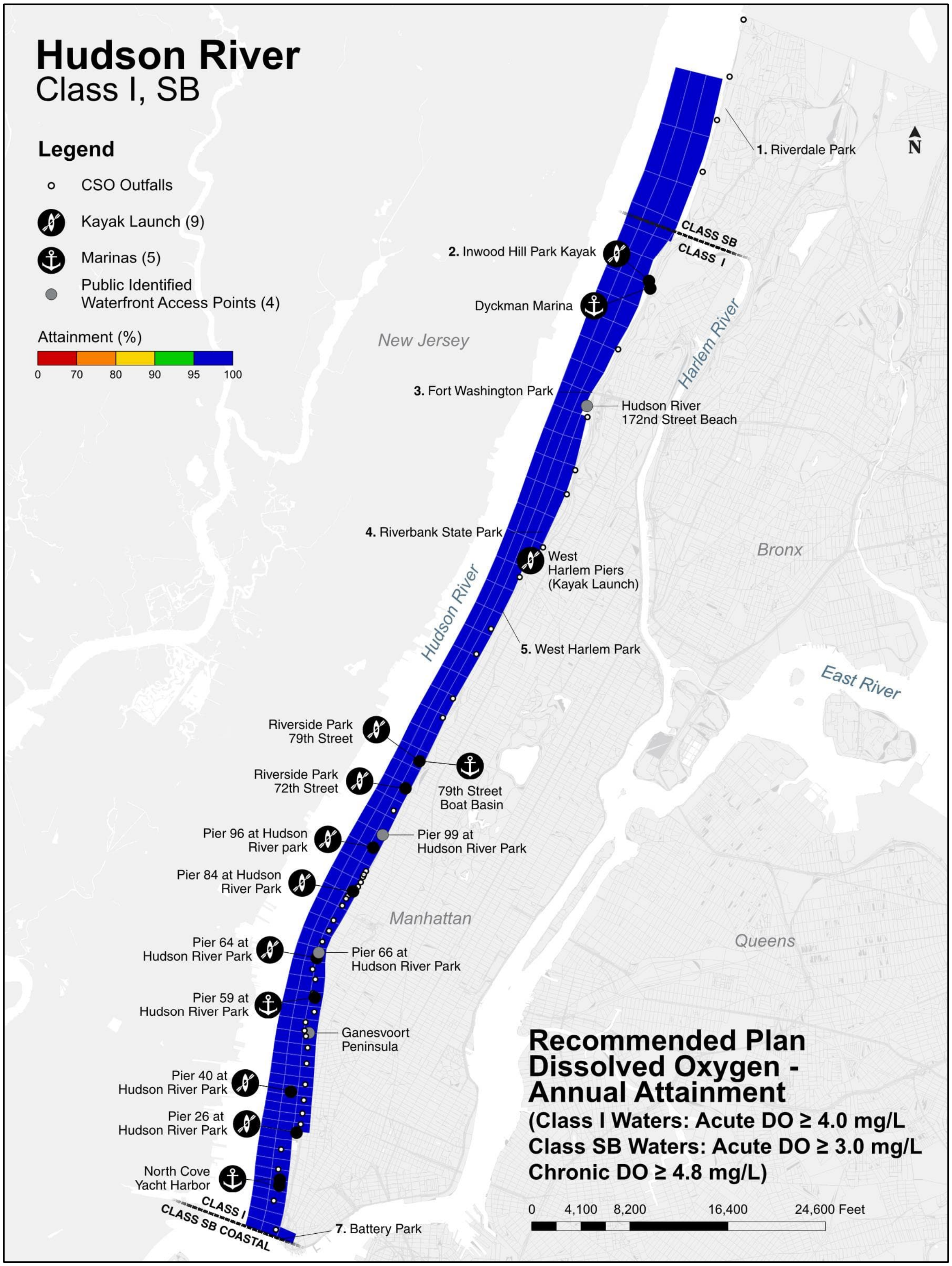

Figure 8.4-17. Hudson River Dissolved Oxygen – Recommended Plan Annual Attainment (2008 Typical Year)

Table 8.4-18 presents the fecal coliform maximum monthly geometric mean, and the percent of time that the fecal coliform monthly GM criterion of 200 cfu/100mL would be attained on an annual basis and for the recreational season (May 1st through October 31st), for the 10-year simulation period, with the Recommended Plan. The locations of the stations and supplemental model output locations listed in Table 8.4-18 are shown on Figure 8.4-18.

Table 8.4-18. Model Calculated 10-Year Fecal Coliform Maximum Monthly GM and Percent Attainment of Existing WQ Criteria for Hudson River Recommended Plan

Recommended Plan: HUD-2 Optimization of Regulators Associated with Outfalls NR-038, 040 and 046				
Station	Maximum Monthly Fecal Coliform GMs (cfu/100mL)		10 Year % Attainment	
	Annual	Recreational Season(1)	Annual Monthly GM <200 cfu/100mL	Recreational Season(1) Monthly GM <200 cfu/100mL
Hudson River (North of Harlem River) – Class SB				
HD-1	125	86	100%	100%
Riverdale Park	87	51	100%	100%
Hudson River (Harlem River to Battery) – Class I				
HD-2	157	96	100%	100%
HD-3	187	95	100%	100%
HD-4	194	98	100%	100%
HD-5	190	99	100%	100%
HD-6	201	96	99%	100%
HD-7	200	101	100%	100%
HD-8	189	102	100%	100%
HD-9	202	125	99%	100%
HD-10	181	98	100%	100%
Inwood Hill Park/Dyckman Marina	135	94	100%	100%
West Harlem Piers	187	94	100%	100%
Riverside Park 79th Street/79th Street Boat Basin	201	95	99%	100%
Riverside Park 72nd Street	201	94	99%	100%

Table 8.4-18. Model Calculated 10-Year Fecal Coliform Maximum Monthly GM and Percent Attainment of Existing WQ Criteria for Hudson River Recommended Plan

Recommended Plan: HUD-2 Optimization of Regulators Associated with Outfalls NR-038, 040 and 046				
Station	**Maximum Monthly Fecal Coliform GMs (cfu/100mL)**		**10 Year % Attainment**	
	Annual	**Recreational Season(1)**	**Annual Monthly GM <200 cfu/100mL**	**Recreational Season(1) Monthly GM <200 cfu/100mL**
Pier 96 at Hudson River Park	200	96	100%	100%
Pier 84 at Hudson River Park	198	99	100%	100%
Pier 64 at Hudson River Park	193	103	100%	100%
Pier 59 at Hudson River Park	190	101	100%	100%
Pier 40 at Hudson River Park	199	119	100%	100%
Pier 26 at Hudson River Park	195	115	100%	100%
North Cove Yacht Harbor	182	100	100%	100%

Note:
(1) Recreational Season is May 1st through October 31st.

The average annual attainment of the Existing WQ Criteria for DO (Class SB and I) for the entire water column is presented at LTCP sampling stations for the Recommended Plan in Table 8.4-19. As indicated in Table 8.4-19, the Existing WQ Criterion for DO (Class I) are predicted to be attained at all stations for the preferred alternative. DO attainment in the Class I portion of the Hudson River ranges from 96.9 to 99.9 percent for the preferred alternative.

As discussed in Section 6, analysis of attainment of Class SB DO criteria are complex because the standard allows for excursions from the daily average limit of 4.8 mg/L for a limited number of consecutive calendar days. To simplify the analysis, attainment was based solely upon attainment of the daily average without the allowed excursions. The results indicate 97.4 percent attainment of the acute criterion (never less than 3.0 mg/L) for the Recommended Plan. Attainment of the chronic criterion (greater than or equal to 4.8 mg/L) is 98.6 percent for the Recommended Plan.

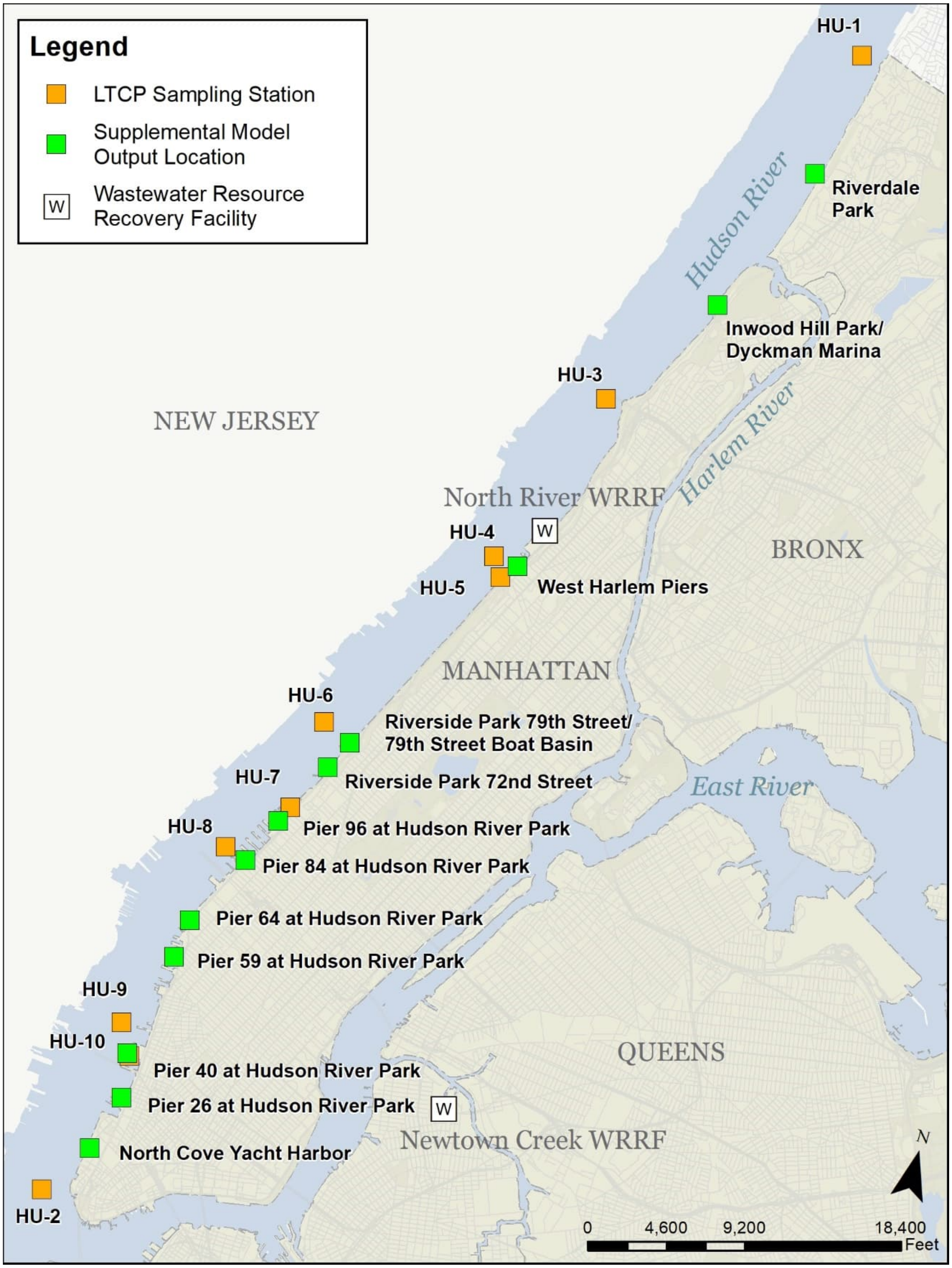

Figure 8.4-18. Sampling Stations and Supplemental Model Output Locations on the Hudson River

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Table 8.4-19. Model Calculated (2008) DO Percent Attainment of Existing Class SB and I WQ Criteria for Hudson River, Recommended Plan

Recommended Plan: HUD-2 Optimization of Regulators Associated with Outfalls NR-038, 040 and 046		
Hudson River (North of Harlem River) - Class SB		
Station	**Acute (≥ 3.0 mg/L)**	**Chronic (≥ 4.8 mg/L)**
HD-1	100%	95%
Hudson River (Harlem River to Battery) – Class I		
Station	**Instantaneous (≥ 4.0 mg/L)**	
HD-2	100%	
HD-3	100%	
HD-4	100%	
HD-5	100%	
HD-6	100%	
HD-7	100%	
HD-8	100%	
HD-9	100%	
HD-10	100%	

The key components of the Recommended Plan include enlargement of regulator orifice openings at Regulators NR-26A, 28, and 29A associated with Outfalls NR-040, 038, and 046, respectively. The implementation of these elements is predicted to result in a net reduction of 7 MGY of CSO to the Hudson River, with a PBC of $3M. The proposed schedule for the implementation of the Recommended Plan is presented in Section 9.2.

8.4.i Use Attainability Analysis

The CSO Order requires that a UAA be included in an LTCP “where existing WQS do not meet the Section 101(a)(2) goals of the CWA, or where the proposed alternative set forth in the LTCP will not achieve existing WQS or the Section 101(a)(2) goals.” The UAA shall “examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State.” The UAA process specifies that States can remove a designated use that is not an existing use if the scientific assessment can demonstrate that attaining the designated use is not feasible for at least one of six reasons:

1. Naturally occurring loading concentrations prevent the attainment of the use; or

2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
4. Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or
5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

As part of the LTCP, elements of a UAA, including the six conditions presented above, will be used to determine if changes to the designated use are warranted, considering a potential adjustment to the designated use classification as appropriate.

As noted in previous sections, with the implementation of the Recommended Plan, the Hudson River is predicted to meet the Existing WQ fecal coliform bacteria criterion of 200 cfu/100mL on both an annual and recreational season (May 1st through October 31st) basis for both the 2008 Typical Year rainfall and the 10-year continuous simulation. Class SB and I DO criteria are also predicted to be achieved for the Recommended Plan. Therefore, a Use Attainability Analysis is not needed for the Hudson River.

8.4.j Time to Recovery

As noted above, the Hudson River south of the Harlem River is a Class I waterbody, with best uses identified as secondary contact recreation and fishing, and the applicable Water Quality Criteria for fecal coliform bacteria are based on a monthly geometric mean. However, to gain insight into the shorter-term impacts of wet-weather sources of bacteria, DEP has performed an analysis to assess the amount of time following the end of a rainfall event required for the Hudson River to recover and return to fecal coliform concentrations less than 1,000 cfu/100mL.

The analyses consisted of examining the WQ model-calculated bacteria concentrations in the Hudson River for recreational periods (May 1st through October 31st) abstracted from 10 years of model simulations. For the Hudson River, the JFK Airport rainfall data was compared against water quality model bacteria results for the 10 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. The chosen target threshold concentration was 1,000 cfu/100mL for fecal coliform. The various rainfall events were then placed into rain event size "bins" ranging from less than 0.1 inch to greater than 1.5 inches. Only rain events that reached the target threshold concentrations before the beginning of the next storm were included. The median time to recovery for each bin at each water quality station was calculated.

Table 8.4-20 presents the median time to recovery for the Recommended Plan for the Hudson River, for the storms in the greater than 1.0 to 1.5 inch rainfall bin, which includes the 90th percentile event. In other words, this rainfall bin covers approximately 90 percent of the rain events that would occur in an average year. Values are presented at the LTCP sampling stations, and the waterbody access locations.

DEC has advised that it seeks to have a time to recovery of less than 24 hours, and this target has been consistent in the previously approved LTCPs. As indicated in Table 8.4-20, under the Recommended Plan, none of the locations assessed had a median time to recovery greater than 2 hours, and most locations had median times to recovery of 0 hours, indicating a quick recovery following greater than 90 percent of the storms.

Table 8.4-20. Hudson River Time to Recovery, Fecal Coliform, Recommended Plan

Location	Median Time to Recovery (hours) Fecal Coliform Threshold (1,000 cfu/100mL)(1)
HD-1	0(2)
HD-2	0
HD-3	0
HD-4	0
HD-5	0
HD-6	0
HD-7	0
HD-8	0
HD-9	2
HD-10	0
Riverdale Park	0
Inwood Hill Park/Dyckman Marina	0
West Harlem Piers	0
Riverside Park 79th Street/79th	0
Riverside Park 72nd Street	0
Pier 96 at Hudson River Park	0
Pier 84 at Hudson River Park	0
Pier 64 at Hudson River Park	0
Pier 59 at Hudson River Park	0
Pier 40 at Hudson River Park	0
Pier 26 at Hudson River Park	0
North Cove Yacht Harbor	0

Notes:
(1) Median time to recovery values presented for storms from the 10-year simulation, recreational seasons, in the size range of >1.0 to 1.5-inches of rainfall, which includes the 90th percentile rain event.
(2) Median time to recovery of "0" means that the average concentration across the water column never reached the 1,000 cfu/100mL threshold at the referenced station for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

8.4.k Recommended LTCP Elements to Meet Water Quality Goals for Hudson River

The actions identified in this LTCP include:

- Enlargement of regulator orifice openings at Regulators NR-26A, 28, and 29A associated with Outfalls NR-040, 038, and 046, respectively.
- Costs (in 2019 dollars) for the recommended alternative are: NPW $3, PBC of $3M, and no annual O&M cost.
- Compliance with Primary Contact WQ Criteria on an annual basis for the 2008 Typical Year and based on a 10-year continuous simulation. As a result, a UAA is not required as part of this LTCP.
- DEP will establish with the DOHMH through public notification a wet-weather advisory during the recreational season (May 1st through October 31st), informing the public which recreational activities are not recommended in the Hudson River at that time. The LTCP includes a recovery time analysis that can be used to establish the duration of the wet-weather advisory for public notification.

DEP is committed to improving water quality in this waterbody, which will be advanced by the improvements and actions identified in this LTCP. These identified actions have been balanced with input from the public and awareness of the cost to the residents of NYC.

8.5 CSO Control Alternatives for East River/Long Island Sound

As shown in Section 6, WQS for bacteria and dissolved oxygen are met in the East River/Long Island Sound under Baseline Conditions. Therefore, attainment of WQS was not a factor in evaluating CSO control alternatives for the East River/Long Island Sound. Rather, the focus was on evaluating alternatives for cost-effective reduction of CSO activations and volume. The CSO control alternatives that passed the initial screening phase and were retained for the East River generally fell within the categories of system optimization and tunnel storage. System optimization alternatives covered the categories of fixed weirs, parallel interceptor/sewer, bending weirs or control gates, and gravity flow tipping to other watersheds. The storage tunnel alternatives, used to assess 25, 50, 75, and 100 percent CSO capture, also included high-rate clarification for the dewatering flows from the tunnels. Storage tanks were not evaluated due to the number of outfalls and the general lack of available sites of sufficient size for storage tanks. Each CSO control measure was initially evaluated on three of the key considerations described in Section 8.1: (1) benefits, as expressed by level of CSO control and WQS attainment; (2) costs; and (3) challenges, such as siting and operations. Using this methodology, the retained CSO control measures listed in Section 8.1 were evaluated on a cost-performance basis and used to develop the basin-wide alternatives.

The Citywide/Open Waters Baseline Conditions include implementation of the Recommended Plans from the LTCPs for the tributary waterbodies previously submitted to DEC under this program, as well as other grey infrastructure projects implemented as part of earlier planning programs. Those projects are summarized in Section 4.

The following sections present the evaluations of the system optimization and tunnel storage alternatives for the East River.

8.5.a System Optimization Alternatives

The approach to the initial identification and evaluation of system optimization alternatives for the East River using the Optimizer software was presented in Section 3. As described in Section 3, the Optimizer software was configured to prioritize monitored regulators discharging outside the period of critical wet--weather events, high-discharge frequency regulators, and regulators discharging in proximity to official and publicly-identified public access points (kayak launches/marinas).

The optimization alternatives for outfalls to the East River associated with the Tallman Island, Hunts Point, Bowery Bay, Wards Island, Newtown Creek and Red Hook WRRF collections systems were evaluated independently, as the six systems are hydraulically independent. However, each collection system also includes combined sewer outfalls discharging to the other waterbodies and thus, the East River optimization alternatives associated with each collection system need to be considered in conjunction with alternatives for those outfalls discharging to other tributary waterbodies. Table 8.5-1 summarizes the waterbodies impacted by WRRF effluent and CSO discharges from each of the respective collection systems.

The sections below present the evaluations of East River optimization alternatives associated with the Tallman Island, Hunts Point, Bowery Bay, Wards Island, Newtown Creek and Red Hook WRRF collection systems, respectively.

Table 8.5-1. Additional Waterbodies Receiving Discharges from East River WRRF Outfalls and Collection System CSO Outfalls

LTCP Open Waters and Tributary Waterbodies	WRRF & Associated Collection Systems					
	Tallman Island	Bowery Bay	Hunts Point	Wards Island	Red Hook	Newtown Creek
East River	✓	✓	✓	✓	✓	✓
Alley Creek	✓					
Flushing Creek	✓					
Flushing Bay		✓				
Hutchinson River			✓			
Westchester Creek			✓			
Bronx River			✓			
Harlem River/ Bronx Kill				✓		
Hudson River				✓		✓
Newtown Creek						✓
Gowanus Canal/Bay					✓	
New York Bay					✓	

8.5.a.1 System Optimization for East River Outfalls in the Tallman Island WRRF System

Table 8.5-2 summarizes the CSO outfalls and associated regulators tributary to the East River from the Tallman Island WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.5-1. Table 8.5-2 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits ("BMP Regulator")
- A "Key Regulator" as identified in the WRRF SPDES permits
- An outfall in proximity to a public access location (typically within 500 feet of an access location)
- Regulators that activated more than average for the waterbody

Table 8.5-2. East River CSO Outfalls/Regulators Associated with the Tallman Island WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
TI-003	TI-10A	0	0	✓	✓		
	TI-10B	71.0	45				✓
TI-023	TI-13	259.6	45	✓		✓	✓

<u>Findings/Observations from Optimizer Evaluations</u>

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Tallman Island WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Tallman Island WRRF is located along the Powell Cove Boulevard immediately east of the College Point Yacht Club. The collection system primarily serves northern Queens and is bounded to the east by Little Neck Bay, to the south by Kissena Park to the west by Flushing Bay and north by the East River.
- The Tallman Island WRRF 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 WRRF and picks up flow from the College Point and Flushing interceptors.
    - The College Point Interceptor conveys flow from sewersheds along Flushing Bay to the west of the treatment plant, and discharges into the Powell's Cove Pumping Station, which discharges into the Main Interceptor within the WRRF 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 WRRF 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 used to discharge to the Main Interceptor from the west side, just 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 came on-line in mid-2014.

- The Tallman Island WRRF collection system is relatively shallow (<10 feet of cover) at the upstream ends of each interceptor, but ranges from 15 to 25 feet of cover as the interceptors approach the Tallman Island WRRF.
- Regulators contributing to CSO outfalls discharging to the East River generally activate between 16 to 45 times during the typical year with a total average annual overflow volume (AAOV) of 213 MGY.
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally greater than 10 feet from the ground surface with the exception of the upstream end of the upstream end of the Kissena Corridor and Main Interceptor where freeboard is less than 10 feet from the ground surface.
- The Optimizer modeling identified alternatives that included modifications to two or three regulators resulting in varying degrees of improved capture and hydraulic performance. Upon performing InfoWorks runs for the 2008 typical year, limited reductions in AAOV (approximately 1-3%) and activation frequency (approximately 11-21%) were predicted for the better performing alternatives.
- The performance improvements were limited by hydraulic grade line sensitivities. While the interceptor has available storage capacity during smaller storms, the rise in grade line during the 5-year storm translates upstream during the 5-year design storm, affecting some of the shallower reaches of the interceptor beyond the level of acceptable risk.
- In addition, hydraulic balancing occurs, where CSO volume and activations increase at regulators/outfalls upstream or downstream of those regulators/outfalls where reductions were observed in response to the system optimization measures. Although the optimization alternatives produced a net reduction in CSO volume and activations for the typical rainfall year, the CSO volumes and activations increased to Outfalls TI-010 and TI-011, which are tributary to Flushing Creek. Although these outfalls are planned to be disinfected by facilities recommended in the approved Flushing Creek LTCP, it is not desirable to increase CSO discharges to Flushing Creek.

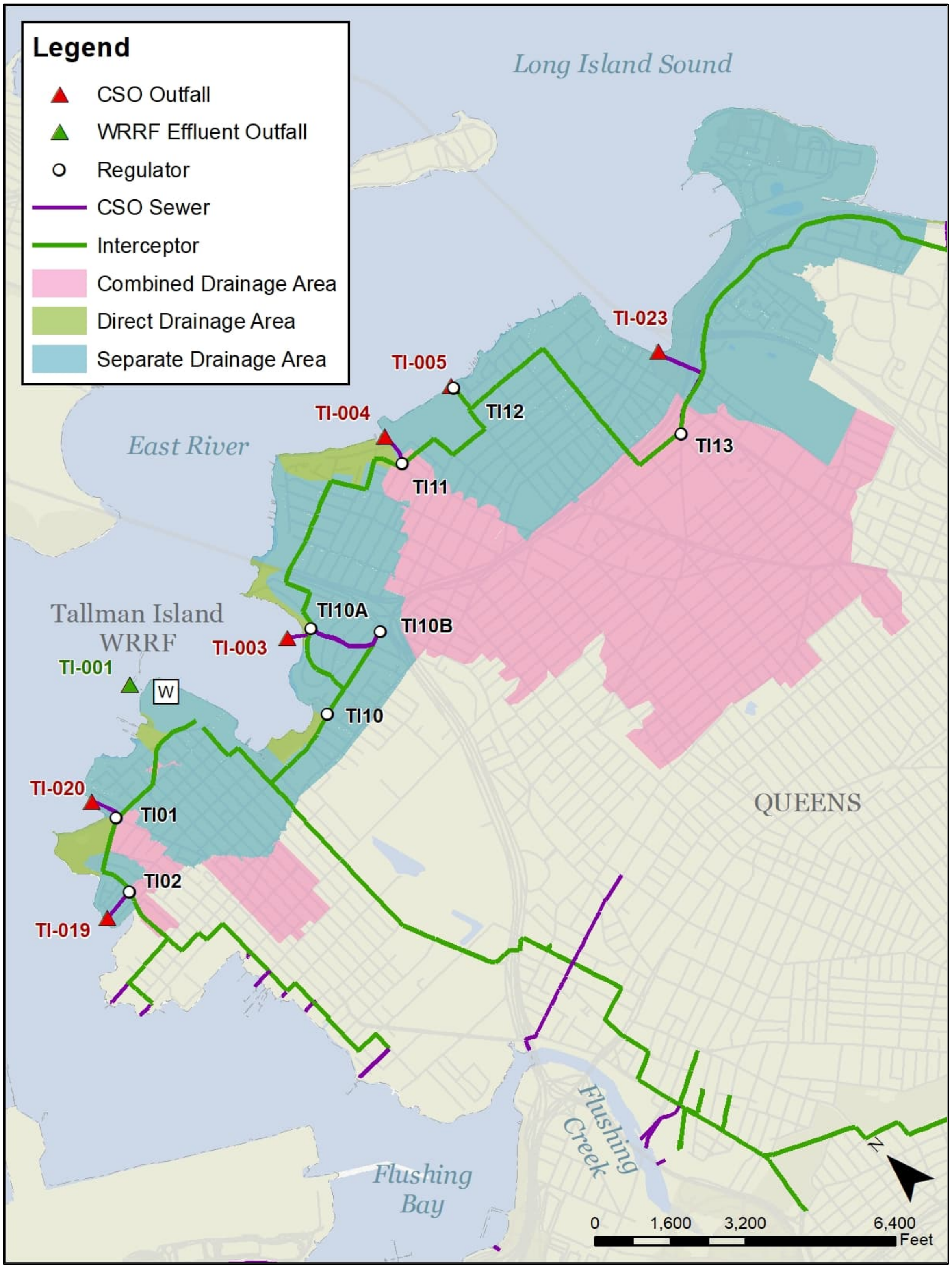

Figure 8.5-1. CSO Outfalls/Regulators Tributary to East River from the Tallman Island WRRF System

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<u>Follow-up Evaluations Based on Full InfoWorks Model</u>

The most promising optimization alternatives coming out of the Optimizer evaluations are summarized in Table 8.5-3:

Table 8.5-3. Tallman Island Optimization Components for Retained Alternatives

Outfall	Regulator	Components	
		ER-3	ER-4
TI-003	TI-10B	□ ⬭	□ ⬭
TI-023	TI-13		□
TI-022	TI-55	□ ⬭	□ ⬭

<u>KEY</u>

□ Increase Orifice Size

⬭ Replace Branch Interceptor

These alternatives were further analyzed in more detail using the full Tallman Island WRRF system InfoWorks model. The resulting impacts of Alternatives ER-3 and ER-4 on peak hydraulic grade line in the 5-year storm are summarized in Figure 8.5-2 and Figure 8.5-3, respectively. The annual CSO volume and frequency for these optimization alternatives are summarized in Table 8.5-4, and estimated probable bid costs and construction/ implementation considerations are summarized in Table 8.5-5.

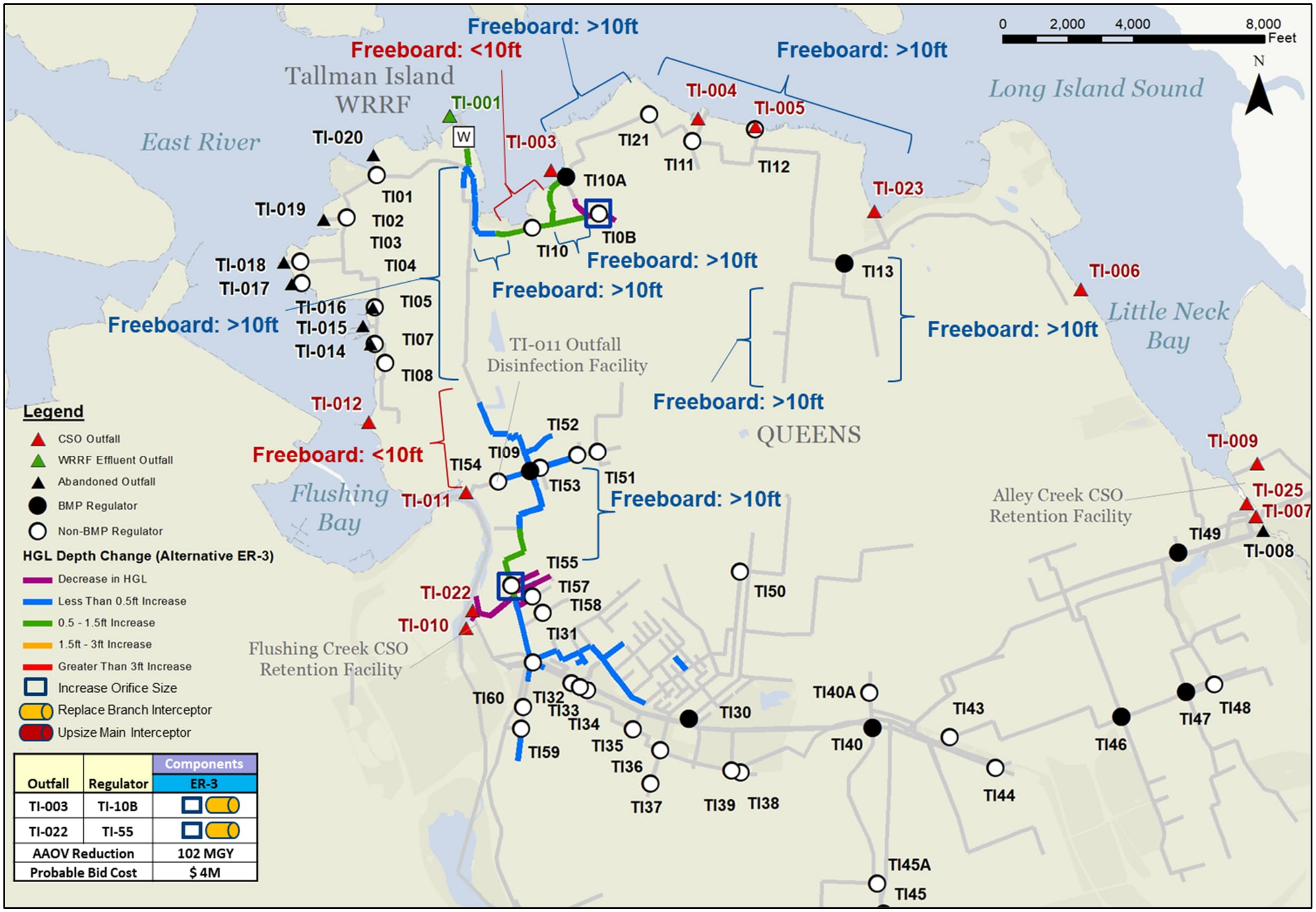
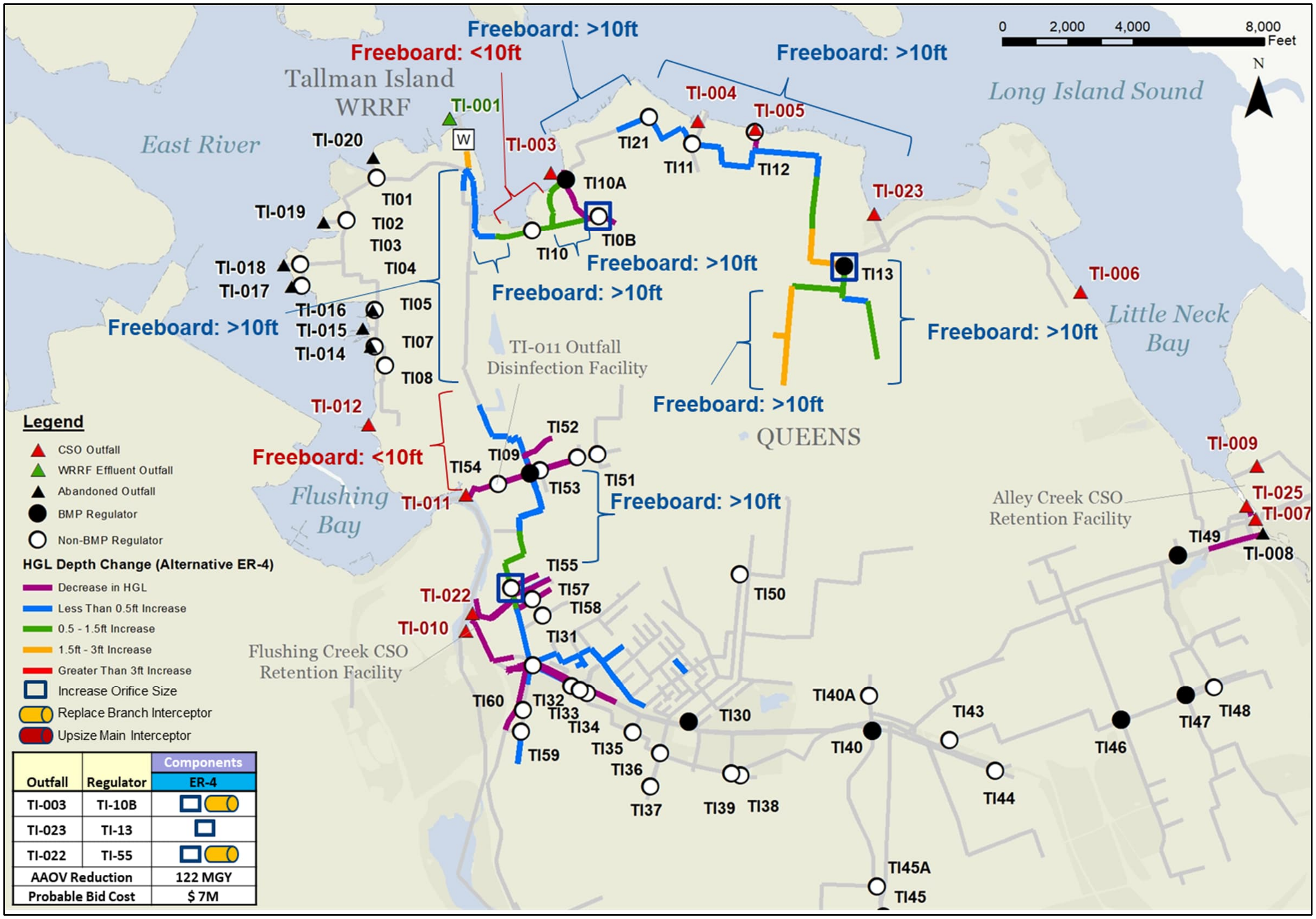


Figure 8.5-2. Hydraulic Grade Line Impacts of Alternative ER-3 vs. Baseline Conditions (5-Year Storm)



Outfall	Regulator	Components ER-4
TI-003	TI-10B	
TI-023	TI-13	
TI-022	TI-55	
AAOV Reduction		122 MGY
Probable Bid Cost		$ 7M

Figure 8.5-3. Hydraulic Grade Line Impacts of Alternative ER-4 vs. Baseline Conditions (5-Year Storm)

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Table 8.5-4. Summary of Performance of Tallman Island Optimization Alternatives ER-3 and ER-4 for East River

Outfall[1]	Regulator	Baseline Conditions Typical Year		Alternative ER-3[2]		Alternative ER-4[3]	
		Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
TI-003	TI-10B	71.0	45	26.7	26	26.7	26
TI-011	TI-09	259.6	45	279.6	45	286.0	45
	TI-51 to 54	130.6	50	130.4	50	130.8	50
TI-022	TI-55 to 58	89.5	59	31.9	25	22.1	22
TI-023	TI-13	138.4	39	138.4	39	127.6	33
Total		**1,590**	**59**	**1,522**	**50**	**1,513**	**50**

Notes:

(1) Outfalls and regulators with negligible impacts to Annual CSO Volume and Activations are not included in this table.

(2) ER-3 reduces CSO volume to the East River by 44 MGY and untreated CSO to Flushing Creek by 58 MGY for a total untreated CSO reduction of 102 MGY. This alternative results in an increase in treated CSO volume to Flushing Creek at TI-010 and TI-011 of 33 MGY.

(3) ER-4 reduces CSO volume to the East River by 55 MGY and untreated CSO to Flushing Creek by 68 MGY for a total untreated CSO reduction of 123 MGY. This alternative results in an increase in treated CSO volume to Flushing Creek at TI-010 and TI-011 of 45 MGY.

Table 8.5-5. Summary of Cost and Implementation Considerations for Tallman Island Optimization Alternatives ER-3 and ER-4 for East River

Alternative	Probable Bid Cost ($M)	Implementation Considerations
ER-3	$4M	• Reduction in CSO to the East River by 44 MGY • Reduction in untreated CSO to Flushing Creek of 58 MGY • Total reduction in untreated CSO of 102 MGY • Increases treated CSO to Flushing Creek by 33 MGY
ER-4	$7M	• Reduction in CSO to the East River by 55 MGY • Reduction in untreated CSO to Flushing Creek of 68 MGY • Total reduction in untreated CSO of 123 MGY • Increases treated CSO to Flushing Creek by 45 MGY

Due to the potential impacts to the hydraulic grade line in the 5-year design storm, and the predicted increase in CSO volume to Flushing Creek, Alternatives ER-3 and ER-4 were not carried forward for further evaluations. However, additional alternatives were evaluated using the InfoWorks model.

In consideration of historical hydraulic grade line sensitivities downstream of Regulator TI-13, a bending weir was evaluated at this site as Alternative ER-5. To improve upon the performance of Alternative ER-5, orifice and branch interceptor optimizations at Regulator TI-10B included in earlier alternatives were combined with the bending weir at Regulator TI-13 to create Alternative ER-6. Table 8.5-6 identifies the components that make up Alternatives ER-5 and ER-6.

Table 8.5-6. Tallman Island Optimization Components for Retained Alternatives

Outfall	Regulator	Components	
		ER-5	ER-6
TI-003	TI-10B		
TI-023	TI-13	BW	BW
TI-022	TI-55		

KEY

Increase Orifice Size

Replace Branch Interceptor

BW Bending Weir

The annual CSO volume and frequency for optimization Alternatives ER-5 and ER-6 are summarized in Table 8.5-7, and estimated probable bid costs and construction/implementation considerations are summarized in Table 8.5-8. As shown in Table 8.5-8, Alternative ER-5 reduced CSO volume by 41 MGY, while ER-6 reduced CSO volume by 86 MGY. Figure 8.5-4 and Figure 8.5-5 illustrate the hydraulic grade line impacts for Alternatives ER-5 and ER-6, respectively, for the 5-year design storm.

Given the potential reduction in CSO activation frequency and volume associated with the relatively modest cost, Alternatives ER-5 and ER-6 were retained for further consideration. Tunnel storage alternatives for Tallman Island WRRF outfalls tributary to the East River/Long Island Sound are evaluated later in this section.

Table 8.5-7. Summary of Performance of Tallman Island Optimization Alternatives ER-5 and ER-6 for East River

Outfall[1]	Regulator	Baseline Conditions Typical Year		Alternative ER-5		Alternative ER-6	
		Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
TI-003	TI-10B	71.0	45	71.0	45	26.7	26
TI-011	TI-09	260	45	260	45	260	45
	TI-51 to 54	131	50	131	50	130	50
TI-022	TI-55 to 58	89.5	59	89.5	59	89.4	59
TI-023	TI-13	138	39	96.5	24	96.1	24
Total		**1,590**	**59**	**1,549**	**59**	**1,504**	**59**

Note:
(1) Outfalls and regulators with negligible impacts to Annual CSO Volume and Activations are not included in this table.

Table 8.5-8. Summary of Cost and Implementation Considerations for Tallman Island Optimization Alternatives ER-5 and ER-6 for East River

Alternative	Probable Bid Cost ($M)	Implementation Considerations
ER-5	$3M	• Reduction in CSO to the East River by 42 MGY. • No impacts to CSOs along tributaries.
ER-6	$6M	• Reduction in CSO to the East River by 86 MGY. • No impacts to CSOs along tributaries.

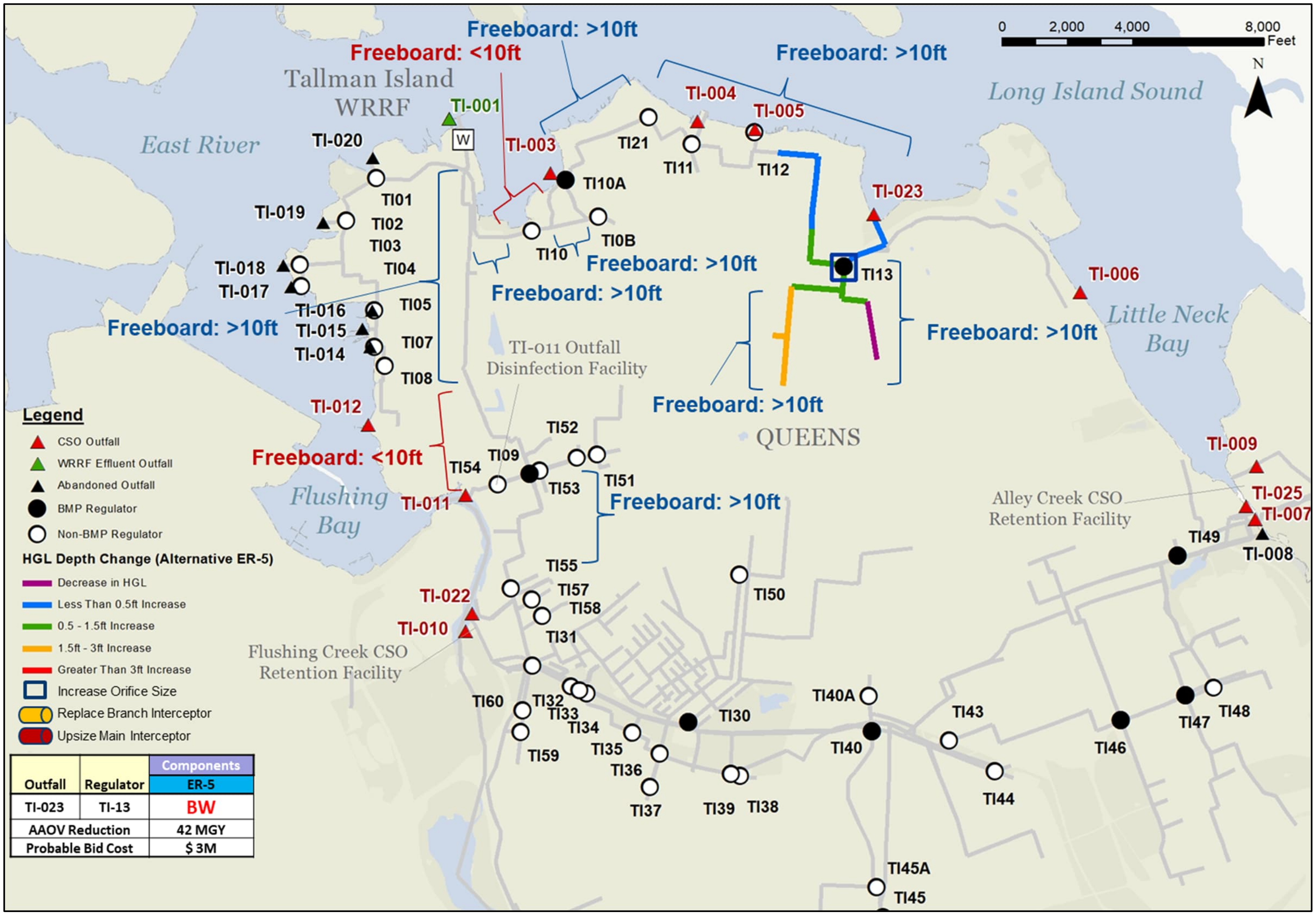


Figure 8.5-4. Hydraulic Grade Line Impacts of Alternative ER-5 vs. Baseline Conditions (5-Year Storm)

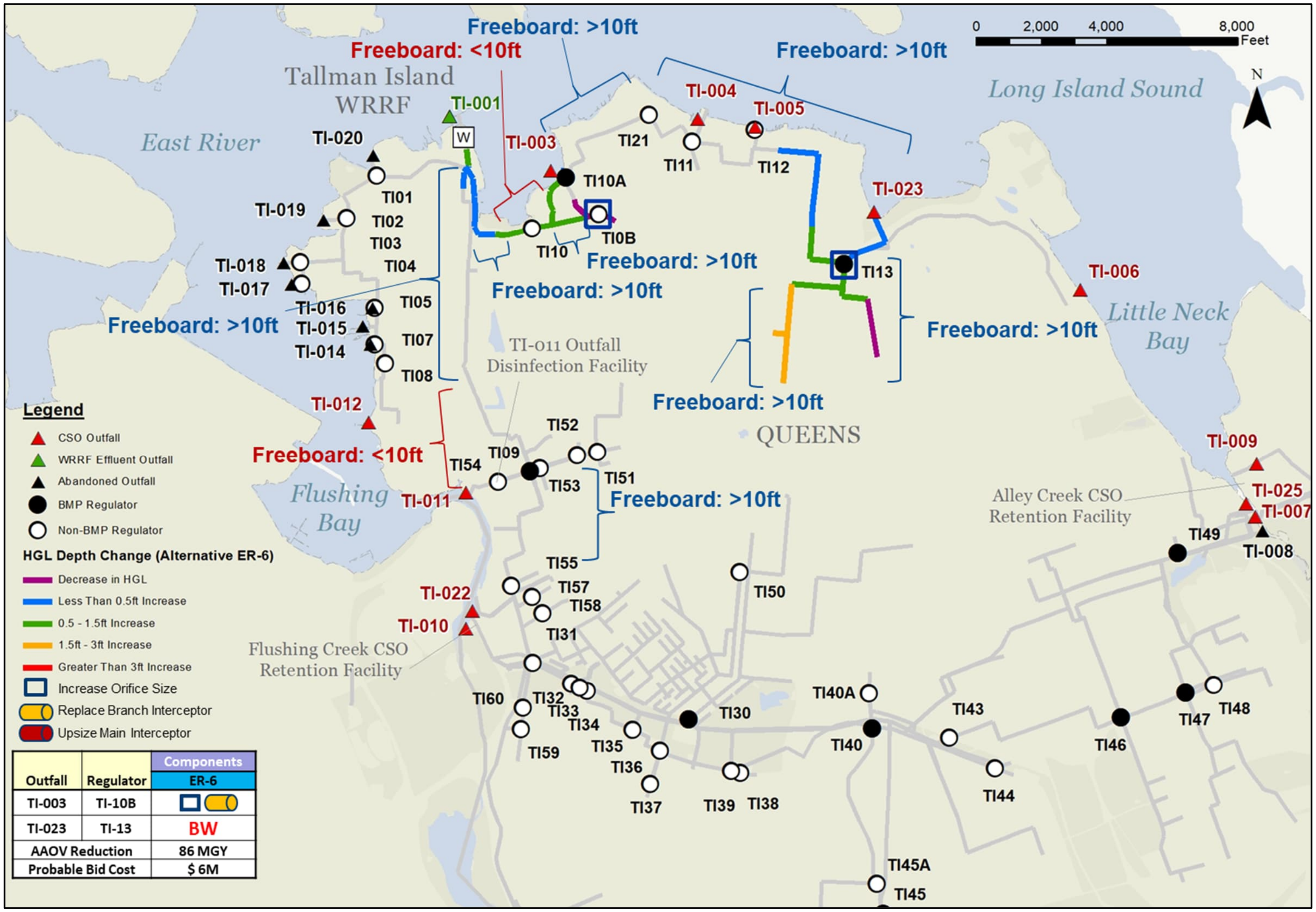


Figure 8.5-5. Hydraulic Grade Line Impacts of Alternative ER-6 vs. Baseline Conditions (5-Year Storm)

8.5.a.2 System Optimization for East River Outfalls in the Bowery Bay WRRF System

Table 8.5-9 lists the CSO outfalls and associated regulators tributary to the East River from the Bowery Bay WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.5-6. Table 8.5-9 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits ("BMP Regulator")
- A "key regulator" as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet) a public access location
- Regulators that activated more than average for the waterbody

Table 8.5-9. East River CSO Outfalls/Regulators Associated with the Bowery Bay WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
BB-002	BBH-02	12.9	19	✓	✓		
BB-003	BBH-03	53.2	32	✓			✓
BB-005	24th Ave	597	35				✓
BB-028	BBL-21	317	43	✓		✓	✓
BB-029	BBL-22	89.6	29	✓	✓	✓	✓
BB-030	BBL-23	24.7	39	✓		✓	✓
BB-034	BBL-30	186	47	✓			✓
BB-021	BBL-15	20.9	30				✓
BB-025	BBL-19	10.0	27				✓
BB-033	BBL-27	5.5	28				✓
BB-035	BBL-31	3.8	31				✓
BB-036	BBL-32	8.4	29				✓
BB-041	BBL-01	85.0	61				✓
BB-046	BBL-26	6.6	30				✓

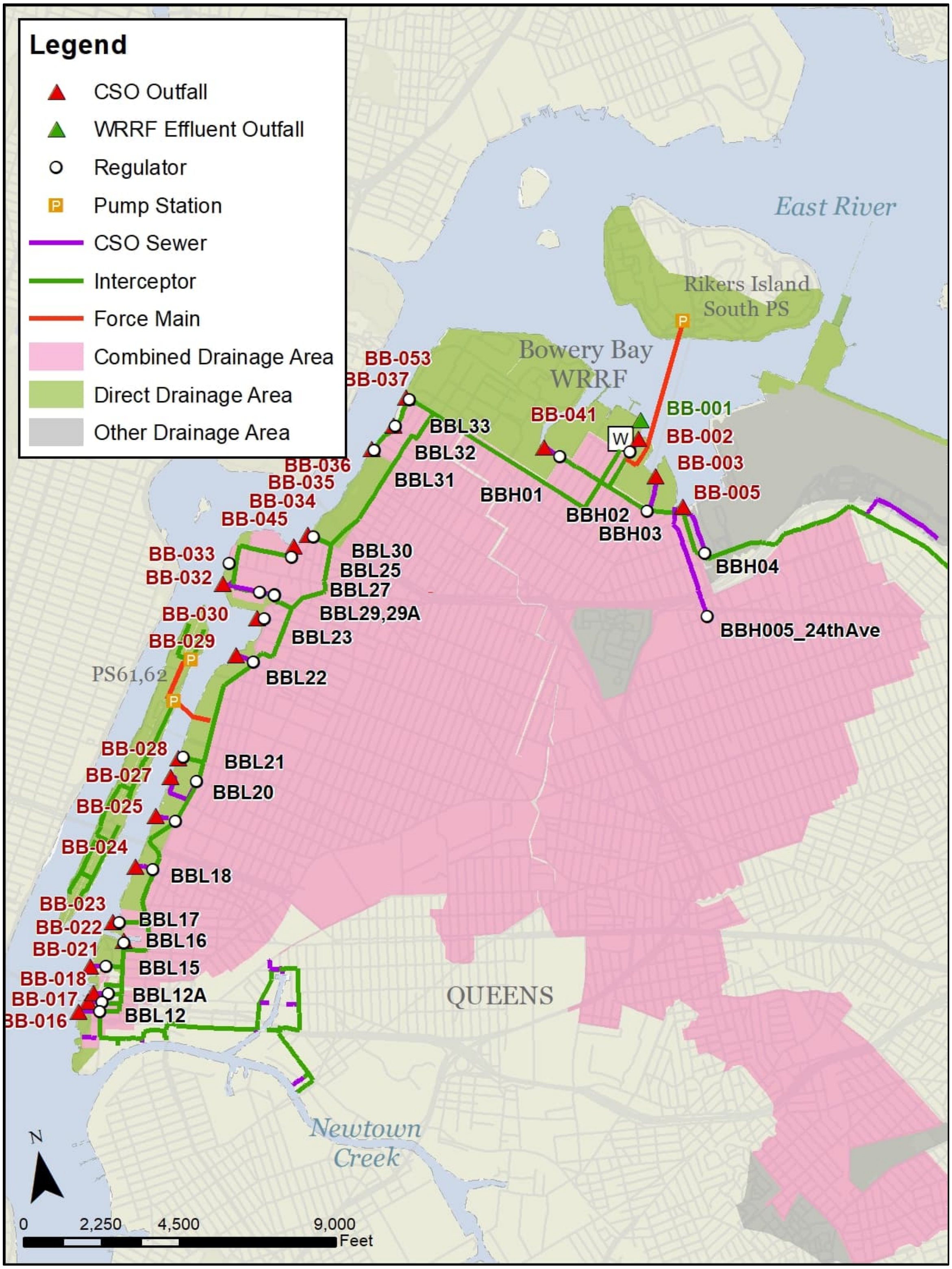


Figure 8.5-6. CSO Outfalls/Regulators Tributary to East River from the Bowery Bay WRRF System

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Bowery Bay WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Bowery Bay WRRF collection system serves the northwestern side of Queens. The Low Level Interceptor (LLI) begins on 27th Street receiving flow from the Borden Avenue Pumping Station and running southward parallel to Newtown Creek towards the East River. At 2nd Street, the LLI bends and runs northerly paralleling the East River through Long Island City, Dutch Kills and Astoria. The LLI bends to the east in Steinway and runs along 20th Avenue to 43rd Street where it bends northward towards the Bowery Bay WRRF. The High Level Interceptor (HLI) generally follows 108th Street, running southward from Rego Park to East Elmhurst. The HLI bends to the west along Ditmars Boulevard, crossing the Grand Central Parkway and the southwestern corner of LaGuardia Airport before heading northward along 81st Street. The HLI bends westward along 19th Avenue and then northward to the Bowery Bay WRRF along 45th Street.
- A total of 43 regulators divert flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to the Dutch Kills (6 CSOs), Newtown Creek (7 CSOs), East River (26 CSOs), and Flushing Bay (3 CSOs).
- The sewers tributary to each regulator are relatively flat due to the topography. Depth of cover on the gravity sewers varies, ranging from relatively shallow (<10 feet of cover) to about 40 feet.
- Regulators in the Bowery Bay WRRF system contributing to CSO outfalls discharging to the East River activate between 1 to 61 times during the typical year with a total average annual overflow volume (AAOV) of 1,621 MGY.
- Low Level Interceptor freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the system is highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified alternatives that included modifications to as many as nine regulators throughout the WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year, limited AAOV (<3 percent) reductions were predicted for the better performing alternatives, and these alternatives resulted in approximately 5 percent increases in the total number of activations.
- The limited performance improvement is a result of the hydraulic grade line sensitivities along the entire stretch of the Low Level Interceptor and portions of the High Level Interceptor near the WRRF. Also, since the system was generally running full during wet-weather, alternatives that reduced CSO at one location tended to result in offsetting increases at other locations.

Follow-up Evaluations Based on Full InfoWorks Model

No retained alternatives were identified from the initial optimization runs due to:

- Hydraulic grade line impacts that increased the potential risk of flooding

- Negligible reductions in CSO volume to the East River, that were accompanied by increases in total numbers of activations of the CSO outfalls to the East River from the Bowery Bay system.

Figure 8.5-7 illustrates the hydraulic grade line (HGL) sensitivities where optimization alternatives increase the potential risk of street flooding and basement backups. Tunnel storage options for the outfalls to the East River from the Bowery Bay WRRF system are evaluated later in this section.

8.5.a.3 System Optimization for East River Outfalls in the Hunts Point WRRF System

Table 8.5-10 lists the CSO outfalls and associated regulators tributary to the East River from the Hunts Point WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.5-8. Table 8.5-10 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits (“BMP Regulator”)
- A “key regulator” as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet) a public access location
- Regulators that activated more than average for the waterbody

<u>Findings/Observations from Optimizer Evaluations</u>

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Hunts Point WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Hunts Point WRRF collection system serves the majority of the Bronx, with the exception of a small portion to the west that is served by the Wards Island WRRF collection system. The eastern portion of the Bronx is served by a combined sewer that parallels Eastchester Bay. The combined sewer connects to an interceptor sewer that parallels the East River and then runs northwest to the Throgs Neck Pumping Station. The middle portion of the collection system is served by a combined sewer that generally parallels the west side of Westchester Creek. This sewer receives flow from the Throgs Neck Pumping Station before connecting to an interceptor sewer near the upstream end of Pugsley Creek. The western portion of the Bronx is served by collector sewers that primarily runs adjacent to the east and west side of the Bronx River. These sewers discharge to an interceptor sewer that generally parallels the East River receiving flow from other combined sewers before discharging to the Hunts Point WRRF.
- A total of 18 regulators, 15 CSO relief structures and 10 pumping stations divert flow to the collection system. During periods when wet-weather flow exceeds the collection system capacity, these facilities may overflow to CSO outfalls discharging to the Bronx River (5 CSOs), Westchester Creek (7 CSOs), Hutchinson River (5 CSOs), Eastchester Bay (3 CSOs), Long Island Sound (2 CSOs) and East River (12 CSOs).

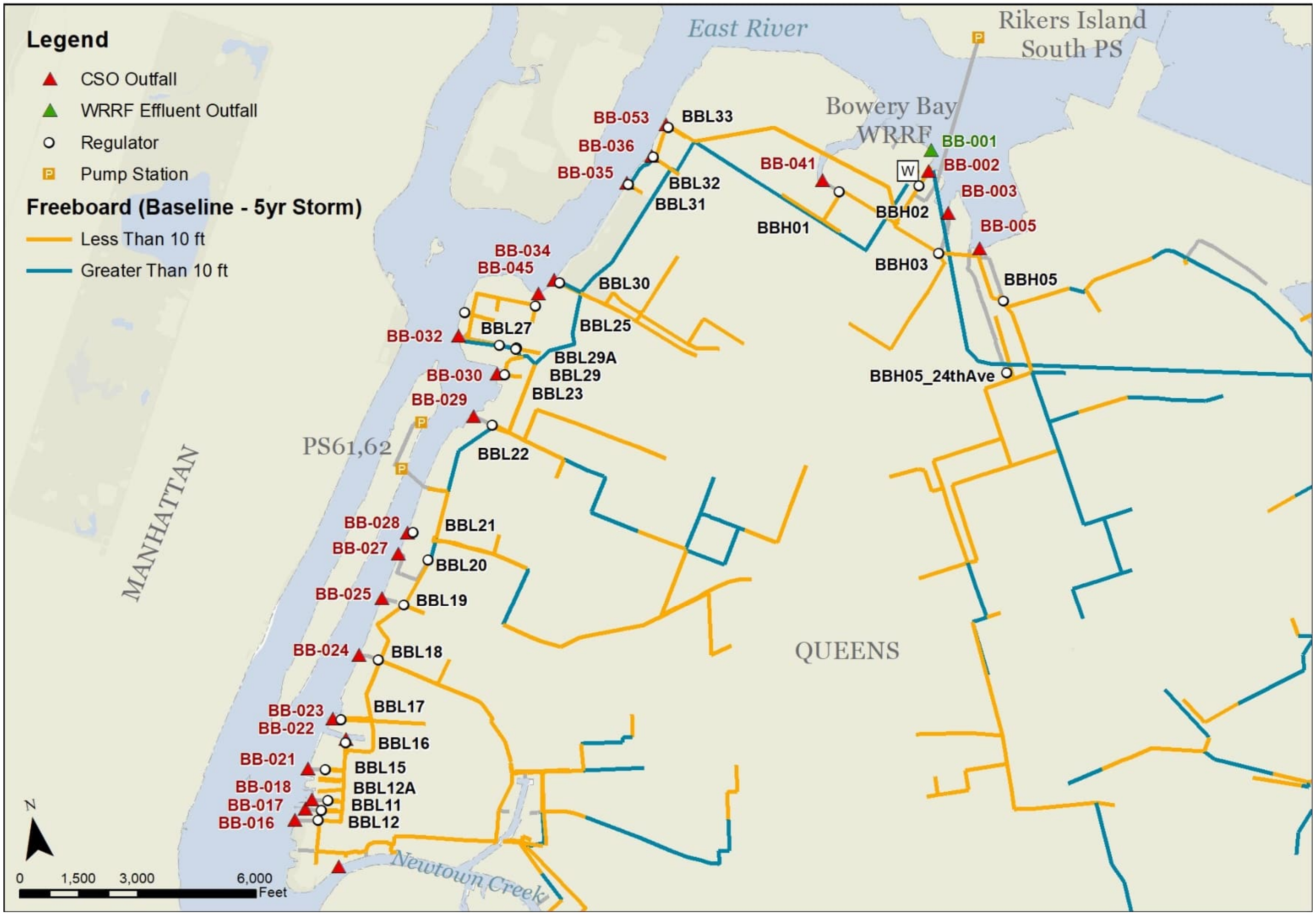


Figure 8.5-7. HGL Impacts of Bowery Bay Collection System Under Baseline Conditions, 5-Year Storm

Table 8.5-10. East River CSO Outfalls/Regulators Associated with the Hunts Point WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
HP-022	HP-01	28.8	29	✓		✓	✓
HP-021	HP-02	201.8	44	✓		✓	✓
HP-019	HP-03	15.3	35	✓		✓	✓
HP-011	HP-05	664.9	34	✓	✓	✓	✓
HP-025	HP-08	95.9	45	✓		✓	✓
HP-002	HP-09	47.8	19	✓		✓	✓
HP-003	HP-10	138.2	30	✓	✓		✓
HP-017	HP-11	38.5	28	✓		✓	✓
HP-018	HP-12	3.4	15	✓		✓	
HP-009	HP-13	323.2	36	✓	✓		✓

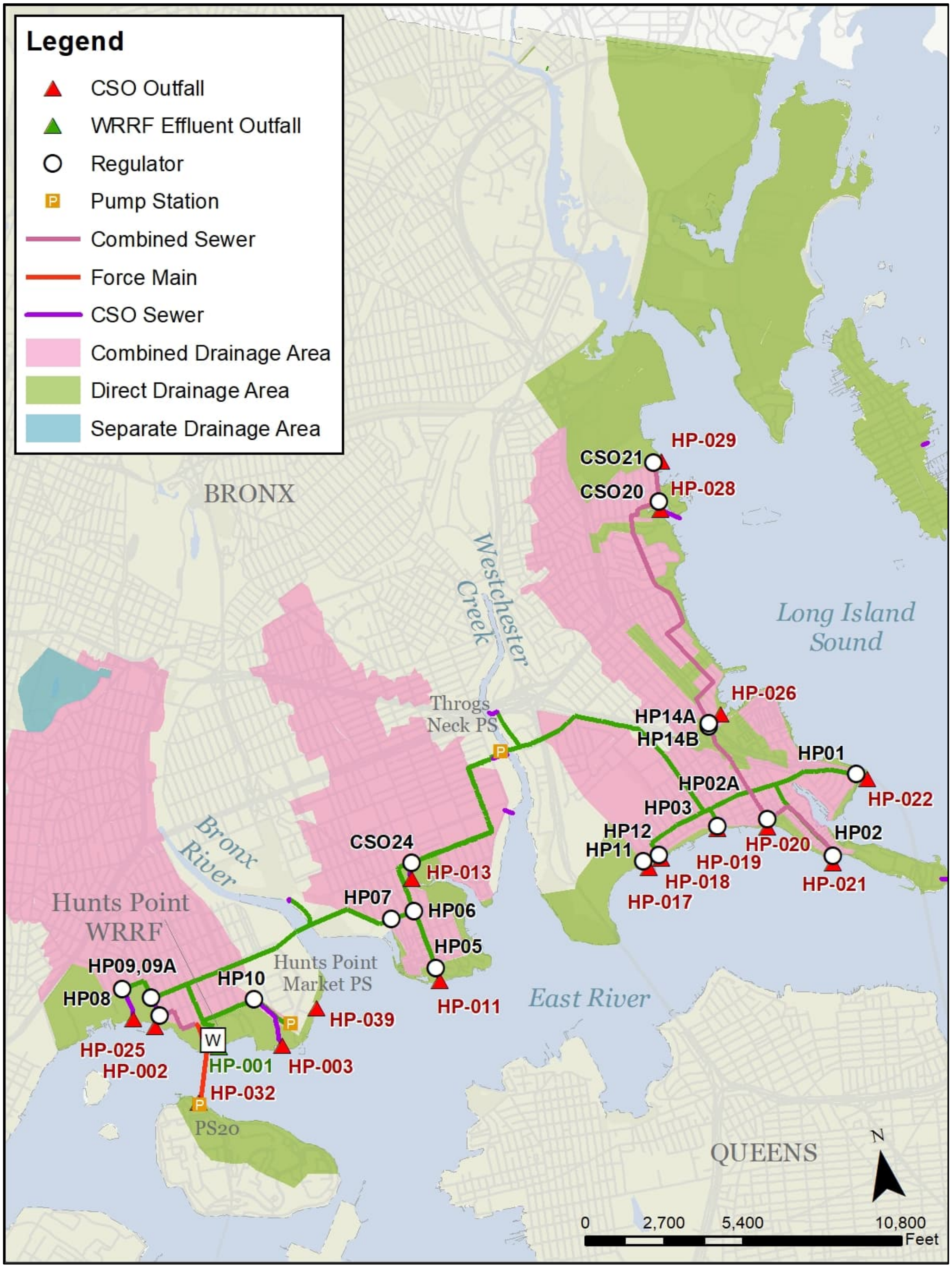


Figure 8.5-8. CSO Outfalls/Regulators Tributary to East River from the Hunts Point WRRF System

- The sewers tributary to each regulator, or relief structure, are relatively flat due to the topography. Depth of cover on the gravity sewers varies, ranging from relatively shallow (<10 feet of cover) to about 50 feet.
- Regulators contributing to CSO outfalls discharging to the East River activate between 0 to 45 times during the typical year with a total average annual overflow volume (AAOV) of 2,370 MGY.
- Interceptor freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the system is highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified alternatives that included modifications to as many as 12 regulators and relief structures throughout the Hunts Point WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year, limited reductions in AAOV (<1 percent) and activation frequency (<10 percent) were predicted for the better performing alternatives.
- The limited performance improvement is a result of the hydraulic grade line sensitivities along the entire stretch of the interceptor.

<u>Follow-up Evaluations Based on Full InfoWorks Model</u>

The most promising optimization alternatives coming out of the Optimizer evaluations are summarized in Table 8.5-11:

Table 8.5-11. Hunts Point Optimization Components for Retained Alternatives

		Components	
Outfall	Regulator	ER-1	ER-2
HP-016	HP-04		□
HP-018	HP-12		□ ⬬
HP-019	HP-03		□ ⬬
HP-025	HP-08	□ ⬬	□ ⬬

<u>KEY</u>

□ Increase Orifice Size

⬬ Replace Branch Interceptor

These alternatives were further analyzed in more detail using the full Hunts Point WRRF system InfoWorks model. The resulting impacts of Alternatives ER-1 and ER-2 on peak hydraulic grade line in the 5-year storm are summarized in Figure 8.5-9 and Figure 8.5-10, respectively. The annual CSO volume and frequency for these optimization alternatives are summarized in Table 8.5-12 and estimated probable bid costs and construction/implementation considerations are summarized in Table 8.5-13.

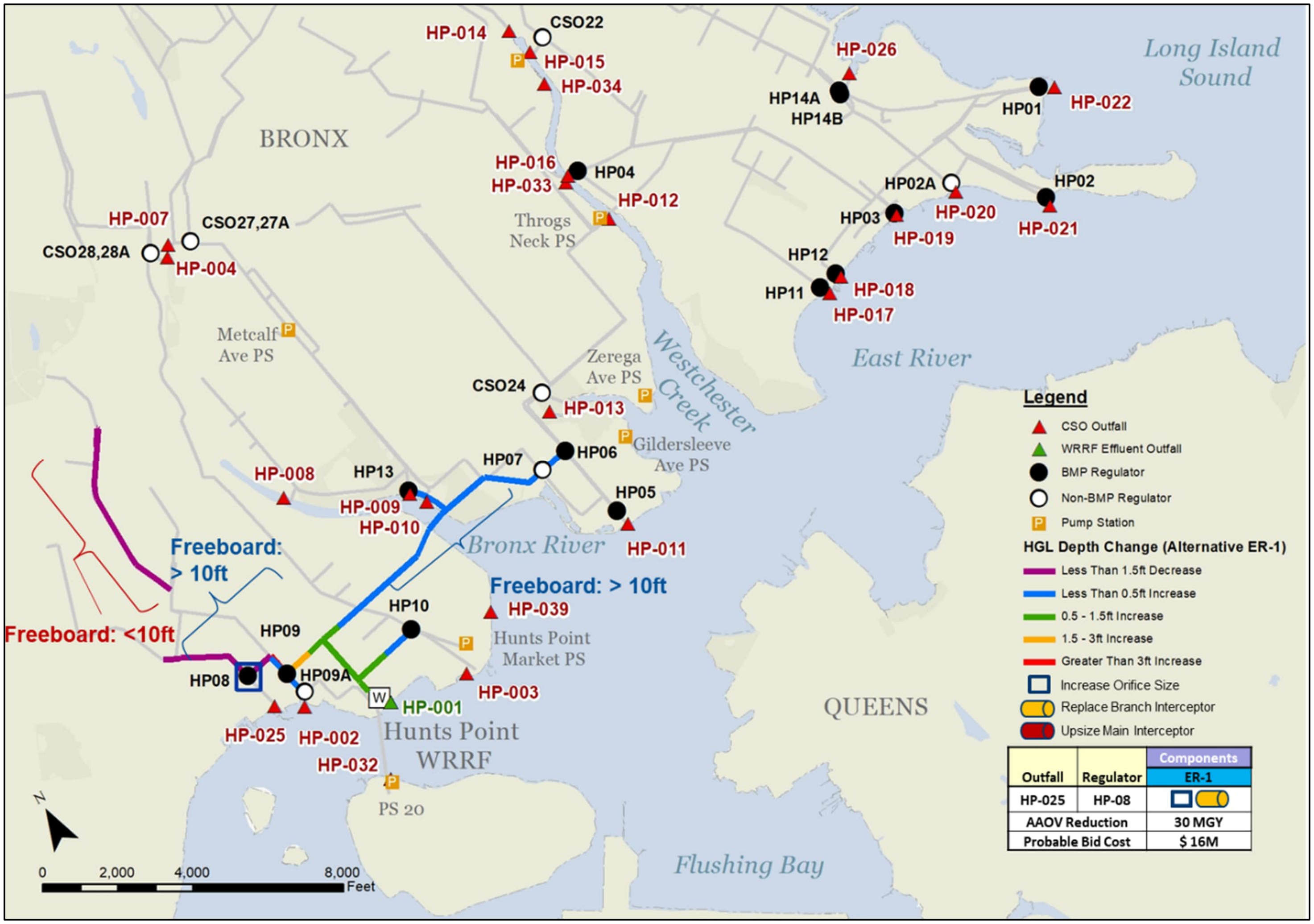
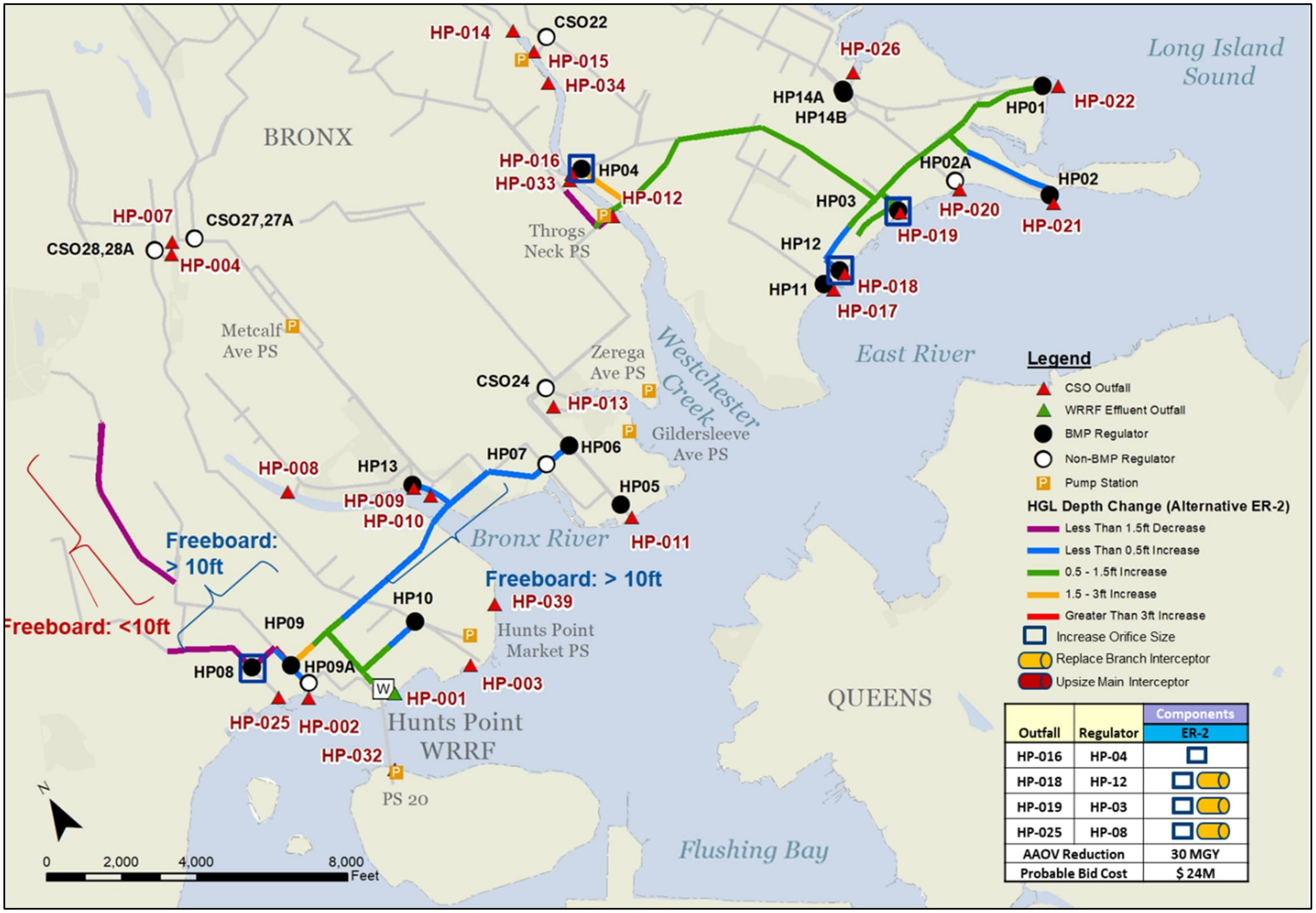


Figure 8.5-9. Hydraulic Grade Line Impacts of Alternative ER-1 vs. Baseline Conditions (5-Year Storm)



Outfall	Regulator	Components ER-2
HP-016	HP-04	
HP-018	HP-12	
HP-019	HP-03	
HP-025	HP-08	
AAOV Reduction		30 MGY
Probable Bid Cost		$ 24M

Figure 8.5-10. Hydraulic Grade Line Impacts of Alternative ER-2 vs. Baseline Conditions (5-Year Storm)

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Table 8.5-12. Summary of Performance of Hunts Point Optimization Alternatives for East River

Outfall[(1)]	Regulator	Baseline Conditions Typical Year		Alternative ER-1[(2)]		Alternative ER-2[(3)]	
		Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
HP-022	HP-01	28.8	29	28.8	29	30.7	30
HP-021	HP-02	202	44	202	44	209	44
HP-019	HP-03	15.3	35	15.3	35	5.8	14
HP-011	HP-05	665	34	682	34	682	34
HP-025	HP-08	95.9	45	21.3	14	22.4	14
HP-002	HP-09	47.8	19	62.8	21	62.8	21
HP-003	HP-10	138	30	142	30	143	30
HP-017	HP-11	38.5	28	38.5	28	41.9	29
HP-018	HP-12	3.4	15	3.4	15	2.7	14
HP-009	HP-13	323	36	323	36	337	36
Total		**2,370**	**45**	**2,348**	**44**	**2,348**	**44**

Notes:
(1) Outfalls and regulators with negligible impacts to Annual CSO Volume and Activations are not included in this table.
(2) ER-1 reduces CSO volume to the East River by 37 MGY. This alternative results in an increase in treated CSO volume to the Bronx River of 15 MGY and Westchester Creek of 1 MGY.
(3) ER-2 reduces CSO volume to the East River by 34 MGY and Westchester Creek by 2 MGY. This alternative results in an increase in treated CSO volume to the Bronx River of 14 MGY.

Table 8.5-13. Summary of Cost and Implementation Considerations for Hunts Point Optimization Alternatives for East River

Alternative	Probable Bid Cost ($M)	Implementation Considerations
ER-1	$16M	• Reduction in CSO to the East River of 37 MGY • Increase in CSO to the Bronx River of 15 MGY and Westchester Creek of 1 MGY • Net CSO reduction of 21 MGY
ER-2	$24M	• Reduction in CSO to the East River of 34 MGY and Westchester Creek of 2 MGY • Increase in CSO to the Bronx River of 14 MGY • Net CSO reduction of 22 MGY

Given the potential cost-effective reduction in CSO activation frequency and volume, Alternatives ER-1 and ER-2 were retained for further consideration. However, the increases in CSO discharges to the Bronx River (which was evaluated under a separate LTCP) are a concern and must be considered in the selection of the preferred alternative for the East River. Tunnel storage options for the outfalls to the East River from the Hunts Point WRRF system are evaluated later in this section.

8.5.a.4 System Optimization for East River Outfalls in the Wards Island WRRF System

Table 8.5-14 summarizes the CSO outfalls and associated regulators tributary to the East River from the Wards Island WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.5-11. Table 8.5-14 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits ("BMP Regulator")
- A "key regulator" as identified in the WRRF SPDES permits
- An outfall in proximity to a public access location (typically within 500 feet of an access location)
- Regulators that activated more than average for the waterbody

Table 8.5-14. East River CSO Outfalls/Regulators Associated with the Wards Island WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
WIM-003	WIM-02B	89.6	43	✓			✓
WIM-008	WIM-07	115	45	✓			✓
WIM-016	WIM-15	13.3	38	✓			✓
WIB-072	WIB-68	33.1	37	✓			✓

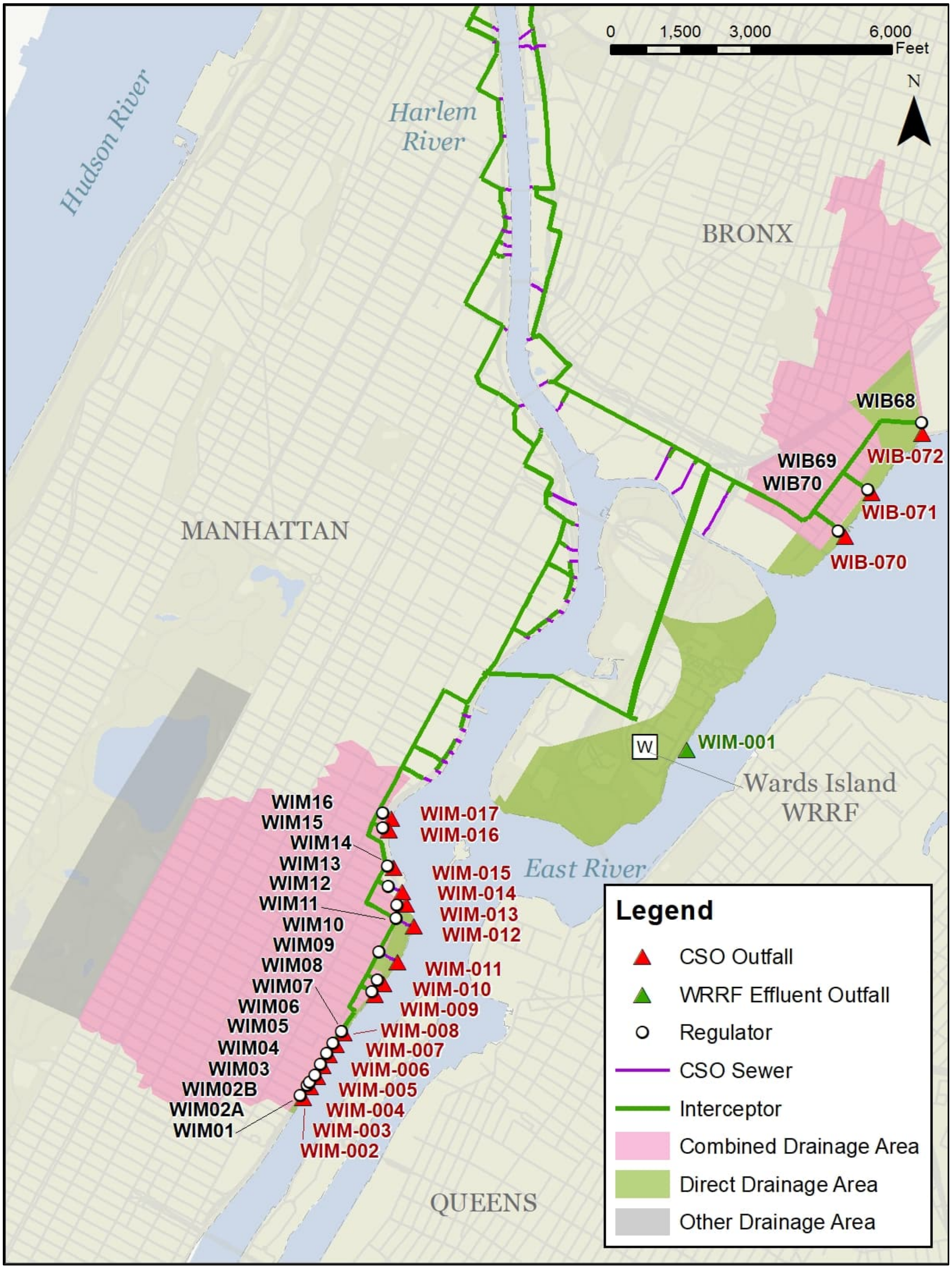

Figure 8.5-11. CSO Outfalls/Regulators Tributary to East River from the Wards Island WRRF System

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Wards Island WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Wards Island WRRF collection system serves the northeastern portion of Manhattan and western Bronx. The Manhattan interceptor parallels the Harlem River Drive, while the Bronx Interceptor initially parallels the Hudson River along Palisades Avenue, then bends eastward along the Harlem River and then to the south generally following the Major Deegan Expressway.
- A total of 75 regulators contribute flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to the Hudson River (3 CSOs), Harlem River (49 CSOs), Bronx Kill (3 CSOs) and East River (20 CSOs). The interceptor sewers convey flow to the Wards Island WRRF located to the south and east of Randall's Island Park.
- The sewers tributary to each regulator are relatively flat due to the topography. Depth of cover on the gravity sewers varies, ranging from relatively shallow (<10 feet of cover) to about 50 feet.
- Regulators contributing to CSO outfalls discharging to the East River from the Wards Island WRRF system activate between 0 to 50 times during the typical year with a total average annual overflow volume (AAOV) of 311 MGY.
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the portions of the collection system along the East River are highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified alternatives that included modifications to as many as 25 regulators throughout the WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year, limited reductions in AAOV (<1.5 percent) and activation frequency (<2.5 percent) were predicted for the better performing alternatives.

Follow-up Evaluations Based on Full InfoWorks Model

No retained alternatives were identified from the initial optimization runs due to hydraulic grade line impacts that increased the potential risk of flooding, while providing negligible reductions in CSO volume and activations to the East River. Figure 8.5-12 illustrates the hydraulic grade line sensitivities where optimization alternatives increase the potential risk of street flooding and basement backups. Tunnel options for CSO outfalls to the East River from the Wards Island WRRF system are evaluated later in this section.

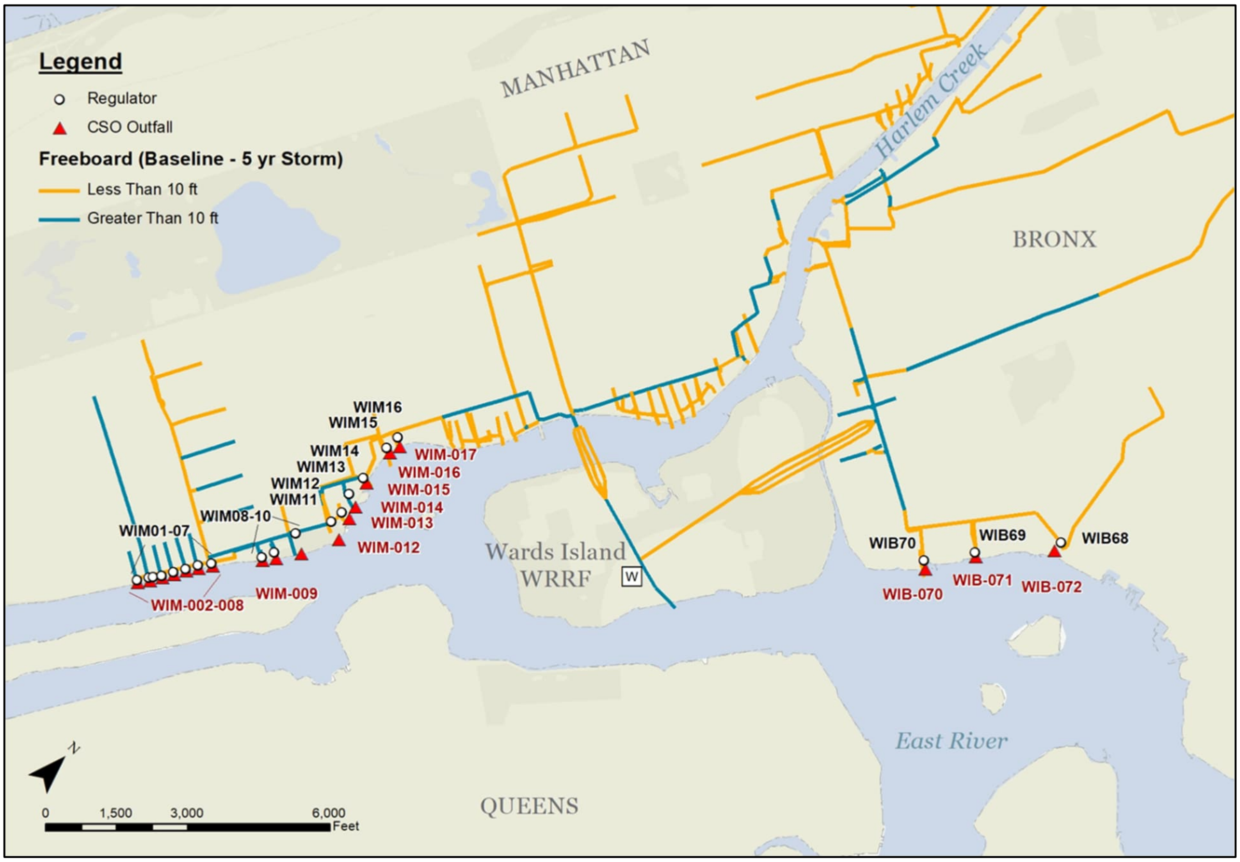

Figure 8.5-12. Hydraulic Grade Line Impacts of Wards Island Collection System Under Baseline Conditions (5-Year Storm)

8.5.a.5 System Optimization for East River Outfalls in the Newtown Creek WRRF System

Table 8.5-15 summarizes the CSO outfalls and associated regulators tributary to the East River from the Newtown Creek WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.5-13. Table 8.5-15 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits ("BMP Regulator")
- A "key regulator" as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet) a public access location
- Regulators that activated more than average for the waterbody

Table 8.5-15. East River CSO Outfalls/Regulators Associated with the Newtown Creek WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
NCB-006	NCB-09	113	17	✓		✓	
NCB-012	NCB-06	16.3	8	✓			
NCB-013	NCB-05	98.2	28	✓			✓
NCB-014	NCB-04	727	30	✓	✓		✓
NCM-032	NCM-50	5.57	11	✓			
NCM-036	NCM-47	79.9	15	✓	✓		
NCM-037	NCM-44	0.94	4	✓			
NCM-041	NCM-42	29.2	16	✓			
NCM-045	NCM-40	22.11	14	✓			
NCM-049	NCM-37	17.6	12	✓			
NCM-050	NCM-19	34.76	19	✓			
NCM-052	NCM-36	24.44	15	✓			
NCM-063	NCM-21	10.12	9	✓			
NCM-066	NCM-17	4.95	12	✓			
NCM-069	NCM-10	9.24	12	✓			
NCM-078	NCM-16	1.06	4	✓			
NCB-004	NCB-10	17.9	36			✓	✓
NCB-007	NCB-8	8.63	29				✓
NCB-008	NCB-7	23.2	26				✓
NCB-027	NCB-12	18.8	30				✓

Table 8.5-15. East River CSO Outfalls/Regulators Associated with the Newtown Creek WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
NCM-005	NCM-51	49.9	38				✓
NCM-018	NCM-45	11.7	34				✓
NCM-062	NCM-22	13.35	34				✓

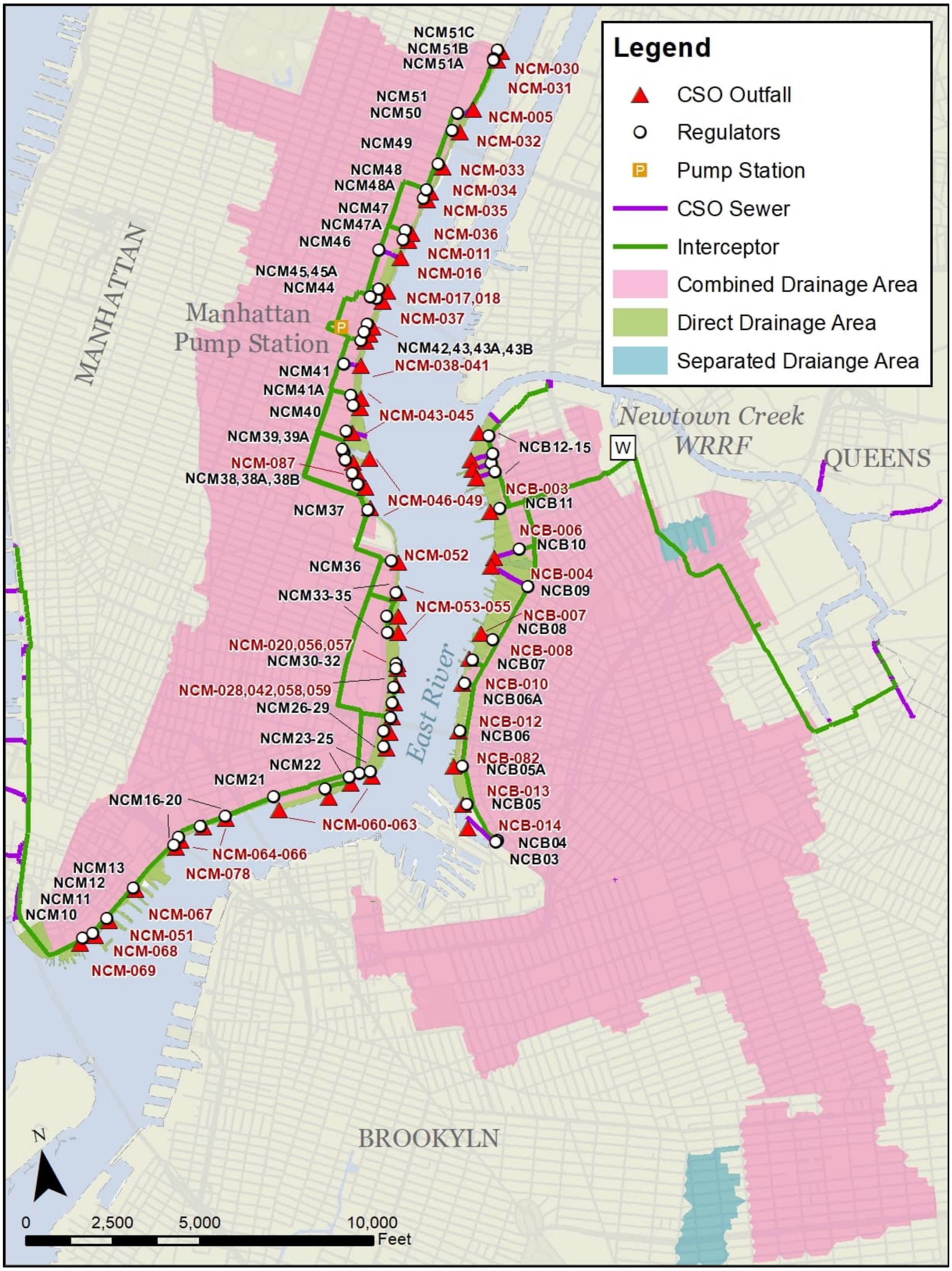

Figure 8.5-13. CSO Outfalls/Regulators Tributary to East River from the Newtown Creek WRRF System

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Newtown Creek WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Newtown Creek WRRF collection system serves the east side and southern portion of Manhattan, along with northern Brooklyn and a portion of Queens. The southern branch of the Manhattan interceptor starts in the vicinity of Outfall NCM-081, and runs south parallel to the Hudson River shoreline. The interceptor continues around the southern tip of Manhattan, then runs north parallel to the East River, to the Manhattan Pumping Station. The northern branch of the Manhattan Interceptor runs south from approximately East 71st Street, parallel to the East River shoreline, to the Manhattan Pumping Station. The Manhattan Pumping Station pumps the flow across the East River to the Newtown Creek WRRF. On the Brooklyn side, the Kent Avenue Interceptor serves the area with outfalls tributary to the East River. The Kent Avenue Interceptor joins with the Morgan Avenue Interceptor, which serves the area tributary to Newtown Creek, before entering the Brooklyn Pumping Station at the Newtown Creek WRRF. A total of 85 regulators divert flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to the Hudson River (9 CSOs), Newtown Creek (8 CSOs) and East River (63 CSOs).
- Depth of cover on the gravity sewers varies, ranging from relatively shallow (<10 feet of cover) to about 20 feet.
- Regulators contributing to CSO outfalls discharging to the East River activate between 0 to 38 times during the typical year with a total average annual overflow volume (AAOV) of 1,490 MGY.
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the system is highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified alternatives that included modifications to as many as 20 regulators throughout the WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year limited reductions in AAOV (<3 percent) and activation frequency (<2 percent) were predicted for the better performing alternatives.
- The limited performance improvement is a result of the hydraulic grade line sensitivities and the capacity of each pumping station. Also, since the system was generally running full during wet--weather, alternatives that reduced CSO at one location tended to result in offsetting increases at other locations.

Follow-up Evaluations Based on Full InfoWorks Model

No retained alternatives were identified from the initial optimization runs due to hydraulic grade line (HGL) impacts that increased the potential risk of flooding, while providing negligible reductions in CSO volume and activations to the East River. Figure 8.5-14 illustrates the hydraulic grade line sensitivities where optimization alternatives would increase the potential risk of street flooding and basement backups.

Figure 8.5-14. Hydraulic Grade Line Impacts of Newtown Creek Collection System Under Baseline Conditions (5-Year Storm)

However, based in input from the public, the InfoWorks model was used to specifically look at additional alternatives to reduce CSOs at Outfalls NCB-004 and NCB-006, which discharge at the mouth of Bushwick Inlet, as well as Outfalls NCB-013 and NCB-014 in the vicinity of Wallabout Channel. As indicated in Figure 8.5-13 above, these two sets of outfalls are located along opposite ends of the Kent Avenue Interceptor. The crest of the overflow weir at Regulator NCB-04, that discharges to Outfall NCB-014, is at elevation -7.73, which is just below the crown of the interceptor at that location. The overflow weir at Regulator NCB-05, associated with Outfall NCB-013, is approximately four feet higher. The overflow weirs at the regulators associated with Outfalls NCB-004 and NCB-006 are about six and just under three feet higher than the weir at NCB-014, respectively.

The interceptor between NCB-014 and NCB-006 runs surcharged during wet-weather, and the peak hydraulic grade line is often above the elevation of the weirs at NCB-006, NCB-013, and NCB-014. Optimization measures such as raising weirs or increasing the size of the connections between the regulators and the interceptors resulted in no net benefit in terms of CSO reduction. Alternatives to reduce CSO volume at Outfalls NCB-004 and NCB-006 resulted in increases in volume at NCB-013 and NCB-014, and vice versa. Raising weirs and/or opening up interceptor connections at both locations resulted in unacceptable increases in the peak hydraulic grade line along the interceptor. For these reasons, no further optimization alternatives were recommended for those outfalls.

Tunnel options are evaluated later in this section.

8.5.a.6 System Optimization for East River Outfalls in the Red Hook WRRF System

The locations of the CSO outfalls and associated regulators tributary to the East River from the Red Hook WRRF system are shown in Figure 8.5-15. The Red Hook WRRF is located at the downstream end of the interceptor system, which extends along the Brooklyn shoreline to Gowanus Bay, and then back north along Gowanus Canal. The optimization evaluations for the Red Hook system were conducted on the system as a whole, without separately evaluating optimization alternatives for the East River outfalls independently of the New York Bay outfalls. This approach was taken due to the hydraulic connectivity among the outfalls provided by the single interceptor system. The Red Hook optimization evaluations are presented as part of the New York Bay evaluations in Section 8.6, below.

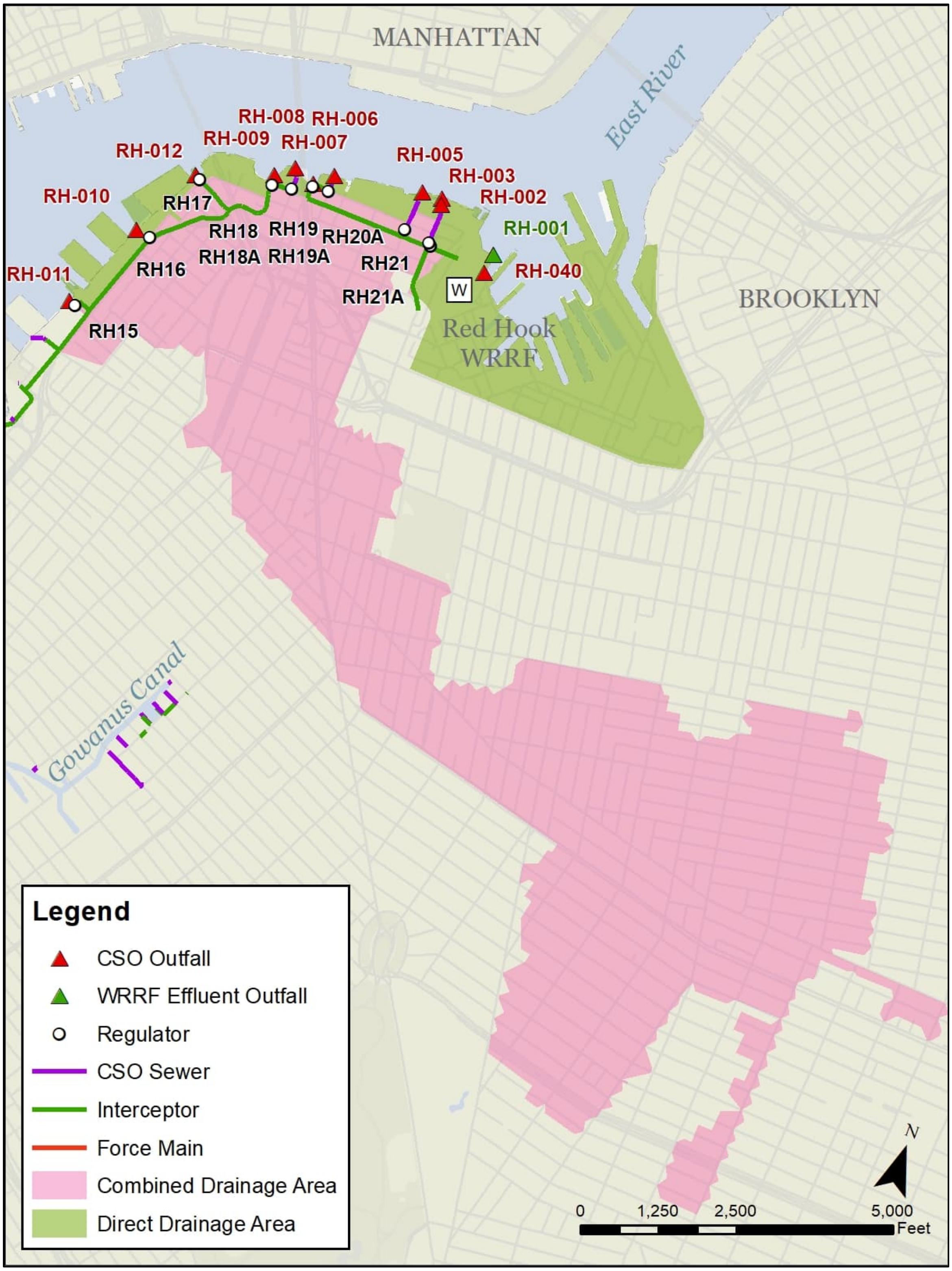

Figure 8.5-15. CSO Outfalls/Regulators Tributary to East River from the Red Hook WRRF System

8.5.b Storage Tunnel Alternatives for 25/50/75/100 Percent CSO Control

Conceptual storage tunnel alternatives were developed to provide 25, 50, 75, and 100 percent CSO control of the annual CSO volume discharged to the East River in the Typical Year. The approach to sizing and layout of the storage tunnel alternatives was as follows:

- For the 50 percent CSO control tunnel, the Typical Year annual overflow volume of each CSO outfall to the East River was reviewed and combinations of outfalls were identified where capture of 100 percent of the CSO from those outfalls would approximately match 50 percent of the total CSO volume from all outfalls to the East River.
- The locations of these outfalls were assessed in relation to the length and diameter of tunnel needed to capture the outfalls.
- Based on DEP expertise, a combination of outfalls was selected that provided reasonable tunnel length/diameter to provide 50 percent volume capture.
- A similar approach was taken for the 75 percent CSO control tunnel.
- For the 25 percent CSO control tunnel, the 50 percent CSO tunnel was downsized until the volume of storage provided would result in approximately 25 percent CSO control.
- For the 100 percent CSO control tunnel, it was assumed that every CSO outfall to the East River that was predicted to be active in the 2008 Typical Year would be tied into the tunnel. Where multiple outfalls were located in close proximity to each other, it was assumed that a near-surface consolidation conduit would be provided to a single drop shaft.
- For each storage tunnel alternative, the dewatering rate required to dewater the storage tunnel within 24 hours was compared to the available dry-weather flow capacity in the WRRF closest to the downstream end of the tunnel. If insufficient dry-weather flow capacity was available at the WRRF to accept the additional dewatering flows, a high-rate clarification wet-weather flow treatment system with disinfection was added to the alternative to treat the dewatered flow.
- A detailed siting assessment was not conducted, so the specific locations of various features of the tunnel alternatives (mining shaft, TBM removal shaft, drop shafts, dewatering pumping station, dewatered flow treatment facility, near-surface diversion structures/connection conduits) were not identified.

The main features of the 25, 50, 75, and 100 percent CSO control storage tunnel modeling scenarios for the East River are summarized in Table 8.5-16. Figure 8.5-16 to Figure 8.5-19 present conceptual layouts of the storage tunnel alternatives. The 25 percent capture tunnel would capture overflow from Outfalls BB-005, BB-005 (24th Avenue), BB-028, and NCB-014 (Figure 8.5-16). The tunnel would start at a mining shaft in the general vicinity of Outfall NCB-014, and run north along the East River shoreline. The tunnel would pick up Outfall NCB-028, then head towards Bowery Bay to pick up Outfalls BB-005 and BB-005 (24th Avenue). The total tunnel length would be about 42,700 feet (8.1 miles), with a diameter of 17 feet. Under this configuration, the tunnel would be dewatered to the Red Hook WRRF, but it could also be configured to dewater to the Bowery Bay WRRF.

Table 8.5-16. Summary of 25, 50, 75 and 100 Percent CSO Control Alternatives for East River

Alternative	ER-7	ER-8	ER-9			ER-10		
Level of CSO Control(1)	25%	50%	75%			100%		
WRRF Outfalls Captured(2)	BB/NC	HP/BB/NC	BB/NC/RH	TI	HP/WI/NC	BB/NC/RH	TI	HP/WI/NC
Length (mi.)	8.1	15.3	8.1	3	10.8	9.5	2.7	15.9
Diameter (ft.)	17	28	37	17	22	37	17	26
Volume (MG)	71	367	344	23	163	394	23	321
Outfalls Captured	• BB-005 • BB-005 (24th Ave.) • BB-028 • NCB-014	• HP-011 • HP-021 • BB-005 • BB-005 (24th Ave.) • BB-028 • NCB-014	• BB-005 • BB-005 (24th Ave.) • BB-028 • BB-029 • BB-034 • BB-041 • NCB-006 • NCB-013 • NCB-014 • RH-005	• TI-003 • TI-023	• HP-011 • HP-021 • HP-025 • WIM-003 • NCM-036	• 26 BB outfalls • 14 NC outfalls • 12 RH outfalls	• Ti-003 • TI-004 • TI-005 • TI-023	• 12 HP outfalls • 19 WI outfalls • 48 NC outfalls
Net CSO Volume Reduction (MGY)	1,294	2,643	2,482	210	1,132	2,814	213	2,145
Wet-Weather Flow Treatment Facility Capacity for Dewatering Flow (MGD)	71	367	344	23	163	394	23	321
Estimated Probable Bid Cost(3)	$1,500M	$4,700M	$5,100M	$600M	$2,300M	$8,300M	$800M	$9,100M
Total Estimated Probable Bid Cost by Level of Control(3)	$1,500M	$4,700M	$8,000M			$18,200M		

Notes:

(1) Annual percent CSO reduction based on the 2008 Typical Year.
(2) HP = Hunts Point; BB = Bowery Bay; NC = Newtown Creek; RH = Red Hook; TI = Tallman Island; WI = Wards Island
(3) 2019 dollars.

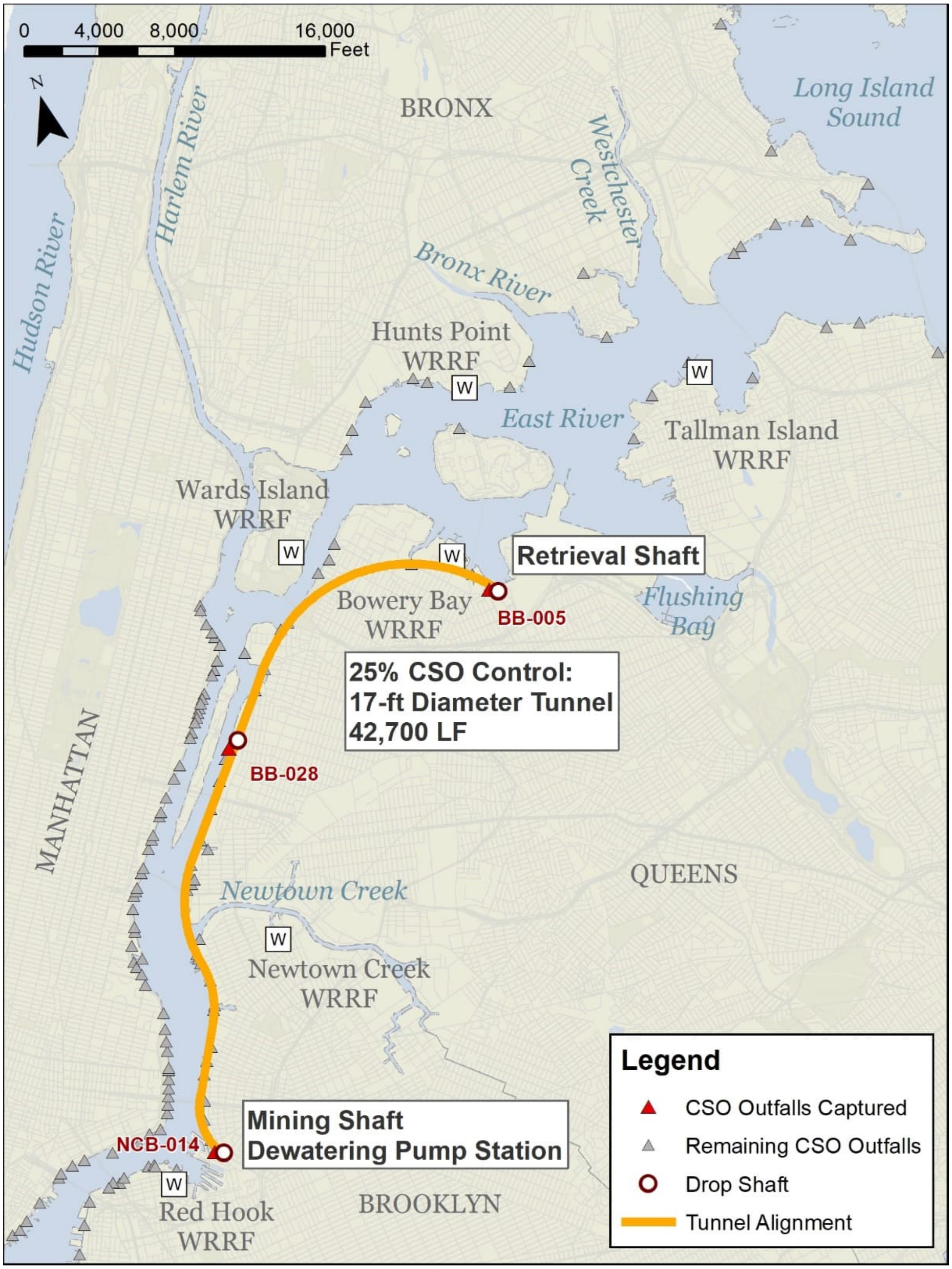

Figure 8.5-16. 25 Percent CSO Control Tunnel for East River

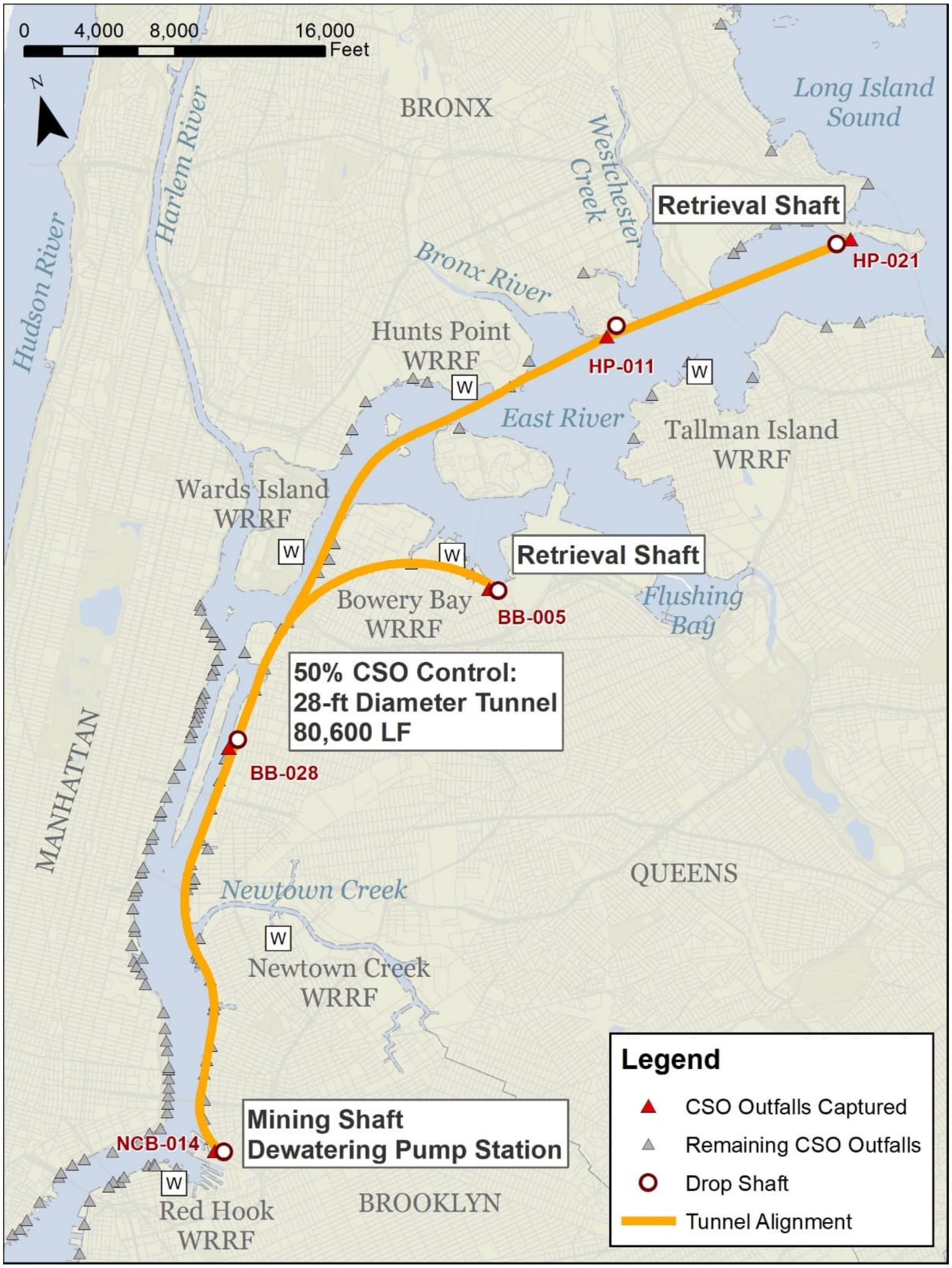

Figure 8.5-17. 50 Percent CSO Control Tunnel for East River

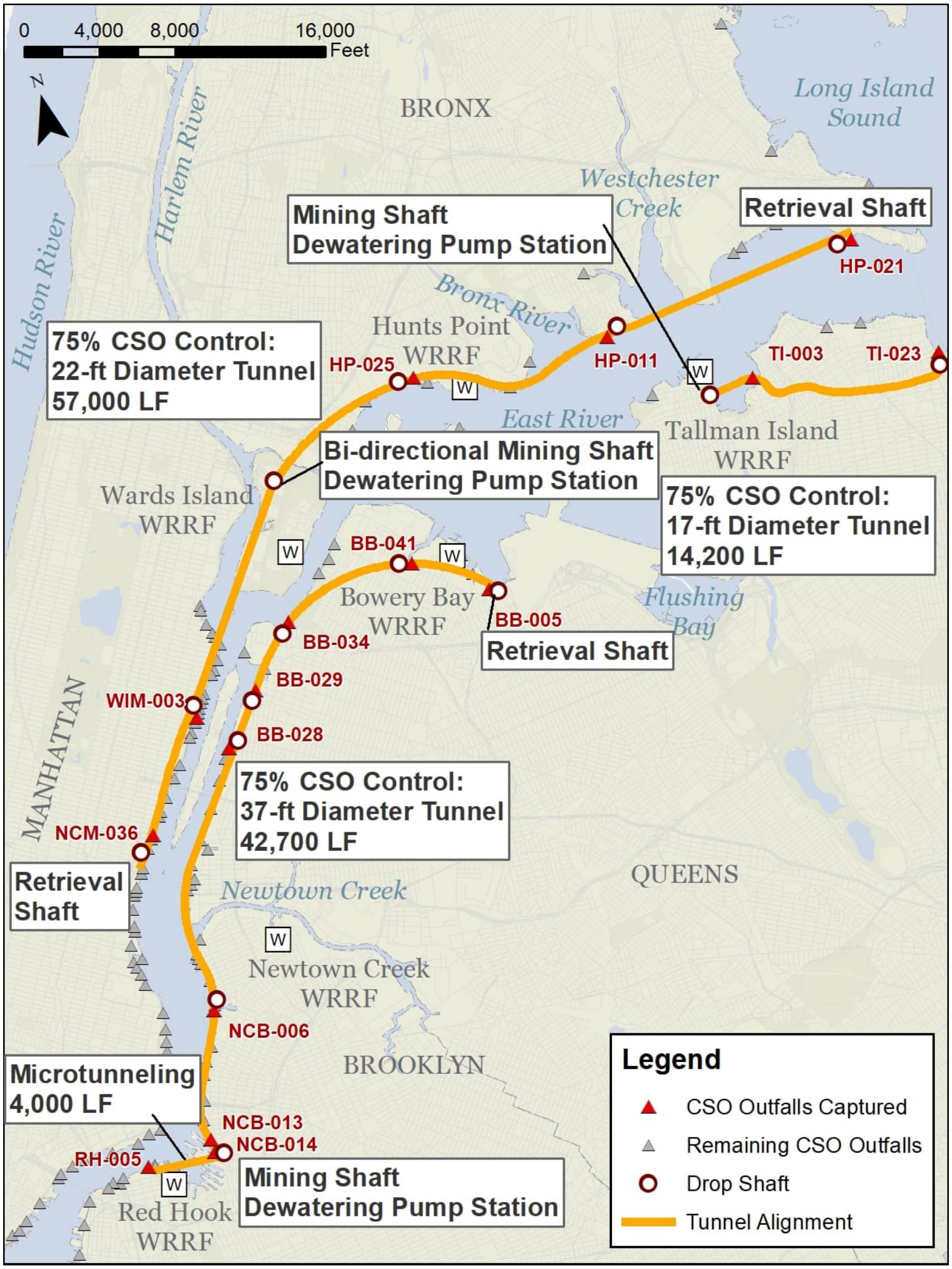

Figure 8.5-18. 75 Percent CSO Control Tunnels for East River

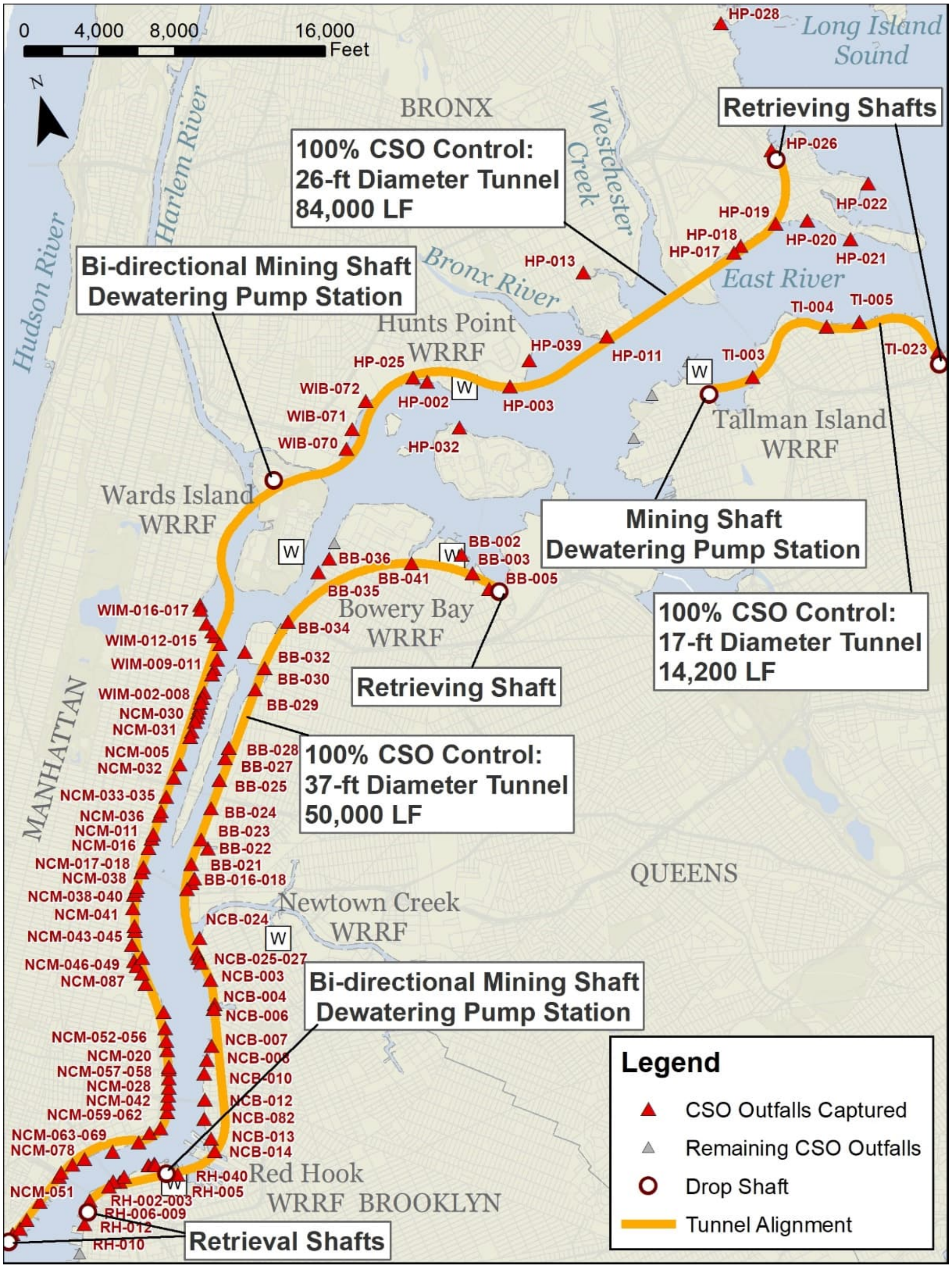

Figure 8.5-19. 100 Percent CSO Control Tunnels for East River

The 50 percent CSO control tunnel would pick up the same outfalls as the 25 percent CSO control tunnel, but in addition would also pick up Outfalls HP-011 and HP-021. It would run along the same route as the 25 percent CSO control tunnel from Outfall NCB-014 to Outfall BB-028. North of Outfall BB-028, the tunnel would split, with one branch going to Outfall BB-005, and the other branch extending north to pick up Outfalls HP-011 and HP-021 (Figure 8.5-17). The total length of the 50 percent CSO control tunnel would be about 80,600 feet, and the diameter would be 28 feet.

The 75 percent CSO control tunnel capturing the BB/NC/RH outfalls would start near Outfall NCB-014 and run north along the shore of the East River, then turn east towards Bowery Bay (Figure 8.5-18). A separate microtunnel would connect the RH-005 outfall to the downstream end of the tunnel. The tunnel length would be about 42,700 feet (8 miles), with a diameter of 37 feet. For this configuration, the tunnel would be dewatered to the Red Hook WRRF, but the tunnel could be configured to dewater to the Bowery Bay WRRF.

The 75 percent CSO control tunnel capturing the TI outfalls would start with a mining shaft near the Tallman Island WRRF and run across Powell Cove to Outfall TI-003, then east to Outfall TI-023 (Figure 8.5-18). The tunnel length would be about 14,200 feet (3 miles), with a diameter of 17 feet. For this configuration, the tunnel would be dewatered to the Tallman Island WRRF.

The 75 percent CSO control tunnel capturing the HP/WI/NC outfalls would start with a mining shaft in the vicinity of the Wards Island WRRF, and run along the shoreline of the East River north and east to Outfall HP-021, and south to Outfall NCM-036 (Figure 8.5-18). The tunnel length would be about 57,000 feet (11 miles), with a diameter of 22 feet. For this configuration, the tunnel would be dewatered to the Wards Island WRRF.

The 100 percent CSO control tunnel capturing the BB/NC/RH outfalls would be configured similar to the 75 percent CSO control tunnel, but the southern end would be extended past Outfall NCB-014 to Outfall RH-012 (Figure 8.5-19). The tunnel length would be about 50,000 feet (10 miles), with a diameter of 37 feet. For this configuration, the tunnel would be dewatered to the Red Hook WRRF, but the tunnel could be configured to dewater to the Bowery Bay WRRF.

The 100 percent CSO control tunnel capturing the TI outfalls would start with a mining shaft near Outfall TI-019, and run west along the shoreline of the East River to Outfall TI-023 (Figure 8.5-19). The mining shaft could also be located near the Tallman Island WRRF, with the tunnel running in two directions from that location. The tunnel length would be about 20,600 feet (4 miles), with a diameter of 14 feet. For this configuration, the tunnel would be dewatered to the Tallman Island WRRF.

The 100 percent CSO control tunnel capturing the HP/WI/NC outfalls would start with a mining shaft in the vicinity of the Wards Island WRRF, and run along the shoreline of the East River north and east to Outfall HP-026, and south to Outfall NCM-069 (Figure 8.5-19). Multiple near-surface consolidation conduits would be provided to convey flow from adjacent outfalls to common drop shafts. The tunnel length would be about 84,000 feet (16 miles), with a diameter of 26 feet. For this configuration, the tunnel would be dewatered to the Wards Island WRRF.

The dewatering capacity needed and the location where the dewatering flow would be conveyed for treatment varies with each of the alternatives described above. However, dedicated wet-weather high-rate treatment facilities would be necessary for the treatment of the CSO retained in the storage tunnel.

While these alternatives provide relatively high levels of CSO control, the significant challenges to implementation include:

- Very high implementation cost
- Limited siting availability for shafts, dewatering pumping station, dewatering flow treatment facility
- Long implementation period
- Significant and prolonged construction impacts (truck traffic, noise, dust) for surface consolidation sewers due to the large number of drop shafts necessary to divert CSO to the tunnel
- Negligible improvement in the annual attainment of applicable water quality standards
- Construction impacts and likelihood of utility conflicts for near-surface diversion structures and connecting conduits

Despite these challenges, these alternatives were retained in order to provide an assessment of a range of levels of CSO control for the East River, per the CSO Control Policy and the Clean Water Act.

8.5.c Summary of Retained Alternatives for East River

The goal of the previous evaluations was to develop a list of retained CSO control measures for the East River. These CSO control measures, whether individually or in combination, form the basis of basin-wide alternatives to be assessed using more rigorous cost-performance and cost-attainment analyses. Table 8.5-17 lists all of the CSO control measures originally identified in the "Alternatives Toolbox" shown above in Figure 8.5-2, and identifies whether the CSO control measure was retained for further analysis. The reasons for excluding the non-retained CSO control measures from further consideration are also noted in the table.

Table 8.5-17. Summary of Control Measure Screening for East River

Control Measure	Category	Retained for Further Analysis?	Remarks
Additional GI Build-out	Source Control	NO(1)	Planned GI build-out in the watershed is included in the baseline. It is unlikely that additional sites will be identified due to site constraints in publicly owned properties.
High Level Storm Sewers	Source Control	NO(1)	No cost-effective opportunities identified
Regulator Modifications	System Optimization	YES	Incorporated into optimization alternatives ER-1, ER-2, ER-5 and ER-6.
Parallel Interceptor Sewer	System Optimization	YES	Incorporated into optimization alternatives ER-1, ER-2 and ER-6.
Bending Weirs/Control Gates	System Optimization	NO	No cost-effective or constructible site opportunities were identified
Pumping Station Optimization	System Optimization	NO	Limited benefit in terms of CSO reduction.

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Table 8.5-17. Summary of Control Measure Screening for East River

Control Measure	Category	Retained for Further Analysis?	Remarks
Pumping Station Expansion	System Optimization	NO	Limited benefit in terms of CSO reduction.
Gravity Flow Redirection to Other Watersheds	CSO Relocation	YES	Optimization Alternatives ER-1 and ER-2 shift some CSO volume between the East River and other waterbodies
Pumping Station Modification	CSO Relocation	NO	No cost-effective opportunities identified.
Flow Redirection with Conduit and Pumping	CSO Relocation	NO	No cost-effective opportunities identified.
Floatables Control	Floatables Control	YES	Programmatic floatables control will be applied and expanded Citywide
Environmental Dredging	Water Quality/ Ecological Enhancement	NO	No specific locations of CSO sediment mounding identified.
Wetland Restoration and Daylighting	Water Quality/ Ecological Enhancement	NO	No daylighting opportunities were identified.
Outfall Disinfection	Treatment: Satellite	NO	Not feasible due to short length of outfalls.
Retention/Treatment Basins	Treatment: Satellite	NO	Significant siting constraints and very high costs. Tunnel storage covers 25/50/75/100% CSO control alternatives.
High-Rate Clarification	Treatment: Satellite	YES	Incorporated into the storage tunnel alternatives for treatment of captured CSO during tunnel dewatering.
WRRF Expansion	Centralized Treatment	NO	Insufficient space available. Limited benefit compared to potential cost.
In-System Storage (Outfalls)	Storage	NO	Negligible levels of CSO control due to short outfalls.
Off-line Storage (Tanks)	Storage	NO	Significant siting constraints and very high costs. Tunnel storage covers 25/50/75/100% CSO control alternatives.
Off-line Storage (Tunnels)	Storage	YES	Tunnel storage alternatives ER-7, ER-8, ER-9 and ER-10 cover 25/50/75/100% CSO control.

Note:
(1) Additional GI and HLSS are considered to be ongoing programs that will continue to be implemented system-wide outside of the LTCP program.

As shown, the retained CSO control measures include system optimization measures, tunnel storage (with high-rate clarification for dewatering flows), and programmatic floatables control.

8.5.d CSO Volume and Loading Reductions for Retained Alternatives for East River

Table 8.5-18 summarizes the projected performance of the retained East River alternatives in terms of annual CSO volume and fecal coliform load reduction, based on the 2008 Typical Year. These data are plotted on Figure 8.5-20. In all cases, the predicted reductions shown are relative to the Baseline Conditions using 2008 JFK rainfall as described in Section 6. The baseline assumptions were described in detail in Section 6 and include the implementation of the grey infrastructure projects from the approved WWFPs, the Recommended Plans from the previously submitted LTCPs, and the projected level of GI identified in Section 5.

Table 8.5-18. East River Retained Alternatives Performance Summary (2008 Rainfall)

Alternative	Annual Performance Based on 2008 Typical Year				
	Remaining CSO Volume (MGY) (1)	Frequency of Overflow (2)	Additional Untreated CSO Volume to Other Waterbodies (MGY) (3)	Net CSO Volume Reduction (%)	Net Fecal Coliform Reduction (%)
Baseline Conditions	5,193	61	-	-	-
ER-1. Optimization of Regulators Associated with Outfall HP-025	5,156	61	16	<1	<1
ER-2. Optimization of Regulators Associated with Outfalls HP-016, HP-018, HP-019 and HP-025	5,159	61	12	<1	<1
ER-5. Optimization of Regulators Associated with Outfall TI-023	5,151	61	0	<1	<1
ER-6. Optimization of Regulators Associated with Outfalls TI-003 and TI-023	5,107	61	0	2	2
ER-7. Tunnel Storage for 25% CSO Control (52 MG Capacity)	3,898	61	0	25	25
ER-8. Tunnel Storage for 50% CSO Control (371 MG Capacity)	2,550	61	0	51	51
ER-9. Tunnel Storage for 75% CSO Control (529 MG Capacity)	1,369	46	0	74	74
ER-10. Tunnel Storage for 100% CSO Control (758 MG Capacity)	0	0	0	100	100

Notes:
(1) Remaining CSO includes all discharges to the East River from the Tallman Island, Hunts Point, Bowery Bay, Red Hook, Newtown Creek, North River, and Wards Island WRRF Collection Systems.
(2) Frequency of overflow is based upon the most frequently active CSO outfall.
(3) Additional untreated CSO volume to other waterbodies accounts for increases at other CSO outfalls in response to the implementation of a CSO control alternative. Net CSO volume reduction and net fecal coliform reduction account for any additional CSO discharge to other waterbodies.

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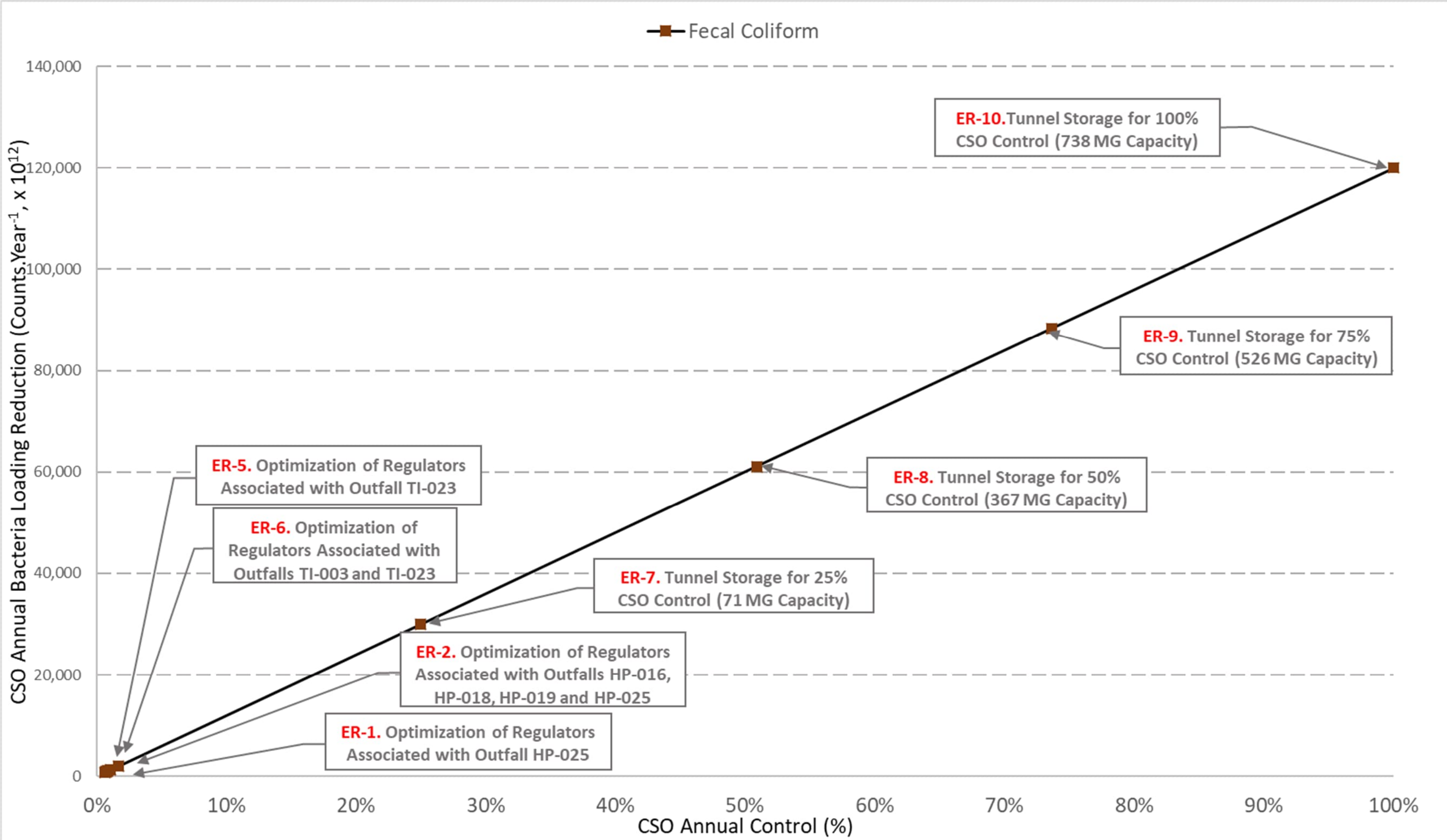

Figure 8.5-20. Untreated CSO Volume Reductions (as % CSO Annual Control) vs. Annual CSO Bacteria Loading Reduction (2008 Typical Year) for East River

Because the retained alternatives for the East River provide volume reduction and not treatment, the predicted bacteria loading reductions of the alternatives are very closely aligned with their projected CSO volume reductions.

8.5.e Cost Estimates for East River Retained Alternatives

Evaluation of the retained alternatives requires cost estimation. The methodology for developing these costs is dependent upon the type of technology and its O&M requirements. The construction costs were developed as Probable Bid Costs (PBC) and the total Net Present Worth (NPW) costs were determined by adding the estimated PBC to the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 100-year life cycle. Design, construction management, and land acquisition costs are not included in the cost estimates. All costs are in 2019 dollars and are considered Level 5 cost estimates by AACE International with an accuracy of -50 percent to +100 percent.

8.5.e.1 Alternative ER-1. Optimization of Outfall HP-025

Costs for Alternative ER-1 include planning-level estimates of the costs to optimize the performance of Regulator HP-8 associated with Outfall HP-025 and reflect the description provided in Section 8.5.a. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative ER-1 is $16M as shown in Table 8.5-19.

Table 8.5-19. Costs for Alternative ER-1

Item	2019 Cost ($ Million)
Probable Bid Cost	$16
Annual O&M Cost	$0
Net Present Worth	$16

8.5.e.2 Alternative ER-2. Optimization of Outfalls HP-016, HP-018, HP-019 and HP-025

Costs for Alternative ER-2 include planning-level estimates of the costs to optimize the performance of Regulators HP-4, HP-12, HP-3, and HP-8 associated with Outfalls HP-016, HP-018, HP-019, and HP-025 and reflects the description provided in Section 8.5.a. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative ER-2 is $24M as shown in Table 8.5-20.

Table 8.5-20. Costs for Alternative ER-2

Item	2019 Cost ($ Million)
Probable Bid Cost	$24
Annual O&M Cost	$0
Net Present Worth	$24

8.5.e.3 Alternative ER-5. Optimization of Outfall TI-023

Costs for Alternative ER-5 include planning-level estimates of the costs to install a bending weir at Regulator TI-13 associated with Outfall TI-023 and reflects the description provided in Section 8.5.a. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative ER-5 is $4M as shown in Table 8.5-21.

Table 8.5-21. Costs for Alternative ER-5

Item	2019 Cost ($ Million)
Probable Bid Cost	$3
Annual O&M Cost	$1
Net Present Worth	$4

8.5.e.4 Alternative ER-6. Optimization of Outfalls TI-003 and TI-023

Costs for Alternative ER-6 include planning-level estimates of the costs to optimize Regulator TI-10B (Outfall TI-003) and install a bending weir at Regulator TI-13 (Outfall TI-023) and reflects the description provided in Section 8.5.a. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative ER-6 is $7M as shown in Table 8.5-22.

Table 8.5-22 Costs for Alternative ER-6

Item	2019 Cost ($ Million)
Probable Bid Cost	$6
Annual O&M Cost	$1
Net Present Worth	$7

8.5.e.5 Alternative ER-7. Tunnel Storage for 25 Percent CSO Control

Costs for Alternative ER-7 include planning-level estimates of the costs for a CSO storage tunnel sized for 25 percent CSO control. A description of the tunnel components is provided in Section 8.5.b and illustrated in Table 8.5-16. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative ER-7 is $1,700M as shown in Table 8.5-23.

Table 8.5-23. Costs for Alternative ER-7

Item	2019 Cost ($ Million)
Probable Bid Cost	$1,500
Annual O&M Cost	$6
Net Present Worth	$1,700

8.5.e.6 Alternative ER-8. Tunnel Storage for 50 Percent CSO Control

Costs for Alternative ER-8 include planning-level estimates of the costs for a CSO storage tunnel sized for 50 percent CSO control. A description of the optimization components is provided in Section 8.5.b and illustrated in Table 8.5-16. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative ER-8 is $5,200M as shown in Table 8.5-24.

Table 8.5-24. Costs for Alternative ER-8

Item	2019 Cost ($ Million)
Probable Bid Cost	$4,700
Annual O&M Cost	$16
Net Present Worth	$5,200

8.5.e.7 Alternative ER-9. Tunnel Storage for 75 Percent CSO Control

Costs for Alternative ER-9 include planning-level estimates of the costs for the three CSO storage tunnels sized for 75 percent CSO control. A description of the optimization components is provided in Section 8.5.b and illustrated in Table 8.5-16. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative ER-9 is $9,000M as shown in Table 8.5-25.

Table 8.5-25. Costs for Alternative ER-9

Item	2019 Cost ($ Million)
Probable Bid Cost	$8,000
Annual O&M Cost	$30
Net Present Worth	$9,000

8.5.e.8 Alternative ER-10. Tunnel Storage for 100 Percent CSO Control

Costs for Alternative ER-10 include planning-level estimates of the costs for the three CSO storage tunnels sized for 100 percent CSO control. A description of the optimization components is provided in Section 8.5.b and illustrated in Table 8.5-16. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative ER-9 is $19,900M as shown in Table 8.5-26.

Table 8.5-26. Costs for Alternative ER-10

Item	2019 Cost ($ Million)
Probable Bid Cost	$18,200
Annual O&M Cost	$37
Net Present Worth	$19,400

The cost estimates of these retained alternatives are summarized below in Table 8.5-27 and are then used in the development of the cost-performance and cost-attainment plots presented in Section 8.5.f.

Table 8.5-27. Cost of Retained Alternatives

Alternative	PBC[1] ($ Million)	Annual O&M Cost ($ Million/Year)	Total Net Present Worth[2] ($ Million)
ER-1. Optimization of Regulators Associated with Outfall HP-025	$16	$0	$16
ER-2. Optimization of Regulators Associated with Outfalls HP-016, HP-018, HP-019, and HP-025	$24	$0	$24
ER-5. Optimization of Regulators Associated with Outfall TI-023	$3	$1	$4
ER-6. Optimization of Regulators Associated with Outfalls TI-003 and TI-023	$6	$1	$7
ER-7. Tunnel Storage for 25% CSO Control (52 MG Capacity)	$1,500	$6	$1,700
ER-8. Tunnel Storage for 50% CSO Control (371 MG Capacity)	$4,700	$16	$5,200
ER-9. Tunnel Storage for 75% CSO Control (529 MG Capacity)	$8,000	$30	$9,000
ER-10. Tunnel Storage for 100% CSO Control (758 MG Capacity)	$18,200	$37	$19,400

Notes:
(1) The Probable Bid Cost (PBC) for the construction contract based upon 2019 dollars.
(2) The Net Present Worth (NPW) is based upon a 100-year service life for tunnels and is calculated by multiplying the annual O&M cost by a present worth of 31.599 and adding this value to the PBC.

8.5.f Cost-Benefit Curves for Retained Alternatives

The final step of the analysis is to evaluate the cost-effectiveness of the basin-wide retained alternatives based on their NPW and projected impact on CSO loadings and attainment of applicable WQS. Section 8.5.f.1 below presents plots of cost versus CSO volume and bacteria load reduction (Cost-Performance Curves), and Section 8.5.g below presents plots of cost versus percent attainment with WQS for selected points along the East River (Cost-Attainment Curves).

8.5.f.1 Cost-Performance Curves

Cost-performance curves were developed by plotting the costs of the retained alternatives against their predicted level of CSO control, both in terms of CSO volume reduction, and in bacteria load reduction. In each case, a best-fit cost curve was developed based on those alternatives judged most cost-effective for a defined level of CSO control as estimated by IW modeling for the typical year rainfall (2008).

Figure 8.5-21 presents a plot of CSO volume reduction versus NPW for the retained alternatives, while Figure 8.5-22 plots the cost of the alternatives against fecal coliform loading reductions.

8.5.g Cost-Attainment Curves

This section evaluates the relationship of the costs of the retained alternatives versus their expected level of attainment of bacteria Primary Contact WQ Criteria as modeled using the LTCPRM water quality model for the 10-year simulation. As indicated in Section 6, based on the 10-year WQ simulations for the East River/Long Island Sound, for the Class SB Coastal Primary Recreational waters of Long Island Sound, east of the Throgs Neck Bridge, the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* and the Class SB WQ criteria for fecal coliform are both met at least 95 percent of the time under Baseline Conditions. Similarly, for the Class SB waters of the East River between the Whitestone Bridge and the Throgs Neck Bridge, as well as the Class I waters of the East River west and south of the Whitestone Bridge, the WQ criteria for fecal coliform are met at least 95 percent of the time under Baseline Conditions.

As a result, implementation of any of the retained alternatives described above, including the 100 percent CSO capture tunnel, results in nominal improvement in the percent attainment of WQ criteria applicable to each reach of the waterbody. Cost-attainment plots are presented below for four locations along the East River/Long Island Sound:

- LTCP sampling Station E-2, located in the Coastal Primary Recreational Class SB Long Island Sound east of Weir Creek (Figure 8.5-23)
- LTCP sampling Station E-5, located in the Class SB reach of the East River between the Throgs Neck and Whitestone Bridges (Figure 8.5-24)
- LTCP sampling Station E-7, located in the Class I reach of the East River adjacent to Bowery Bay (Figure 8.5-25)
- LTCP sampling Station E-12, located in the Class I reach of the East River adjacent to Newtown Creek (Figure 8.5-26)

The locations of these stations are shown on Figure 8.5-32 below. The plots show NPW versus percent attainment with the applicable WQ criteria for bacteria. Figure 8.5-23 shows the attainment with the Class SB WQ criteria for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis, and the attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day geometric mean and STV, recreational season basis). The plots for all four criteria are superimposed on each other at the 100 percent value.

Figure 8.5-24 shows the attainment with the Class SB WQ criteria for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis. The two are superimposed on each other at the 100 percent value.

Figure 8.5-25 and Figure 8.5-26 show the attainment with the Class I WQ criteria for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis. For each figure, the two plots are superimposed on each other at the 100 percent value.

These plots indicate that each of the retained alternatives represent essentially no performance improvement in terms of percent attainment with WQ criteria at highly variable levels of cost, due to the 100 percent level of attainment under Baseline Conditions.

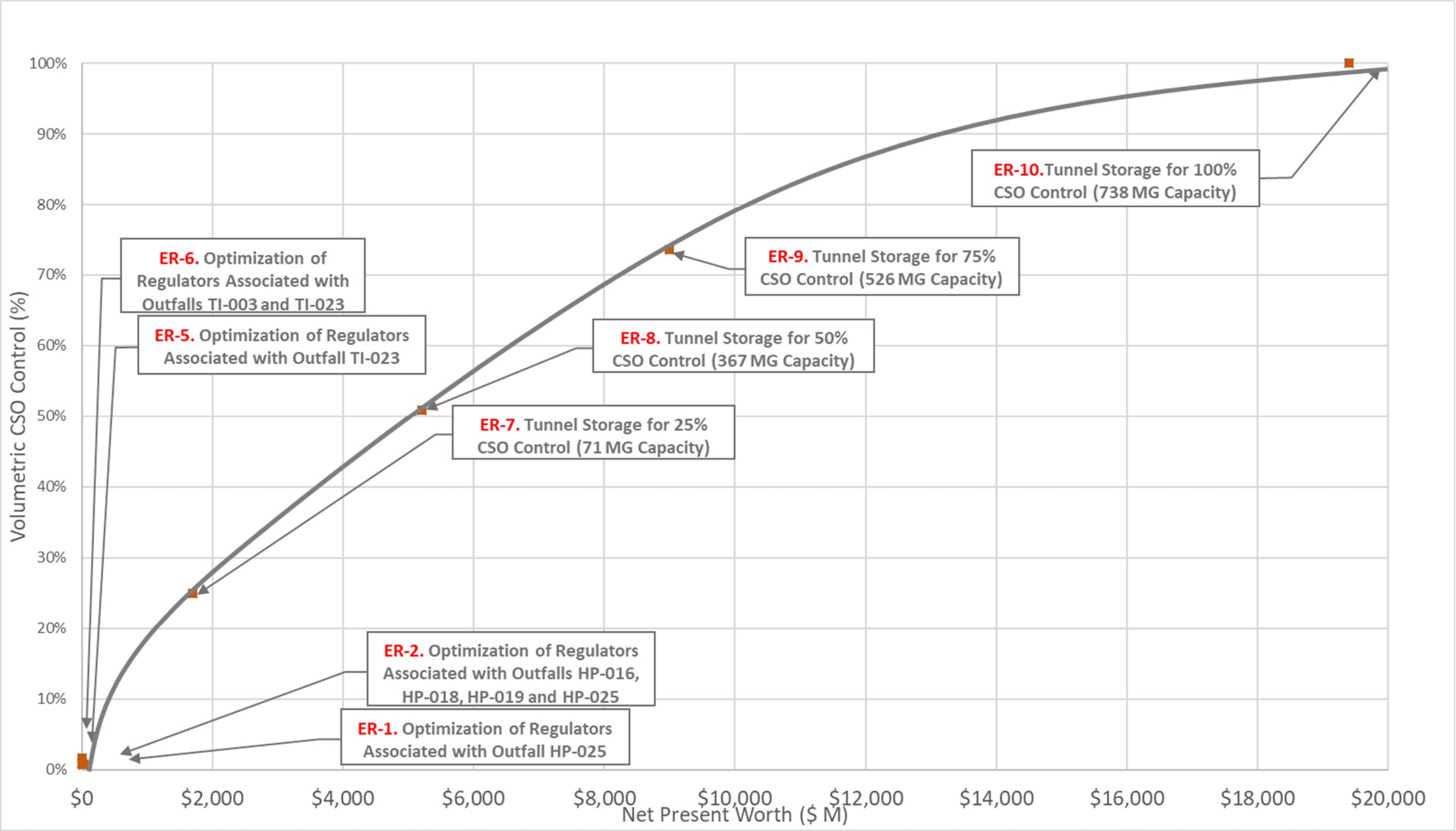

Figure 8.5-21. Cost vs. CSO Control – East River (2008 Typical Year)

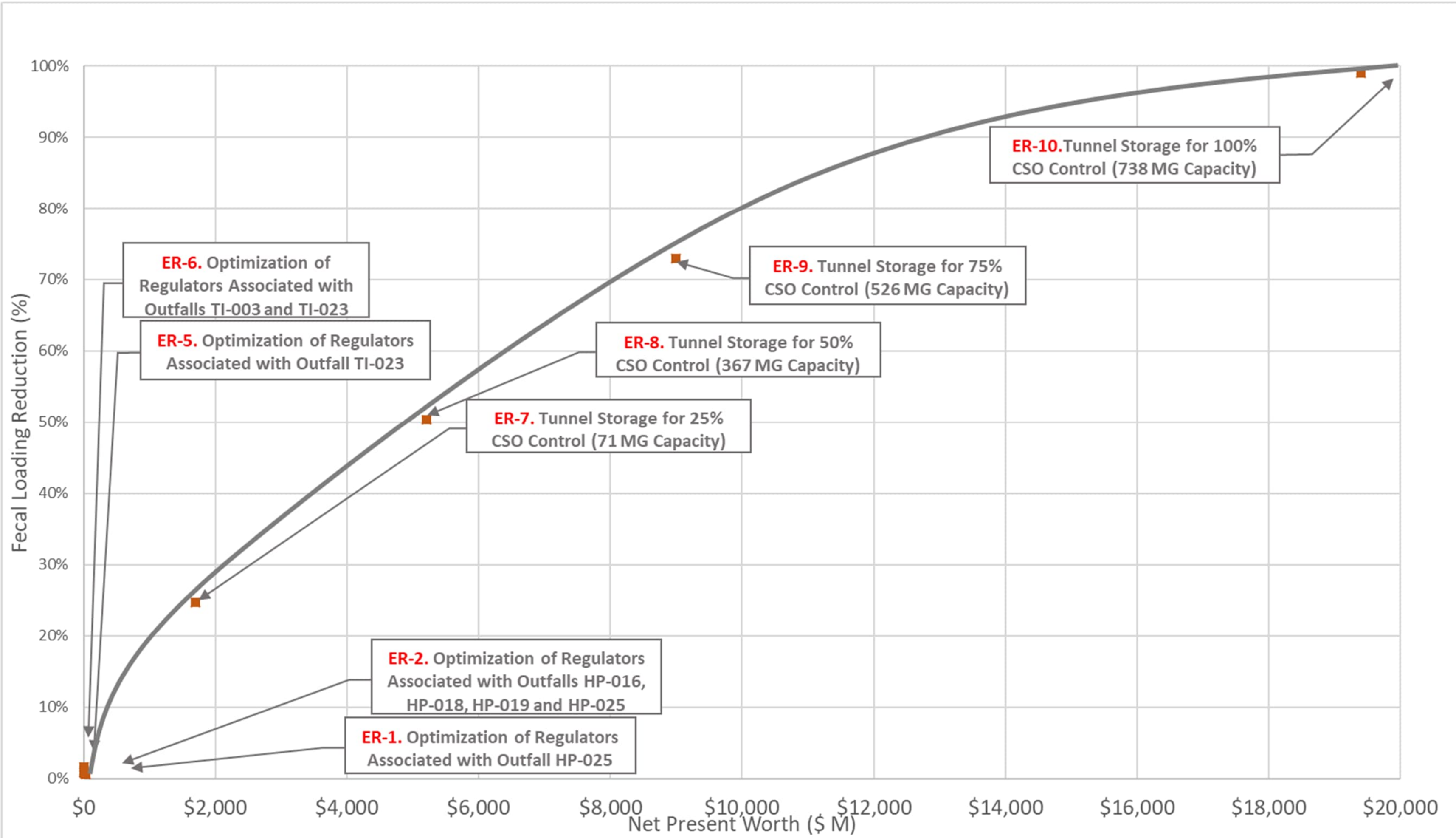

Figure 8.5-22. Cost vs. Fecal Coliform Loading Reduction – East River (2008 Typical Year)

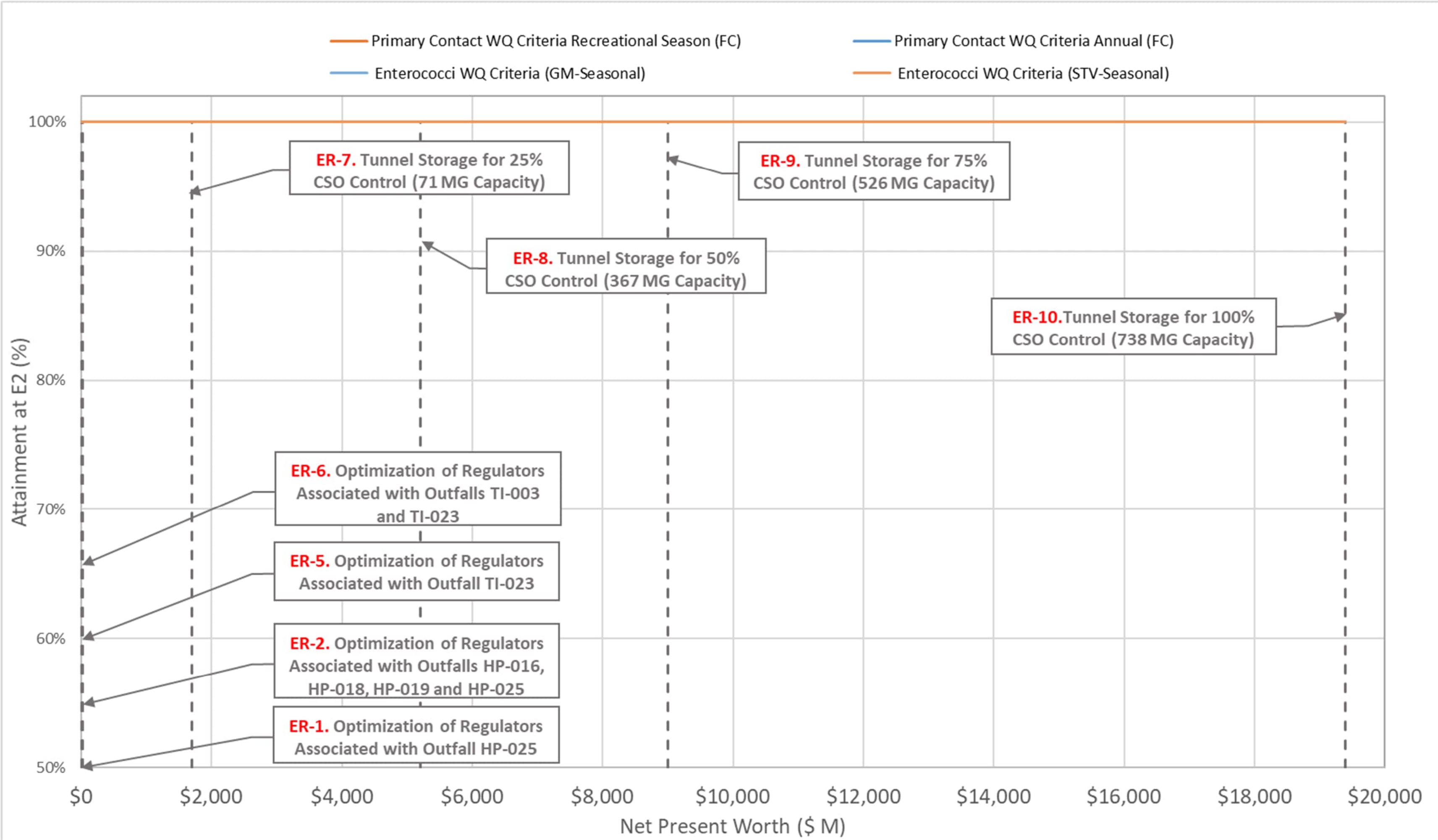

Figure 8.5-23. Cost vs. Bacteria Attainment at Class SB Coastal Primary Recreational Station E-2

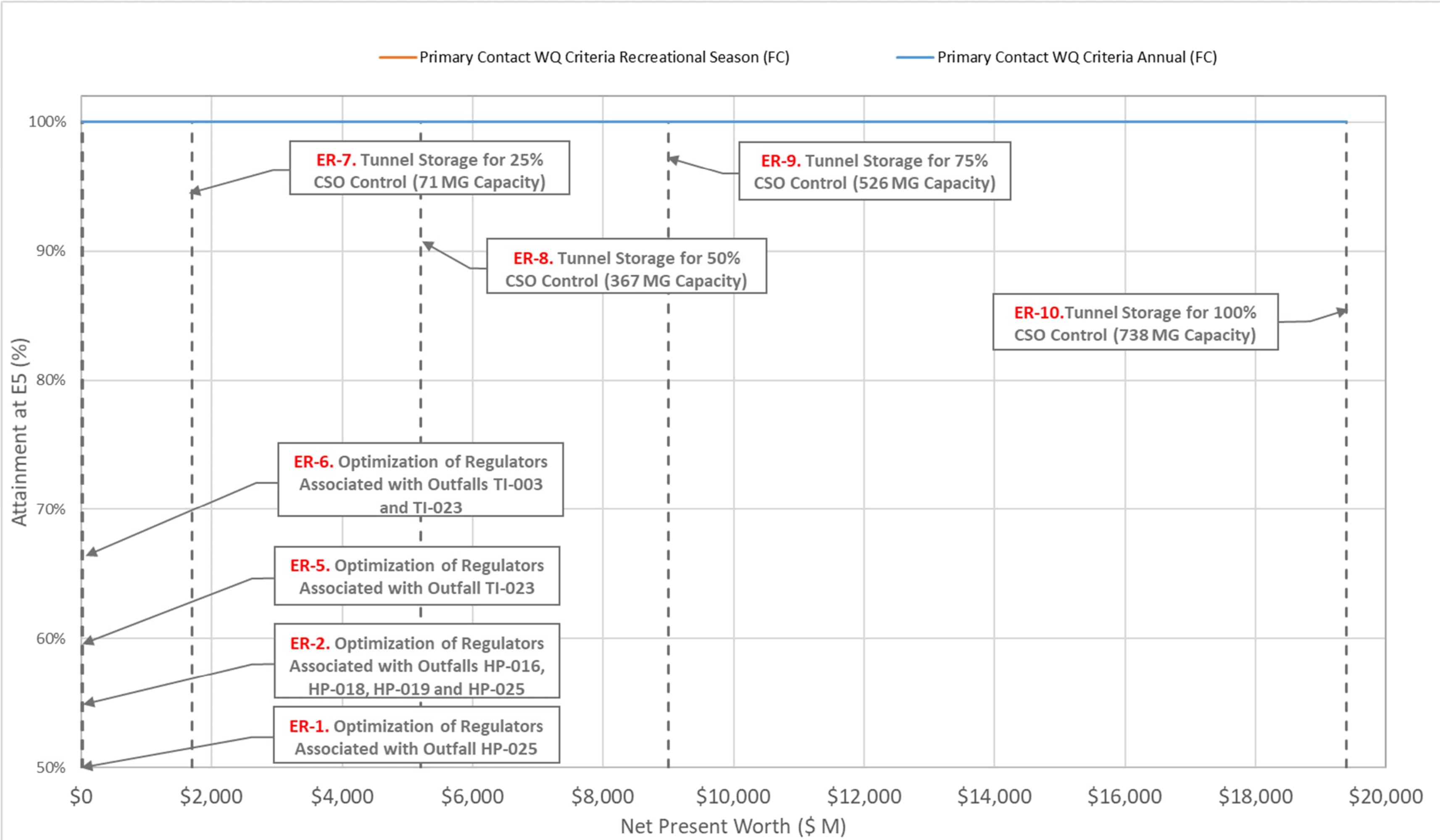

Figure 8.5-24. Cost vs. Bacteria Attainment at Class SB Station E5

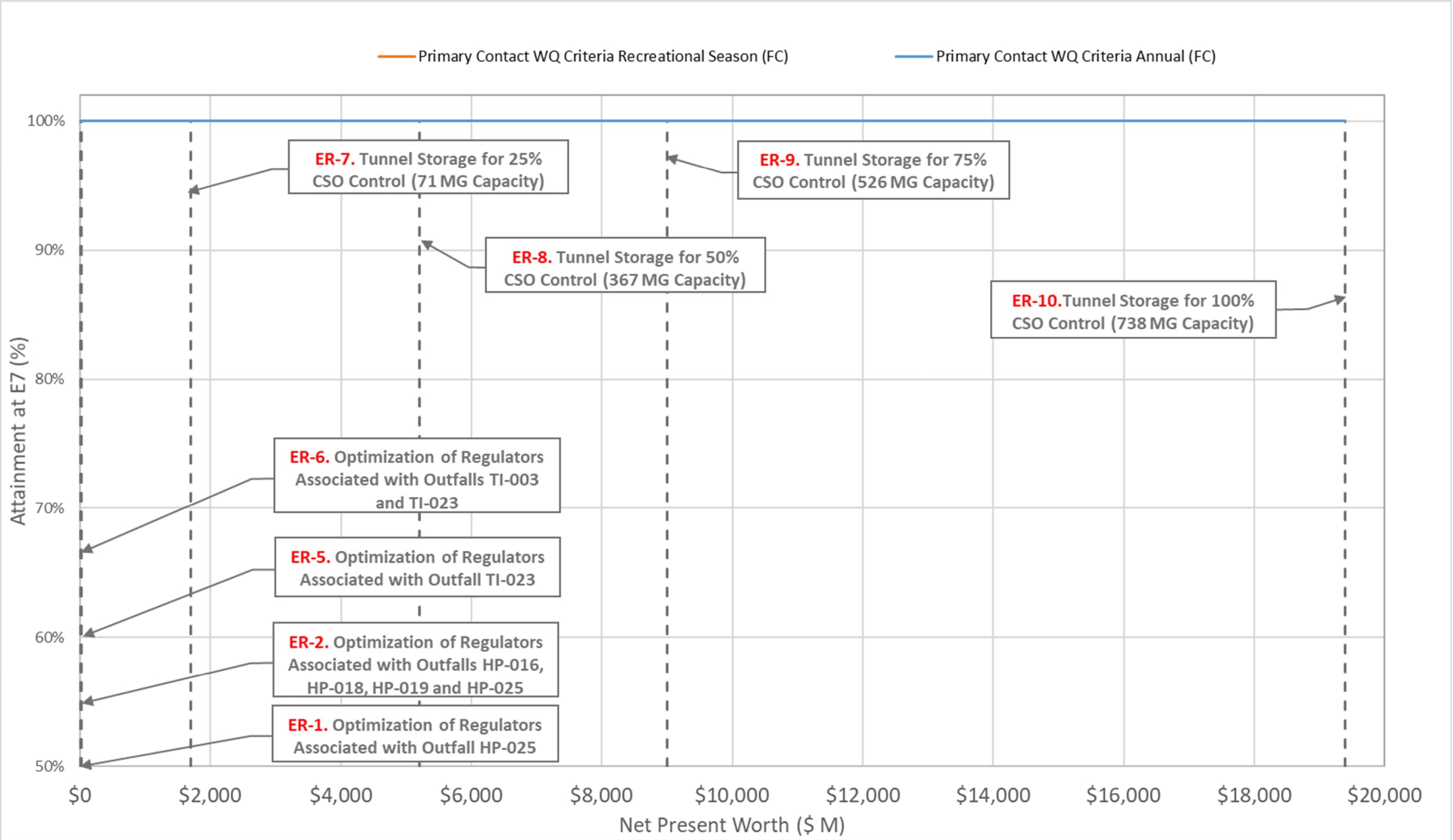

Figure 8.5-25. Cost vs. Bacteria Attainment at Class I Station E7

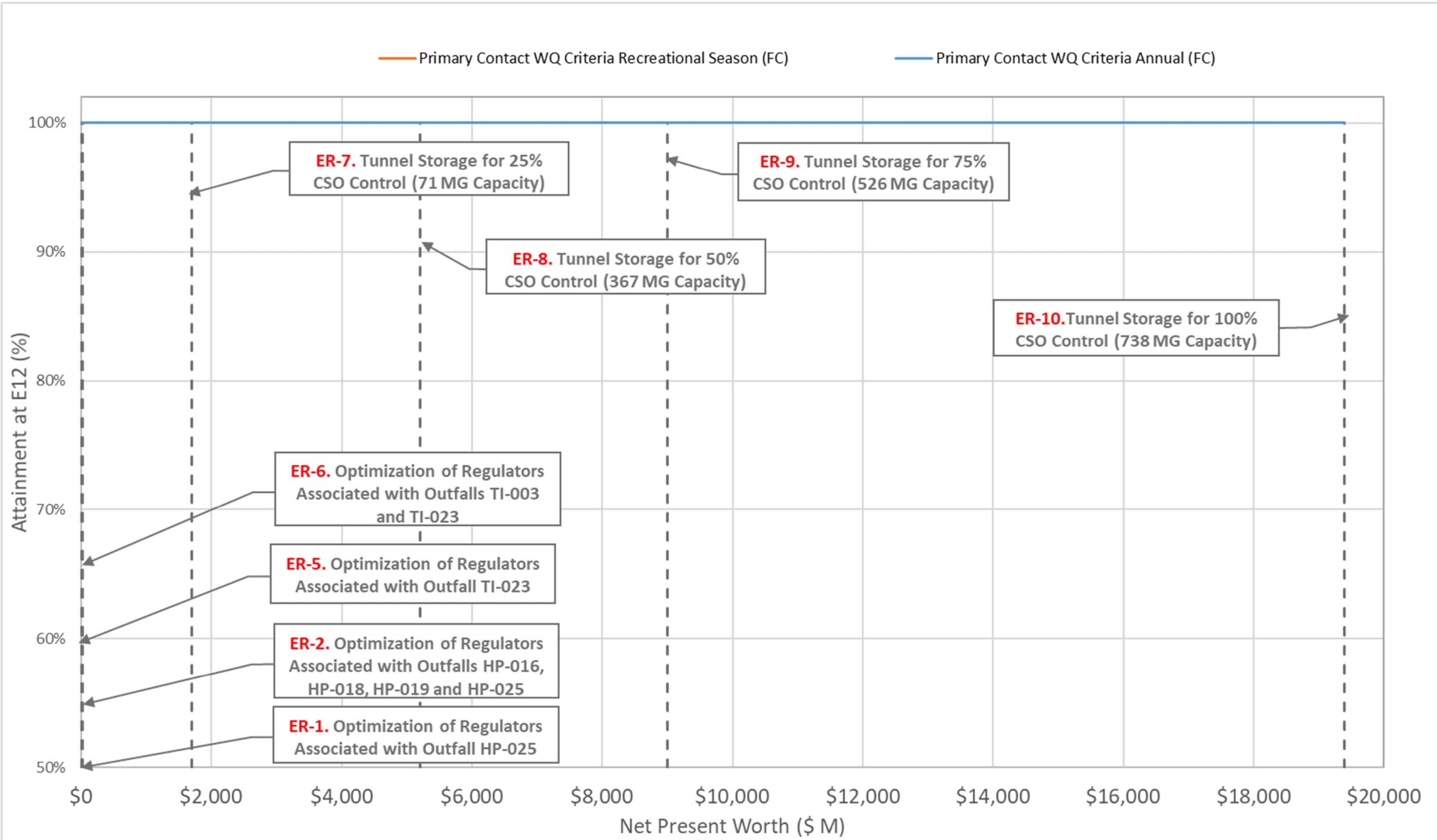

Figure 8.5-26. Cost vs. Bacteria Attainment at Class I Station E12

8.5.h Conclusion on Preferred Alternative

The selection of the preferred alternative for the East River is based on multiple considerations including public input, environmental and water quality benefits, and projected costs. However, as described above and in Section 6, the East River attains applicable water quality standards for bacteria and dissolved oxygen greater than 95 percent of the time under Baseline Conditions. The CSO storage tunnel alternatives would provide a range of levels of CSO reduction to the East River, but the costs associated with those alternatives are very high, and those high-cost alternatives would not change the level of attainment of WQ. Section 9 presents affordability issues and impacts on disadvantaged communities that would come into play if the CSO program costs were to further significantly increase. For these reasons, the CSO storage tunnel alternatives are not recommended.

Of the six optimization alternatives carried forward in the evaluation, ER-6 was selected as the preferred alternative for inclusion in the Recommended Plan. Implementation is projected to reduce net CSO volumes by 86 MGY during the typical year at a PBC of $6M. Note that these costs do not include costs for land acquisition, design, and construction management. This alternative consists of increasing the regulator orifice opening on Regulator TI-10B (CSO TI-003) and installation of a bending weir at Regulator TI-13 (CSO TI-023). While this project provides a relatively nominal reduction in CSO discharge, the project is consistent with DEP BMP practices for maximizing flow to the WRRF.

In summary, the following conclusions can be drawn from these analyses:

1. Under Baseline Conditions, fecal coliform standards attainment is projected to be 100 percent at all East River Stations annually and during the recreational season (May 1st through October 31st), while DO attainment is greater than 99 percent at all stations within the Class I and SB portions of the East River.
2. Under Baseline Conditions, *Enterococci* GM and STV standards attainment is projected to be 100 percent within the Class SB Coastal Primary Recreational portions of Long Island Sound (all stations east of the Throgs Neck Bridge), during the recreational season.
3. The most cost-effective alternative, based on the KOTC analysis approach, consistent with EPA's CSO Control Policy is Alternative ER-6.
4. The PCM will document the WQ improvements upon implementation of these projects.
5. While the annual volume of CSO remaining in the East River is acknowledged to remain relatively high, the time to recovery analysis presented further below demonstrates that the duration of impact of the remaining CSOs is low.

Figure 8.5-27 presents a mosaic of the level of attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day geometric mean) in the applicable area of Long Island Sound, east of the Throgs Neck Bridge, on a recreational season (May 1st through October 31st) basis. Figure 8.5-28 presents a mosaic of the level of attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day STV) in the applicable area of Long Island Sound, east of the Throgs Neck Bridge, on a recreational season (May 1st through October 31st) basis. Figure 8.5-29 presents a mosaic of the level of attainment with the Class SB and Class I WQ criteria for fecal coliform in the East River and Long Island Sound, on an annual basis, and Figure 8.5-30 presents the level of attainment in the recreational season (May 1st through October 31st). Figure 8.5-31 presents the level of attainment with the Existing WQ Criteria for DO on an average annual basis.

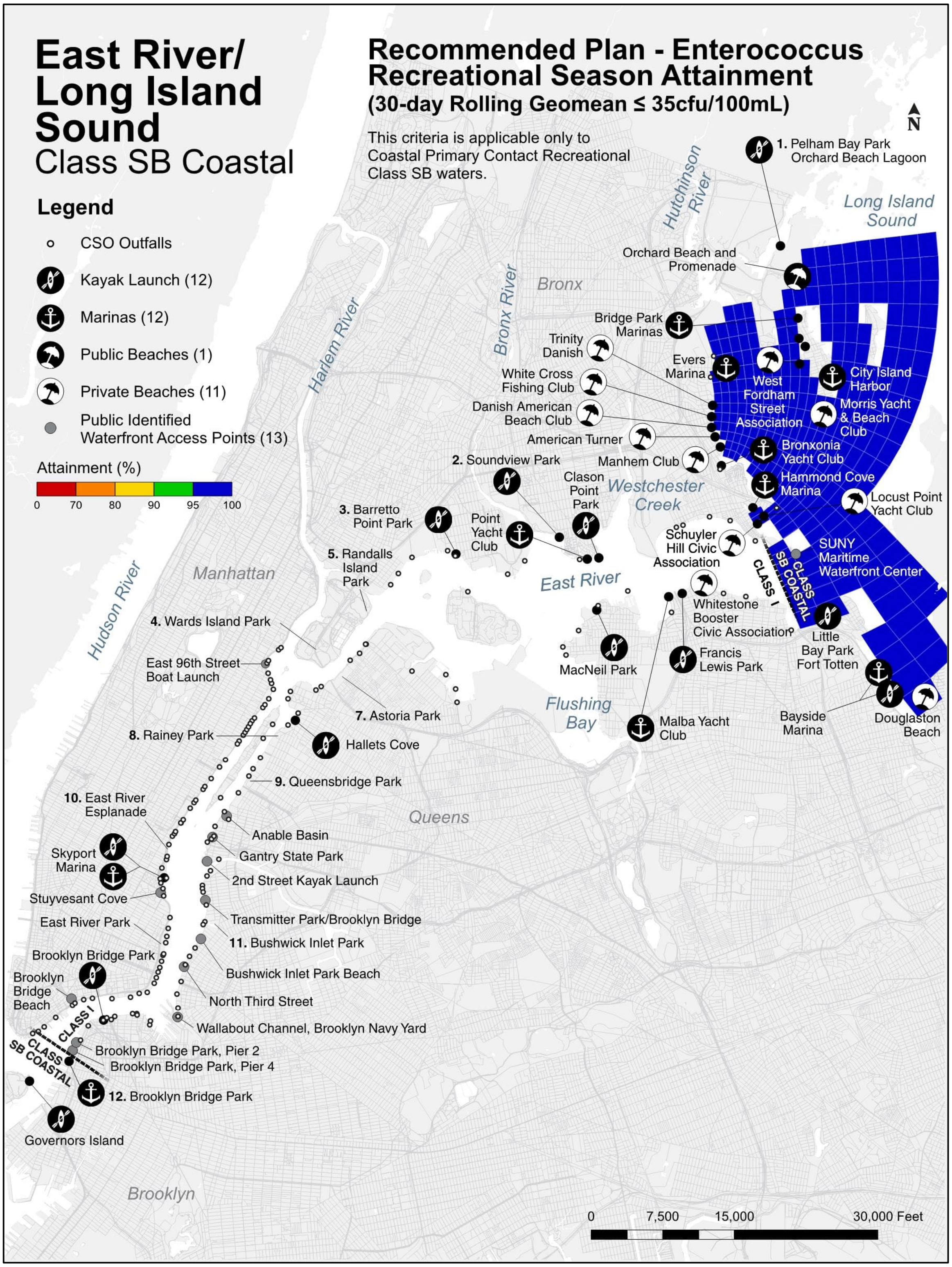

Figure 8.5-27. *Enterococci* Class SB Coastal Primary Recreational GM Attainment (10-year Runs) – Long Island Sound, Recommended Plan

AECOM with Hazen

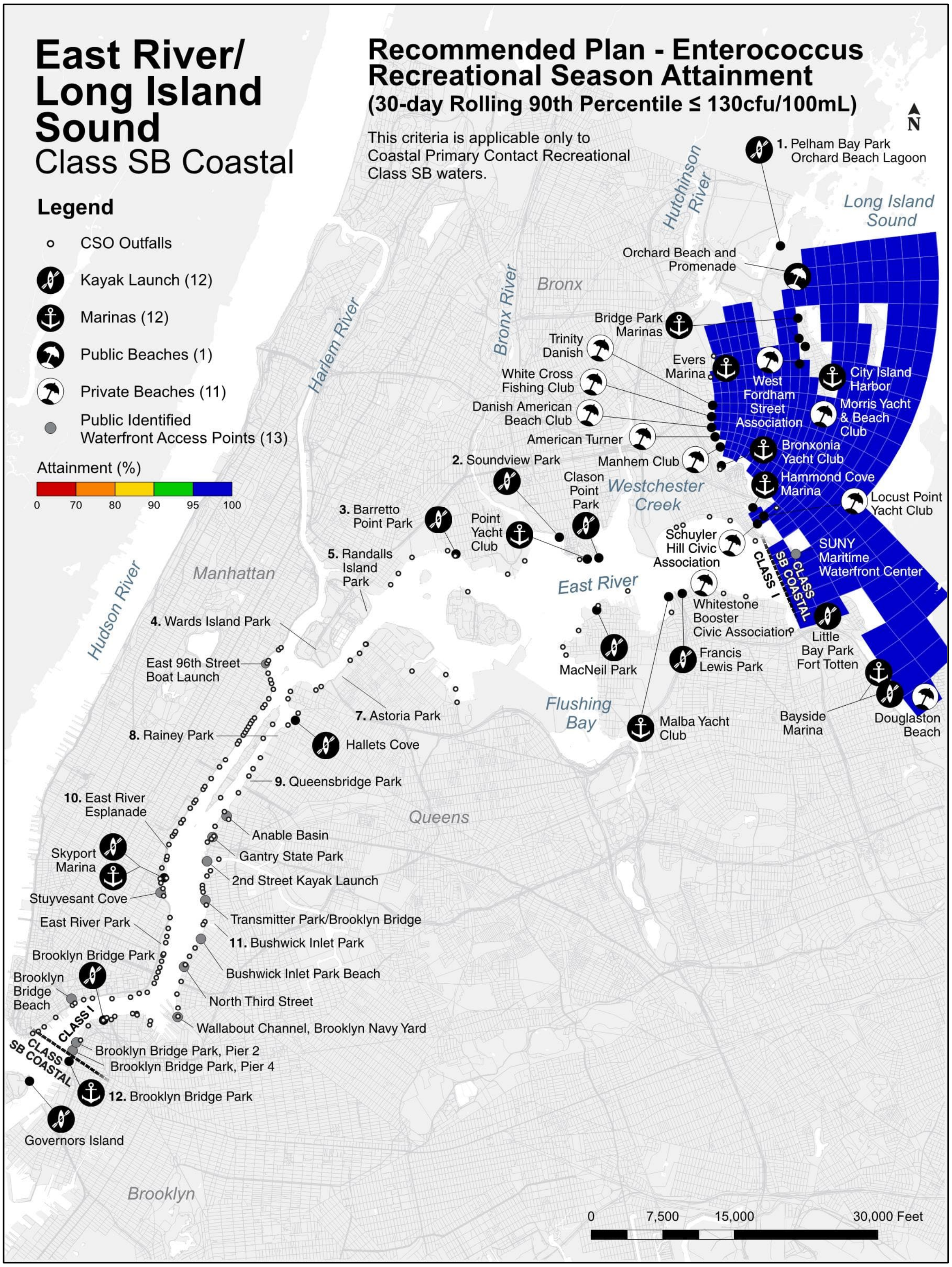

Figure 8.5-28. *Enterococci* Class SB Coastal Primary Recreational STV Attainment (10-year Runs) – Long Island Sound, Recommended Plan

AECOM with Hazen

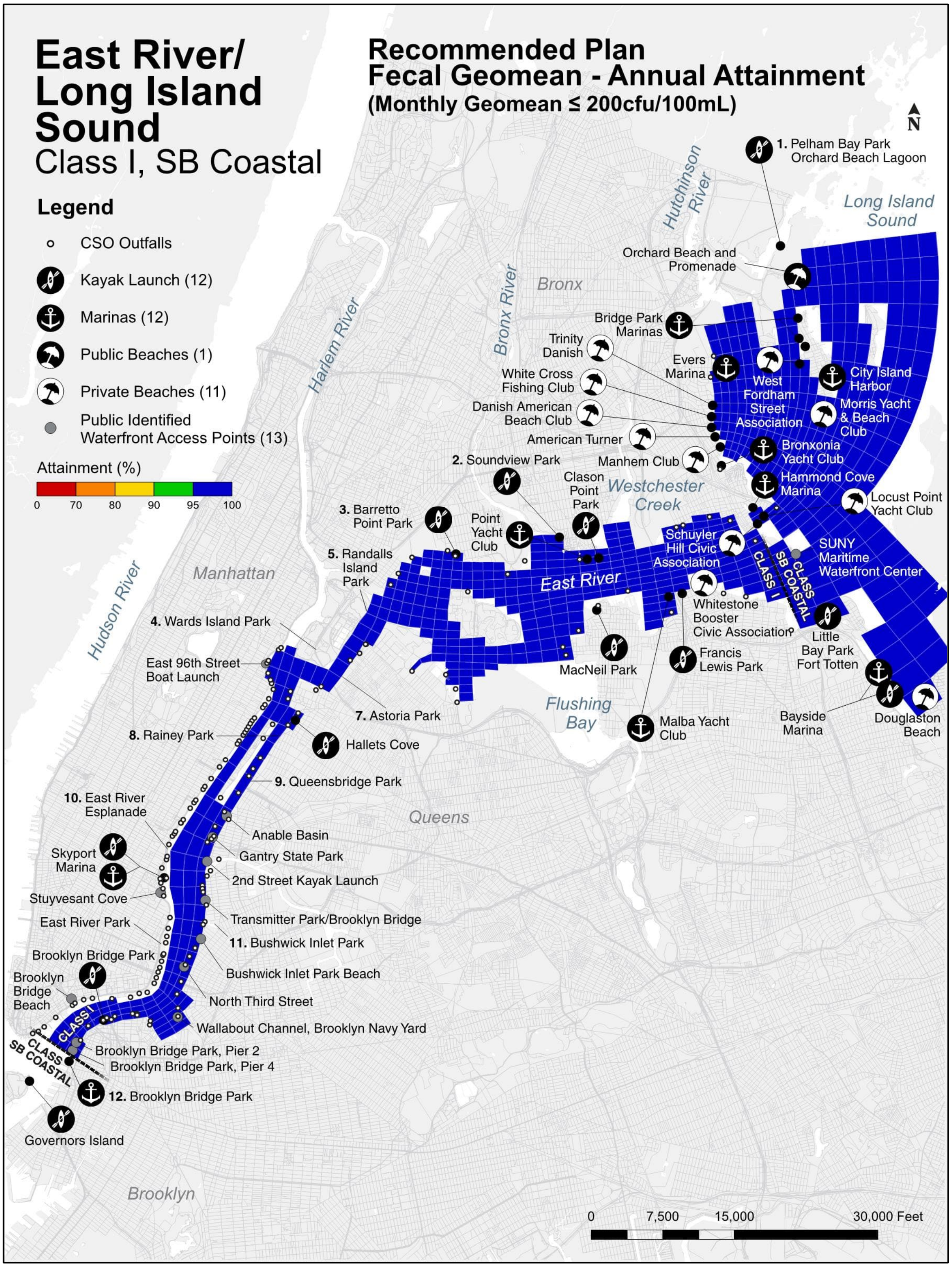

Figure 8.5-29. Fecal Coliform Class I and SB - Annual Attainment (10-year Runs), Recommended Plan

AECOM
with Hazen

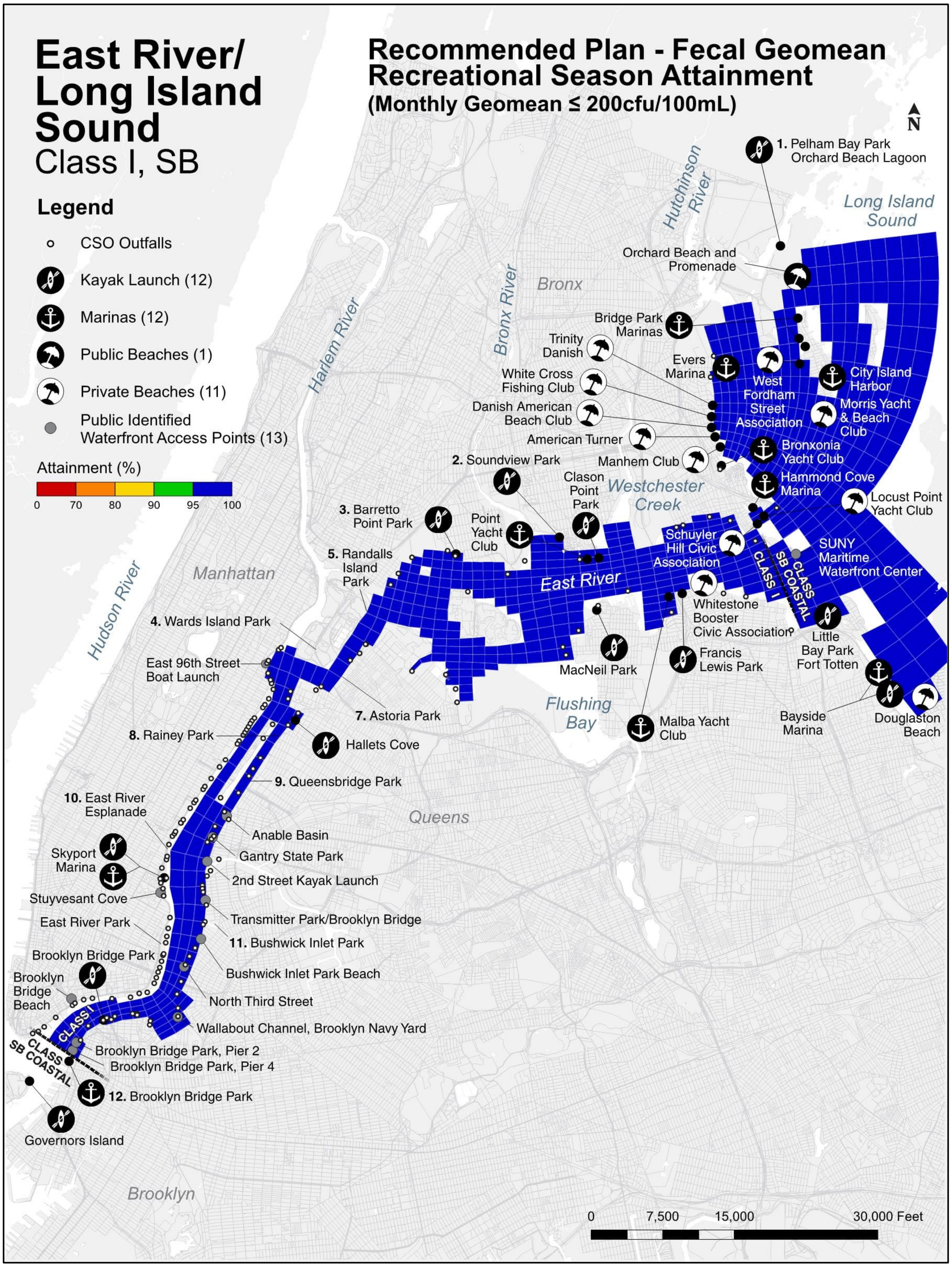

Figure 8.5-30. Fecal Coliform Class I and SB – Recreational Season Attainment (10-year Runs), Recommended Plan

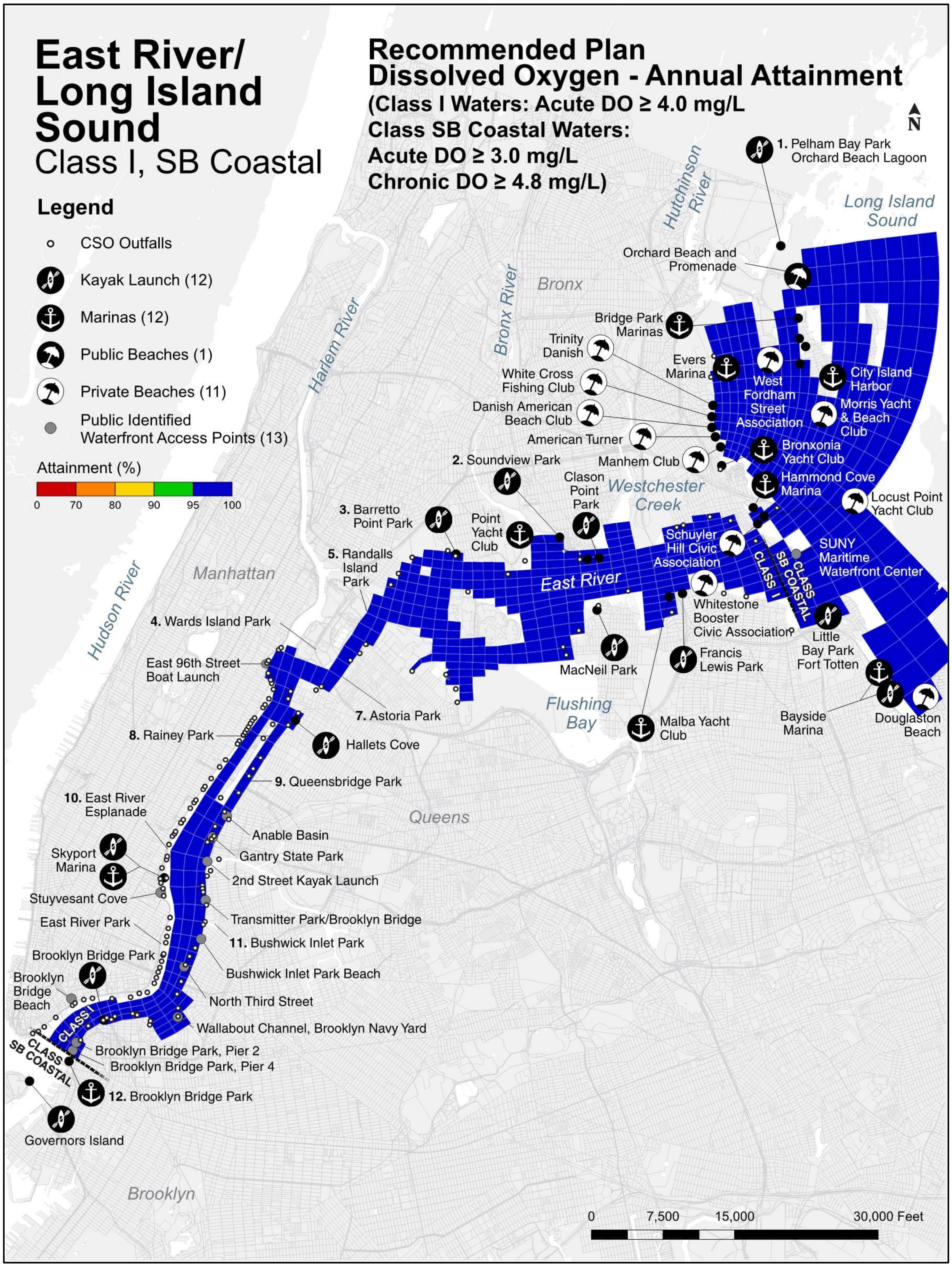

Figure 8.5-31: Dissolved Oxygen Class I and SB - Annual Attainment (2008), Recommended Plan

Table 8.5-28 presents the *Enterococci* maximum 30-day geometric mean and STV, and the percent of time that the *Enterococci* criteria would be attained for the recreational season (May 1st through October 31st), for the 10-year simulation period, within the Class SB Coastal Primary Recreational waters of Long Island Sound, with the Recommended Plan. The locations of the stations and supplemental model output locations listed in Table 8.5-28 are shown on Figure 8.5-32. As indicated in Table 8.5-28, recreational season (May 1st through October 31st) compliance for the Recommended Plan would be in the 99 to 100 percent range for the Class SB coastal primary contact recreational portions of Long Island Sound.

Table 8.5-28. Model Calculated 10-Year *Enterococci* Maximum 30-day GM and STV and Percent Attainment of Class SB Coastal Primary Recreational WQ Criteria for Long Island Sound, Recommended Plan

ER-6 Optimization of Regulators Associated with Outfalls TI-003 and TI-023				
Station	**Maximum Recreational Season(1) 30-day *Enterococci* (cfu/100mL)**		**10 Year Percent Attainment**	
	GM	**90th Percentile STV**	**Annual** Monthly GM <35 cfu/100mL	**Recreational Season(1)** Monthly GM <30 cfu/100mL
Long Island Sound east of Throgs Neck Bridge (Class SB Coastal Primary Recreational)				
ER-1	6	237	100%	99%
ER-2	7	49	100%	100%
ER-3	13	102	100%	100%
Orchard Beach	4	31	100%	100%
Bridge Park Marinas	5	52	100%	100%
City Island Harbor	4	19	100%	100%
Morris Yacht and Beach Club	7	88	100%	100%
West Fordham Street Association	8	129	100%	100%
Evers Marina	8	378	100%	99%
Trinity Danish Beach	8	334	100%	99%
White Cross Fishing Club	8	334	100%	99%
Danish American Beach Club	8	334	100%	99%
American Turner Beach	8	334	100%	99%
Manhem Club Beach/Bronxonia Yacht Club	8	334	100%	99%

Table 8.5-28. Model Calculated 10-Year *Enterococci* Maximum 30-day GM and STV and Percent Attainment of Class SB Coastal Primary Recreational WQ Criteria for Long Island Sound, Recommended Plan

ER-6 Optimization of Regulators Associated with Outfalls TI-003 and TI-023				
Station	**Maximum Recreational Season(1) 30-day *Enterococci* (cfu/100mL)**		**10 Year Percent Attainment**	
	GM	**90th Percentile STV**	**Annual** Monthly GM <35 cfu/100mL	**Recreational Season(1)** Monthly GM <30 cfu/100mL
Long Island Sound east of Throgs Neck Bridge (Class SB Coastal Primary Recreational)				
Hammond Cove Marina	5	31	100%	100%
Locust Point Yacht Club	5	31	100%	100%
Schuyler Hill Civic Association	6	40	100%	100%
Douglaston Beach	10	78	100%	100%
Bayside Marina Little Bay Park Fort Totten	12	155	100%	99%

Note:
(1) The recreational season is from May 1st through October 31st.

Table 8.5-29 presents the fecal coliform maximum monthly geometric mean, and the percent of time that the fecal coliform WQ criteria would be attained on an annual basis and for the recreational season (May 1st through October 31st), for the 10-year simulation period, within the Class SB and Class I waters of the East River, with the Recommended Plan. The locations of the stations and supplemental model output locations listed in Table 8.5-29 are shown on Figure 8.5-29. As indicated in Table 8.5-29, annual and recreational season (May 1st through October 31st) compliance for the Recommended Plan would be 100 percent for the Class SB and Class I portions of the East River.

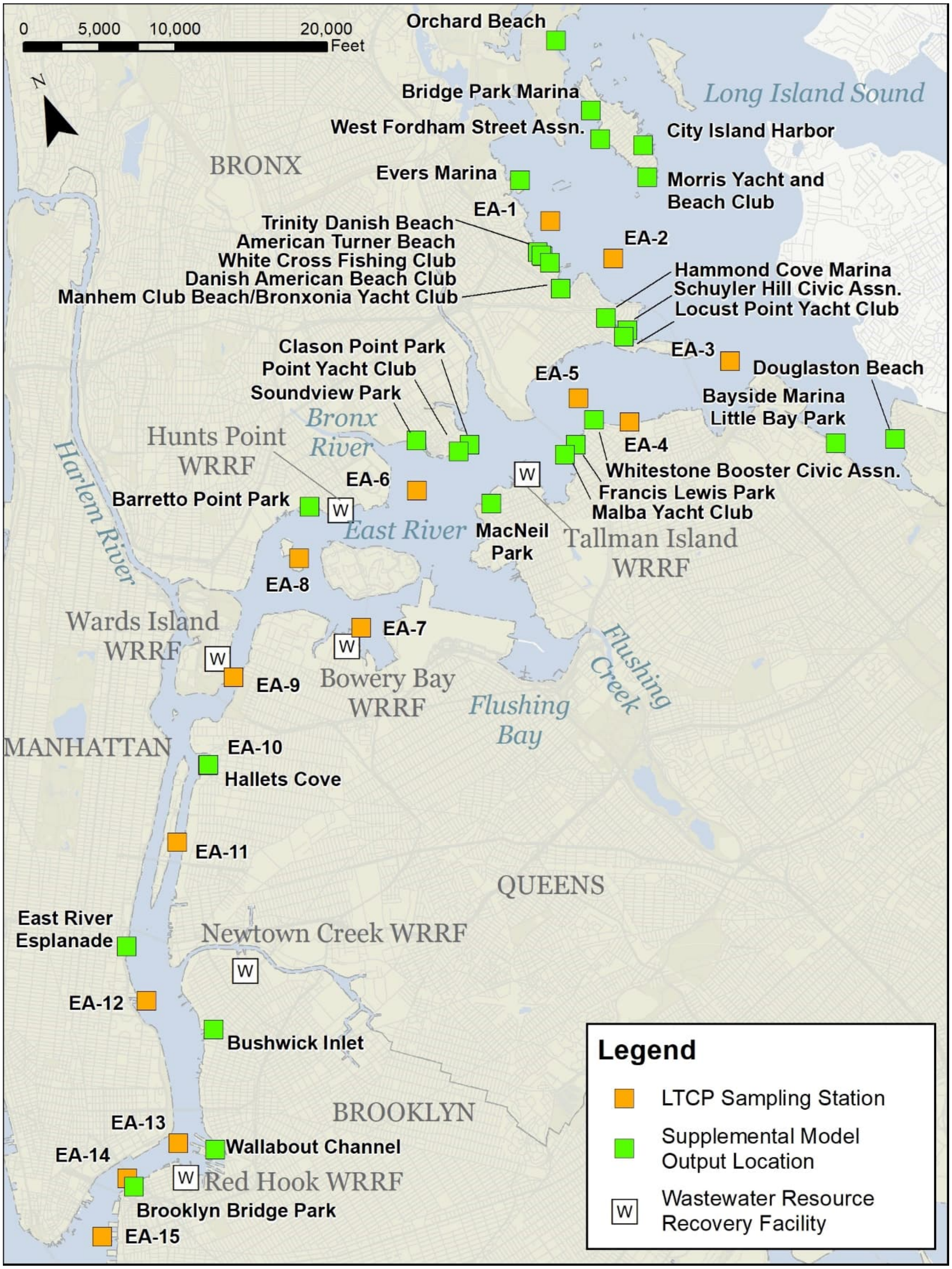

Figure 8.5-32. Sampling Stations and Supplemental Model Output Locations on the East River/Long Island Sound

Table 8.5-29. Model Calculated 10-Year Fecal Coliform Maximum Monthly GM and Percent Attainment of WQ Criteria for East River, Recommended Plan

	Maximum Monthly GMs (cfu/100mL)		% Attainment (GM ≤200 cfu/100mL)	
Description	**Annual**	**Recreational Season(1)**	**Annual**	**Recreational Season(1)**
East River between Whitestone Bridge and Throgs Neck Bridge (Class SB)				
E-4	54	35	100%	100%
E-5	61	42	100%	100%
Whitestone Booster Civic Association	67	49	100%	100%
Francis Lewis Park	66	44	100%	100%
East River, Battery to Whitestone Bridge (Class I)				
ER-6	104	88	100%	100%
ER-7	138	106	100%	100%
ER-8	131	100	100%	100%
ER-9	161	112	100%	100%
ER-10	181	125	100%	100%
ER-11	184	122	100%	100%
ER-12	180	119	100%	100%
ER-13	178	114	100%	100%
ER-14	179	114	100%	100%
ER-15	172	108	100%	100%
Clason Point Park	100	79	100%	100%
Point Yacht Club	118	103	100%	100%
Soundview Park	108	92	100%	100%
Barretto Point Park	124	99	100%	100%
East River Esplanade	182	122	100%	100%
Malba Yacht Club	71	52	100%	100%
MacNeil Park	81	57	100%	100%
Hallets Cove	181	125	100%	100%
Bushwick Inlet	188	122	100%	100%
Wallabout Channel	205	139	99%	100%
Brooklyn Bridge Park	179	114	100%	100%

Note:
(1) The recreational season is from May 1st through October 31st.

The average annual attainment of the Existing WQ Criterion for DO (Class SB and I) for the entire water column is presented for the preferred alternative in Table 8.5-30. As indicated in Table 8.5-30, the Existing WQ Criterion for DO (Class I) are predicted to be attained at all stations for the Recommended Plan. DO attainment in the Class I portion of the East River is 100 percent at all stations for the preferred alternative.

As discussed in Section 6, analysis of attainment of Class SB DO criteria are complex because the standard allows for excursions from the daily average limit of 4.8 mg/L for a limited number of consecutive calendar days. To simplify the analysis, attainment was based solely upon attainment of the daily average without the allowed excursions. The results indicate 100 percent attainment of the acute criterion (never less than 3.0 mg/L) within the Class SB waters for the Recommended Plan. Attainment of the chronic criterion (greater than or equal to 4.8 mg/L) is also 100 percent for the Recommended Plan.

The key components of the Recommended Plan include enlargement of the regulator orifice openings at Regulators TI-10B and TI-13 associated with Outfalls TI-003 and TI-023, respectively. In addition, Regulator TI-13 (CSO TI-023) would be modified to accommodate the installation of a bending weir. The implementation of these elements is predicted to result in a net reduction of 86 MGY of CSO to the East River, with a PBC of $7M. The proposed schedule for the implementation of the Recommended Plan is presented in Section 9.2.

Table 8.5-30. Model Calculated (2008) Preferred Alternative DO Percent Attainment of Existing Class SB and I WQ Criteria

ER-6 Optimization of Regulators Associated with Outfalls TI-003 and TI-023		
Long Island Sound east of Throgs Neck Bridge (Class SB Coastal Primary Contact Recreational)		
Station	**Acute (≥ 3.0 mg/L)**	**Chronic (≥ 4.8 mg/L)**
ER-1	100	100
ER-2	100	100
ER-3	100	100
East River between Throgs Neck and Whitestone Bridges (Class SB)		
Station	**Acute (≥ 3.0 mg/L)**	**Chronic (≥ 4.8 mg/L)**
E-4	100	100
E-5	100	100
East River, Whitestone Bridge to Battery (Class I)		
Station	**Instantaneous (≥ 4.0 mg/L)**	
ER-6	100	
ER-7	100	
ER-8	100	
ER-9	100	
ER-10	100	
ER-11	100	
ER-12	100	
ER-13	100	
ER-14	100	
ER-15	100	

8.5.i Use Attainability Analysis

The CSO Order requires that a UAA be included in an LTCP "where existing WQS do not meet the Section 101(a)(2) goals of the CWA, or where the proposed alternative set forth in the LTCP will not achieve existing WQS or the Section 101(a)(2) goals." The UAA shall "examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State." The UAA process specifies that States can remove a designated use that is not an existing use if the scientific assessment can demonstrate that attaining the designated use is not feasible for at least one of six reasons:

1. Naturally occurring loading concentrations prevent the attainment of the use; or
2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or
5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

As part of the LTCP, elements of a UAA, including the six conditions presented above, will be used to determine if changes to the designated use are warranted, considering a potential adjustment to the designated use classification as appropriate.

As noted in previous sections, with the implementation of the Recommended Plan, the East River is predicted to meet the Existing WQ fecal coliform bacteria criterion of 200 cfu/100mL on both an annual and recreational season (May 1st through October 31st) basis for both the 2008 Typical Year rainfall and the 10-year continuous simulation. For the Class SB Coastal Primary Recreation section of Long Island Sound, the *Enterococci* geometric mean criterion of 35 cfu/100mL and the 30-day STV criterion of 135 cfu/100mL are projected to be attained during the recreational season for the Recommended Plan. In addition, Class SB and I DO criteria are also predicted to be achieved for the Recommended Plan on an annual average basis. Therefore, a Use Attainability Analysis is not needed for the East River/Long Island Sound.

8.5.j Time to Recovery

As noted above, Long Island Sound east of the Throgs Neck Bridge is a Class SB Coastal Primary Recreational waterbody. The East River between the Throgs Neck and Whitestone Bridges is a Class SB waterbody, while the East River west and south of the Whitestone Bridge is a Class I waterbody. The applicable Water Quality Criteria for bacteria for these waterbodies include monthly geometric mean criteria. However, to gain insight into the shorter-term impacts of wet-weather sources of bacteria, DEP has performed an analysis to assess the amount of time following the end of a rainfall event required for the

East River/Long Island Sound to recover and return to fecal coliform concentrations less than 1,000 cfu/100mL.

The analyses consisted of examining the WQ model-calculated bacteria concentrations in the East River/Long Island Sound for recreational periods (May 1st through October 31st) abstracted from 10 years of model simulations. For the East River/Long Island Sound, the JFK Airport rainfall data was compared against water quality model bacteria results for the 10 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. The chosen target threshold concentration was 1,000 cfu/100mL for fecal coliform. The various rainfall events were then placed into rain event size "bins" ranging from less than 0.1 inch to greater than 1.5 inches. Only rain events that reached the target threshold concentrations before the beginning of the next storm were included. The median time to recovery for each bin at each water quality station was calculated. Table 8.5-31 presents the median time to recovery for the Recommended Plan for the East River/Long Island Sound. Results are presented for the greater than 1.0 to 1.5 inch rainfall bin, which includes the 90th percentile event.

DEC has advised that it seeks to have a time to recovery of less than 24 hours, and this target has been consistent in the previously approved LTCPs. As indicated in Table 8.5-31, for the Recommended Plan, most of the stations assessed had median time to recovery of zero hours, indicating that the fecal coliform concentration never reached the level of 1,000 cfu/100mL for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

Table 8.5-31. East River Time to Recovery, Fecal Coliform, Recommended Plan

Location	Time to Recovery (hours) Fecal Coliform Threshold (1,000 cfu/100mL)(1)
Long Island Sound East of Throgs Neck Bridge (Class SB Coastal Primary Contact Recreational)	
ER-1	0(2)
ER-2	0
ER-3	0
Orchard Beach	0
Bridge Park Marinas	0
City Island Harbor	0
Morris Yacht and Beach Club	0
West Fordham Street Association	0
Evers Marina	0
Trinity Danish Beach	0
White Cross Fishing Club	0
Danish American Beach Club	0
American Turner Beach	0
Manhem Club Beach/Bronxonia	0
Hammond Cove Marina	0
Locust Point Yacht Club	0
Schuyler Hill Civic Association	0
Douglaston Beach	0
Bayside Marina Little Bay Park Fort	0

Table 8.5-31. East River Time to Recovery, Fecal Coliform, Recommended Plan

Location	Time to Recovery (hours) Fecal Coliform Threshold (1,000 cfu/100mL)(1)
East River between Throgs Neck and Whitestone Bridges (Class SB)	
E-4	0
E-5	0
Whitestone Booster Civic	0
Francis Lewis Park	0
East River, Whitestone Bridge to Battery (Class I)	
ER-6	0
ER-7	0
ER-8	0
ER-9	0
ER-10	0
ER-11	0
ER-12	0
ER-13	0
ER-14	0
ER-15	0
Clason Point Park	0
Point Yacht Club	2
Soundview Park	0
Barretto Point Park	0
East River Esplanade	0
Malba Yacht Club	0
MacNeil Park	0
Hallets Cove	0
Bushwick Inlet	0
Wallabout Channel	8.5
Brooklyn Bridge Park	0

Notes:
(1) Median time to recovery values presented for storms from the 10-year simulation, recreational seasons, in the size range of >1.0 to 1.5-inches of rainfall, which includes the 90th percentile rain event.
(2) Median time to recovery of "0" means that the average concentration across the water column never reached the 1,000 cfu/100mL threshold at the referenced station for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

A similar analysis was conducted to assess time to recovery to an *Enterococci* concentration of 130 cfu/100mL, corresponding to the STV criterion for Class SB coastal primary contact recreational waters. The results of that analysis for the Recommended Plan are presented in Table 8.5-32. As indicated in Table 8.5-32, for the Recommended Plan, all of the stations assessed had median time to recovery of zero hours, indicating that the concentration of *Enterococci* at those locations was less than 130 cfu/100mL for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

Table 8.5-32. East River Time to Recovery, *Enterococci*, Recommended Plan

Location	Time to Recovery (hours) *Enterococci* Threshold (130 cfu/100mL)(1)
Long Island Sound East of Throgs Neck Bridge (Class SB Coastal Primary Contact Recreational)	
ER-1	0(2)
ER-2	0
ER-3	0
Orchard Beach	0
Bridge Park Marinas	0
City Island Harbor	0
Morris Yacht and Beach Club	0
West Fordham Street Association	0
Evers Marina	0
Trinity Danish Beach	0
White Cross Fishing Club	0
Danish American Beach Club	0
American Turner Beach	0
Manhem Club Beach/Bronxonia	0
Hammond Cove Marina	0
Locust Point Yacht Club	0
Schuyler Hill Civic Association	0
Douglaston Beach	0
Bayside Marina Little Bay Park	0

Notes:
(1) Median time to recovery values presented for storms from the 10-year simulation, recreational seasons, in the size range of >1.0 to 1.5-inches of rainfall, which includes the 90th percentile rain event.
(2) Median time to recovery of "0" means that the average concentration across the water column never reached the 130 cfu/100mL threshold at the referenced station for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

8.5.k Recommended LTCP Elements to Meet Water Quality Goals for East River

The actions identified in this LTCP include:

- Enlargement of regulator orifice openings at TI-10B and TI-13 associated with Outfalls TI-003 and TI-023, respectively and installation of a bending weir within Regulator TI-13 (CSO TI-023).
- Costs (2019 dollars) for the recommended alternative are: NPW $7M, PBC of $6M, and annual O&M of $1M.
- Compliance with Existing WQ Criteria. As a result, a UAA is not required for the East River/Long Island Sound as part of this LTCP.
- DEP will establish with the DOHMH (through public notification) a wet-weather advisory for the recreational season (May 1st through October 31st) informing the public which recreational activities are not recommended in the East River/Long Island Sound at that time. The LTCP includes a

recovery time analysis that can be used to establish the duration of the wet-weather advisory for public notification.

DEP is committed to improving water quality in this waterbody, which will be advanced by the improvements and actions identified in this LTCP. These identified actions have been balanced with input from the public and awareness of the cost to the residents of NYC.

8.6 CSO Control Alternatives for New York Bay

As shown in Section 6, WQS for bacteria and dissolved oxygen are generally met in most of New York Bay under Baseline Conditions. Non-attainment of dissolved oxygen criteria and *Enterococcus* STV criteria in an area off the southwest corner of Staten Island is driven by sources from outside of NYC, as no NYC CSOs are located in that vicinity. Along the Brooklyn shoreline, the *Enterococcus* geometric mean criteria are met under Baseline Conditions, but the *Enterococcus* STV criteria are not met. As described below, a high level of CSO control (50 percent) would be needed to meet the *Enterococcus* STV criteria along the Brooklyn shoreline. Therefore, attainment of WQS was generally not a factor in evaluating CSO control alternatives for New York Bay. Rather, the focus was on evaluating alternatives for cost-effective reduction of CSO activations and volume.

The CSO control alternatives that passed the initial screening phase and were retained for New York Bay generally fell within the categories of system optimization and tunnel storage. System optimization alternatives covered the categories of fixed weirs, parallel interceptor/sewer, bending weirs or control gates, and gravity flow tipping to other watersheds. The storage tunnel alternatives, used to assess 50, 75 and 100 percent CSO capture, also included high-rate clarification for the dewatering flows from the tunnels. Storage tanks were not evaluated due to the number of outfalls and the general lack of available sites of sufficient size for storage tanks. Each control measure was initially evaluated on three of the key considerations described in Section 8.1: (1) benefits, as expressed by level of CSO control and WQS attainment; (2) costs; and (3) challenges, such as siting and operations. Using this methodology, the retained control measures listed in Section 8.1 were evaluated on a cost-performance basis and used to develop the basin-wide alternatives.

The Citywide/Open Waters Baseline Conditions include implementation of the Recommended Plans from the LTCPs for the tributary waterbodies previously submitted to DEC under this program, as well as other grey infrastructure projects implemented as part of earlier planning programs. Those projects are summarized in Section 4. The following sections present the evaluations of the system optimization and tunnel storage alternatives for New York Bay.

8.6.a System Optimization Alternatives

The approach to the initial identification and evaluation of system optimization alternatives for New York Bay using the Optimatics Optimizer software was presented in Section 3. As described in Section 3, the Optimizer software was configured to prioritize monitored regulators discharging outside the period of critical wet-weather events, high-discharge frequency regulators, and regulators discharging in proximity to official and publicly-identified public access points (kayak launches/marinas).

The optimization alternatives for outfalls to New York Bay associated with the Red Hook, Owls Head, and Port Richmond WRRF collections systems were evaluated independently, as the three systems are hydraulically independent. However, the Red Hook WRRF system also includes outfalls discharging to the East River, and the Port Richmond WRRF includes outfalls that discharge to Kill Van Kull. Thus, the New York Bay optimization alternatives associated with the Red Hook WRRF system needed to be considered in conjunction with alternatives for the East River outfalls associated with the Red Hook WRRF system, and the New York Bay optimization alternatives associated with the Port Richmond WRRF needed to be considered in conjunction with alternatives for Kill Van Kull.

The sections below present the evaluations of New York Bay optimization alternatives associated with the Red Hook, Owls Head, and Port Richmond WRRF collection systems, respectively.

8.6.a.1 System Optimization for Outfalls in the Red Hook WRRF System

As described above in Section 8.4, optimization of the Red Hook WRRF system outfalls discharging to the East River were evaluated in conjunction with the Red Hook outfalls to New York Bay, due to the hydraulic connectivity among the outfalls through the single interceptor. Table 8.6-1 summarizes the CSO outfalls and associated regulators tributary to the East River and New York Bay from the Red Hook WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.6-1. Table 8.6-1 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits ("BMP Regulator")
- A "Key Regulator" as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet of) a public access location
- Regulators that activated more than average for the waterbody

<u>Findings/Observations from Optimizer Evaluations</u>

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Red Hook WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation, and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Red Hook WRRF is located at 63 Flushing Avenue in Brooklyn next to the Brooklyn Navy Yard. The collection system primarily serves the western Brooklyn neighborhoods of Carroll Gardens, Gowanus, Boerum Hill, Cobble Hill, Brooklyn Heights, and Vinegar Hill.
- The main interceptor conveying flow to the Red Hook WRRF interceptor system extends along the Brooklyn shoreline from the southern end of the East River to Gowanus Bay, and then back north along Gowanus Canal.
- The Red Hook WRRF collection system is relatively shallow (<10 feet of cover) at the upstream ends of each interceptor, but reaches approximately 25 feet of cover as the interceptor approaches the Red Hook WRRF.
- Regulators from the Red Hook system contributing to CSO outfalls discharging to New York Bay generally activate between 13 to 43 times during the typical year with a total average annual overflow volume (AAOV) of 141 MGY. Regulators from the Red Hook system contributing to CSO outfalls discharging to the East River generally activate between 0 to 26 times during the typical year with a total AAOV of 189 MGY.

Table 8.6-1. New York Bay and East River CSO Outfalls/Regulators Associated with the Red Hook WRRF

Waterbody	Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
			Annual CSO Volume	Annual CSO Activations				
New York Bay	RH-014	RH-14	33.2	43				✓
	RH-016	RH-12	34.9	19				✓
	RH-018	RH-11	10.4	19				
	RH-019	RH-9	15.0	20				✓
	RH-021	RH-9A	2.7	21				✓
	RH-028	RH-02	22.0	14	✓	✓		
	RH-029	RH-1	2.5	22				✓
	RH-002	RH-21A	0	0	✓			
East River	RH-005	RH-20A	134.0	20	✓	✓		✓
	RH-006	RH-19A	8.1	26				✓
	RH-008	RH18A	3.1	16			✓	
	RH-009	RH-18	2.5	18			✓	
	RH-011	RH-15	4.5	16			✓	
	RH-013	RH-14	0.3	6			✓	
	RH-040	RH-26	24.4	23				✓

Figure 8.6-1. CSO Outfalls/Regulators Tributary to New York Bay and the East River from the Red Hook WRRF System

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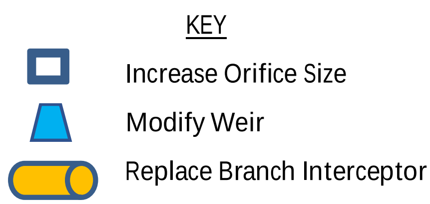
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is less than 10 feet from the ground surface at multiple locations along the interceptor.
- The Optimizer modeling identified alternatives that included modifications to up to 17 regulators resulting in varying degrees of improved capture and hydraulic performance. Upon performing InfoWorks runs for the 2008 typical year, limited net reductions in AAOV (approximately 1 percent) were predicted for the better performing alternatives, but the activation frequency of the most active regulator could be reduced by approximately 50 percent.
- The performance improvements were limited by hydraulic grade line sensitivities. While the interceptor has available storage capacity during smaller storms, the rise in grade line during the 5-year storm translates upstream during the 5-year design storm, affecting some of the shallower reaches of the interceptor beyond the level of acceptable risk.
- In addition, hydraulic balancing occurs, where CSO volume and activations increase at regulators/outfalls upstream or downstream of those regulators/outfalls where reductions were observed in response to the system optimization measures. Although the optimization alternatives reduced the activation frequency of the most active outfall in the Red Hook system (RH-014), which discharges to New York Bay, the CSO volume to the East River increased slightly (about 3 percent, 5 MG).

<u>Follow-up Evaluations Based on Full InfoWorks Model</u>

The most promising optimization alternative coming out of the Optimizer evaluations is summarized in Table 8.6-2:

Table 8.6-2. Red Hook Optimization Components for Retained Alternatives

Outfall	Regulator	Components
		NYB-1
RH-005	RH-20A	
RH-014	RH-13	



This alternative was further analyzed in more detail using the full Red Hook WRRF system InfoWorks model. The resulting impacts of Alternative NYB-1 on peak hydraulic grade line in the 5-year storm are summarized in Figure 8.6-2. The annual CSO volume and frequency for this optimization alternative are summarized in Table 8.6-3, and estimated probable bid costs and construction/implementation considerations are summarized in Table 8.6-4.

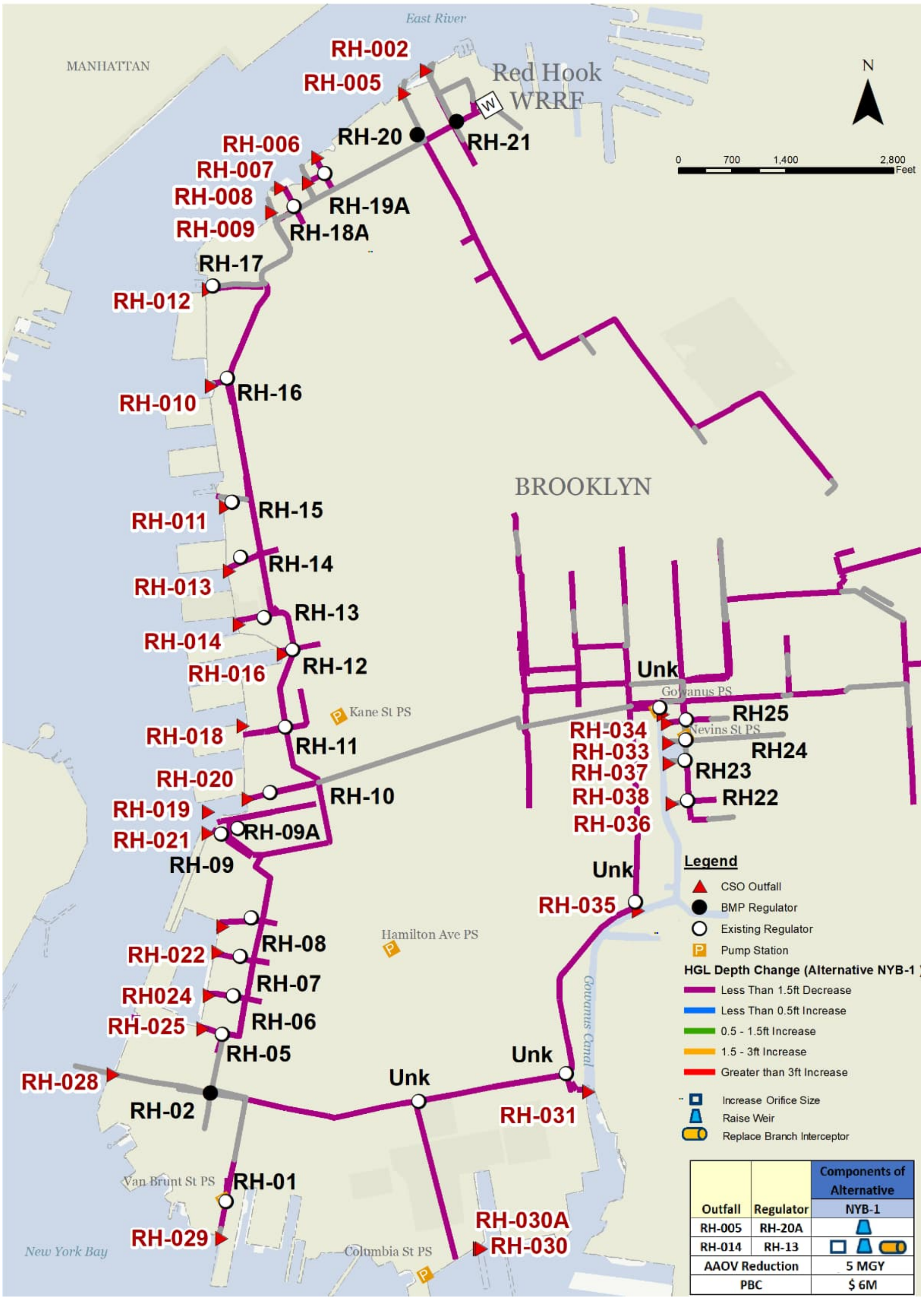


Figure 8.6-2. Hydraulic Grade Line Impacts of Alternative NYB-1 vs. Baseline Conditions (5-Year Storm)

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Table 8.6-3. Summary of Performance of Red Hook Optimization Alternative NYB-1 for New York Bay and East River

Waterbody	Outfall(1)	Regulator	Baseline Conditions Typical Year		Alternative NYB-1	
			Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
East River(2)	RH-005	R-20A	134	20	137	21
	RH-006	R-19A	8.1	26	8.2	26
	RH-008	R-18A	3.1	16	3.2	17
	RH-009	R-18	2.5	18	2.6	18
	RH-011	R-15	4.5	16	4.8	17
	RH-012	R-17	9.6	14	10.2	17
New York Bay(2)	RH-014	R-13	33.2	43	10.1	21
	RH-016	R-12	34.9	19	37.8	20
	RH-018	R-11	10.4	19	10.9	19
	RH-019	R-9	15.0	20	15.4	21
	RH-028	R-2	22.0	14	30.0	15
	RH-029	R-1	2.5	22	2.5	22
	RH-040	R-26	24.4	23	24.8	24
	Total		**414**	**43 (Max.)**	**409**	**26 (Max.)**

Notes:

(1) Outfalls and regulators with negligible impacts to Annual CSO Volume and Activations are not included in this table.

(2) Reduction of 10 MG to New York Bay is partially offset by an increase of 5 MG to the East River.

Table 8.6-4. Summary of Cost and Implementation Considerations for New York Bay Optimization Alternative NYB-1

Alternative	Probable Bid Cost ($M)	Implementation Considerations
NYB-1	$6M	• Reduction in CSO to New York Bay of 10 MGY • Increase in CSO to East River of 5 MGY • Net reduction in CSO of 5 MGY • Reduces activation frequency of most active outfall (RH-014) from 42 to 21 activations/year

Given the potential cost-effective reduction in CSO activation frequency and volume, Alternative NBY-1 was retained for further consideration. Tunnel storage alternatives for Red Hook WRRF outfalls tributary to New York Bay are evaluated later in this section.

8.6.a.2 System Optimization for New York Bay Outfalls in the Port Richmond WRRF System

Table 8.6-5 summarizes the CSO outfalls and associated regulators tributary to New York Bay from the Port Richmond WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.6-3. Table 8.6-5 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits ("BMP Regulator")
- A "key regulator" as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet of) a public access location
- Regulators that activated more than average for the waterbody

Table 8.6-5. New York Bay CSO Outfalls/Regulators Associated with the Port Richmond WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
PR-013	R-17	40.7	30			✓	✓
PR-014	R-15	28.3	30				✓
PR-017	R-09	13.1	30				✓
PR-018	R-08	2.88	20				✓
PR-019	R-07	67.4	38			✓	✓
PR-020	R-05	25.2	44				✓
PR-021	R-04	7.25	38			✓	✓
PR-030	R-06	8.55	41				✓
PR-031	R-13	183	34	✓	✓		
PR-032	R-16	7.39	26				✓
PR-23A	R-03/R-01	41.9	25			✓	✓

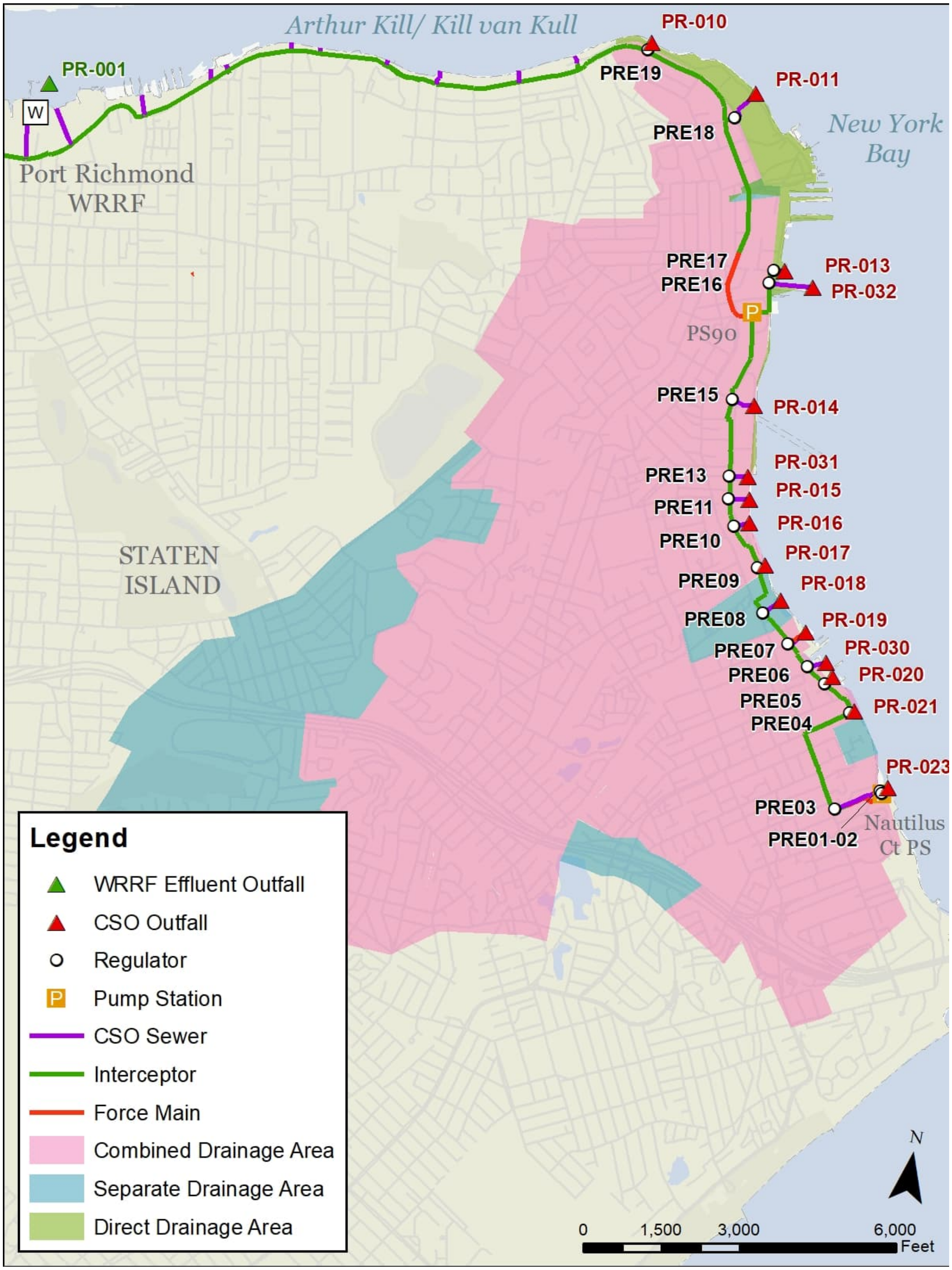

Figure 8.6-3. CSO Outfalls/Regulators Tributary to New York Bay from the Port Richmond WRRF System

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Port Richmond WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Port Richmond WRRF collection system serves the northern part of Staten Island. The East Interceptor runs east from the WRRF along the shoreline of Kill Van Kull, then turns south along the shoreline of New York Bay. The West Interceptor runs west from the WRRF along the shoreline of Kill Van Kull.
- A total of 35 regulators contribute flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to New York Bay (15 CSOs), and Kill Van Kull (19 CSOs). The interceptor sewers convey flow to the Port Richmond WRRF located along Kill Van Kull.
- Depth of cover on the gravity sewers varies, ranging from relatively shallow (<10 feet of cover) to over 20 feet.
- Regulators from the Port Richmond system contributing to CSO outfalls discharging to New York Bay activate between 3 to 44 times during the typical year with a total average annual overflow volume (AAOV) of 431 MGY.
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the portions of the collection system along New York Bay are highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified alternatives that included modifications to as many as 20 regulators throughout the WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year, limited reductions in AAOV (<1 percent) and activation frequency (<8 percent) were predicted for the better performing alternatives.

Follow-up Evaluations Based on Full InfoWorks Model

No retained alternatives were identified from the initial optimization runs due to hydraulic grade line impacts that increased the potential risk of flooding, while providing negligible reductions in CSO volume and activations to New York Bay. Figure 8.6-4 illustrates the hydraulic grade line sensitivities where optimization alternatives increase the potential risk of street flooding and basement backups.

Additional Optimization Alternative

In prior WWFP evaluations for the Port Richmond WRRF system, an optimization alternative had been identified that was unique to the configuration of the system in the vicinity of the Hannah Street Pumping Station. That alternative was reassessed as part of the Citywide/Open Waters LTCP, and was determined to be a potentially feasible, cost-effective means of reducing CSO activations and volume to New York Bay.

The Hannah Street Pumping Station is located along the East Interceptor, just downstream of the branch interceptor connection from Regulators R-16 (Outfall PR-032) and R-17 (Outfall PR-013) (see Figure 8.6-3). The force main from the Hannah Street Pumping Station ties back into the East Interceptor on Bay Street, north of Victory Boulevard. The force main crosses over a combined sewer on Victory Boulevard, that feeds into Regulator R-17. The invert elevation of the Victory Boulevard combined sewer is above the invert of the East Interceptor at the point where the force main ties into the interceptor. As a result, the opportunity exists to divert the dry-weather flow and a portion of the wet-weather flow from the Victory Boulevard combined sewer directly to the interceptor via a gravity flow connection. This alternative would not only reduce CSOs at Regulator R-17 (Outfall PR-013), but would also reduce pumping costs and energy requirements at the Hannah Street Pumping Station. The sizing and configuration of the diversion connection was set to limit the peak wet-weather flow through the connection, so as not to create adverse hydraulic grade line impacts in the East Interceptor downstream of the proposed connection. Figure 8.6-5 shows a conceptual layout of the proposed bypass connection. This alternative has been designated "NBY-2."

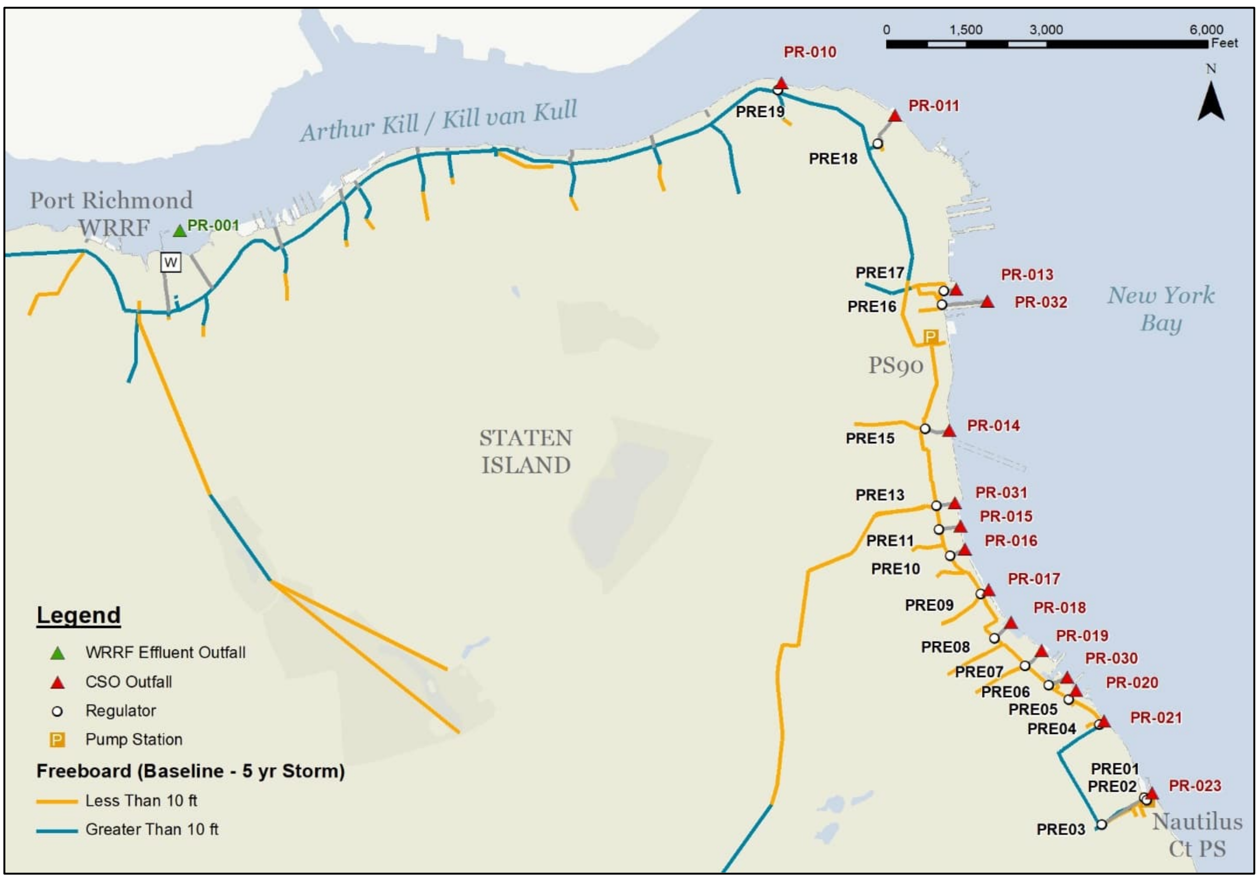

Figure 8.6-4. Baseline Conditions Hydraulic Grade Line Impacts in Port Richmond System (5-Year Storm)

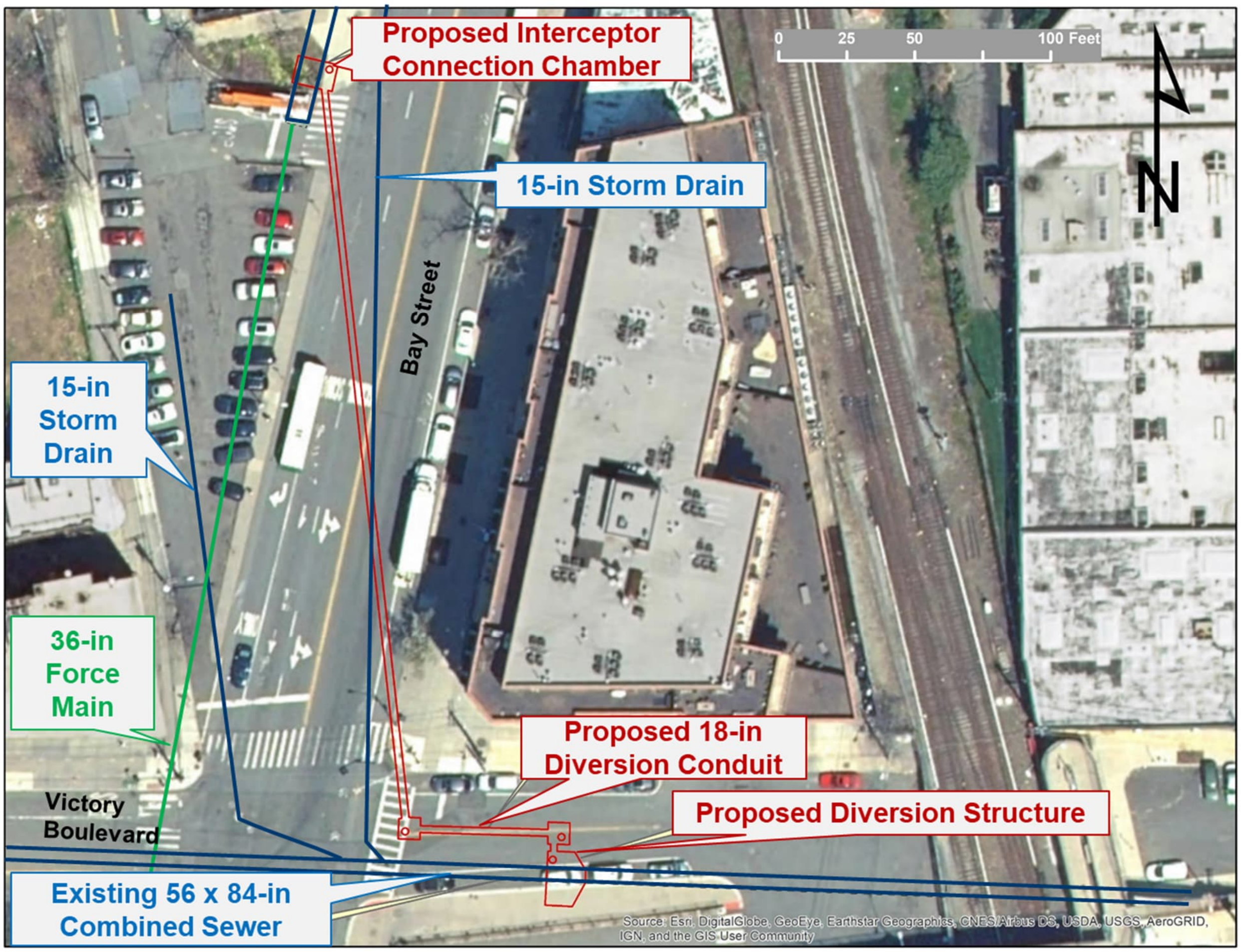

Figure 8.6-5. Conceptual Layout of Alternative NYB-2 - Hannah Street Pumping Station Bypass

The predicted impacts of Alternative NYB-2 on CSO activations and volumes to New York Bay are presented in Table 8.6-6. As indicated in Table 8.6-6, Alternative NYB-2 results in a slight increase (5 MG, 3 percent) in the CSO volume to Kill Van Kull, primarily at Outfall PR-029. The total decrease in CSO volume to New York Bay is 42 MG, so the alternative results in an overall net CSO reduction of 37 MG. Estimated probable bid costs and construction/implementation considerations for Alternative NYB-3 are summarized in Table 8.6-7.

Table 8.6-6. Performance of Alternative NYB-2, 2008 Typical Year

Waterbody	Outfall[1]	Baseline Conditions Typical Year		Alternative NYB-2	
		Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
New York Bay[2]	PR-010	0.96	8	0.96	8
	PR-011	0.22	3	0.22	3
	PR-013	40.7	30	19.5	18
	PR-014	28.3	30	30.1	26
	PR-015	2.14	15	2.10	15
	PR-016	1.72	16	1.63	15
	PR-017	13.1	30	11.6	26
	PR-018	2.88	20	2.14	14
	PR-019	67.4	38	62.0	33
	PR-020	25.2	44	23.5	42
	PR-021	7.25	38	7.02	36
	PR-23A	41.9	25	41.6	25
	PR-030	8.55	41	7.8	39
	PR-031	183	34	175	33
	PR-032	7.39	26	3.7	17
	Subtotal	**431**	**44 (Max.)**	**389**	**42 (Max.)**
Kill Van Kull[2]	PR-006	6.35	15	6.5	15
	PR-026	1.40	6	1.6	6
	PR-027	1.71	10	1.8	10
	PR-028	15.1	23	15.5	23
	PR-029	146	47	149	47
	PR-037	2.93	12	3.1	12
	Subtotal	**173**	**47 (Max.)**	**178**	**47 (Max.)**
Total		**604**	**47 (Max.)**	**567**	**47 (Max.)**

Notes:
(1) Outfalls and regulators with negligible impacts to Annual CSO Volume and Activations are not included in this table.
(2) Reduction of 42 MG to New York Bay is partially offset by an increase of 5 MG to Kill Van Kull.

Table 8.6-7. Summary of Cost and Implementation Considerations for New York Bay Optimization Alternative NYB-2

Alternative	Probable Bid Cost ($M)	Implementation Considerations
NYB-2	$22M	• Reduction in CSO to New York Bay of 42 MGY • Increase in CSO to Kill Van Kull of 5 MGY • Net reduction in CSO of 37 MGY

Tunnel options for CSO outfalls to New York Bay from the Port Richmond WRRF system are evaluated later in this section.

8.6.a.3 System Optimization for New York Bay Outfalls in the Owls Head WRRF System

Table 8.6-8 lists the CSO outfalls and associated regulators tributary to New York Bay from the Owls Head WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.6-6. Table 8.6-8 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits ("BMP Regulator")
- A "key regulator" as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet) a public access location
- Regulators that activated more than average for the waterbody

Table 8.6-8. New York Bay CSO Outfalls/Regulators Associated with the Owls Head WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume	Annual CSO Activations				
OH-002	OH-6A,B,C	407	41	✓	✓		✓
OH-003	OH-7A,B,C	374	57	✓			✓
OH-004	OH-7D	9.2	12	✓			
OH-015	OH-9A,B,C	1,105	64	✓		✓	✓
OH-017	OH-1	449	39	✓	✓	✓	✓
OH-018	OH-2,3	121	32	✓			✓
OH-019	OH-4	22.7	26	✓			✓

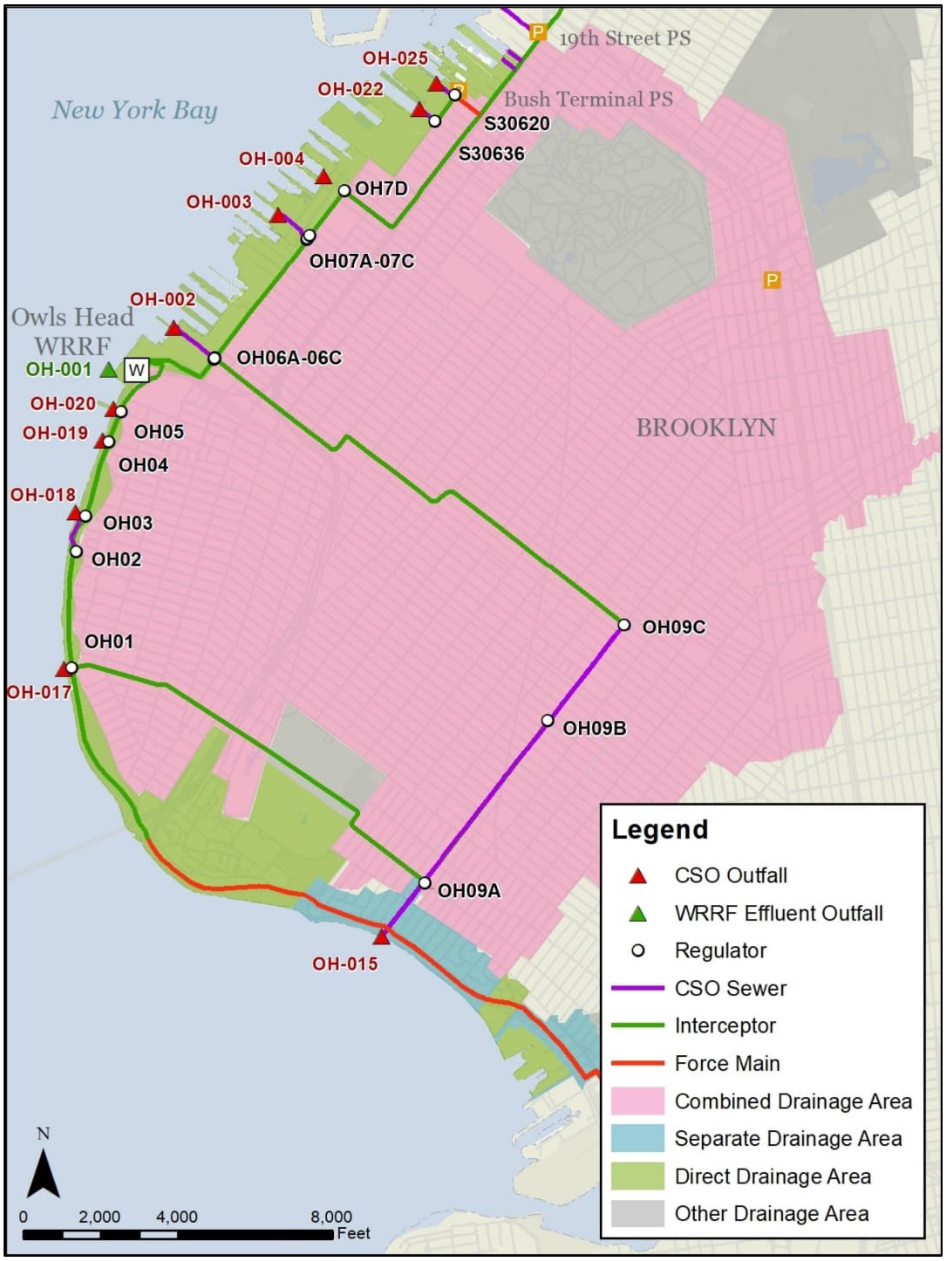

Figure 8.6-6. CSO Outfalls/Regulators Tributary to New York Bay from the Owls Head WRRF System

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Owls Head WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Owls Head WRRF is located in the Bay Ridge section of Brooklyn, and its collection system serves the southwestern side of Brooklyn. One interceptor runs north from the WRRF parallel to the shoreline of New York Bay, extending to the east side of Gowanus Canal. A second branch runs south from the WRRF parallel to the New York Bay shoreline, then southeast along the shoreline of Gravesend Bay.
- A total of 21 regulators divert flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to the New York Bay (10 CSOs), Gowanus Canal (8 CSOs), and Coney Island Creek (1 CSO).
- Depth of cover on the gravity sewers varies, ranging from relatively shallow (<10 feet of cover) to about 20 feet.
- Regulators from the Owls Head system contributing to CSO outfalls discharging to New York Bay activate between 0 to 64 times during the typical year with a total AAOV of 2,489 MGY.
- Interceptor freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the system is highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified alternatives that included modifications to as many as nine regulators throughout the WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year, limited AAOV (<1 percent) reductions were predicted for the better performing alternatives.
- The limited performance improvement is a result of the hydraulic grade line sensitivities along the interceptor running south from the Owls Head WRRF. Also, since the system was generally running full during wet-weather, alternatives that reduced CSO at one location tended to result in offsetting increases at other locations.

Follow-up Evaluations Based on Full InfoWorks Model

Although no retained alternatives were identified from the initial optimization runs due to the reasons listed here, further optimization evaluations using the InfoWorks model are discussed below.

- Hydraulic grade line impacts that increased the potential risk of flooding
- Negligible reductions in CSO volume to New York Bay

Figure 8.6-7 illustrates the HGL sensitivities where optimization alternatives increase the potential risk of street flooding and basement backups.

Figure 8.6-7. HGL Impacts of Owls Head Collection System Under Baseline Conditions, 5-Year Storm

Additional Optimization Using InfoWorks Model

As part of the evaluations of the Optimizer alternatives using the InfoWorks model, an opportunity was identified for using a control gate to optimize the overflow volume from Regulator 9C, which discharges to Outfall OH-015. The combined sewer tributary to Regulator 9C is a double-barrel conduit, with one barrel sitting on top of the other. At Regulator 9C, flow from the upper conduit is diverted to the lower conduit, where the flow can enter a branch sewer on 60th Street for conveyance to the regulators associated with Outfall OH-002. The InfoWorks model indicated that approximately 90 percent of the overflow at Outfall OH-015 comes out of the lower outfall conduit, while the upper conduit was not running full. Flow remaining in the upper conduit downstream of Regulator 9C can still be diverted to the interceptor system further downstream at Regulator 9A.

Simply closing off the connection between the upper and lower conduits at Regulator 9C was predicted to have unacceptable hydraulic grade line impacts upstream of Regulator 9C during the 5-year storm. However, if a control gate could be installed in the connection between the upper and lower conduits, the gate could be triggered to close during smaller storms, but open during large storms to avoid the upstream hydraulic grade line impacts. Functionally, the gate would be controlled based on level measurement upstream of Regulator 9C, such that once the water surface upstream reached a pre-determined set point, the gate would be triggered to re-open.

This alternative was designated as "NYB-3." The predicted impacts of Alternative NYB-3 on CSO activations and volumes to New York Bay are presented in Table 8.6-9. This alternative would not affect discharges from the Owls Head system to Gowanus Canal or Coney Island Creek. As indicated in Table 8.6-9, Alternative NYB-2 is predicted to reduce CSO volumes at Outfalls OH-002 and OH-015, and slightly increase CSO volume at Outfall OH-017, with a net overall reduction in CSO volume to New York Bay of 90 MG. The increase in overflow at Outfall OH-017 is due to more flow being diverted into the interceptor from the upper barrel of the OH-015 system at Regulator 9A, while the reduction at Outfall OH-002 is due to less flow being diverted into the 60th Street combined sewer at Regulator 9C.

Estimated probable bid costs and construction/implementation considerations for Alternative NYB-3 are summarized in Table 8.6-10.

Table 8.6-9. Performance of Alternative NYB-3, 2008 Typical Year

Outfall[1]	Regulator	Baseline Conditions Typical Year		Alternative NYB-1	
		Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
OH-002	OH-6A,B,C	407	41	367	41
OH-003	OH-7A,B,C	373	57	374	57
OH-004	OH-7D	9.2	12	9.2	12
OH-015	OH-9A,B,C	1,105	64	994	64

Table 8.6-9. Performance of Alternative NYB-3, 2008 Typical Year

Outfall[1]	Regulator	Baseline Conditions Typical Year		Alternative NYB-1	
		Annual CSO Volume (MG)	Annual CSO Activations	Annual CSO Volume (MG)	Annual CSO Activations
OH-017	OH-1	449	39	508	40
OH-018	OH-2,3	121	32	123	33
OH-019	OH-4	22.7	26	22.8	27
OH-020	OH-5	1.3	25	1.2	25
Total		2,489	**64 (Max.)**	**2,399**	**64 (Max.)**

Table 8.6-10. Summary of Cost and Implementation Considerations for New York Bay Optimization Alternative NYB-3

Alternative	Probable Bid Cost ($M)	Implementation Considerations
NYB-3	$5M	• Reduction in CSO to New York Bay of 90 MGY

Tunnel storage options for the outfalls to New York Bay from the Owls Head WRRF system are evaluated in the subsection below.

8.6.b Storage Tunnel Alternatives for 25/50/75/100 Percent CSO Control

Conceptual storage tunnel alternatives were developed to provide modeling scenarios for 25, 50, 75, and 100 percent CSO control of the annual CSO volume discharged to New York Bay in the Typical Year. The approach to sizing and layout of the storage tunnel alternatives was as follows:

- For the 50 percent CSO control tunnel, the Typical Year annual overflow volume of each CSO outfall to New York Bay was reviewed and combinations of outfalls were identified where capture of 100 percent of the CSO from those outfalls would approximately match 50 percent of the total CSO volume from all outfalls to New York Bay.
- The locations of these outfalls were assessed in relation to the length and diameter of tunnel needed to capture the outfalls.
- Based on DEP expertise, a combination of outfalls was selected that provided reasonable tunnel length/diameter to provide 50 percent volume capture.
- A similar approach was taken for the 75 percent CSO control tunnel.

- For the 25 percent CSO control tunnel, the 50 percent CSO tunnel was downsized until the volume of storage provided would result in approximately 25 percent CSO control.
- For the 100 percent CSO control tunnel, it was assumed that every CSO outfall to New York Bay that was predicted to be active in the 2008 Typical Year would be tied into the tunnel. Where multiple outfalls were located in close proximity to each other, it was assumed that a near-surface consolidation conduit would be provided to a single drop shaft.
- For each storage tunnel alternative, the dewatering rate required to dewater the storage tunnel within 24 hours was compared to the available dry-weather flow capacity in the WRRF closest to the downstream end of the tunnel. If insufficient dry-weather flow capacity was available at the WRRF to accept the additional dewatering flows, a high-rate clarification wet-weather flow treatment system with disinfection was added to the alternative to treat the dewatered flow.
- A detailed siting assessment was not conducted, so the specific locations of various features of the tunnel alternatives (mining shaft, TBM removal shaft, drop shafts, dewatering pumping station, dewatered flow treatment facility, near-surface diversion structures/connection conduits) were not identified.

The main features of the 25, 50, 75, and 100 percent CSO control storage tunnels for New York Bay are summarized in Table 8.6-11. The 25 percent capture tunnel would capture overflow from Outfalls OH-015 and OH-017 (Figure 8.6-8). The tunnel would start at a mining shaft in the general vicinity of the Owls Head WRRF, and run south along the New York Bay shoreline. The tunnel would pick up Outfalls OH-015 and OH-017, then continue south past Outfall OH-017 to an equipment removal shaft. The total tunnel length would be about 24,500 feet (4.6 miles), with a diameter of 12 feet. The tunnel would be dewatered to the Owls Head WRRF.

The 50 percent CSO control tunnel would pick up the same outfalls as the 25 percent CSO control tunnel, and run along the same route (Figure 8.6-8). The difference would be that the tunnel would consist of two parallel 23-foot diameter barrels.

The 75 percent CSO control tunnel would follow the same route as the 50 percent tunnel, but would extend north of the Owls Head WRRF to capture Outfalls OH-002 and OH-003 (Figure 8.6-9). This tunnel system would have a length of 28,500 feet (5.4 miles) consist of two parallel 28-foot diameter barrels.

The 100 percent CSO control tunnel capturing the OH/RH outfalls would start with a mining shaft near the Red Hook WRRF, and run along the shoreline of New York Bay to a point south of Outfall OH-015 (Figure 8.6-10). The mining shaft could also be located near the Owls Head WRRF, with the tunnel running in two directions from that location. The tunnel would consist of two parallel barrels, each 23-foot diameter, with a length of about 49,000 feet (9 miles). The tunnel could be dewatered to the either the Red Hook or Owls Head WRRF, depending on the location of the mining shaft.

The 100 percent CSO control tunnel capturing the PR outfalls would start with a mining shaft in the vicinity of Outfall PR-10, and run south along the shoreline of New York Bay to Outfall PR-023A (Figure 8.6-10). The tunnel would have a length of approximately 16,300 feet (5 miles), and a diameter of 25 feet. The tunnel would be dewatered to the Port Richmond WRRF.

Table 8.6-11. Summary of 25, 50, 75, and 100 Percent CSO Control Alternatives for New York Bay

Alternative	NYB-4	NYB-5	NYB-6	NYB-7	
Level of CSO Control(1)	**25%**	**50%**	**75%**	**100%**	
WRRF Outfalls Captured(2)	**OH**	**OH**	**OH**	**OH/RH**	**PR**
Length (mi.)	4.6	2 x 4.6(3)	2 x 5.4(4)	2 x 9.3(5)	3.1
Diameter (ft.)	12	23	28	23	25
Volume (MG)	22	156	253	300	61
Outfalls Captured	• OH-015 • OH-017	• OH-015 • OH-017	• OH-002 • OH-003 • OH-015 • OH-017	• 10 OH outfalls • 12 RH outfalls	• 15 PR outfalls
Net CSO Volume Reduction (MGY)	768	1,554	2,335	2,630	431
Wet-Weather Flow Treatment Facility Capacity for Dewatering Flow (MGD)	22	156	253	300	61
Estimated Probable Bid Cost(5)	$900M	$2,900	$4,300M	$6,700	$1,800
Total Estimated Probable Bid Cost by Level of Control(6)	$900M	$2,900	$4,300M	$8,500	

Notes:
(1) Modeled annual percent CSO reduction based on the 2008 Typical Year.
(2) OH = Owls Head; RH = Red Hook; PR = Port Richmond
(3) “2 x 4.6” = Double-barrel tunnel, 4.6 miles long
(4) “2 x 5.4” = Double-barrel tunnel, 5.4 miles long
(5) “2 x 9.3” = Double-barrel tunnel, 9.3 miles long
(6) 2019 dollars.

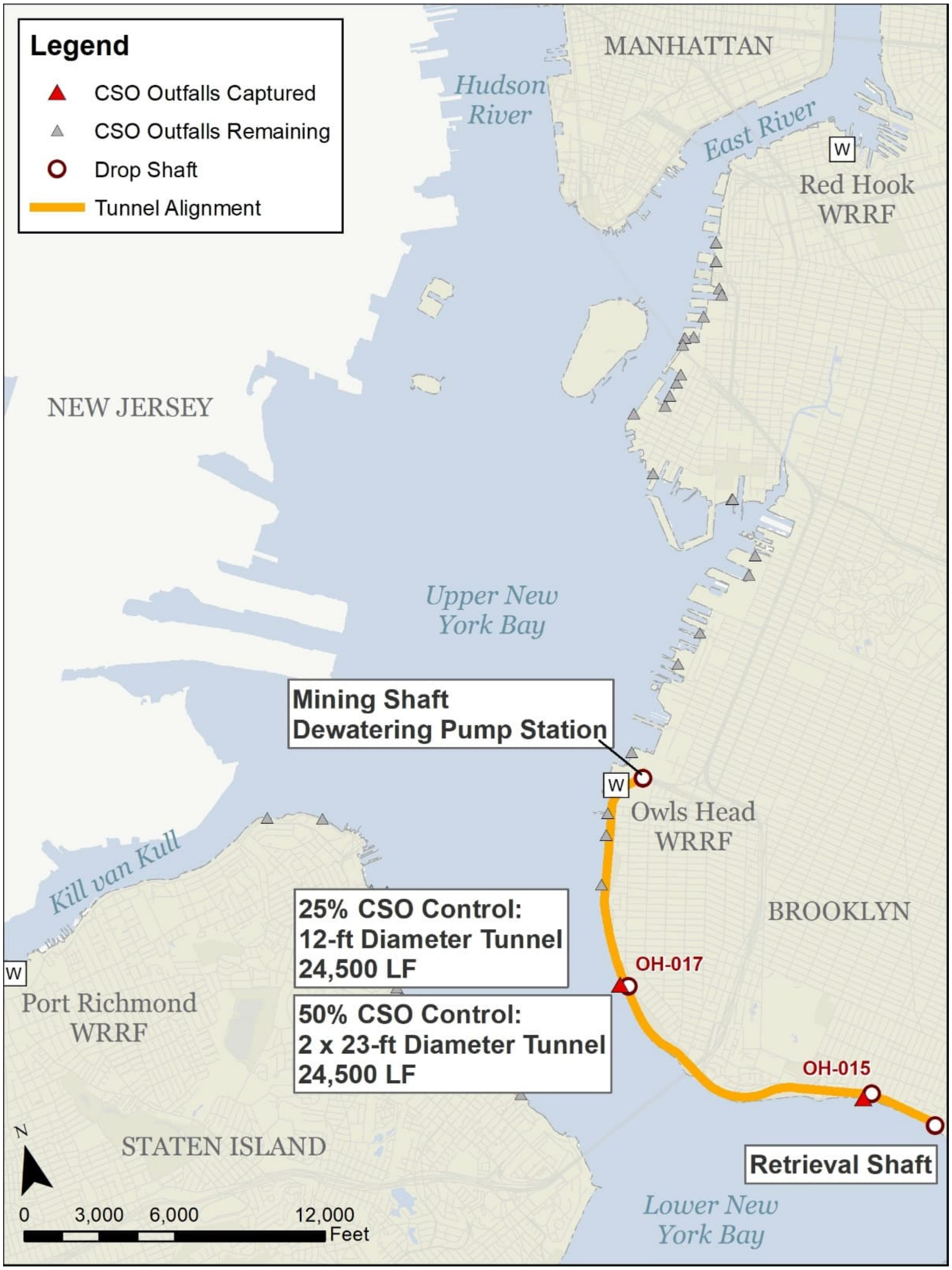

Figure 8.6-8. 25 and 50 Percent CSO Control Tunnels for New York Bay

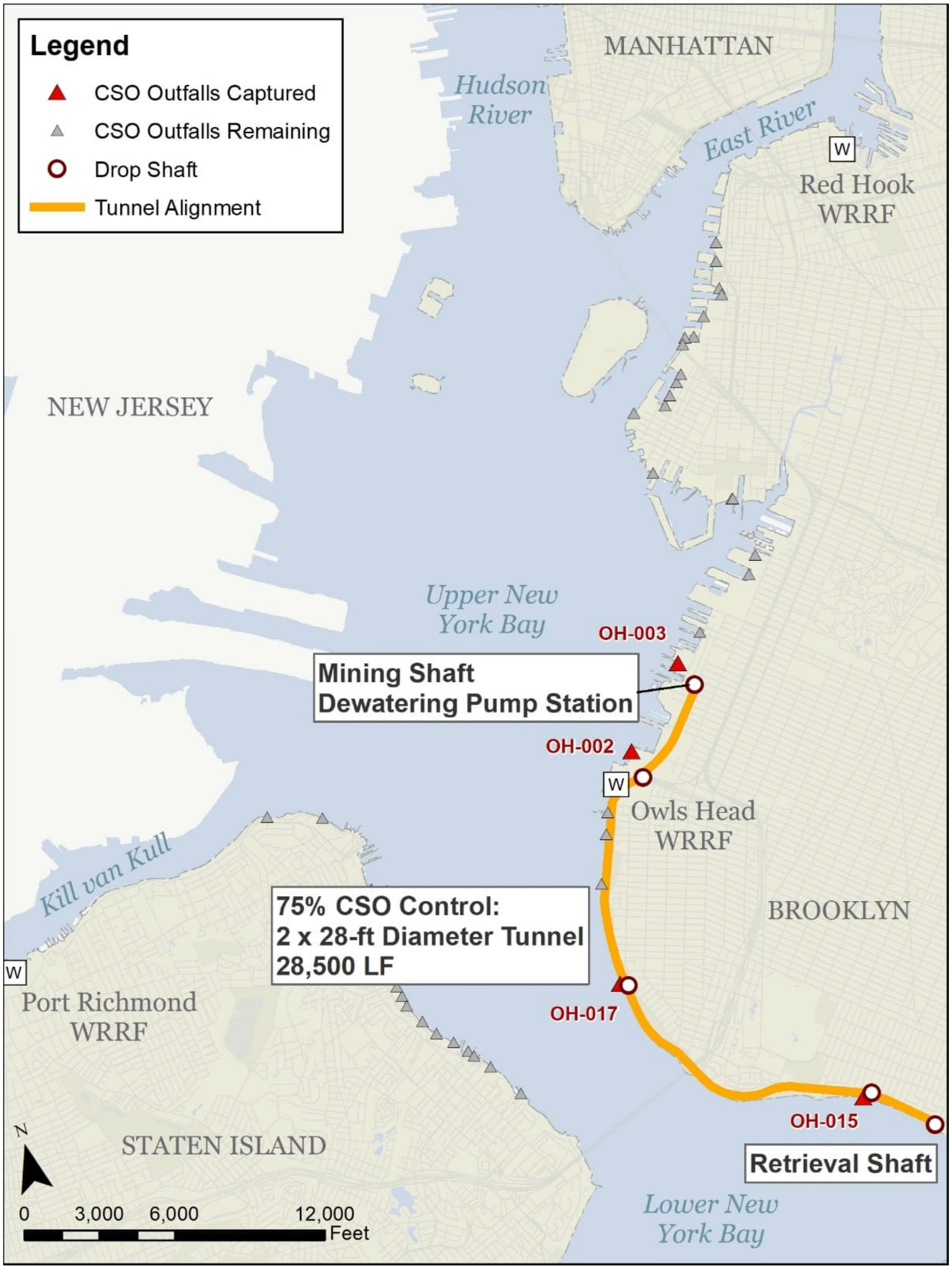

Figure 8.6-9. 75 Percent CSO Control Tunnel for New York Bay

Figure 8.6-10. 100 Percent CSO Control Tunnels for New York Bay

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The dewatering capacity needed and the location where the dewatering flow would be conveyed for treatment varies with each of the alternatives described above. However, dedicated wet-weather high-rate treatment facilities would be necessary for the treatment of the CSO retained in the storage tunnels.

While these alternatives provide relatively high levels of CSO control, the significant challenges to implementation include:

- Very high implementation cost
- Limited siting availability for shafts, dewatering pumping station, dewatering flow treatment facility
- Long implementation period
- Significant and prolonged construction impacts (truck traffic, noise, dust) for surface consolidation sewers due to the large number of drop shafts necessary to divert CSO to the tunnel
- Negligible improvement in the annual attainment of applicable water quality standards
- Construction impacts and likelihood of utility conflicts for near-surface diversion structures and connecting conduits

Despite these challenges, these alternatives were retained in order to provide an assessment of a range of levels of CSO control for New York Bay, per the CSO Policy and the Clean Water Act.

8.6.c Summary of Retained Alternatives for New York Bay

The goal of the previous evaluations was to develop a list of retained control measures for New York Bay. These control measures, whether individually or in combination, form the basis of basin-wide alternatives to be assessed using more rigorous cost-performance and cost-attainment analyses. Table 8.6-12 lists all of the control measures originally identified in the "Alternatives Toolbox" shown above in Figure 8.6-2, and identifies whether the control measure was retained for further analysis. The reasons for excluding the non-retained control measures from further consideration are also noted in the table.

Table 8.6-12. Summary of Control Measure Screening for New York Bay

Control Measure	Category	Retained for Further Analysis?	Remarks
Additional GI Build-out	Source Control	NO(1)	Planned GI build-out in the watershed is included in the baseline. It is unlikely that additional sites will be identified due to site constraints in publicly owned properties.
High Level Storm Sewers	Source Control	NO(1)	No cost-effective opportunities identified
Regulator Modifications	System Optimization	YES	Incorporated into optimization Alternatives NYB-1 and NYB-3
Parallel Interceptor Sewer	System Optimization	YES	Incorporated into optimization Alternative NYB-2

Table 8.6-12. Summary of Control Measure Screening for New York Bay

Control Measure	Category	Retained for Further Analysis?	Remarks
Bending Weirs/Control Gates	System Optimization	NO	Incorporated into optimization Alternative NYB-3
Pumping Station Optimization	System Optimization	NO	Limited benefit in terms of CSO reduction.
Pumping Station Expansion	System Optimization	NO	Limited benefit in terms of CSO reduction.
Gravity Flow Redirection to Other Watersheds	CSO Relocation	YES	Optimization Alternatives NYB-1 and NYB-2 shift some CSO volume between New York Bay and other waterbodies
Pumping Station Modification	CSO Relocation	NO	No cost-effective opportunities identified.
Flow Redirection with Conduit and Pumping	CSO Relocation	NO	No cost-effective opportunities identified.
Floatables Control	Floatables Control	YES	Programmatic floatables control will be applied and expanded Citywide.
Environmental Dredging	Water Quality/ Ecological Enhancement	NO	No specific locations of CSO sediment mounding identified.
Wetland Restoration and Daylighting	Water Quality/ Ecological Enhancement	NO	No daylighting opportunities were identified.
Outfall Disinfection	Treatment: Satellite	NO	Not feasible due to short length of outfalls.
Retention/Treatment Basins	Treatment: Satellite	NO	Significant siting constraints and very high costs. Tunnel storage covers 25/50/75/100% CSO control alternatives.
High-Rate Clarification	Treatment: Satellite	YES	Incorporated into the storage tunnel alternatives for treatment of captured CSO during tunnel dewatering.
WRRF Expansion	Centralized Treatment	NO	Insufficient space available. Limited benefit compared to potential cost.
In-System Storage (Outfalls)	Storage	NO	Negligible levels of CSO control due to short outfalls.
Off-line Storage (Tanks)	Storage	NO	Significant siting constraints and very high costs. Tunnel storage covers 25/50/75/100% CSO control alternatives.
Off-line Storage (Tunnels)	Storage	YES	Tunnel storage Alternatives NYB-4, NYB-5, NYB-6 and NYB-7 cover 25/50/75/100% CSO control.

Note:
(1) Additional GI and HLSS are considered to be ongoing programs that will continue to be implemented system-wide outside of the LTCP program.

As shown, the retained control measures include system optimization measures, tunnel storage (with high-rate clarification for dewatering flows), and programmatic floatables control.

8.6.d CSO Volume and Loading Reductions for Retained Alternatives for New York Bay

Table 8.6-13 summarizes the projected performance of the retained New York Bay alternatives in terms of annual CSO volume and fecal coliform load reduction, based on the 2008 Typical Year. These data are plotted on Figure 8.6-11. In all cases, the predicted reductions shown are relative to the Baseline Conditions using 2008 JFK rainfall as described in Section 6. The baseline assumptions were described in detail in Section 6 and include the implementation of the grey infrastructure projects from the approved WWFPs, the Recommended Plans from the previously submitted LTCPs, and the projected level of GI identified in Section 5. Since Alternatives NYB-1, NYB-2 and NYB-3 are hydraulically independent of each other, Table 8.6-13 includes values for each of those alternatives independently, and also for a case where all three alternatives would be implemented (combined NYB-1, NYB-2 and NYB-3).

Table 8.6-13. New York Bay Retained Alternatives Performance Summary (2008 Rainfall)

Alternative	Annual Performance Based on 2008 Typical Year				
	Remaining CSO Volume (MGY) (1)	Frequency of Overflow (2)	Additional Untreated CSO Volume to Other Waterbodies (MGY) (3)	Net CSO Volume Reduction (%)	Net Fecal Coliform Reduction (%)
Baseline Conditions	3,062	64	0	0	0
NYB-1. Optimization of Regulators Associated with Outfalls RH-005 and RH-014	3,057(4)	64	5	<1	<1
NYB-2. Hannah Street Pumping Station Bypass	3,025(5)	64	5	1	1
NYB-3. Control Gate at Regulator 9C (Outfall OH-015)	3,152	64	0	3	3
NYB-1, NYB-2, NYB-3 Combined	2,930(6)	64	10	4	4
NYB-4. Tunnel Storage for 25% CSO Control (22 MG Capacity)	2,294	57	0	25	25
NYB-5. Tunnel Storage for 50% CSO Control (156 MG Capacity)	1,508	57	0	51	51
NYB-6. Tunnel Storage for 75% CSO Control (253 MG Capacity)	727	42	0	76	76
NYB-7. Tunnel Storage for 100% CSO Control (361 MG Capacity)	0	0	0	100	100

Notes:

(1) Remaining CSO includes all discharges to New York Bay from the Red Hook, Owls Head, and Port Richmond WRRF Collection Systems.
(2) Frequency of overflow is based upon the most frequently active CSO outfall.
(3) Additional untreated CSO volume to other waterbodies accounts for increases at other CSO outfalls in response to the implementation of a CSO control alternative. Net CSO volume reduction and net fecal coliform reduction account for any additional CSO discharge to other waterbodies.
(4) Reduction in CSO to New York Bay of 10 MG; alternative also results in an increase in CSO to the East River of 5 MG.
(5) Reduction in CSO to New York Bay of 42 MG; alternative also results in an increase in CSO to Kill Van Kull of 5 MG.
(6) See Notes 4 and 5.

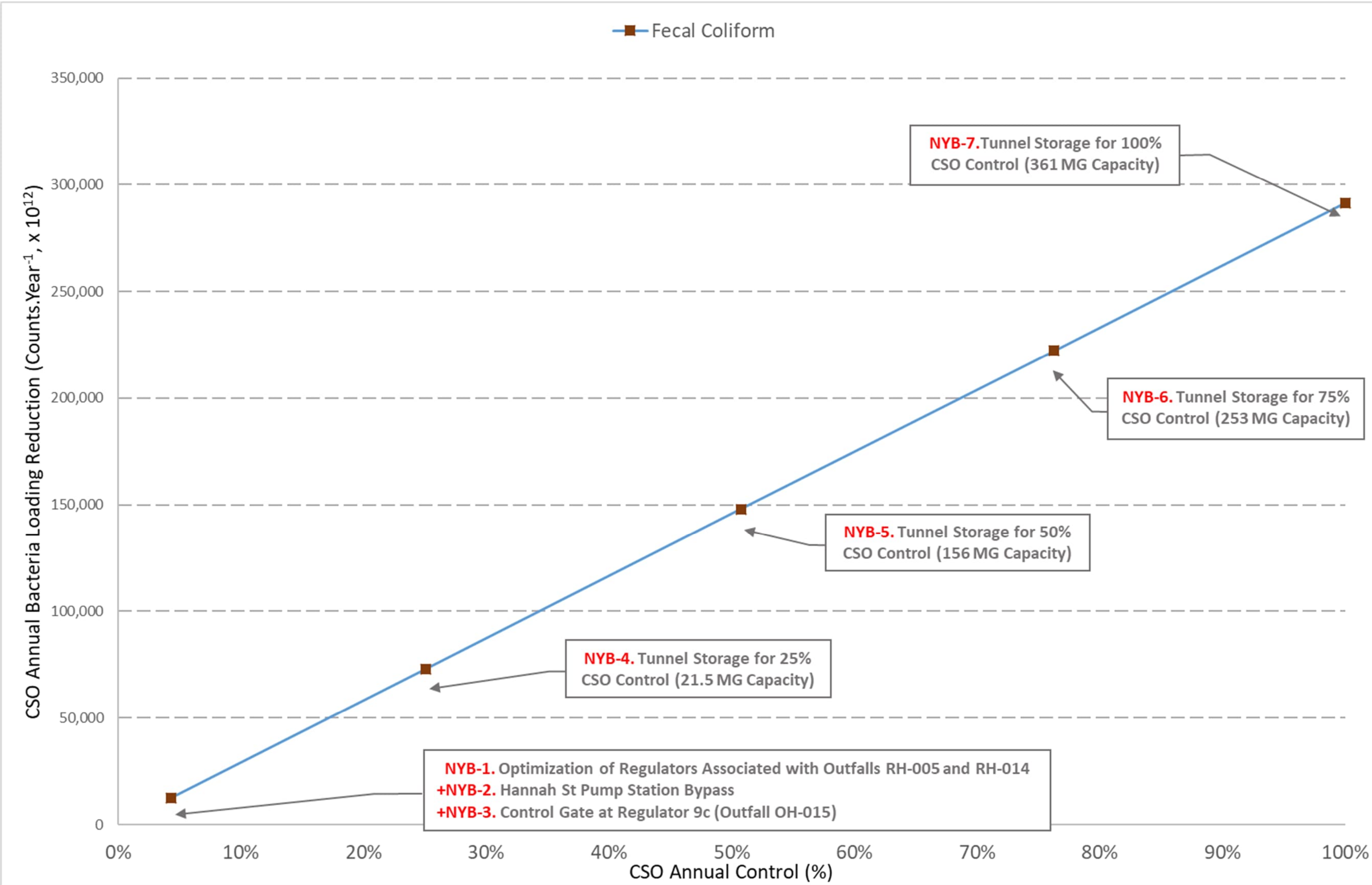

Figure 8.6-11. Untreated CSO Volume Reductions (as Percent CSO Annual Control) vs. Annual CSO Bacterial Loading Reduction (2008 Typical Year) for New York Bay

Because the retained alternatives for New York Bay provide volume reduction and not treatment, the predicted bacteria loading reductions of the alternatives are very closely aligned with their projected CSO volume reductions.

8.6.e Cost Estimates for East River Retained Alternatives

Evaluation of the retained alternatives requires cost estimation. The methodology for developing these costs is dependent upon the type of technology and its O&M requirements. The construction costs were developed as Probable Bid Costs (PBC) and the total Net Present Worth (NPW) costs were determined by adding the estimated PBC to the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 100-year life cycle. Design, construction management, and land acquisition costs are not included in the cost estimates. All costs are in 2019 dollars and are considered Level 5 cost estimates by AACE International with an accuracy of -50 percent to +100 percent.

8.6.e.1 Alternative NYB-1. Optimization of Outfalls RH-005 and RH-014

Costs for Alternative NYB-1 include planning-level estimates of the costs to optimize the performance of Regulator RH-20A associated with Outfall RH-005, and Regulator RH-13, associated with Outfall RH-014 and reflect the description provided in Section 8.6.a. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative NYB-1 is $6M as shown in Table 8.6-14.

Table 8.6-14. Costs for Alternative NYB-1

Item	2019 Cost ($ Million)
Probable Bid Cost	$6
Annual O&M Cost	$0
Net Present Worth	$6

8.6.e.2 Alternative NYB-2. Hannah Street Pumping Station Bypass

Costs for Alternative NYB-2 include planning-level estimates of the costs to construct a bypass connection for the flow in the Victory Boulevard combined sewer, to direct the dry-weather flow and a portion of the wet-weather flow directly to the East Interceptor by gravity, and reflects the description provided in Section 8.6.a. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative NYB-2 is $22M as shown in Table 8.6-15.

Table 8.6-15. Costs for Alternative NYB-2

Item	2019 Cost ($ Million)
Probable Bid Cost	$22
Annual O&M Cost	$0
Net Present Worth	$22

8.6.e.3 Alternative NBY-3. Control Gate for Regulator 9C, Outfall OH-015

Costs for Alternative NYB-3 include planning-level estimates of the costs to install a control gate in Regulator OH-9C associated with Outfall OH-015 and reflects the description provided in Section 8.6.a. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative NYB-3 is $23M as shown in Table 8.6-16.

Table 8.6-16. Costs for Alternative NYB-3

Item	2019 Cost ($ Million)
Probable Bid Cost	$5
Annual O&M Cost	$0.5
Net Present Worth	$23

8.6.e.4 Alternative NYB-4. Tunnel Storage for 25 Percent CSO Control

Costs for Alternative NYB-4 include planning-level estimates of the costs for a CSO storage tunnel sized for 25 percent CSO control. A description of the tunnel components is provided in Section 8.6.b and illustrated in Table 8.6-11. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative NYB-4 is $1,100M as shown in Table 8.6-17.

Table 8.6-17. Costs for Alternative NYB-4

Item	2019 Cost ($ Million)
Probable Bid Cost	$900
Annual O&M Cost	$5
Net Present Worth	$1,100

8.6.e.5 Alternative NYB-5. Tunnel Storage for 50 Percent CSO Control

Costs for Alternative NYB-5 include planning-level estimates of the costs for a CSO storage tunnel sized for 50 percent CSO control. A description of the optimization components is provided in Section 8.6.b and illustrated in Table 8.6-11. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative NYB-5 is $3,200M as shown in Table 8.6-18.

Table 8.6-18. Costs for Alternative NYB-5

Item	2019 Cost ($ Million)
Probable Bid Cost	$2,900
Annual O&M Cost	$9
Net Present Worth	$3,200

8.6.e.6 Alternative NYB-6. Tunnel Storage for 75 Percent CSO Control

Costs for Alternative NYB-6 include planning-level estimates of the costs for the CSO storage tunnel sized for 75 percent CSO control. A description of the optimization components is provided in Section 8.6.b and illustrated in Table 8.6-11. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative NYB-6 is $4,700M as shown in Table 8.6-19.

Table 8.6-19. Costs for Alternative NYB-6

Item	2019 Cost ($ Million)
Probable Bid Cost	$4,300
Annual O&M Cost	$13
Net Present Worth	$4,700

8.6.e.7 Alternative NBY-7. Tunnel Storage for 100 Percent CSO Control

Costs for Alternative NYB-7 include planning-level estimates of the costs for the two CSO storage tunnels sized for 100 percent CSO control. A description of the optimization components is provided in Section 8.6.b and illustrated in Table 8.6-11. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative NYB-7 is $9,100M as shown in Table 8.6-20.

Table 8.6-20. Costs for Alternative NYB-7

Item	2019 Cost ($ Million)
Probable Bid Cost	$8,500
Annual O&M Cost	$21
Net Present Worth	$9,100

The cost estimates of these retained alternatives are summarized below in Table 8.6-21 and are then used in the development of the cost-performance and cost-attainment plots presented in Section 8.6.f.

Table 8.6-21. Cost of Retained Alternatives – New York Bay

Alternative	PBC(1) ($ Million)	Annual O&M Cost ($ Million/Year)	Total Net Present Worth(2) ($ Million)
NYB-1. Optimization of Regulators Associated with Outfalls RH-005 and RH-014	$6	$0	$6
NYB-2. Hannah Street Pumping Station Bypass	$22	$0	$22
NYB-3. Real Time Control of Regulator 9C (Outfall OH-015)	$5	$0.5	$23
NYB-1, NYB-2, NYB-3 Combined	$33	$0.5	$51
NYB-4. Tunnel Storage for 25% CSO	$900	$5	$1,100

Table 8.6-21. Cost of Retained Alternatives – New York Bay

Alternative	PBC(1) ($ Million)	Annual O&M Cost ($ Million/Year)	Total Net Present Worth(2) ($ Million)
Control (22 MG Capacity)			
NYB-5. Tunnel Storage for 50% CSO Control (156 MG Capacity)	$2,900	$9	$3,200
NYB-6. Tunnel Storage for 75% CSO Control (253 MG Capacity)	$4,300	$13	$4,700
NYB-7. Tunnel Storage for 100% CSO Control (361 MG Capacity)	$8,500	$21	$9,100

Notes:
(1) The Probable Bid Cost (PBC) for the construction contract based upon 2019 dollars.
(2) The Net Present Worth (NPW) is based upon a 100-year service life for tunnels and is calculated by multiplying the annual O&M cost by a present worth of 31.599 and adding this value to the PBC.

8.6.f Cost-Benefit Curves for Retained Alternatives

The final step of the analysis is to evaluate the cost-effectiveness of the basin-wide retained alternatives based on their NPW and projected impact on CSO loadings and attainment of applicable WQS. Section 8.6.f.1 below presents plots of cost versus CSO volume and bacteria load reduction (Cost-Performance Curves), and Section 8.6.g below presents plots of cost versus percent attainment with WQS for selected points within New York Bay (Cost-Attainment Curves).

8.6.f.1 Cost-Performance Curves

Cost-performance curves were developed by plotting the costs of the retained alternatives against their predicted level of CSO control, both in terms of CSO volume reduction, and in bacteria load reduction. In each case, a best-fit cost curve was developed based on those alternatives judged most cost-effective for a defined level of CSO control as estimated by IW modeling for the typical year rainfall (2008).

Figure 8.6-12 presents a plot of CSO volume reduction versus NPW for the retained alternatives, while Figure 8.6-13 plots the cost of the alternatives against fecal coliform loading reductions.

8.6.g Cost-Attainment Curves

This section evaluates the relationship of the costs of the retained alternatives versus their expected level of attainment of bacteria Primary Contact WQ Criteria as modeled using the LTCPRM water quality model for the 10-year simulation. As indicated in Section 6, based on the 10-year WQ simulations for New York Bay, the Class SB WQ Criteria for fecal coliform and Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* 30-day geometric mean are both met at least 95 percent of the time under Baseline Conditions. Attainment of the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* 30-day STV ranges from about 50 to greater than 95 percent.

As a result, implementation of any of the retained alternatives described above, including the 100 percent CSO capture tunnel, results in nominal improvement in the percent attainment of the Class SB WQ Criteria for fecal coliform and Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* 30-day geometric mean.

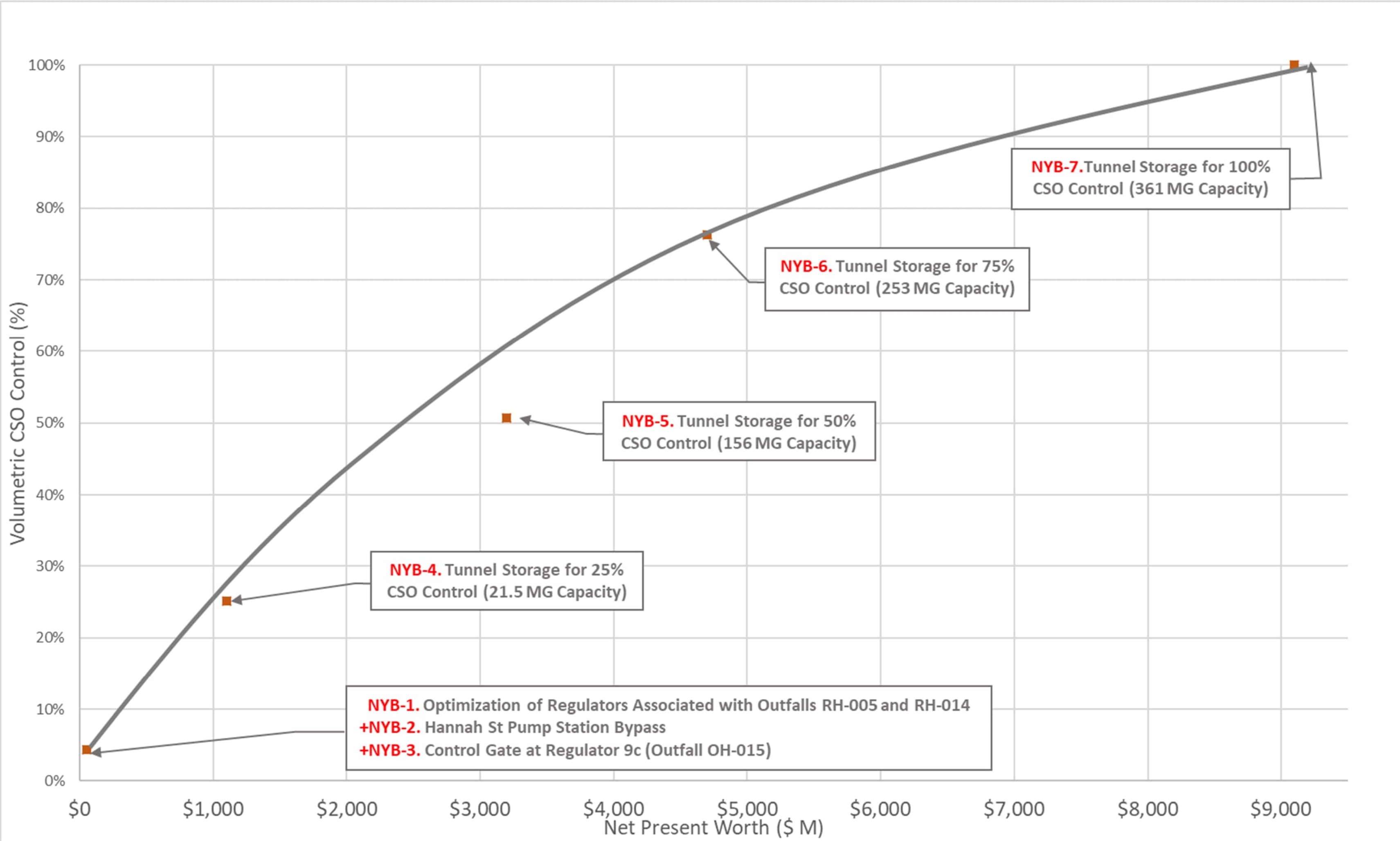

Figure 8.6-12. Cost vs. CSO Control – New York Bay (2008 Typical Year)

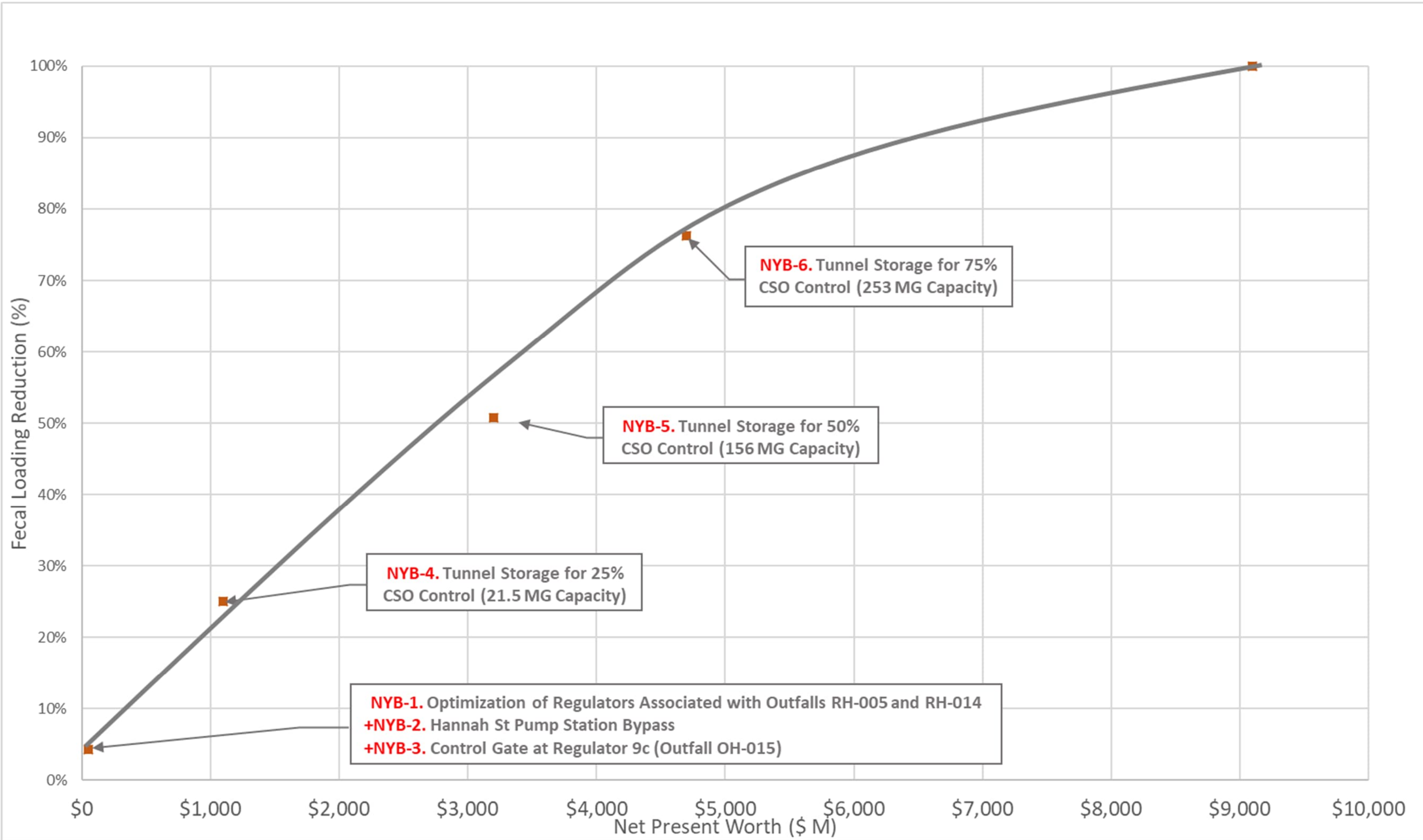

Figure 8.6-13. Cost vs. Fecal Coliform Load Reduction – New York Bay (2008 Typical Year)

Cost-attainment plots are presented below for three locations within New York Bay:

- LTCP sampling Station NB-4, located along the Brooklyn shoreline of New York Bay adjacent to the Owls Head WRRF (Figure 8.6-14).
- LTCP sampling Station NB-5, located west of Station NB-4, in Upper New York Bay approximately half way between the Brooklyn and Staten Island shorelines (Figure 8.6-15).
- LTCP sampling Station NB-6, located along the Brooklyn shoreline of Graves End Bay adjacent to Dyker Beach Park (Figure 8.6-16).

The locations of these stations are shown on Figure 8.6-23 below. The plots in Figure 8.6-14 to Figure 8.6-15 show NPW versus percent attainment with the Class SB WQ Criteria for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis, and the attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day geometric mean and STV, recreational season basis). In each of these three figures, the plots for attainment with the Class SB criteria for fecal coliform on an annual and recreational season basis, as well as the plots for attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day geometric mean) are generally superimposed on each other at a level of 100 percent.

These plots indicate that each of the retained alternatives represent essentially no performance improvement in terms of percent attainment with the Class SB WQ Criteria for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis, and the attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day geometric mean) at highly variable levels of cost, due to the 100 percent or near-100 percent level of attainment under Baseline Conditions. Attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day STV) throughout New York Bay would require the 50 percent level of CSO control, with an un-escalated PBC of $2,900M ($3,200M NPW).

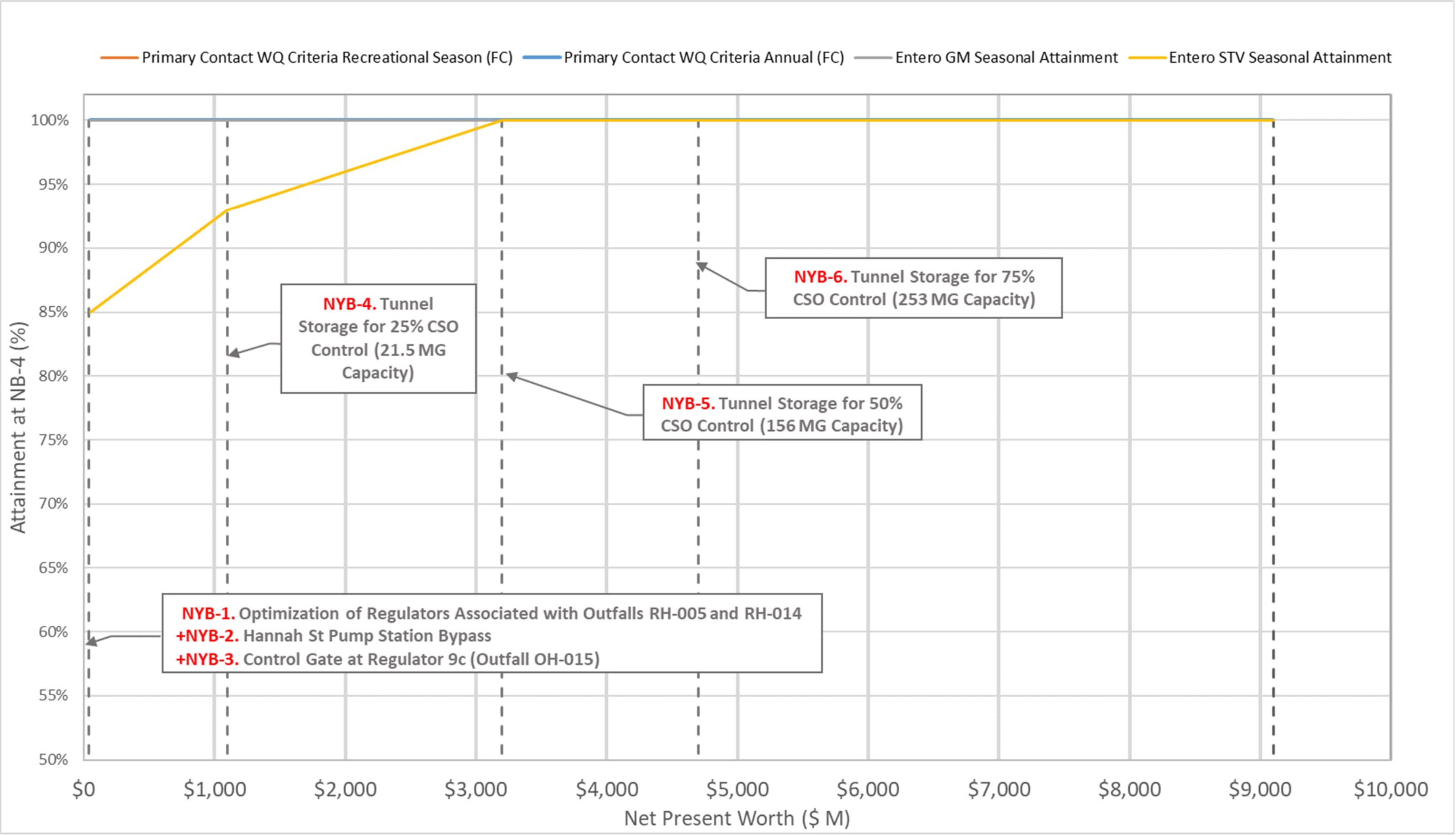

Figure 8.6-14. Cost vs. Bacteria Attainment at Class SB Coastal Primary Recreational Station NB-4

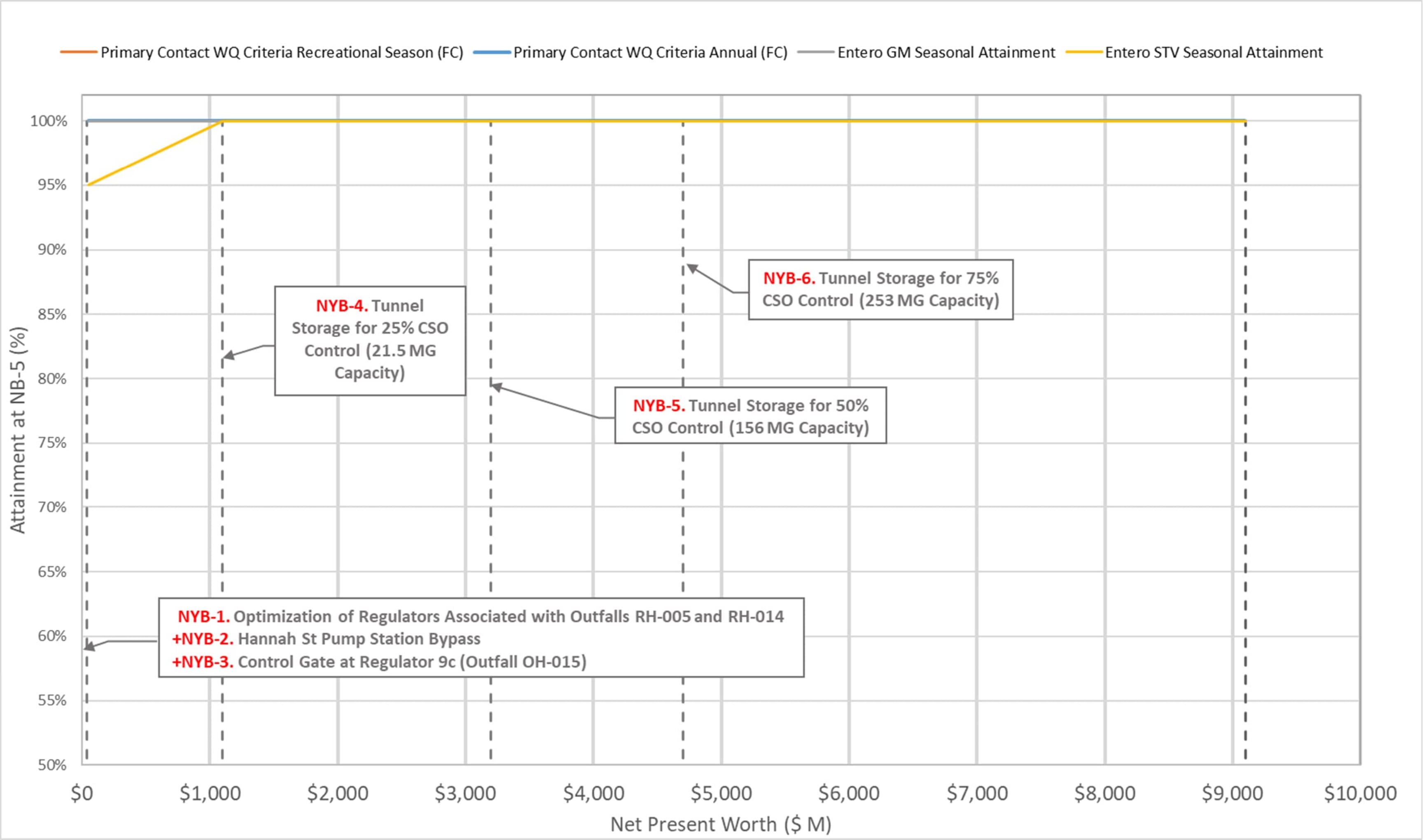

Figure 8.6-15. Cost vs. Bacteria Attainment at Class SB Coastal Primary Recreational Station NB-5

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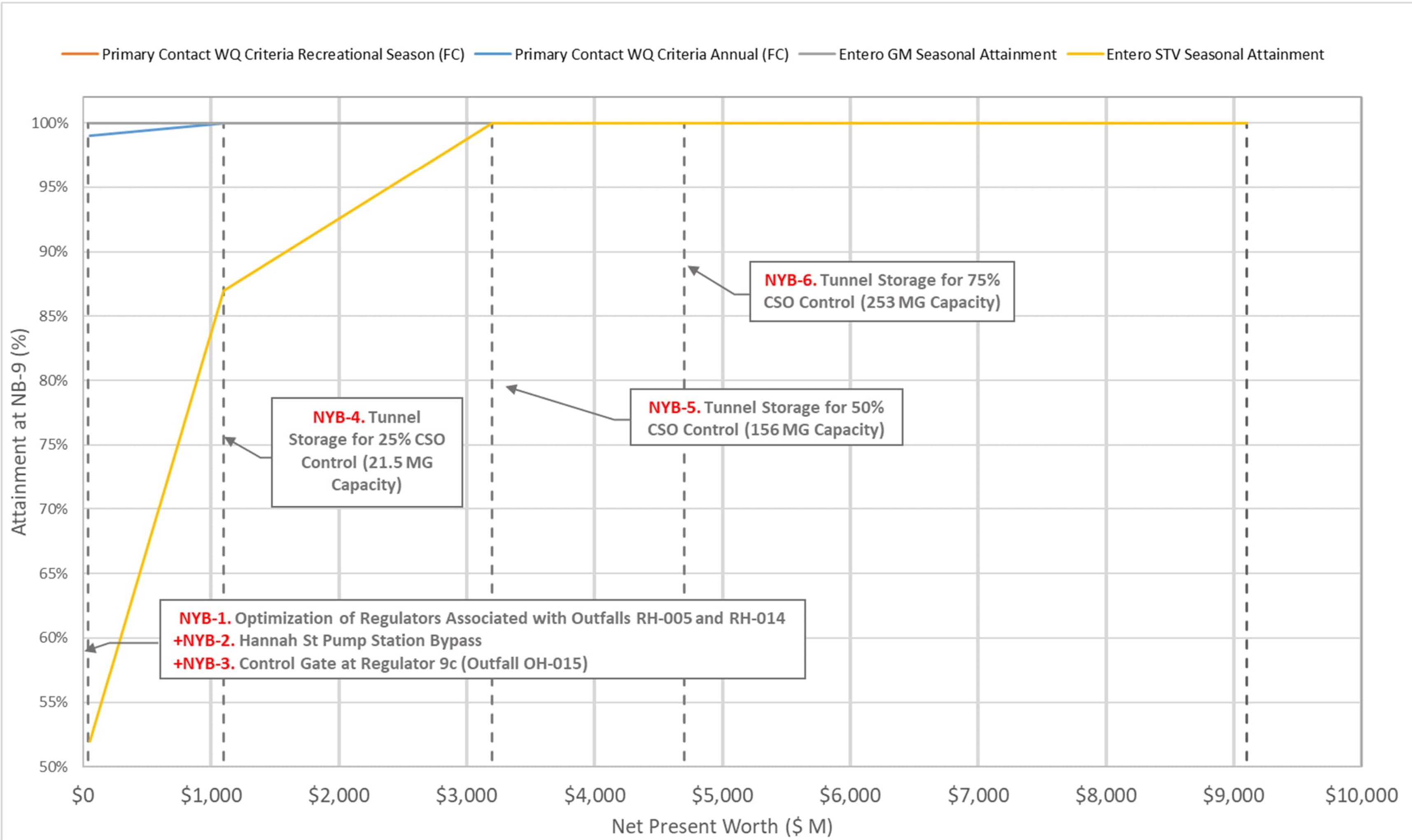

Figure 8.6-16. Cost vs. Bacteria Attainment at Class SB Coastal Primary Recreational Station NB-9

8.6.h Conclusion on Preferred Alternative

The selection of the preferred alternative for New York Bay is based on multiple considerations including public input, environmental and water quality benefits, and projected costs. However, as described above and in Section 6, New York Bay is achieving Class SB fecal coliform WQ criteria, and Class SB Coastal Primary Recreational *Enterococci* WQ 30-day geometric mean criteria greater than 95 percent of the time under Baseline Conditions. The CSO storage tunnel alternatives would provide a range of levels of CSO reduction to New York Bay, but the costs associated with those alternatives are very high. The 50 percent CSO control tunnel would generally achieve attainment with the Class SB Coastal Primary Recreational *Enterococci* WQ 30-day STV criteria throughout New York Bay, but at an un-escalated PBC of $2,900M. Those high-cost alternatives would not substantially change the level of the other applicable WQ criteria for bacteria. Section 9 presents affordability issues and impacts on disadvantaged communities that would come into play if the CSO program costs were to further significantly increase. Also, as presented below in the discussion of time to recovery, the duration of impacts of wet-weather events in New York Bay is short. For these reasons, the CSO storage tunnel alternatives are not recommended.

All three of the optimization alternatives carried forward in the evaluation, NYB-1, NYB-2, and NYB-3, were selected for inclusion in the Recommended Plan. Implementation is projected to reduce net CSO volumes by 132 MGY during the typical year at a PBC of $33M. These projected costs do not include costs for land acquisition, design, and construction management. Alternative NYB-1 consists of modifying the weir at Regulator RH-020A (CSO RH-005), and modifying the weir, increasing the regulator orifice opening, and enlarging the branch interceptor connection at Regulator RH-13 (CSO RH-014). Alternative NYB-2 consists of installing a diversion connection on the Victory Boulevard combined sewer upstream of Regulator 17 (CSO PR-013). This connection would divert dry-weather flow and a portion of the wet-weather flow directly to the East Interceptor by gravity. Alternative NYB-3 consists of installing a control gate in Regulator 9C (CSO OH-015), to keep more wet-weather flow in the upper of the two combined sewer conduits entering the regulator.

In summary, the following conclusions can be drawn from these analyses:

1. Under Baseline Conditions, attainment with the Class SB WQ Criteria for fecal coliform is projected to be 100 percent at all New York Bay Stations annually and during the recreation season (May 1st through October 31st), while attainment with the Class SB WQ Criteria for DO is greater than 99 percent at all stations within New York Bay with the exception of an area off the southwestern tip of Staten Island. DO attainment at that location is not affected by NYC CSOs.
2. Under Baseline Conditions, the Class SB Coastal Primary Recreational *Enterococci* GM criteria attainment is projected to be in the 99 to 100 percent range, while the Class SB Coastal Primary Recreational *Enterococci* STV criteria attainment is projected to be in the 50 to 100 percent range.
3. The most cost-effective alternative, based on the KOTC analysis approach, consistent with EPA’s CSO Control Policy is a combination of Alternatives NYB-1, NYB-2, and NYB-3.
4. The PCM will document the WQ improvements upon implementation of these projects.
5. While the annual volume of CSO remaining in New York Bay is acknowledged to remain relatively high, the time to recovery analysis presented further below demonstrates that the duration of impact of the remaining CSOs is low.

Figure 8.6-17 presents a mosaic of the level of attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day geometric mean) in New York Bay, on a recreational season (May 1st through October 31st) basis, for the Recommended Plan. Figure 8.6-18 presents a mosaic of the level of attainment with the Class SB Coastal Primary Recreational WQ Criteria for *Enterococci* (30-day STV) in New York Bay, on a recreational season (May 1st through October 31st) basis, for the Recommended Plan. Figure 8.6-19 presents a mosaic of the level of attainment with the Class SB WQ Criteria for fecal coliform in New York Bay, on an annual basis, for the Recommended Plan, and Figure 8.6-20 presents the level of attainment in the recreational season (May 1st through October 31st). Figure 8.6-21 presents the level of attainment with the Existing WQ Criteria for DO (acute) on an average annual basis, and Figure 8.6-22 presents the level of attainment with the Existing WQ Criteria for DO (chronic) on an average annual basis.

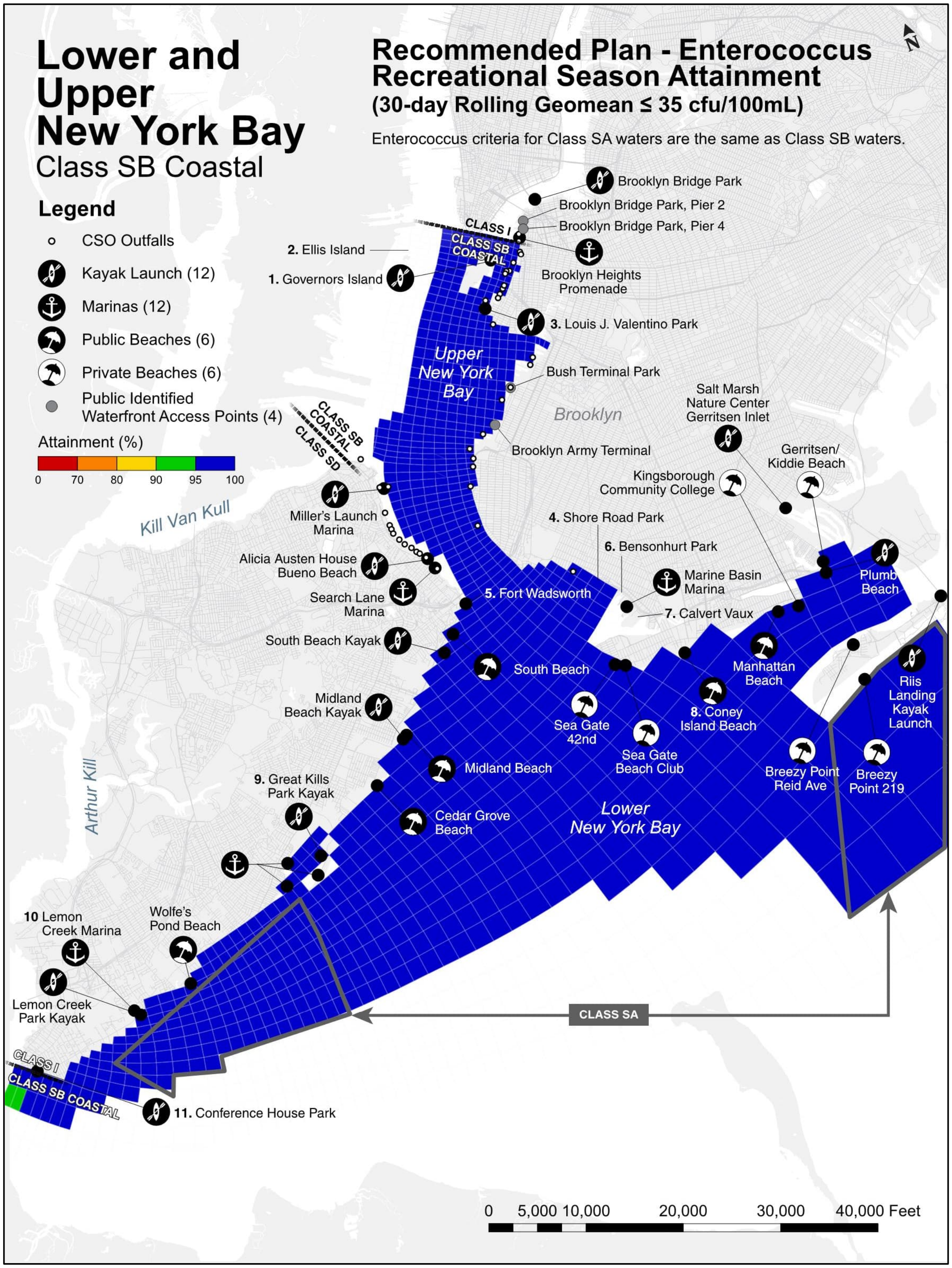

Figure 8.6-17. *Enterococci* Class SB Coastal Primary Recreational GM Attainment (10-year Runs) – New York Bay, Recommended Plan

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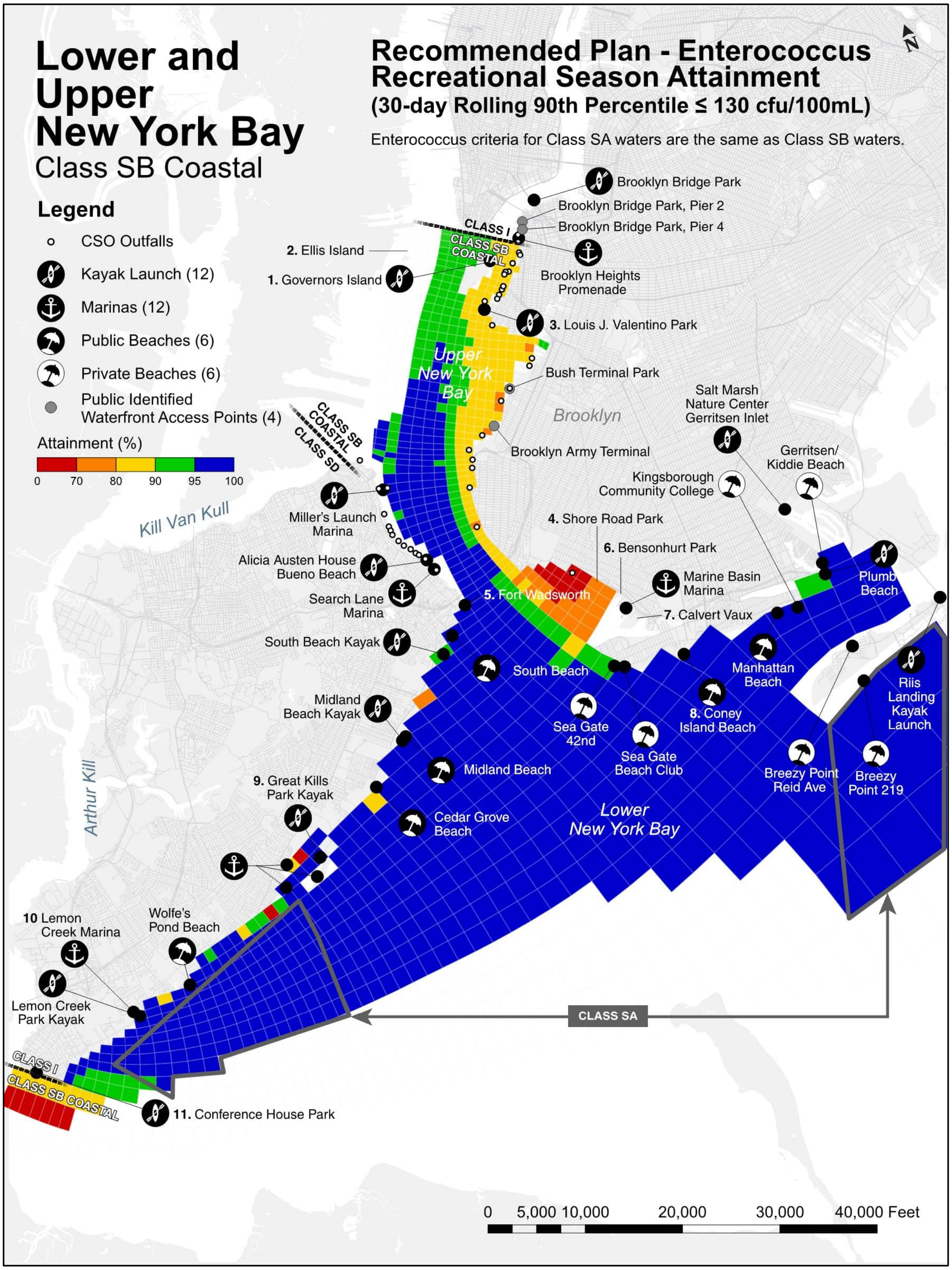

Figure 8.6-18. *Enterococci* Class SB Coastal Primary Recreational STV Attainment (10-year Runs) – New York Bay, Recommended Plan

AECOM with Hazen

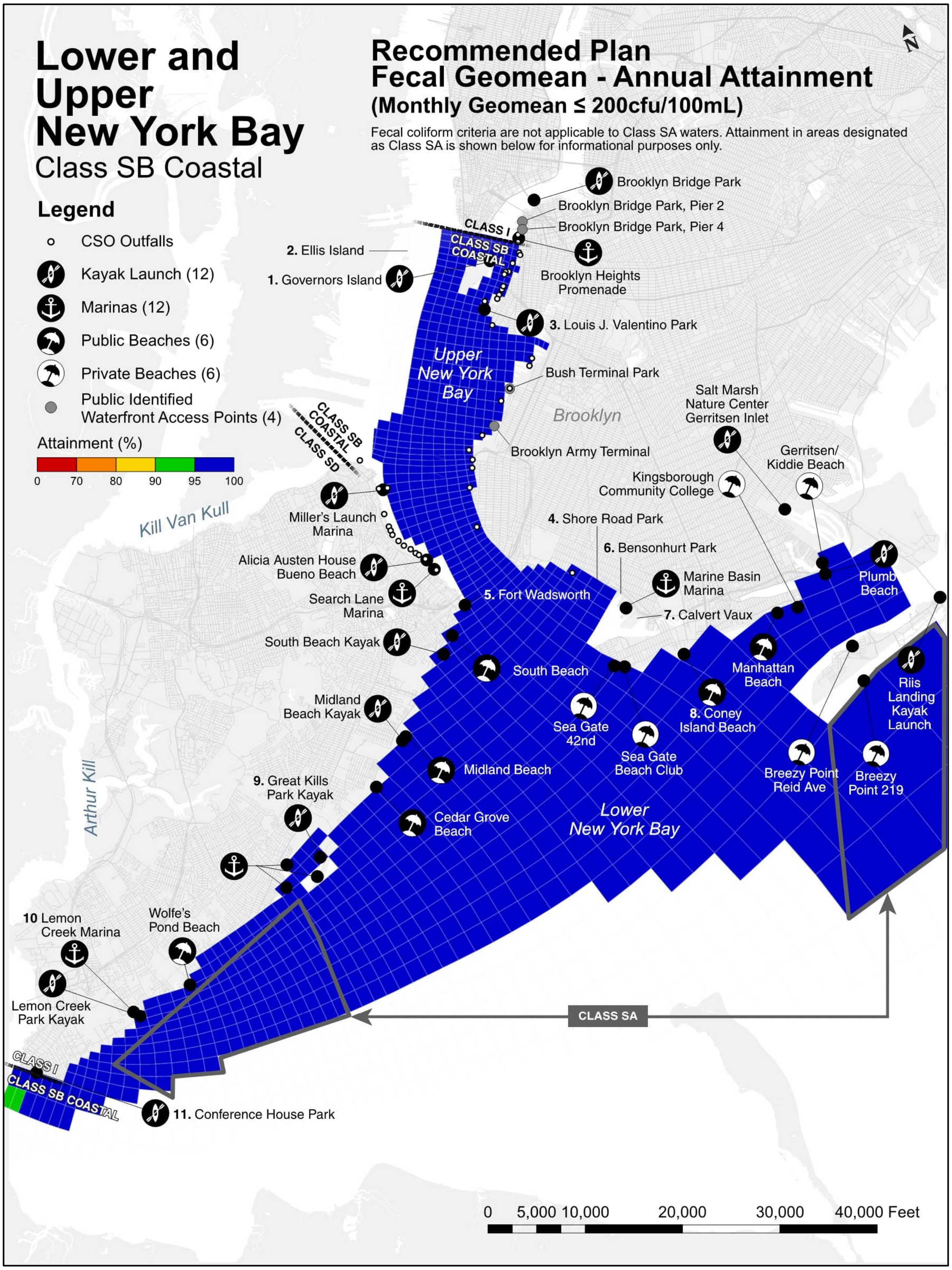

Figure 8.6-19. Fecal Coliform Class SB - Annual Attainment (10-year Runs), New York Bay, Recommended Plan

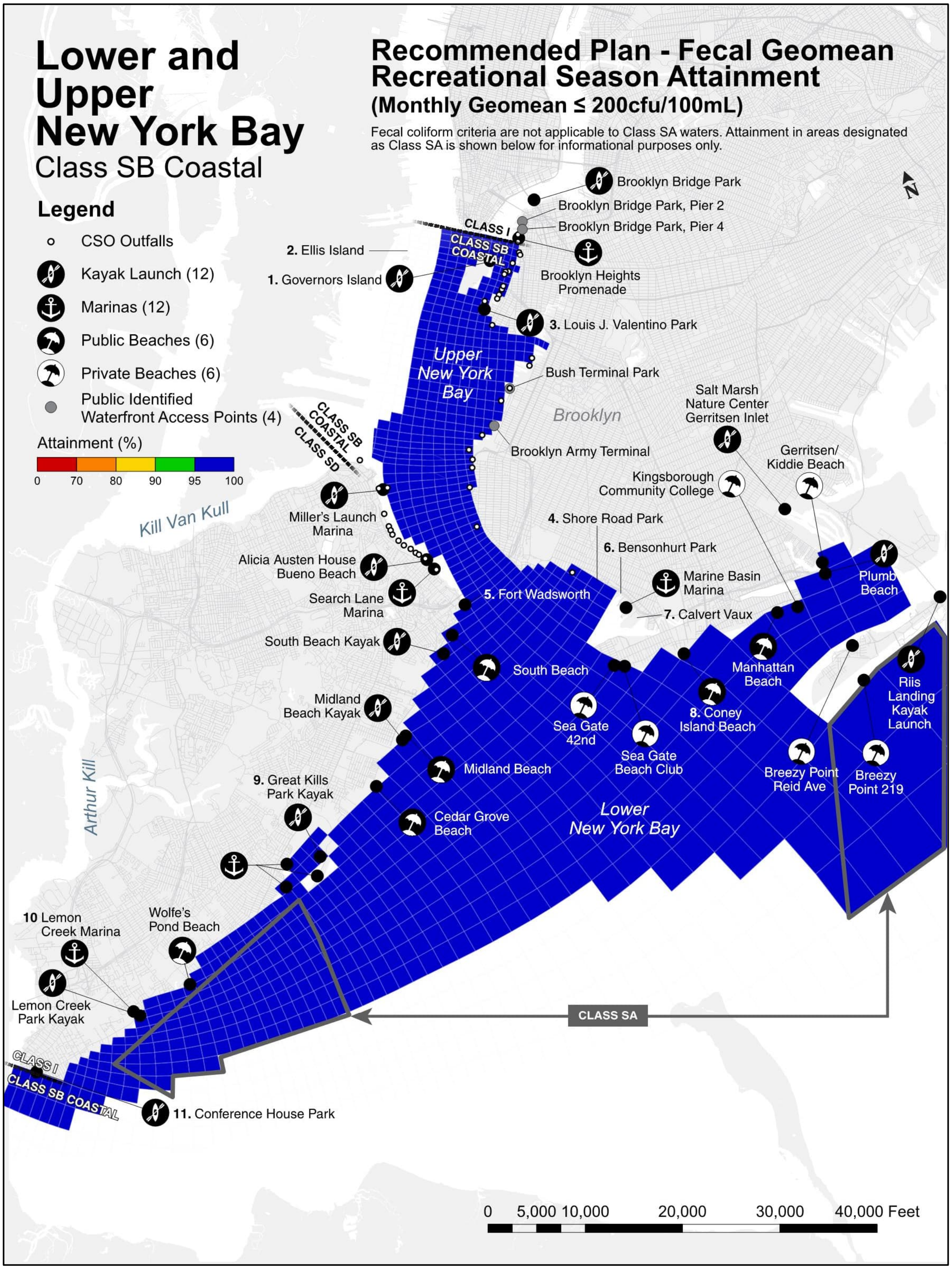

Figure 8.6-20. Fecal Coliform Class SB – Recreational Season Attainment (10-year Runs), Recommended Plan

AECOM with Hazen

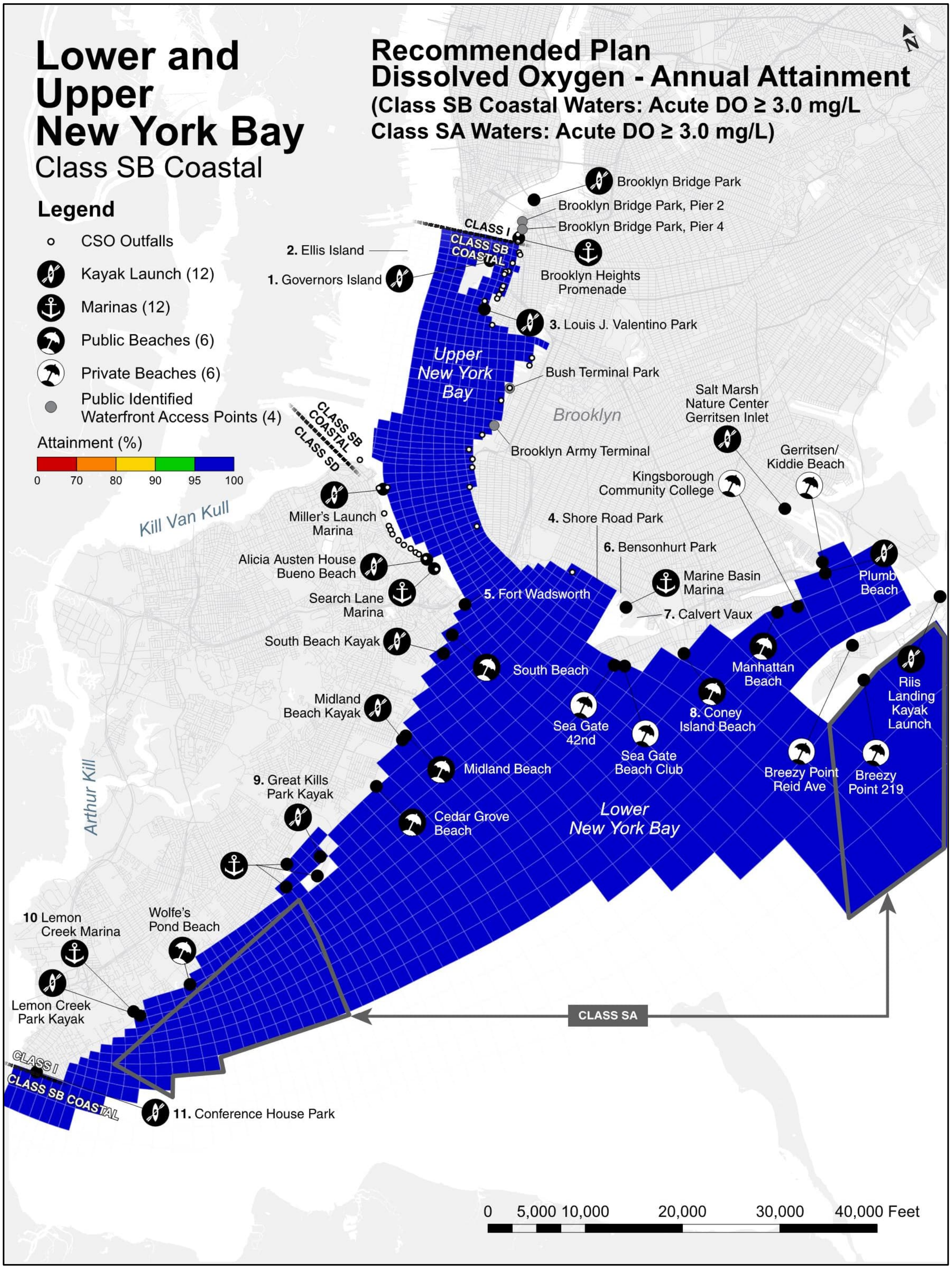

Figure 8.6-21. DO Class SB Acute Criteria - Annual Attainment (2008 Typical Year), New York Bay, Recommended Plan

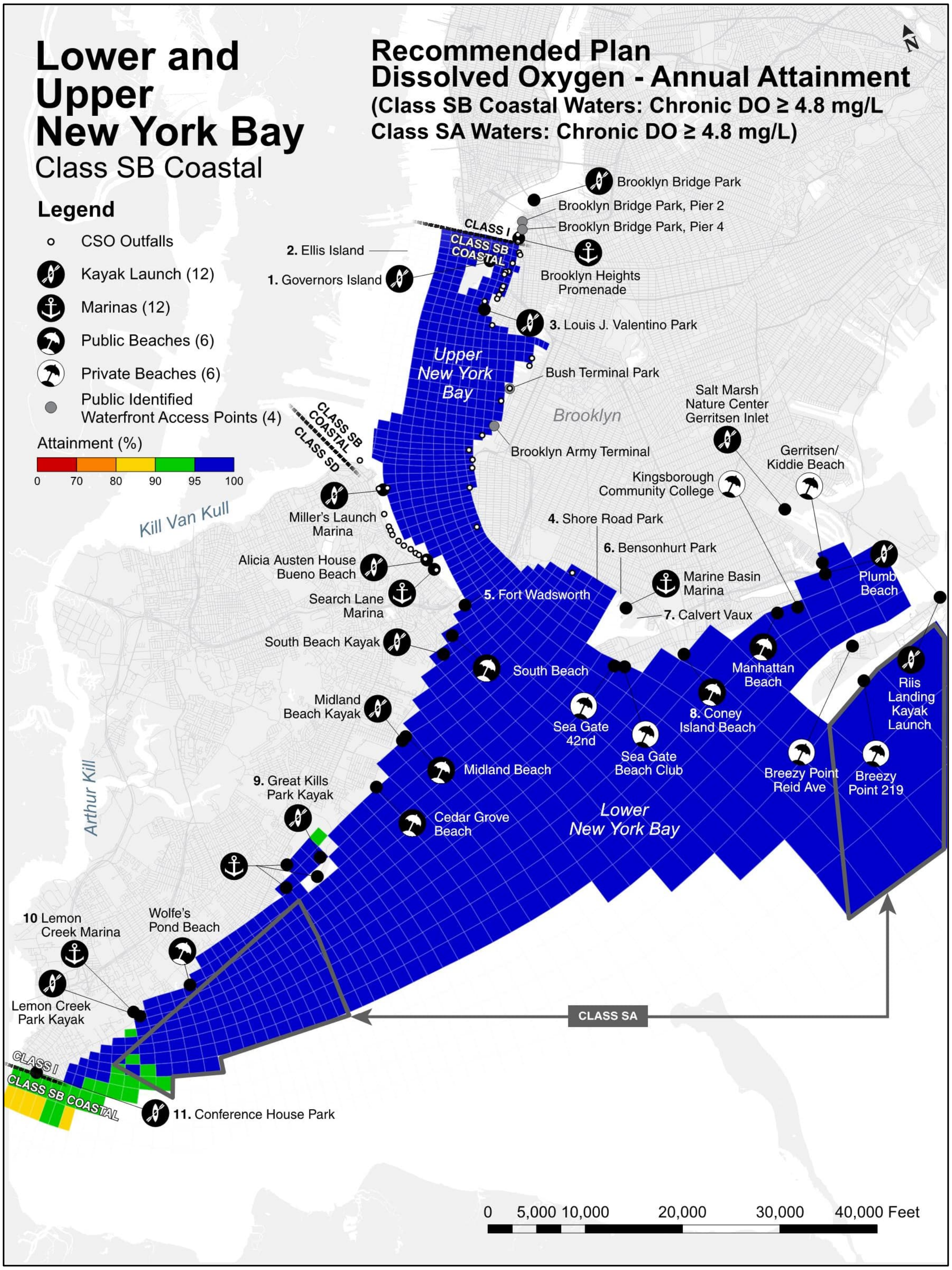

Figure 8.6-22. DO Class SB Chronic Criteria - Annual Attainment (2008 Typical Year), Recommended Plan

Table 8.6-22 presents the *Enterococci* maximum 30-day geometric mean and STV, and the percent of time that the *Enterococci* criteria would be attained for the recreational season (May 1st through October 31st), for the 10-year simulation period, within the Class SB Coastal Primary Recreational waters of New York Bay, with the Recommended Plan. The locations of the stations and supplemental model output locations listed in Table 8.6-22 are shown on Figure 8.6-23. As indicated in Table 8.6-22, compliance of the Recommended Plan with the *Enterococci* 30-day geometric mean criteria would be greater than 95 percent throughout New York Bay. Compliance with the *Enterococci* 30-day STV criteria would be above 95 percent in portions of the Bay, but along the Brooklyn shoreline the compliance would be less than 95 percent, with a low of about 50 percent in Gravesend Bay. Another pocket of low attainment with the *Enterococci* STV criteria is located off the southwest tip of Staten Island. This location is affected primarily by loads from outside of NYC, and is not affected by NYC CSOs.

Table 8.6-22. Model Calculated 10-Year *Enterococci* Maximum 30-day GM and STV and Percent Attainment of Class SB Coastal Primary Recreational WQ Criteria for New York Bay, Recommended Plan

Station	Maximum Recreational Season(1) 30-day *Enterococci* (cfu/100mL)		10 Year Percent Attainment Recreational Season(1)	
	GM	90th Percentile STV	30-Day GM <35 cfu/100mL	30-Day STV <130 cfu/100mL
New York Bay (Class SB Coastal Primary Recreational)				
NB-1	40	555	99.7%	85%
NB-2	36	464	100%	90%
NB-3	39	595	99.8%	85%
NB-4	40	647	99.7%	85%
NB-5	34	366	100%	95%
NB-6	33	290	100%	96%
NB-7	37	772	99.8%	84%
NB-8	29	278	100%	97%
NB-9	52	3619	99.5%	52%
NB-10	10	134	100%	99%
NB-11	13	166	100%	98%
NB-12	13	128	100%	100%
K5A	119	1,417	97%	67%
J11	10	363	100%	91%
N9A	6	55	100%	100%

Table 8.6-22. Model Calculated 10-Year *Enterococci* Maximum 30-day GM and STV and Percent Attainment of Class SB Coastal Primary Recreational WQ Criteria for New York Bay, Recommended Plan

Station	Maximum Recreational Season(1) 30-day *Enterococci* (cfu/100mL)		10 Year Percent Attainment Recreational Season(1)	
	GM	90th Percentile STV	30-Day GM <35 cfu/100mL	30-Day STV <130 cfu/100mL
New York Bay (Class SB Coastal Primary Recreational)				
Governors Island	1	1	100%	100%
Louis Valentino Park	41	535	99.7%	87%
Search Lane Marina	33	323	100%	97%
Marine Basin Marina	28	875	100%	76%
Sea Gate Beach Club/42nd	26	392	100%	94%
Coney Island Beach	12	185	100%	98%
Manhattan Beach/ Kingsborough Community College Beach	7	83	100%	100%
Gerritson/Plumb Beach	8	281	100%	97%
Riis Landing Kayak Launch	5	47	100%	100%
Breezy Point Reid Ave. Beach	6	60	100%	100%
Breezy Point 219	2	8	100%	100%
Millers Launch Marina	36	346	99.9%	96%
Alice Austen House Buono Beach	33	323	100%	97%
South Beach Kayak/Midland Beach	11	126	100%	100%
Cedar Grove Beach	8	98	100%	100%
Great Kills Park Kayak	1	1	100%	100%
Wolf's Pond Beach	23	257	100%	97%
Lemon Creek Marina/Kayak	23	257	100%	97%

Note:
(1) The recreational season is from May 1st through October 31st.

Figure 8.6-23. Sampling Stations and Supplemental Model Output Locations on New York Bay

AECOM with Hazen

Table 8.6-23 presents the fecal coliform maximum monthly geometric mean, and the percent of time that the fecal coliform WQ criteria would be attained on an annual basis and for the recreational season (May 1st through October 31st), for the 10-year simulation period, within the Class SB waters of New York Bay, with the Recommended Plan. The locations of the stations listed in Table 8.6-23 are shown on Figure 8.6-23, along with the waterbody access locations. As indicated in Table 8.6-23, annual and recreational season (May 1st through October 31st) compliance for the Recommended Plan would be at least 95 percent for New York Bay, with most parts of the Bay being at 100 percent.

Table 8.6-23. Model Calculated 10-Year Fecal Coliform Maximum Monthly GM and Percent Attainment with Fecal Coliform WQ Criteria, Annual and Recreational Season, New York Bay, Recommended Plan

	Maximum Monthly Fecal Coliform GMs (cfu/100mL)		% Attainment (GM ≤200 cfu/100mL)	
Description	Annual	Recreational Season(1)	Annual	Recreational Season(1)
New York Bay (Class SB)				
NB-1	169	105	100%	100%
NB-2	164	97	100%	100%
NB-3	156	103	100%	100%
NB-4	159	106	100%	100%
NB-5	152	87	100%	100%
NB-6	146	84	100%	100%
NB-7	152	99	100%	100%
NB-8	122	68	100%	100%
NB-9	208	145	99%	100%
NB-10	66	26	100%	100%
NB-11	74	31	100%	100%
NB-12	81	25	100%	100%
K5A	276	134	95%	100%
J11	49	19	100%	100%
N9A	30	11	100%	100%
Governors Island	1	1	100%	100%
Louis Valentino Park	168	104	100%	100%
Search Lane Marina	142	80	100%	100%
Marine Basin Marina	160	90	100%	100%
Sea Gate Beach Club/42nd	117	63	100%	100%
Coney Island Beach	70	24	100%	100%
Manhattan Beach/ Kingsborough Community	39	14	100%	100%

Table 8.6-23. Model Calculated 10-Year Fecal Coliform Maximum Monthly GM and Percent Attainment with Fecal Coliform WQ Criteria, Annual and Recreational Season, New York Bay, Recommended Plan

	Maximum Monthly Fecal Coliform GMs (cfu/100mL)		% Attainment (GM ≤200 cfu/100mL)	
Description	**Annual**	**Recreational Season(1)**	**Annual**	**Recreational Season(1)**
College Beach				
Gerritson/Plumb Beach	39	17	100%	100%
Riis Landing Kayak Launch	29	12	100%	100%
Breezy Point Reid Ave. Beach	30	12	100%	100%
Breezy Point 219	11	2	100%	100%
Millers Launch Marina	148	85	100%	100%
Alice Austen House Buono Beach	142	80	100%	100%
South Beach Kayak/Midland Beach	82	39	100%	100%
Cedar Grove Beach	63	21	100%	100%
Great Kills Park Kayak	1	1	100%	100%
Wolf's Pond Beach	103	30	100%	100%
Lemon Creek Marina/Kayak	98	26	100%	100%

Note:
(1) The recreational season is from May 1st through October 31st.

The average annual attainment of the Existing WQ Criterion for DO (Class SB) for the entire water column is presented for the Recommended Plan in Table 8.6-24. As indicated in Table 8.6-24, the Existing WQ Criterion for DO (Class SB) are predicted to be attained at all stations in New York Bay for the Recommended Plan.

As discussed in Section 6, analysis of attainment of Class SB DO criteria are complex because the standard allows for excursions from the daily average limit of 4.8 mg/L for a limited number of consecutive calendar days. To simplify the analysis, attainment was based solely upon attainment of the daily average without the allowed excursions. The results indicate 99 to 100 percent attainment of the acute criterion (never less than 3.0 mg/L) and the chronic criterion (greater than or equal to 4.8 mg/L) for all stations within New York Bay except for Station K5A, located off the southwestern tip of Staten Island. As noted above, this location is affected primarily by loads from outside of NYC, and is not affected by NYC CSOs.

Table 8.6-24. Model Calculated (2008) Recommended Plan DO Percent Attainment of Existing Class SB and I WQ Criteria

New York Bay (Class SB Coastal Primary Contact Recreational)		
Station	**Acute (≥ 3.0 mg/L)**	**Chronic (≥ 4.8 mg/L)**
NB-1	100%	100%
NB-2	100%	100%
NB-3	100%	100%
NB-4	100%	100%
NB-5	100%	100%
NB-6	100%	100%
NB-7	100%	100%
NB-8	100%	100%
NB-9	100%	100%
NB-10	100%	100%
NB-11	100%	100%
NB-12	100%	99%
K5A	98%	89%
J11	100%	100%
N9A	100%	100%

Recap

The key components of the Recommended Plan include:

- NYB-1 - modifying the weir at Regulator RH-020A (CSO RH-005), increasing the regulator orifice opening, and enlarging the branch interceptor connection at Regulator RH-13 (CSO RH-014).
- NYB-2 - installing a diversion connection on the Victory Boulevard combined sewer upstream of Regulator 17 (CSO PR-013). This connection would divert dry-weather flow and a portion of the wet-weather flow directly to the East Interceptor by gravity.
- NYB-3 - installing a control gate in Regulator 9C (CSO OH-015), to keep more wet-weather flow in the upper of the two combined sewer conduits entering the regulator.

The implementation of these elements is predicted to result in a reduction of 142 MGY of CSO to New York Bay (132 MGY overall net reduction of CSO to Citywide/Open Waters waterbodies), with a PBC of $33M. The proposed schedule for the implementation of the Recommended Plan is presented in Section 9.2.

With the Recommended Plan, New York Bay will be in at least 95 percent attainment of the Class SB WQ Criteria for fecal coliform and the Class SB Coastal Primary Recreational Enterococci 30-day geometric mean criteria. All areas except for the area in the vicinity of Station K5A, off the southwestern tip of Staten Island, will be in attainment with the Class SB WQ Criteria for DO. Parts of New York Bay will be in attainment with the Class SB Coastal Primary Recreational *Enterococci* 30-day STV, but along the Brooklyn shoreline and in the vicinity of Station K5A, the compliance would be less than 95 percent, with a low of about 50 percent in Graves End Bay.

8.6.i Use Attainability Analysis

The CSO Order requires that a UAA be included in an LTCP "where existing WQS do not meet the Section 101(a)(2) goals of the CWA, or where the proposed alternative set forth in the LTCP will not achieve existing WQS or the Section 101(a)(2) goals." The UAA shall "examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State." The UAA process specifies that States can remove a designated use that is not an existing use if the scientific assessment can demonstrate that attaining the designated use is not feasible for at least one of six reasons:

1. Naturally occurring loading concentrations prevent the attainment of the use; or
2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or
5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

As part of the LTCP, elements of a UAA, including the six conditions presented above, will be used to determine if changes to the designated use are warranted, considering a potential adjustment to the designated use classification as appropriate.

As noted in previous sections, with the implementation of the Recommended Plan, parts of New York Bay along the Brooklyn shoreline and in the vicinity of Station K5A will achieve less than 95 percent compliance with the Class SB Coastal Primary Recreation *Enterococci* 30-day STV criteria, and parts of

New York Bay in the vicinity of Station K5A will achieve less than 95 percent compliance with the Class SB DO criteria. Therefore, a Use Attainability Analysis is needed for New York Bay.

8.6.i.1 Use Attainability Analysis Elements

The objectives of the CWA include providing for the protection and propagation of fish, shellfish, wildlife, and recreation in and on the water. Cost-effectively maximizing the water quality benefits associated with CSO reduction is a cornerstone of this LTCP.

To simplify this process, DEP and DEC have developed a framework that outlines the steps taken under the LTCP in two possible scenarios:

1. Waterbody meets WQ requirements. This may either be the existing WQS (where primary contact is already designated) or for an upgrade to the Primary Contact WQ Criteria (where the existing standard is not a Primary Contact WQ Criteria). In either case, a high-level assessment of the factors that define a given designated use is performed, and if the level of CSO control required to meet this goal can be reasonably implemented, a change in designation may be pursued following implementation of CSO controls and Post-Construction Compliance Monitoring.

2. Waterbody does not meet WQ requirements. In this case, if a higher level of CSO control is not feasible, the UAA must justify the shortcoming using at least one of the six criteria (see Section 8.6.i above). It is assumed that if 100 percent elimination of CSO sources does not result in attainment, the UAA would include factor number 3 at a minimum as justification (human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied, or would cause more environmental damage to correct than to leave in place).

As indicated in Table 8.6-22 and Table 8.6-24, the modeled attainment of the Class SB Coastal Primary Recreational *Enterococci* STV criteria and the Class SB DO criteria will not be fully achieved upon implementation of the LTCP Recommended Plan. Implementation of the plan will lead to Class SB WQ Criteria for fecal coliform, and Class SB Coastal Primary Recreational *Enterococci* geometric mean criteria being fully attained throughout the waterbody. Future revisions of the New York Bay WQ classification should await completion of construction of the preferred alternative and the results of the Post-Construction Compliance Monitoring.

8.6.j Fishable/Swimmable Waters

The goal of this LTCP is to identify appropriate CSO controls necessary to achieve waterbody-specific WQS, consistent with EPA's CSO Control Policy and subsequent guidance. DEC considers that compliance with Class SB Coastal Primary Recreational WQS, the current classification for New York Bay, as fulfillment of the CWA's fishable/swimmable goal.

The preferred alternative summarized in Section 8.6.h results in the levels of attainment with fishable/swimmable criteria as follows:

- For the 10-year continuous simulation, summarized in Table 8.6-22, attainment of the Class SB Coastal Primary Recreational *Enterococci* STV criteria is not predicted to be met for the recreational season (May 1st through October 31st).

- Based on the 2008 typical year simulations, as summarized in Table 8.6-24, the preferred alternative would not achieve full attainment of the Class SB DO criteria on an annual average basis.

8.6.k Assessment of Highest Attainable Use

The 2012 CSO Order Goal Statement stipulates that, in situations where the proposed alternatives presented on the LTCP will not achieve the CWA Section 101(a)(2) goals, the LTCP will include a UAA. Because the analyses developed herein indicate that New York Bay is not projected to fully attain the Class SB Coastal Primary Recreational *Enterococci* STV criteria or the Class SB DO criteria, a UAA is required under the 2012 CSO Order. Table 8.6-25 summarizes the compliance for the identified plan.

Table 8.6-25. Recommended Plan Compliance with Water Quality Criteria

Compliance with Class SB Fecal Coliform Criteria 10-year Simulation(1)		Compliance with Class SB Coastal Primary Recreational *Enterococci* Criteria 10-year Simulation(1)		Compliance with Class SB DO Criteria 2008 Typical Year(1)	
Annual	**Recreational Season(2)**	**Recreational Season(2)**		**Annual**	
Monthly GM (≤ 200 mg/L)	**Monthly GM (≤ 200 mg/L)**	**30-day Rolling GM (≤ 35 mg/L)**	**30-day Rolling STV (≤ 130 mg/L)**	**Acute (≥ 3.0 mg/L)**	**Chronic (≥ 4.8 mg/L)**
95-100%	100%	97-100%	52-100%	99-100%	89-100%

Notes:

(1) Range of attainment based on Table 8.6-22 to Table 8.6-24 above.

(2) Recreational season is from May 1st through October 31st.

8.6.l Time to Recovery

As noted above, New York Bay is a Class SB Coastal Primary Recreational waterbody. The applicable Water Quality Criteria for bacteria for this waterbody include monthly and 30-day geometric mean criteria. However, to gain insight into the shorter-term impacts of wet-weather sources of bacteria, DEP has performed an analysis to assess the amount of time following the end of a rainfall event required for New York Bay to recover and return to fecal coliform concentrations less than 1,000 cfu/100mL.

The analyses consisted of examining the WQ model calculated bacteria concentrations in New York Bay for recreational season (May 1st through October 31st) abstracted from 10 years of model simulations. For New York Bay, the JFK Airport rainfall data was compared against water quality model bacteria results for the 10 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. The chosen target threshold concentration was 1,000 cfu/100mL for fecal coliform. The various rainfall events were then placed into rain event size "bins" ranging from less than 0.1 inch to greater than 1.5 inches. Only rain events that reached the target threshold concentrations before the beginning of the next storm were included. The median time to recovery for each bin at each water quality station was calculated. Table 8.6-26 presents the median time to recovery for the Recommended Plan for New York Bay. Results are presented for the greater than 1.0 to 1.5 inch rainfall bin, which includes the 90th percentile event.

DEC has advised that it seeks to have a time to recovery of less than 24 hours, and this target has been consistent in the previously approved LTCPs. As indicated in Table 8.6-26, for the Recommended Plan, all of the stations assessed except for NB-7 and NB-9 had median time to recovery of zero hours, indicating that the fecal coliform concentration never reached the level of 1,000 cfu/100mL at the referenced station for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed. Times to recovery for Stations NB-7 and NB-9 were eight hours or less.

Table 8.6-26. New York Bay Time to Recovery, Fecal Coliform, Recommended Plan

Location	Median Time to Recovery (hours) Fecal Coliform Threshold (1,000 cfu/100mL)(1)
New York Bay (Class SB Coastal Primary Contact Recreational)	
NB-1	0(2)
NB-2	0
NB-3	0
NB-4	0
NB-5	0
NB-6	0
NB-7	4
NB-8	0
NB-9	8
NB-10	0
NB-11	0
NB-12	0
K5A	0
J11	0
N9A	0
Governors Island	0
Louis Valentino Park	0
Search Lane Marina	0
Marine Basin Marina	0
Sea Gate Beach Club/42nd	0
Coney Island Beach	0
Manhattan Beach/	0
Gerritson/Plumb Beach	0
Riis Landing Kayak Launch	0
Breezy Point Reid Ave. Beach	0
Breezy Point 219	0
Millers Launch Marina	0
Alice Austen House Buono Beach	0

Table 8.6-26. New York Bay Time to Recovery, Fecal Coliform, Recommended Plan

Location	Median Time to Recovery (hours) Fecal Coliform Threshold (1,000 cfu/100mL)(1)
South Beach Kayak/Midland	0
Cedar Grove Beach	0
Great Kills Park Kayak	0
Wolf's Pond Beach	0
Lemon Creek Marina/Kayak	0

Notes:
(1) Median time to recovery values presented for storms from the 10-year simulation, recreational seasons, in the size range of >1.0 to 1.5-inches of rainfall, which includes the 90th percentile rain event.
(2) Median time to recovery of "0" means that the average concentration across the water column never reached the 1,000 cfu/100mL threshold at the referenced station for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

A similar analysis was conducted to assess time to recovery to an *Enterococci* concentration of 130 cfu/100mL, corresponding to the STV criterion for Class SB coastal primary contact recreational waters. The results of that analysis for the Recommended Plan are presented in Table 8.6-27. As indicated in Table 8.6-27, for the Recommended Plan, the highest median time to recovery for the stations assessed was 12 hours, and most of the stations assessed had median time to recovery of zero hours, indicating that the concentration of *Enterococci* at those locations was less than 130 cfu/100mL for the for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

Table 8.6-27. New York Bay Time to Recovery, *Enterococci*, Recommended Plan

Location	Median Time to Recovery (hours) *Enterococci* Threshold (130 cfu/100mL)(1)
New York Bay (Class SB Coastal Primary Contact Recreational)	
NB-1	7
NB-2	6
NB-3	4
NB-4	5
NB-5	0(2)
NB-6	0
NB-7	11
NB-8	0
NB-9	12
NB-10	0
NB-11	0

Table 8.6-27. New York Bay Time to Recovery, *Enterococci*, Recommended Plan

Location	Median Time to Recovery (hours) *Enterococci* Threshold (130 cfu/100mL)(1)
NB-12	0
K5A	0
J11	2
N9A	0
Governors Island	0
Louis Valentino Park	7
Search Lane Marina	0
Marine Basin Marina	0
Sea Gate Beach Club/42nd	0
Coney Island Beach	0
Manhattan Beach/	0
Gerritson/Plumb Beach	0
Riis Landing Kayak Launch	0
Breezy Point Reid Ave. Beach	0
Breezy Point 219	0
Millers Launch Marina	0
Alice Austen House Buono Beach	0
South Beach Kayak/Midland	0
Cedar Grove Beach	0
Great Kills Park Kayak	0
Wolf's Pond Beach	0
Lemon Creek Marina/Kayak	0

Notes:

(1) Median time to recovery values presented for storms from the 10-year simulation, recreational seasons, in the size range of >1.0 to 1.5-inches of rainfall, which includes the 90th percentile rain event.

(2) Median time to recovery of "0" means that the average concentration across the water column never reached the 130 cfu/100mL threshold at the referenced station for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

8.6.m Recommended LTCP Elements to Meet Water Quality Goals for New York Bay

The actions identified in this LTCP include:

- Modifying the weir at Regulator RH-020A (CSO RH-005), increasing the regulator orifice opening, and enlarging the branch interceptor connection at Regulator RH-13 (CSO RH-014) (NYB-1).
- Installing a diversion connection on the Victory Boulevard combined sewer upstream of Regulator 17 (CSO PR-013). This connection would divert dry-weather flow and a portion of the wet--weather flow directly to the East Interceptor by gravity (NYB-2).

- Installing a control gate in Regulator 9C (CSO OH-015), to keep more wet-weather flow in the upper of the two combined sewer conduits entering the regulator (NYB-3).
- Costs (2019 dollars) for the recommended alternative are: NPW $51M, PBC of $33M, and annual O&M of $0.5M.
- Compliance with Existing Class SB WQ Criteria for fecal coliform, and compliance with Class SB Coastal Primary Recreational *Enterococci* 30-day geometric mean criteria. However, full attainment of the Class SB DO criteria, and the Class SB Coastal Primary Recreational *Enterococci* 30-day STV criteria will not be achieved. As a result, a UAA is required as part of this LTCP for the referenced DO criteria and the *Enterococci* 30-day STV criteria.
- DEP will establish with the DOHMH (through public notification) a wet-weather advisory for the recreational season (May 1st through October 31st) during which recreational activities would not be recommended in New York Bay. The LTCP includes a recovery time analysis that can be used to establish the duration of the wet-weather advisory for public notification.

DEP is committed to improving water quality in this waterbody, which will be advanced by the improvements and actions identified in this LTCP. These identified actions have been balanced with input from the public and awareness of the cost to the residents of NYC.

8.7 CSO Control Alternatives for Arthur Kill/Kill Van Kull

No CSO outfalls are located on Arthur Kill, and thus no CSO discharges directly to Arthur Kill. As a result, no CSO control alternatives were developed specifically for Arthur Kill. As shown in Section 6, WQS for dissolved oxygen are met in Kill Van Kull under Baseline Conditions, and the non-attainment of the WQS for fecal coliform is driven by sources outside of NYC. Therefore, attainment of WQS was not a factor in evaluating CSO control alternatives for Kill Van Kull. Rather, the focus was on evaluating alternatives for cost-effective reduction of CSO activations and volume.

It should also be noted that DEP has implemented an extensive Bluebelt program on Staten Island. Bluebelts are ecologically rich and cost-effective drainage systems that naturally handle the runoff precipitation that falls on streets and sidewalks. The program preserves natural drainage corridors including streams, ponds, and wetlands, and enhances them to perform their functions of conveying, storing, and filtering runoff precipitation or stormwater. In addition to being an excellent mechanism for reducing urban flooding and improving the health of local waterways, Bluebelts also provide open green space for their communities and diverse habitat for wildlife since they are not constricted by closed pipes or underground infrastructure like traditional storm sewers. As New York City prepares for rising sea levels and heavier rains due to climate change, Bluebelts offer a natural and effective solution for stable and sound stormwater management.

The Staten Island Bluebelt system drains 15 watersheds clustered at the southern end of the Island, in addition to the Richmond Creek watershed. The combined area of these 16 watersheds totals approximately 10,000 acres. The Bluebelt drainage plan for these 16 watersheds connects natural drainage corridors with conventional storm sewers for an integrated stormwater management system.

Wetlands located within the watershed areas act as flood control measures. Urban wetlands are especially valuable because impervious surfaces, like streets and rooftops, increase the rate, velocity, and volume of stormwater runoff. By temporarily storing stormwater, urban wetlands help protect adjacent and downstream property owners from flood damage.

For Kill Van Kull, the CSO control alternatives that passed the initial screening phase and were retained generally fell within the categories of system optimization and tunnel storage. System optimization alternatives covered the categories of fixed weirs, parallel interceptor/sewer, bending weirs or control gates, and gravity flow tipping to other watersheds. The storage tunnel alternatives, used to assess 50, 75 and 100 percent CSO capture, also included high-rate clarification for the dewatering flows from the tunnels. Storage tanks were not evaluated due to the number of outfalls and the general lack of available sites of sufficient size for storage tanks. Each CSO control measure was initially evaluated on three of the key considerations described in Section 8.1: (1) benefits, as expressed by level of CSO control and WQS attainment; (2) costs; and (3) challenges, such as siting and operations. Using this methodology, the retained CSO control measures listed in Section 8.1 were evaluated on a cost-performance basis and used to develop the basin-wide alternatives.

The Citywide/Open Waters Baseline Conditions include implementation of the Recommended Plans from the LTCPs for the tributary waterbodies previously submitted to DEC under this program, as well as other grey infrastructure projects implemented as part of earlier planning programs. Those projects are summarized in Section 4.The following sections present the evaluations of the system optimization and tunnel storage alternatives for Kill Van Kull.

8.7.a System Optimization Alternatives

The approach to the initial identification and evaluation of system optimization alternatives for Kill Van Kull using the Optimatics Optimizer software was presented in Section 3. As described in Section 3, the Optimizer software was configured to prioritize monitored regulators discharging outside the period of critical wet-weather events, high-discharge frequency regulators, and regulators discharging in proximity to official and publicly-identified public access points (kayak launches/marinas).

The CSO outfalls to Kill Van Kull are all part of the Port Richmond WRRF collection system, which also includes outfalls discharging to New York Bay. Thus, the Kill Van Kull optimization alternatives needed to be considered in conjunction with alternatives for New York Bay associated with the Port Richmond WRRF.

The section below presents the evaluations of Kill Van Kull optimization alternatives.

8.7.a.1 System Optimization for Kill Van Kull Outfalls in the Port Richmond WRRF System

Table 8.7-1 summarizes the CSO outfalls and associated regulators tributary to Kill Van Kull from the Port Richmond WRRF system that were the initial focus of the optimization evaluations. The locations of these outfalls/regulators are shown in Figure 8.7-1. Table 8.7-1 identifies the annual CSO volume and activation frequency under Baseline Conditions, and whether the outfall/regulator falls within one or more of the following categories:

- One of the 100 monitored regulators listed in the WRRF SPDES permits (“BMP Regulator”)
- A “key regulator” as identified in the WRRF SPDES permits
- An outfall in proximity to (typically within 500 feet of) a public access location
- Regulators that activated more than average for the waterbody

Table 8.7-1. Kill Van Kull CSO Outfalls/Regulators Associated with the Port Richmond WRRF

Outfall	Regulator	Baseline Conditions		BMP Regulator	Key Regulator	Outfall in Proximity to Public Access	Higher Frequency Regulator
		Annual CSO Volume (MG)	Annual CSO Activations				
PR-006	R-23	6.35	15			✓	
PR-028	R-5W	15.1	23				✓
PR-029	R-6W	146	47	✓	✓		✓

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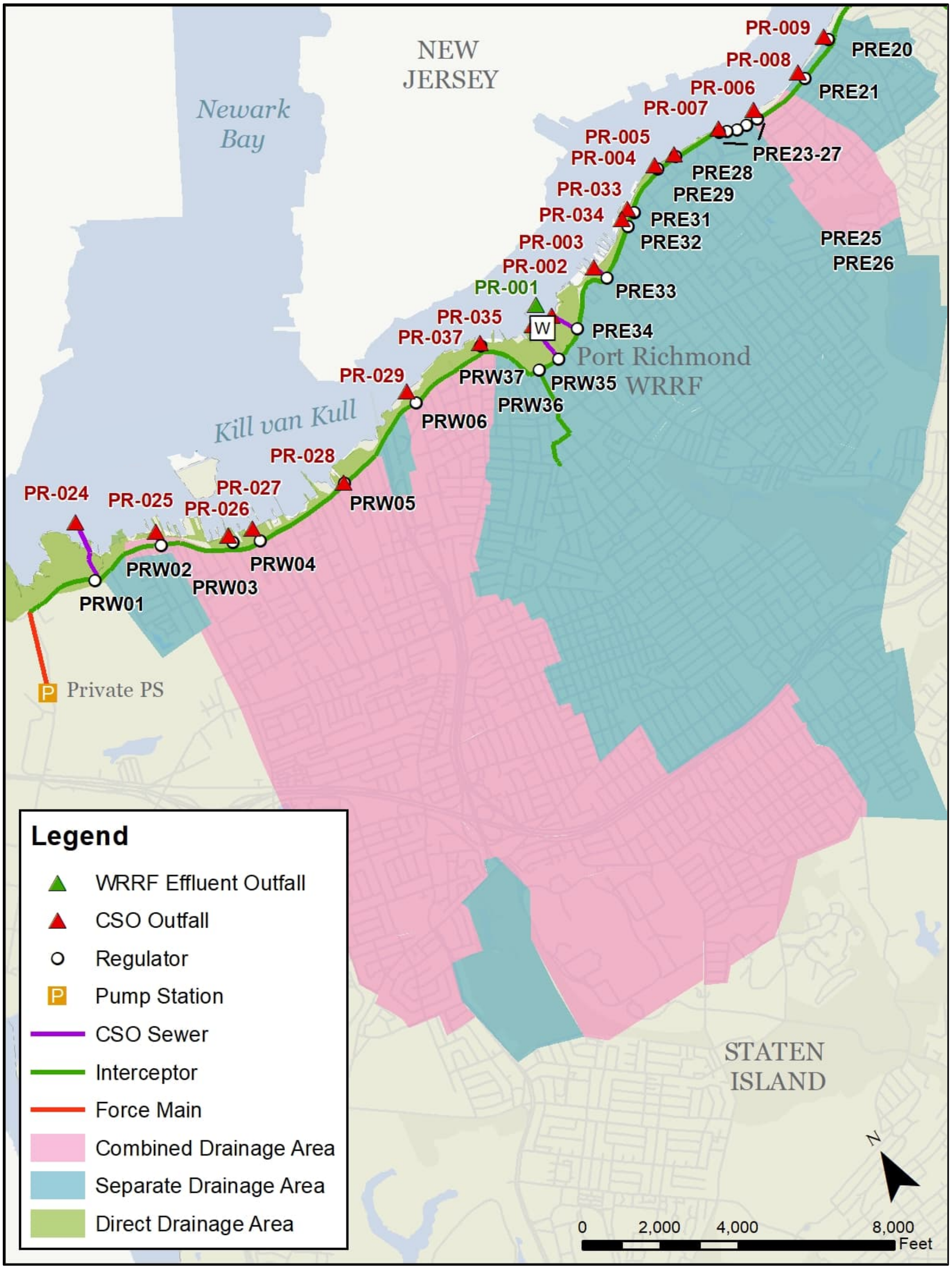

Figure 8.7-1. CSO Outfalls/Regulators Tributary to Kill Van Kull from the Port Richmond WRRF System

Findings/Observations from Optimizer Evaluations

The Optimizer evaluations served as an initial screening step to identify potentially promising optimization alternatives to be further evaluated using the full Port Richmond WRRF InfoWorks model. These evaluations included the assessment of the impacts to CSO volume, activation, and peak hydraulic grade line elevations relative to Baseline Conditions, as well as other general system conditions. General collection system information and findings of the initial Optimizer evaluations included the following:

- The Port Richmond WRRF collection system serves the northern part of Staten Island. The East Interceptor runs east from the WRRF along the shoreline of Kill Van Kull, then turns south along the shoreline of Kill Van Kull. The West Interceptor runs west from the WRRF along the shoreline of Kill Van Kull.
- A total of 35 regulators contribute flow to the interceptors. During wet-weather, flow in excess of the interceptor capacity can overflow to CSO outfalls discharging to Kill Van Kull (19 CSO outfalls). The interceptor sewers convey flow to the Port Richmond WRRF located along Kill Van Kull.
- Depth of cover on the gravity sewers varies, ranging from relatively shallow (<10 feet of cover) to over 20 feet.
- Regulators from the Port Richmond system contributing to CSO outfalls discharging to Kill Van Kull activate between 0 to 47 times during the typical year with a total average annual overflow volume (AAOV) of 173 MGY.
- Freeboard for the 5-year design storm and many of the larger storms during the typical year is generally less than 10 feet from the ground surface indicating the portions of the collection system along Kill Van Kull are highly sensitive to hydraulic grade line impacts.
- The Optimizer modeling identified alternatives that included modifications to as many as 20 regulators throughout the WRRF collection system that resulted in varying degrees of improved capture and hydraulic performance. However, upon performing InfoWorks runs for the 2008 typical year, limited reductions in AAOV (<1 percent) and activation frequency (<8 percent) were predicted for the better performing alternatives.

Follow-up Evaluations Based on Full InfoWorks Model

No retained alternatives were identified from the initial optimization runs due to hydraulic grade line impacts that increased the risk of potential flooding, while providing negligible reductions in CSO volume and activations to Kill Van Kull. Figure 8.7-2 illustrates the hydraulic grade line sensitivities where optimization alternatives increase the potential risk of street flooding and basement backups.

Additional Optimization Alternatives

As indicated in Table 8.7-1, Outfall PR-029 is the largest outfall discharging to Kill Van Kull. Given that nearly 85 percent of the total CSO volume to Kill Van Kull in the Typical Year is discharged from Outfall PR-029, this outfall was targeted for further investigation of the feasibility of reducing CSOs using a real-time controlled gate. Currently, the size of the connection between Regulator R-6W (which discharges to Outfall PR-029) and the West Interceptor limits the peak wet-weather flow from the upstream combined sewer system into the interceptor. This limitation in the peak wet-weather flow is necessary to protect the interceptor from excessive surcharging during larger wet-weather events. However, if the interceptor connection could be enlarged and fitted with a remotely controlled gate, in concept more flow could be allowed into the interceptor during smaller storms, thereby reducing CSO volumes. In larger storms, the gate could be triggered to throttle, to protect the interceptor from high flows just as the current regulator configuration does today.

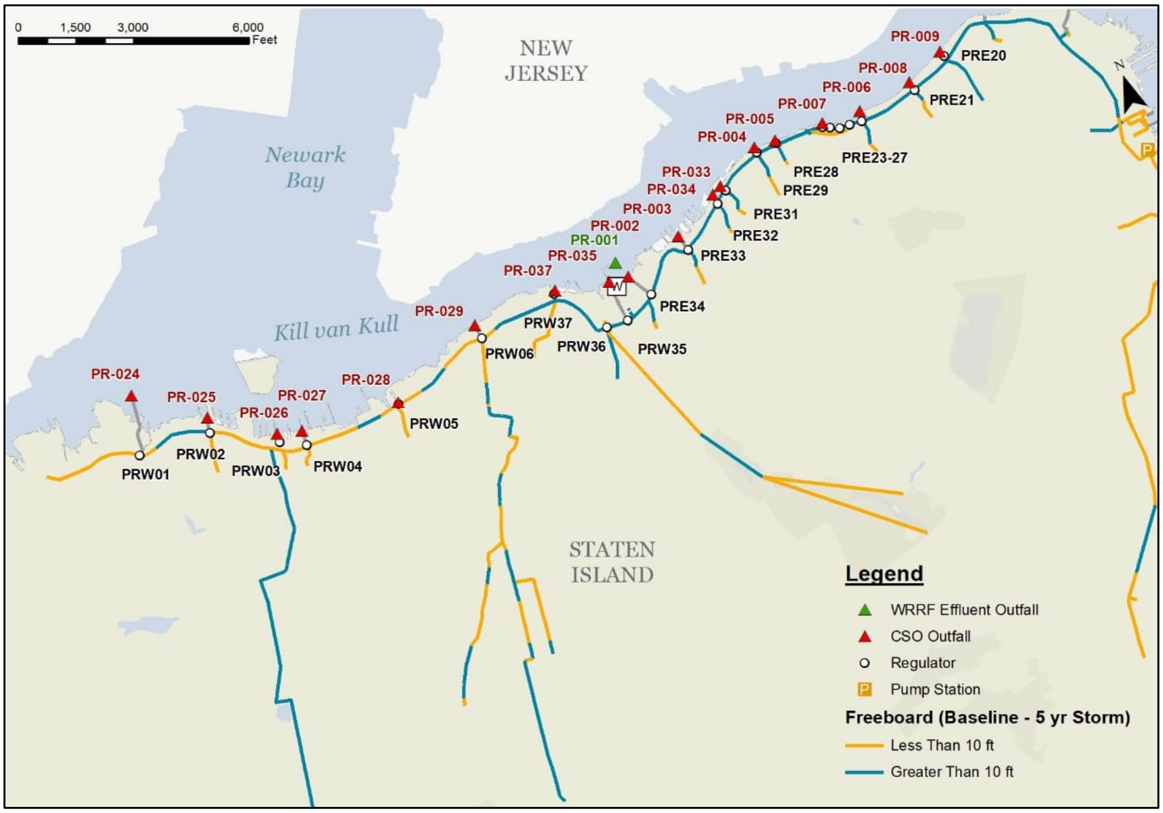

Figure 8.7-2. Depth to Peak Hydraulic Grade Line, 5-year Storm, Baseline Conditions, Kill Van Kull

A number of potential configurations of the interceptor connection and gate were tested using the InfoWorks model. These configurations involved various degrees of up-sizing of the interceptor connection, coupled with a gate that would be triggered to throttle as soon as the hydraulic grade line in the interceptor reached a high-level set point. However, the findings were that in large storms, the hydraulic grade line in the interceptor rose so quickly, that a remotely controlled gate could not react fast enough to prevent adverse hydraulic grade line impacts in the interceptor. For alternatives that successfully prevented adverse hydraulic grade line impacts, the set point in the interceptor for triggering the gate to close had to be set so low, that almost no CSO reduction benefit was achieved. As a result of these findings, this alternative was not pursued further.

The Hannah Street Pumping Station is scheduled in the near term for a needed upgrade to maintain a state of good repair for the pumping station, and the upgrade will maintain the current pumping capacity of the existing facility. The Hannah Street Pumping Station Bypass alternative described above under the New York Bay Section 8.5 (Alternative NYB-2) will increase flow into the downstream East Interceptor. Modeling evaluations indicated that further increasing the wet-weather flow to the East Interceptor beyond Alternative NYB-2 would likely have adverse impacts on the hydraulic grade line in the interceptor. For these reasons, expansion of the capacity of the Hannah Street Pumping Station was not evaluated further.

Storage options for CSO outfalls to Kill Van Kull from the Port Richmond WRRF system are evaluated in the following sub-section.

8.7.b Storage Alternatives for 25/50/75/100 Percent CSO Control

Conceptual storage alternatives were developed to provide 25, 50, 75, and 100 percent CSO control of the annual CSO volume discharged to Kill Van Kull in the Typical Year. The approach to sizing and layout of the storage alternatives was as follows:

- For 25, 50, and 75 percent CSO control, a storage tank for Outfall PR-029 was sized such that the capture at that outfall would equate to 25, 50, and 75 percent capture of the total CSO volume to Kill Van Kull.
- For 100 percent CSO control, it was assumed that every CSO outfall to Kill Van Kull that was predicted to be active in the 2008 Typical Year would be captured by a tunnel. Where multiple outfalls were located in close proximity to each other, it was assumed that a near-surface consolidation conduit would be provided to a single drop shaft.
- For each storage alternative, the dewatering rate required to dewater the storage facility within 24 hours was compared to the available dry-weather flow capacity in the Port Richmond WRRF. For the 100 percent CSO control tunnel, a high-rate clarification wet-weather flow treatment system with disinfection was added to the alternative to treat the dewatered flow.
- A detailed siting assessment was not conducted, so the specific locations of features of the storage alternatives (storage tank, tunnel mining shaft, TBM removal shaft, drop shafts, dewatering pumping station, dewatered flow treatment facility, near-surface diversion structures/connection conduits) were not identified.

The main features of the 25, 50, 75, and 100 percent CSO control storage alternatives for Kill Van Kull are summarized in Table 8.7-2. The 25, 50, and 75 percent capture storage tanks would capture overflow from Outfall PR-029 (see Figure 8.7-1 for location of Outfall PR-029). The size of the storage tank for each level of CSO control would be 2.5, 7.0, and 15.6 MG, respectively.

The 100 percent CSO control tunnel capturing the Port Richmond WRRF outfalls discharging to Kill Van Kull would start with a mining shaft near the Port Richmond WRRF, and run in two directions along the shoreline of Kill Van Kull. The westerly branch would run to Outfall PR-026, and the easterly branch would run to Outfall PR-006 (Figure 8.7-3). The tunnel would be 16 feet in diameter, with a length of about 21,000 feet (4.1 miles). A dedicated wet-weather high-rate treatment facility would be necessary for the treatment of the CSO retained in the storage tunnel.

Table 8.7-2. Summary of 25, 50, 75, and 100 Percent CSO Control Alternatives for Kill Van Kull

Alternative	KVK-1	KVK-2	KVK-3	KVK-4
Level of CSO Control[(1)]	**25%**	**50%**	**75%**	**100%**
WRRF Outfalls Captured[(2)]	**PR**	**PR**	**PR**	**PR**
Storage Tank Volume (MG)	2.5	7.0	15.6	N/A
Length (mi.)	N/A	N/A	N/A	4.1
Diameter (ft.)	N/A	N/A	N/A	16
Tunnel Volume (MG)	N/A	N/A	N/A	30
Outfalls Captured	• PR-029	• PR-029	• PR-029	• 6 PR outfalls
Net CSO Volume Reduction (MGY)	44	87	130	173
Wet-Weather Flow Treatment Facility Capacity for Dewatering Flow (MGD)	N/A	N/A	N/A	30
Estimated Probable Bid Cost[(3)]	$300M	$500M	$800M	$1,000M

Notes:
(1) Modeled annual percent CSO reduction based on the 2008 Typical Year.
(2) PR = Port Richmond
(3) 2019 dollars.

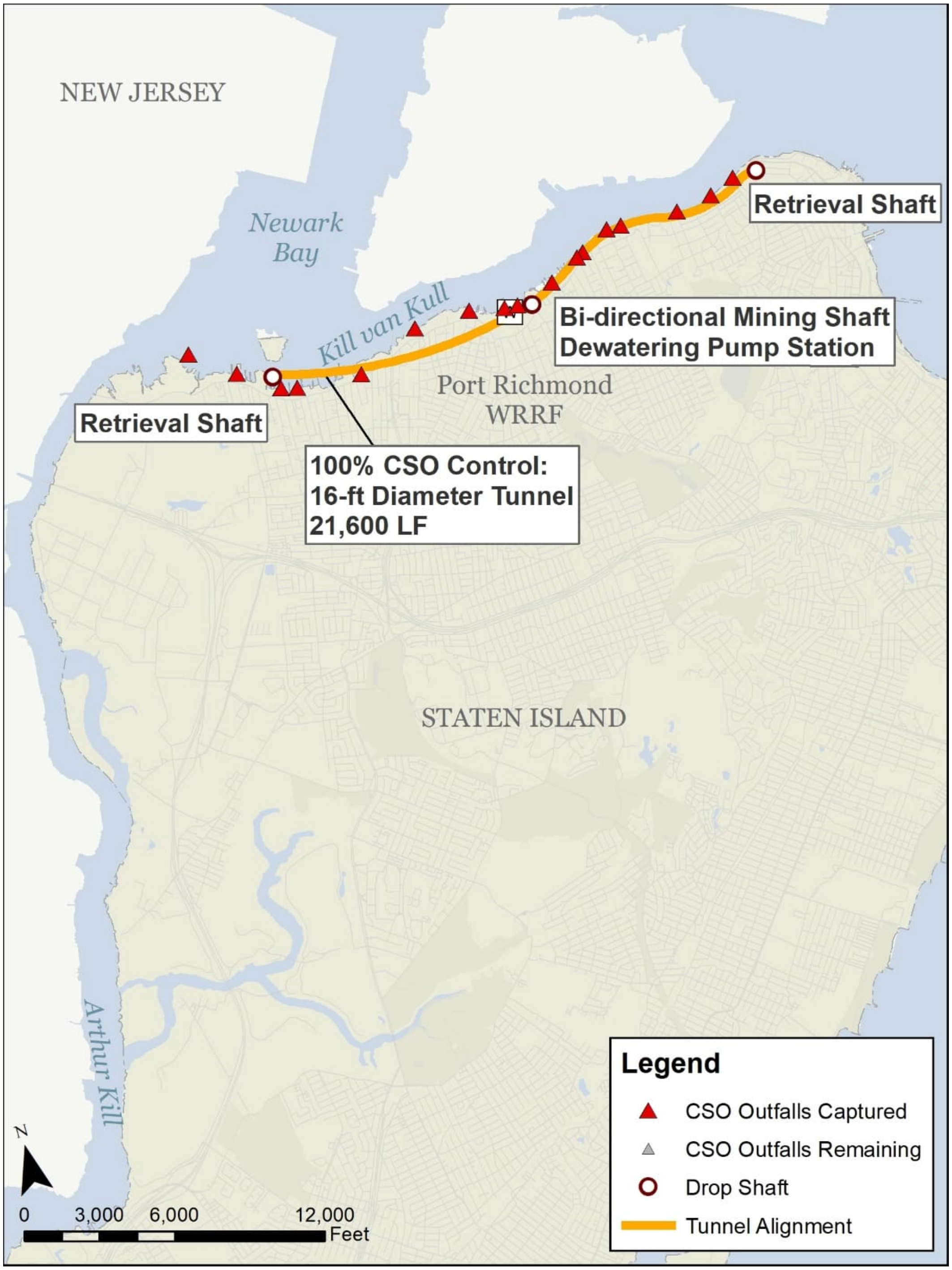

Figure 8.7-3. 100 Percent CSO Control Tunnel for Kill Van Kull (PR)

While these storage alternatives provide relatively high levels of CSO control, the significant challenges to implementation include:

- Very high implementation cost
- Limited siting availability for the storage tanks, or the shafts, dewatering pumping station, and dewatering flow treatment facility associated with the tunnel storage alternative
- Long implementation period
- Significant and prolonged construction impacts (truck traffic, noise, dust)
- Negligible improvement in the annual attainment of applicable water quality standards
- Construction impacts and likelihood of utility conflicts for near-surface diversion structures and connecting conduits

Despite these challenges, these alternatives were retained in order to provide an assessment of a range of levels of CSO control for Kill Van Kull, per the CSO Control Policy and the Clean Water Act.

8.7.c Summary of Retained Alternatives for Kill Van Kull

The goal of the previous evaluations was to develop a list of retained CSO control measures for Kill Van Kull. These CSO control measures, whether individually or in combination, form the basis of basin-wide alternatives to be assessed using more rigorous cost-performance and cost-attainment analyses. Table 8.7-3 lists all of the CSO control measures originally identified in the "Alternatives Toolbox" shown above in Figure 8.7-2, and identifies whether the CSO control measure was retained for further analysis. The reasons for excluding the non-retained CSO control measures from further consideration are also noted in the table.

Table 8.7-3. Summary of Control Measure Screening for Kill Van Kull

Control Measure	Category	Retained for Further Analysis?	Remarks
Additional GI Build-out	Source Control	NO(1)	Planned GI build-out in the watershed is included in the baseline. It is unlikely that additional sites will be identified due to site constraints in publicly owned properties. The Port Richmond WRRF system is largely a separate system, with a lot of pervious area.
High Level Storm Sewers	Source Control	NO(1)	No cost-effective opportunities identified
Regulator Modifications	System Optimization	NO	Optimization alternatives showed limited benefit in terms of CSO reduction
Parallel Interceptor Sewer	System Optimization	NO	Optimization alternatives showed limited benefit in terms of CSO reduction
Bending Weirs/Control Gates	System Optimization	NO	No hydraulically feasible opportunities identified

Table 8.7-3. Summary of Control Measure Screening for Kill Van Kull

Control Measure	Category	Retained for Further Analysis?	Remarks
Pumping Station Optimization	System Optimization	NO	No hydraulically feasible opportunities identified
Pumping Station Expansion	System Optimization	NO	No hydraulically feasible opportunities identified
Gravity Flow Redirection to Other Watersheds	CSO Relocation	NO	No cost-effective opportunities identified
Pumping Station Modification	CSO Relocation	NO	No hydraulically feasible opportunities identified.
Flow Redirection with Conduit and Pumping	CSO Relocation	NO	No cost-effective opportunities identified.
Floatables Control	Floatables Control	YES	Programmatic floatables control will be applied and expanded Citywide.
Environmental Dredging	Water Quality/ Ecological Enhancement	NO	No specific locations of CSO sediment mounding identified.
Wetland Restoration and Daylighting	Water Quality/ Ecological Enhancement	NO	No daylighting opportunities were identified.
Outfall Disinfection	Treatment: Satellite	NO	Not feasible due to short length of outfalls.
Retention/Treatment Basins	Treatment: Satellite	NO	Significant siting constraints and very high costs. Tunnel storage covers 25/50/75/100% CSO control alternatives.
High-Rate Clarification	Treatment: Satellite	YES	Incorporated into the storage tunnel alternative for treatment of captured CSO during tunnel dewatering.
WRRF Expansion	Centralized Treatment	NO	Insufficient space available. Limited benefit compared to potential cost.
In-System Storage (Outfalls)	Storage	NO	Negligible levels of CSO control due to short outfalls.
Off-line Storage (Tanks)	Storage	YES	Storage tank alternatives KVK-1, KVK-2 and KVK-3 cover 25/50/75% CSO control.
Off-line Storage (Tunnels)	Storage	YES	Tunnel storage Alternative KVK-4 covers 100% CSO control.

Note:
(1) Additional GI and HLSS are considered to be ongoing programs that will continue to be implemented system-wide outside of the LTCP program.

As shown, the retained CSO control measures include tunnel storage (with high-rate clarification for dewatering flows for the 100 percent CSO control tunnel), and programmatic floatables control.

8.7.d CSO Volume and Loading Reductions for Retained Alternatives for Kill Van Kull

Table 8.7-4 summarizes the projected performance of the retained Kill Van Kull alternatives in terms of annual CSO volume and fecal coliform load reduction, based on the 2008 Typical Year. These data are plotted on Figure 8.7-4. In all cases, the predicted reductions shown are relative to the Baseline Conditions.

Table 8.7-4. Kill Van Kull Retained Alternatives Performance Summary (2008 Rainfall)

Alternative	Annual Performance Based on 2008 Typical Year				
	Remaining CSO Volume (MGY) (1)	Frequency of Overflow (2)	Additional Untreated CSO Volume to Other Waterbodies (MGY) (3)	Net CSO Volume Reduction (%)	Net Fecal Coliform Reduction (%)
Baseline Conditions	173	47	0	0	0
KVK-1. Storage Tank at PR-029 for 25% CSO Control (2.5 MG Capacity)	129	23	0	25	25
KVK-2. Storage Tank at PR-029 for 50% CSO Control (7.0 MG Capacity)	86	23	0	50	50
KVK-3. Storage Tank at PR-029 for 75% CSO Control (15.6 MG Capacity)	43	23	0	75	75
KVK-4. Tunnel Storage for 100% CSO Control (30 MG Capacity)	0	0	0	100	100

Notes:

(1) Remaining CSO includes all discharges to Kill Van Kull from the Port Richmond WRRF Collection System.
(2) Frequency of overflow is based upon the most frequently active CSO outfall.
(3) Additional untreated CSO volume to other waterbodies accounts for increases at other CSO outfalls in response to the implementation of a CSO control alternative. Net CSO volume reduction and net fecal coliform reduction account for any additional CSO discharge to other waterbodies.

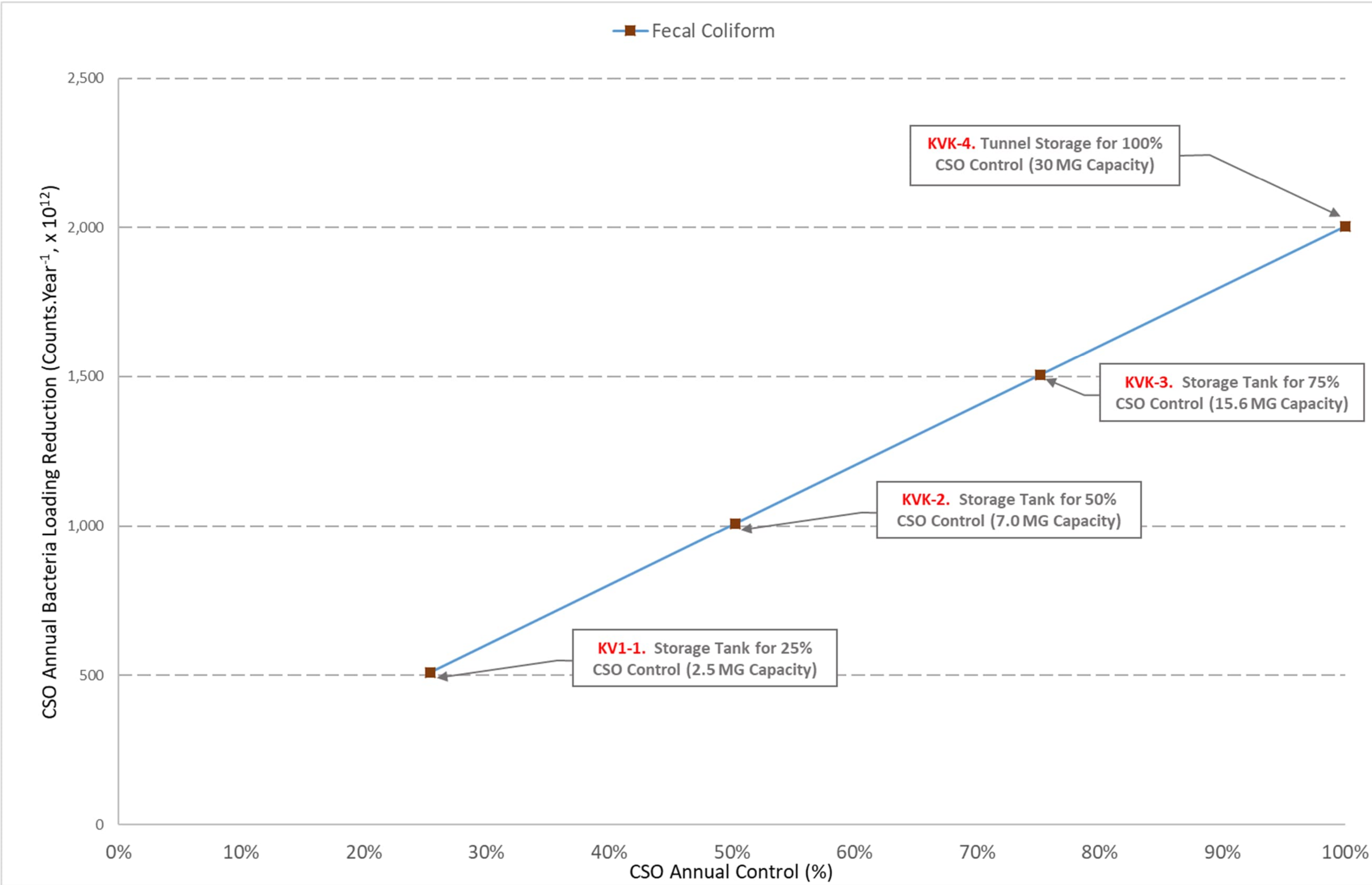

Figure 8.7-4. Untreated CSO Volume Reductions (as Percent CSO Annual Control) vs. Annual CSO Bacteria Loading Reduction (2008 Typical Year) for Kill Van Kull

Because the retained alternatives for Kill Van Kull provide volume reduction and not treatment, the predicted bacteria loading reductions of the alternatives are very closely aligned with their projected CSO volume reductions.

8.7.e Cost Estimates for Kill Van Kull Retained Alternatives

Evaluation of the retained alternatives requires cost estimation. The methodology for developing these costs is dependent upon the type of technology and its O&M requirements. The construction costs were developed as Probable Bid Costs (PBC) and the total Net Present Worth (NPW) costs were determined by adding the estimated PBC to the NPW of the projected annual O&M costs at an assumed interest rate of 3 percent over a 100-year life cycle. Design, construction management, and land acquisition costs are not included in the cost estimates. All costs are in 2019 dollars and are considered Level 5 cost estimates by AACE International with an accuracy of -50 percent to +100 percent.

8.7.e.1 Alternative KVK-1. Storage Tank for 25 Percent CSO Control

Costs for Alternative KVK-1 include planning-level estimates of the costs for a CSO storage tank sized for 25 percent CSO control. A description of the tank components is provided in Section 8.7.b and illustrated in Table 8.7-2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative KVK-1 is $400M as shown in Table 8.7-5.

Table 8.7-5. Costs for Alternative KVK-1

Item	2019 Cost ($ Million)
Probable Bid Cost	$300
Annual O&M Cost	$2
Net Present Worth	$400

8.7.e.2 Alternative KVK-2. Storage Tank for 50 Percent CSO Control

Costs for Alternative KVK-2 include planning-level estimates of the costs for a CSO storage tank sized for 50 percent CSO control. A description of the tank components is provided in Section 8.7.b and illustrated in Table 8.7-2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative KVK-2 is $600M as shown in Table 8.7-6.

Table 8.7-6. Costs for Alternative KVK-2

Item	2019 Cost ($ Million)
Probable Bid Cost	$500
Annual O&M Cost	$2
Net Present Worth	$600

8.7.e.3 Alternative KVK-3. Storage Tank for 75 Percent CSO Control

Costs for Alternative KVK-3 include planning-level estimates of the costs for a CSO storage tank sized for 75 percent CSO control. A description of the tank components is provided in Section 8.7.b and illustrated in Table 8.7-2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative KVK-3 is $900M as shown in Table 8.7-7.

Table 8.7-7. Costs for Alternative KVK-3

Item	2019 Cost ($ Million)
Probable Bid Cost	$800
Annual O&M Cost	$3
Net Present Worth	$900

8.7.e.4 Alternative KVK-4. Tunnel Storage for 100 Percent CSO Control

Costs for Alternative KVK-4 include planning-level estimates of the costs for a CSO storage tunnel sized for 100 percent CSO control. A description of the tunnel components is provided in Section 8.7.b and illustrated in Table 8.7-2. Site acquisition costs are not included. The total cost, expressed as NPW, for Alternative KVK-4 is $1,100M as shown in Table 8.7-8.

Table 8.7-8. Costs for Alternative KVK-4

Item	2019 Cost ($ Million)
Probable Bid Cost	$1,000
Annual O&M Cost	$5
Net Present Worth	$1,100

The cost estimates of these retained alternatives are summarized below in **Table** 8.7**-**9 and are then used in the development of the cost-performance and cost-attainment plots presented in Section 8.7.f.

Table 8.7-9. Cost of Retained Alternatives – Kill Van Kull

Alternative	PBC(1) ($ Million)	Annual O&M Cost ($ Million/Year)	Total Net Present Worth(2) ($ Million)
KVK-1. Storage Tank at PR-029 for 25% CSO Control (2.5 MG Capacity)	$300	$2	$400
KVK-2. Storage Tank at PR-029 for 50% CSO Control (7.0 MG Capacity)	$500	$2	$600
KVK-3. Storage Tank at PR-029 for 75% CSO Control (15.6 MG Capacity)	$800	$3	$900
KVK-4. Tunnel Storage for 100% CSO Control (30 MG Capacity)	$1,000	$5	$1,100

Notes:
(1) The Probable Bid Cost (PBC) for the construction contract based upon 2019 dollars.
(2) The Net Present Worth (NPW) is based upon a 100-year service life for tunnels and is calculated by multiplying the annual O&M cost by a present worth of 31.599 and adding this value to the PBC.

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8.7.f Cost-Benefit Curves for Retained Alternatives

The final step of the analysis is to evaluate the cost-effectiveness of the basin-wide retained alternatives based on their NPW and projected impact on CSO loadings and attainment of applicable WQS. Section 8.7.f.1 below presents plots of cost versus CSO volume and bacteria load reduction (Cost-Performance Curves), and Section 8.7.g below presents plots of cost versus percent attainment with WQS for selected points within Kill Van Kull (Cost-Attainment Curves).

8.7.f.1 Cost-Performance Curves

Cost-performance curves were developed by plotting the costs of the retained alternatives against their predicted level of CSO control, both in terms of CSO volume reduction, and in bacteria load reduction. In each case, a best-fit cost curve was developed based on those alternatives judged most cost-effective for a defined level of CSO control as estimated by IW modeling for the typical year rainfall (2008).

Figure 8.7-5 presents a plot of CSO volume reduction versus NPW for the retained alternatives, while Figure 8.7-6 plots the cost of the alternatives against fecal coliform loading reductions.

8.7.g Cost-Attainment Curves

This section evaluates the relationship of the costs of the retained alternatives versus their expected level of attainment of the bacteria Primary Contact WQ Criteria as modeled using the LTCPRM water quality model for the 10-year simulation. As indicated in Section 6, based on the 10-year WQ simulations for Kill Van Kull, the Class SD WQ Criteria for fecal coliform are not fully met in Kill Van Kull under Baseline Conditions, or a condition with No NYC CSO Loads. The remaining non-attainment is due to sources outside of NYC.

As a result, implementation of any of the retained alternatives described above, including the 100 percent CSO capture tunnel, results in nominal improvement in the percent attainment of the Class SB WQ Criteria for fecal coliform.

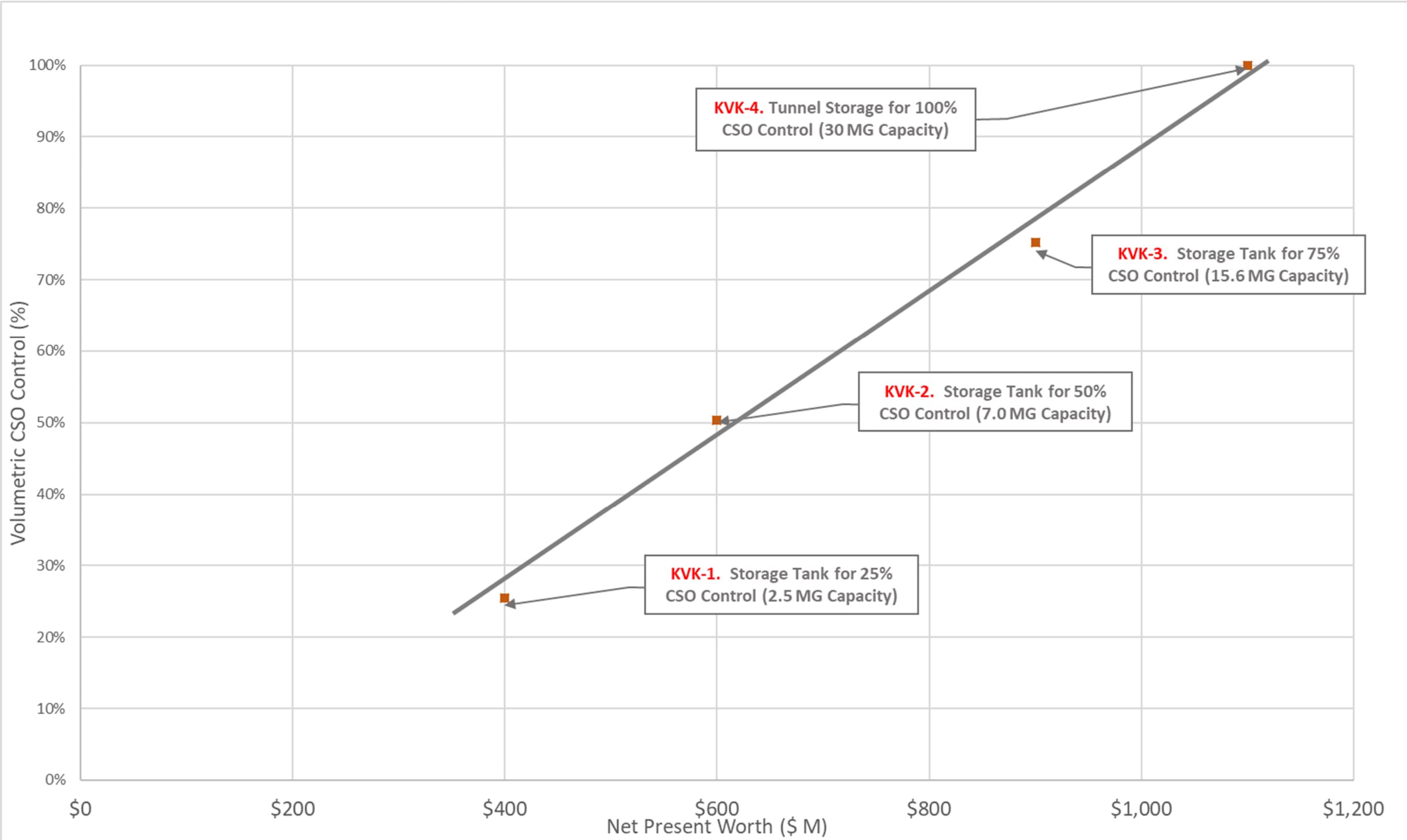


Figure 8.7-5. Cost vs. CSO Control – Kill Van Kull (2008 Typical Year)

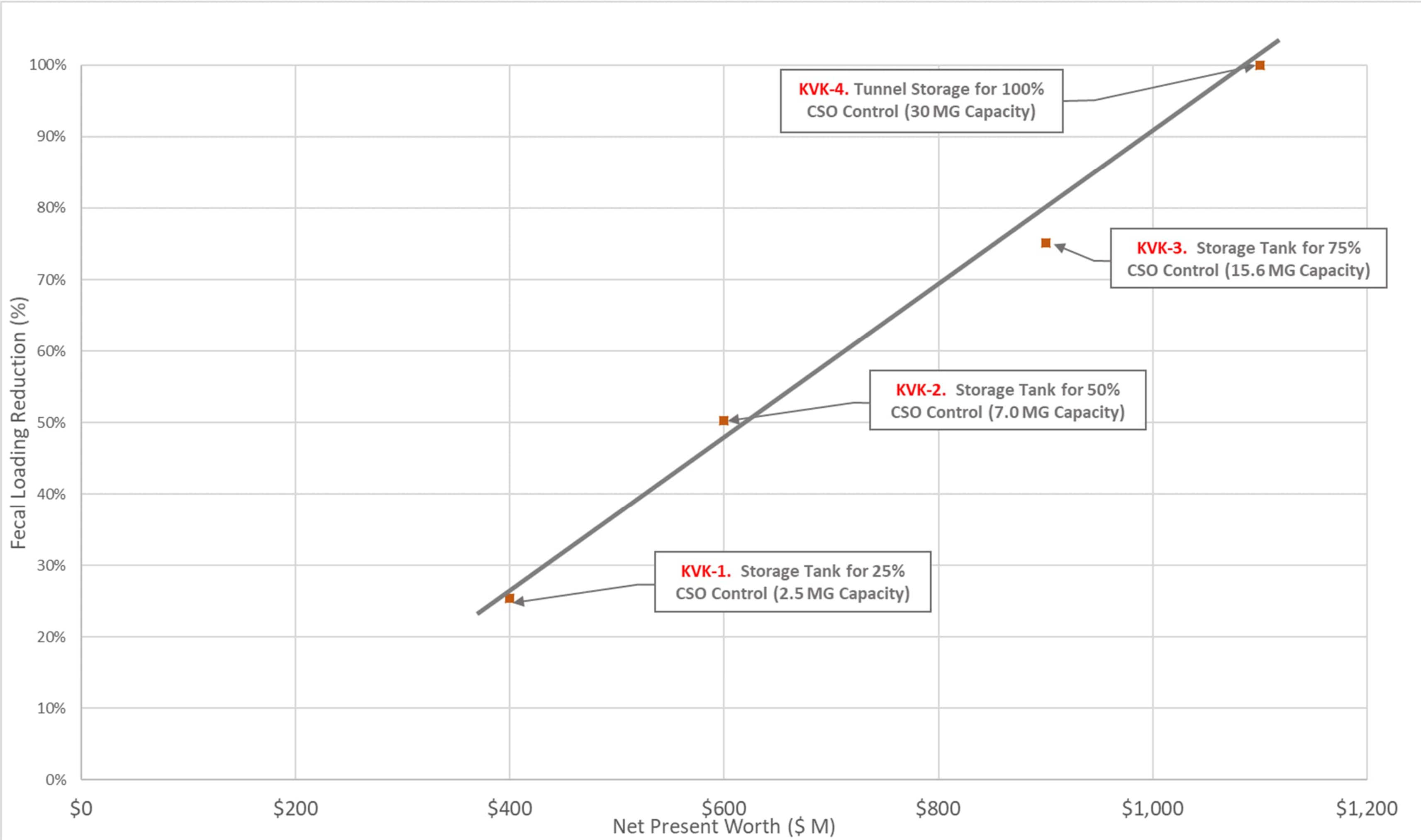


Figure 8.7-6. Cost vs. Fecal Coliform Load Reduction – Kill Van Kull (2008 Typical Year)

Cost-attainment plots are presented below for two locations within Kill Van Kull and one location within Arthur Kill. The locations of these stations are shown in Figure 8.7-13, and described as follows:

- LTCP sampling Station KK-3, located at the eastern mouth of Kill Van Kull (Figure 8.7-7)
- LTCP sampling Station KK-1, located in Kill Van Kull west of the Bayonne Bridge (Figure 8.7-8)
- LTCP sampling Station K-4, located in Arthur Kill adjacent to Cedar Point (Figure 8.7-9)

The plots in Figure 8.7-7 to Figure 8.7-9 show NPW versus percent attainment with the Class SD WQ Criteria for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis. In Figure 8.7-7, the plots for attainment with the Class SD criteria for fecal coliform on an annual and recreational season basis are superimposed on each other at a level of 100 percent. Figure 8.7-7 to Figure 8.7-9 also include a point for zero cost, which corresponds to Baseline Conditions.

These plots indicate that each of the retained alternatives represent essentially no performance improvement in terms of percent attainment with the Class SD WQ Criteria for fecal coliform on both an annual and recreational season (May 1st through October 31st) basis. At Stations KK-3 and KK-1, the waterbody is already at 95 percent attainment or greater on both an annual and recreational season basis. At Station K-4 in Arthur Kill, attainment in the recreational season is greater than 95 percent under Baseline Conditions, while on an annual basis, the Baseline Conditions level of attainment of less than 80 percent would not be significantly improved even with 100 percent CSO control to Kill Van Kull.

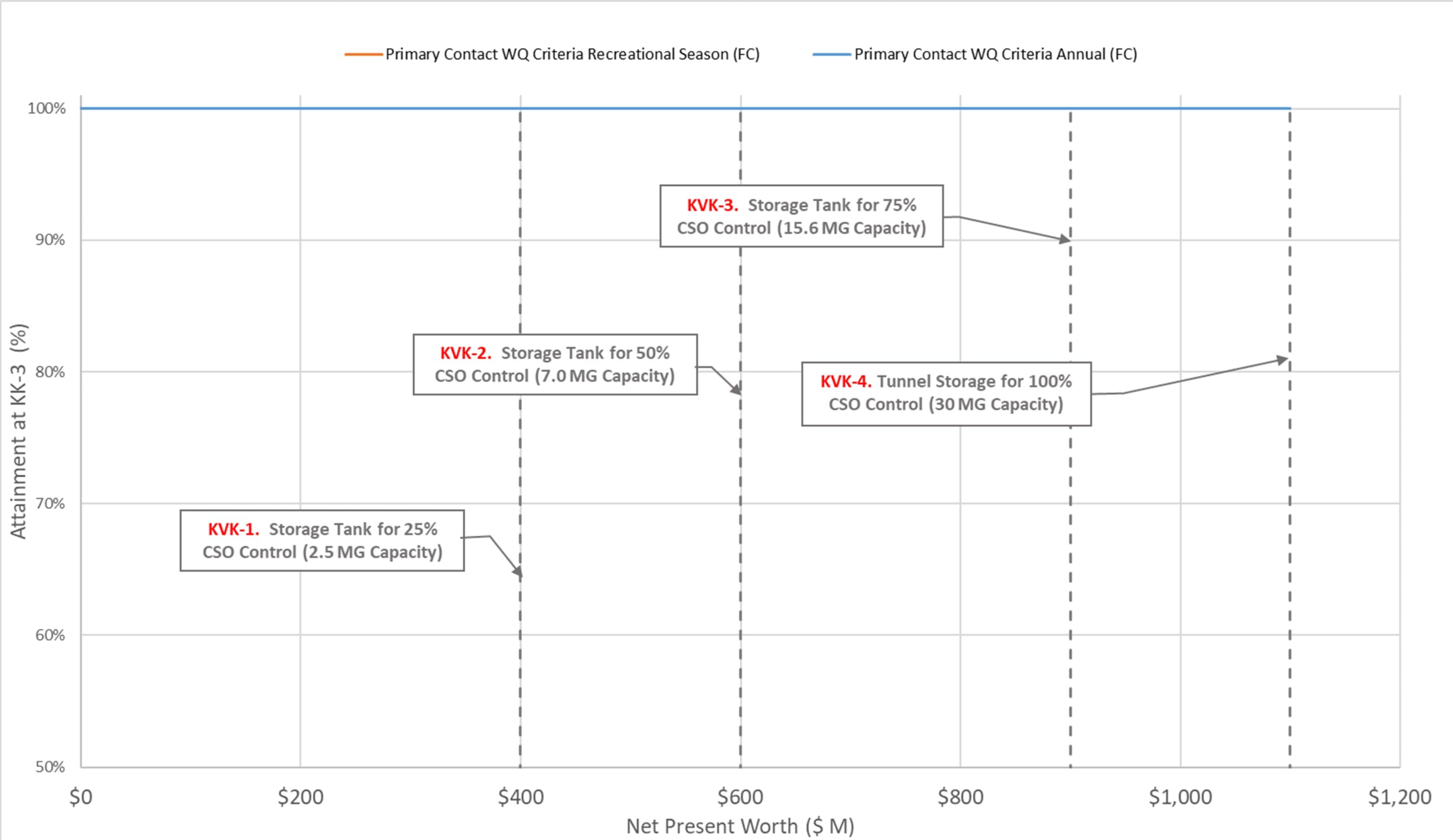


Figure 8.7-7. Cost vs. Bacteria Attainment at Class SD Station KK-3

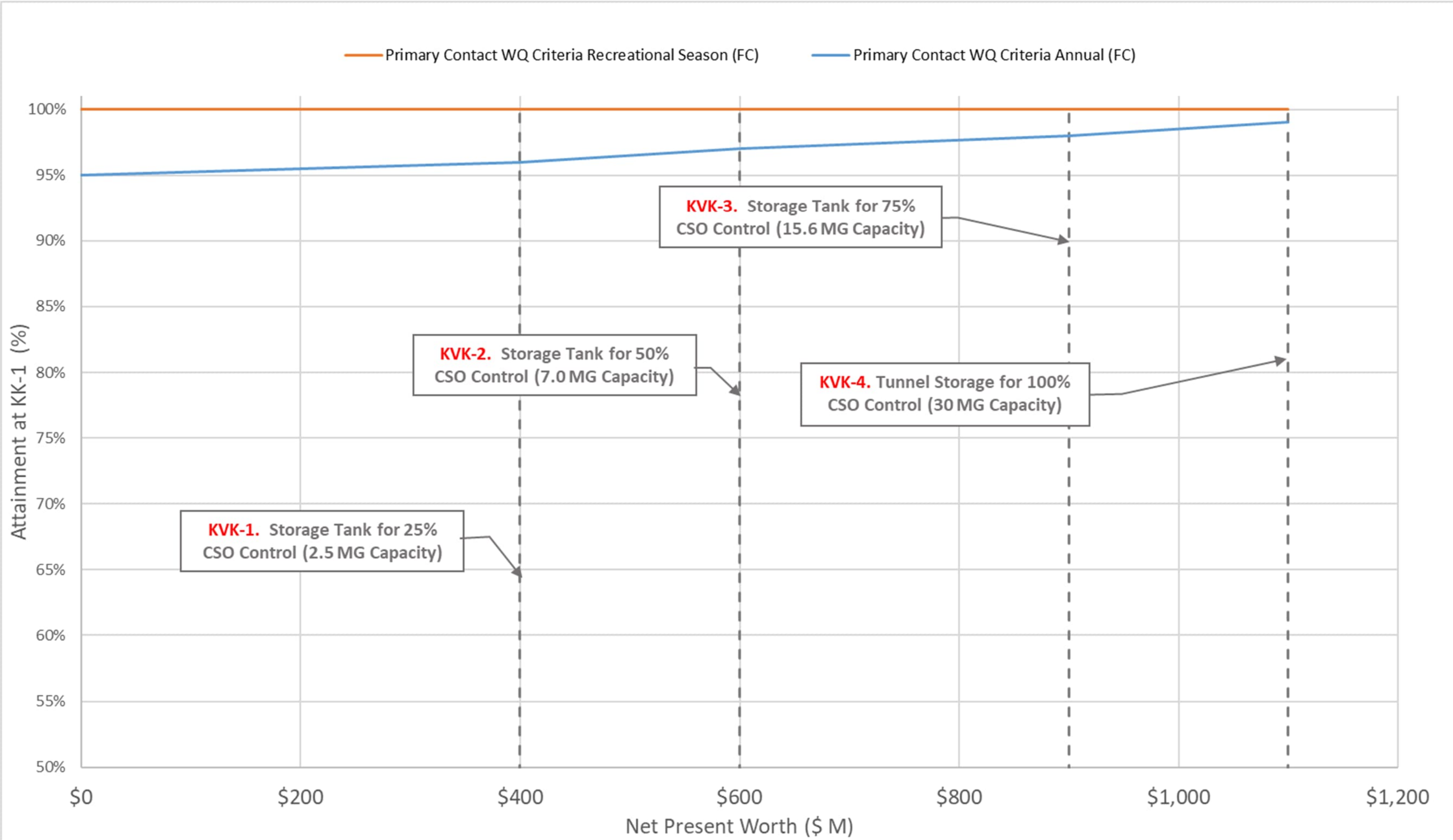


Figure 8.7-8. Cost vs. Bacteria Attainment at Class SD Station KK-1

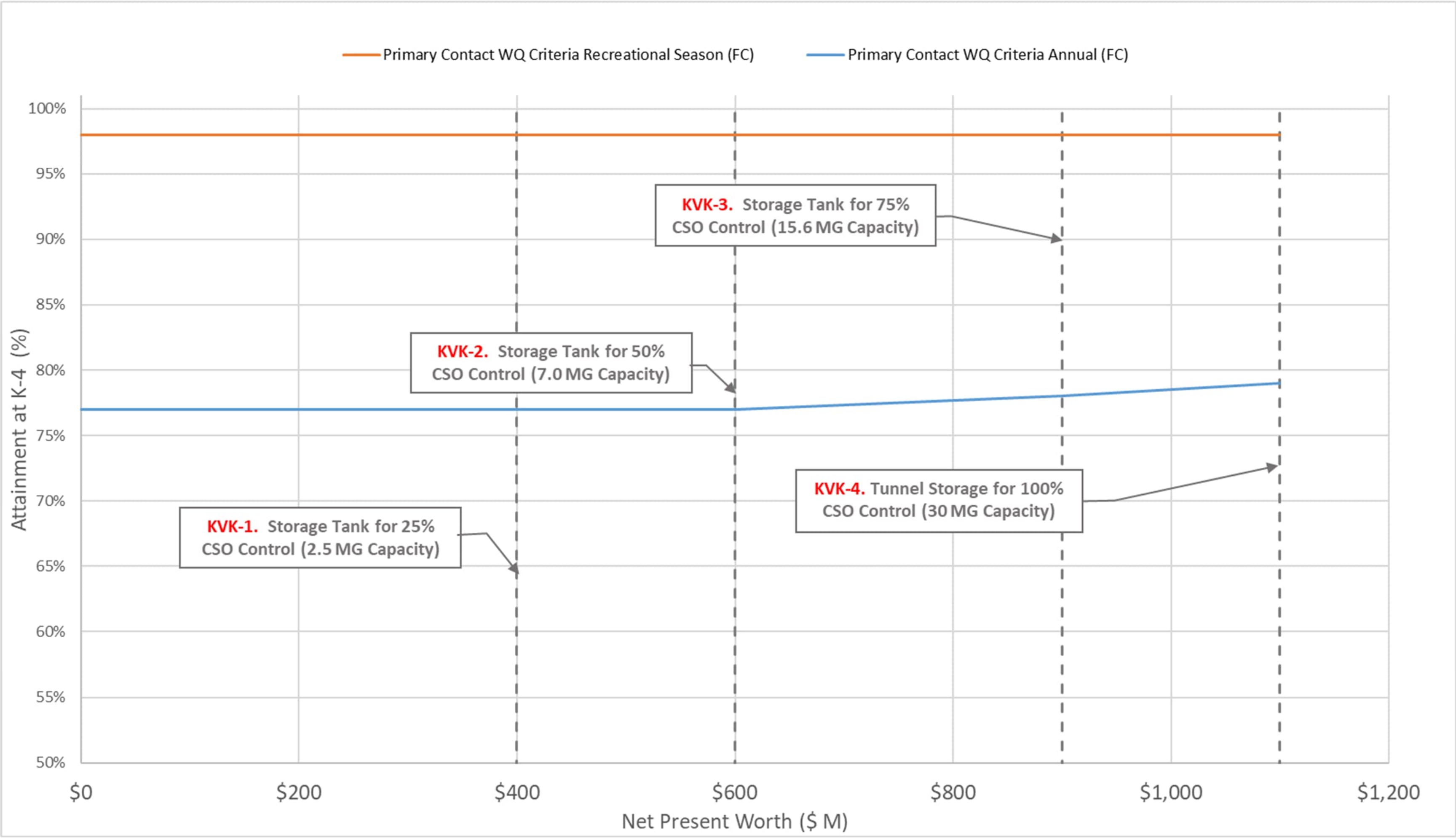


Figure 8.7-9. Cost vs. Bacteria Attainment at Class SD Station K-4

8.7.h Conclusion on Preferred Alternative

The selection of the preferred alternative for Kill Van Kull is based on multiple considerations including public input, environmental and water quality benefits, and projected costs. As described in Section 6, the reach of Kill Van Kull east of Newark Bay is achieving Class SD fecal coliform WQ criteria greater than 95 percent of the time under Baseline Conditions. For the reach along Newark Bay, attainment with the Class SD fecal coliform WQ criteria falls into the 80 to 95 percent range under both Baseline Conditions and 100 percent CSO control. Thus, the non-attainment in this reach is not due to NYC CSOs. Similarly, Baseline Conditions and 100 percent CSO control attainment of the Class SD fecal coliform criteria in Arthur Kill north of the Outerbridge Crossing Bridge is in the less than 70 to less than 95 percent range. Baseline Conditions and 100 percent CSO control attainment of the Class I fecal coliform criteria in Arthur Kill south of the Outerbridge Crossing Bridge is in the 90 to greater than 95 percent range. Therefore, the non-attainment in Arthur Kill is also not due to NYC CSOs.

As described above, none of the optimization alternatives evaluated for the CSOs discharging to Kill Van Kull from the Port Richmond WRRF system were found to either provide more than nominal CSO reduction, or to be hydraulically feasible. The CSO storage alternatives would provide a range of levels of CSO reduction to Kill Van Kull, but the costs associated with those alternatives are very high, and none of the storage alternatives would change the level of attainment with the applicable WQ criteria for fecal coliform. Section 9 presents affordability issues and impacts on disadvantaged communities that would come into play if the CSO program costs were to further significantly increase. Also, as presented below in the discussion of time to recovery, the duration of impacts of wet-weather events in Kill Van Kull is relatively short. For these reasons, none of the CSO storage alternatives was recommended.

In summary, no new CSO projects are recommended for Kill Van Kull. Water quality improvements will continue to be achieved through implementation of the GI program, as well as ongoing programmatic floatables control activities. The following conclusions can be drawn from these analyses:

1. Under Baseline Conditions, attainment with the Class SD WQ Criteria for fecal coliform is projected to be greater than 95 percent in Kill Van Kull east of Newark Bay annually and during the recreational season (May 1st through October 31st). Attainment with the Class SD WQ Criteria along Newark Bay falls into the 80 to 95 percent range under both Baseline Conditions and 100 percent CSO control, thus NYC CSOs are not causing the identified non-attainment.
2. Annual attainment with the Class SD WQ Criteria for fecal coliform in Arthur Kill north of the Outerbridge Crossing Bridge is in the less than 70 to less than 95 percent range under both Baseline Conditions and 100 percent CSO control. Annual attainment with the Class I WQ Criteria for fecal coliform in Arthur Kill south of the Outerbridge Crossing Bridge is in the 90 to greater than 95 percent range under both Baseline Conditions and 100 percent CSO control. Therefore, NYC CSOs are also not causing the non-attainment in Arthur Kill.
3. Under Baseline Conditions, attainment with the Class SD WQ Criteria for DO is greater than 95 percent in Kill Van Kull and Arthur Kill north of the Outerbridge Crossing Bridge on an annual average basis. In Arthur Kill south of the Outerbridge Crossing Bridge, attainment with the Class I WQ Criteria for DO falls into the 90 to 95 percent range under both Baseline Conditions and 100 percent CSO control. Therefore, NYC CSOs are not affecting the level of attainment with the applicable DO criteria in Kill Van Kull or Arthur Kill.

4. No hydraulically feasible or cost-effective alternatives were identified for the CSOs to Kill Van Kull.
5. The time to recovery analysis presented further below demonstrates that the duration of impact of the remaining CSOs is relatively low.

Figure 8.7-10 presents a mosaic of the level of attainment with the applicable WQ criteria for fecal coliform in Kill Van Kull and Arthur Kill on an annual basis, for the Recommended Plan, and Figure 8.7-11 presents a mosaic of the level of attainment for the recreational season (May 1st through October 31st). Figure 8.7-12 presents the level of attainment with the applicable WQ Criteria for DO on an average annual basis.

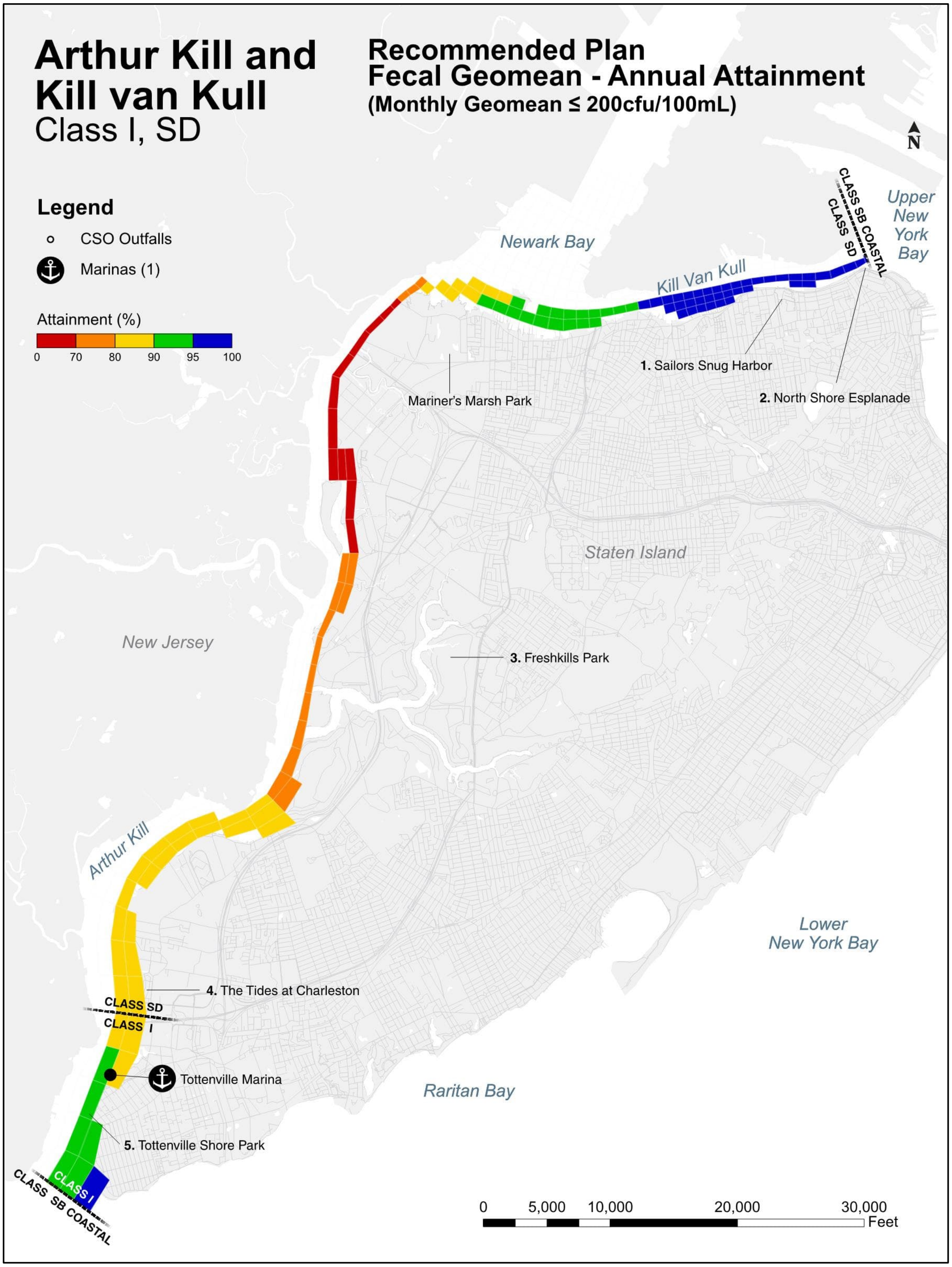


Figure 8.7-10. Fecal Coliform - Annual Attainment (10-year Runs), Kill Van Kull, Recommended Plan

Figure 8.7-11. Fecal Coliform – Recreational Season Attainment (10-year Runs), Kill Van Kull, Recommended Plan

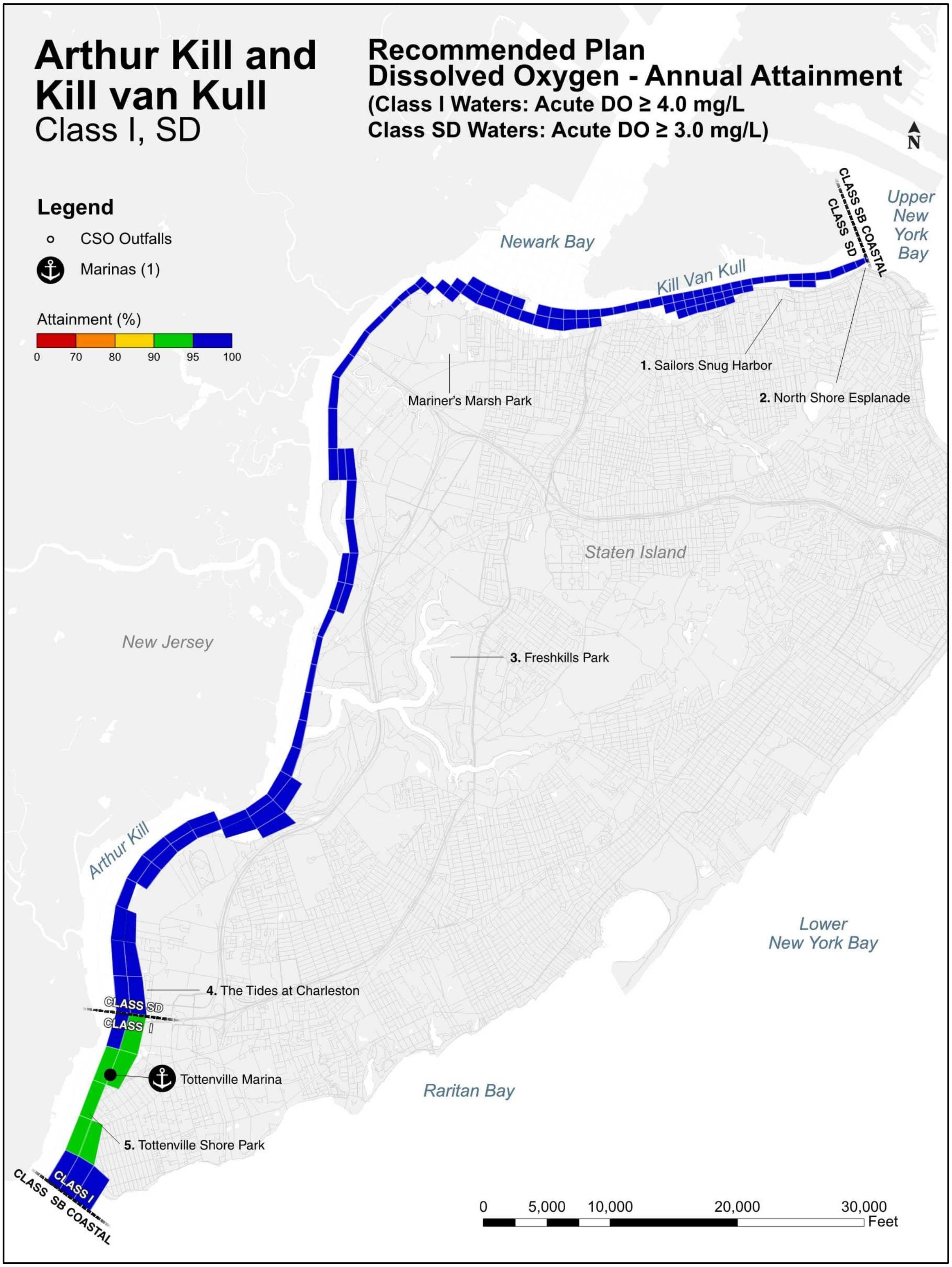


Figure 8.7-12. Annual Average DO Attainment, Arthur Kill and Kill Van Kull, Recommended Plan

Table 8.7-10 presents the fecal coliform maximum monthly geometric mean, and the percent of time that the fecal coliform WQ criteria would be attained on an annual basis and for the recreational season (May 1st through October 31st), for the 10-year simulation period, at locations within the Class SD waters of Kill Van Kull and the Class SD and Class I waters of Arthur Kill, with the Recommended Plan. The locations of the stations and supplemental model output locations listed in Table 8.7-10 are shown on Figure 8.7-13.

Table 8.7-10. Model Calculated 10-Year Fecal Coliform Maximum Monthly GM and Percent Attainment with Fecal Coliform WQ Criteria, Annual and Recreational Season, Kill Van Kull and Arthur Kill, Recommended Plan

	Maximum Monthly GMs (cfu/100mL)		% Attainment (GM ≤200 cfu/100mL)	
Description	**Annual**	**Recreational Season(1)**	**Annual**	**Recreational Season(1)**
Kill Van Kull (Class SD)				
KK-1	247	134	96%	100%
KK-2	243	134	96%	100%
KK-3	163	95	100%	100%
Mariners Marsh Park	428	237	86%	98%
Sailors Snug Harbor	183	106	100%	100%
Arthur Kill (Class SD)				
K3	647	456	60%	90%
K4	517	279	77%	98%
Arthur Kill (Class I)				
K5	339	142	93%	100%
Tottenville Marina	388	141	89%	100%

Note:
(1) The recreational season is from May 1st through October 31st.

Table 8.7-11 presents the average annual attainment of DO criteria for the 2008 typical year for the Recommended Plan at LTCP sampling locations in Kill Van Kull and Arthur Kill.

Table 8.7-11. 2008 Annual Average DO Attainment for Kill Van Kull and Arthur Kill, Recommended Plan

Station	2008 Annual Attainment (%) (Entire Water Column)
Kill Van Kull Class SD Instantaneous (≥3.0 mg/L)	
KK-1	100%
KK-2	100%
KK-3	100%
Arthur Kill Class SD Instantaneous (≥3.0 mg/L)	
K-3	100%
K-4	99%
Arthur Kill Class I Instantaneous (≥4.0 mg/L)	
K-5	94%

Note:
The recreational season is from May 1st through October 31st.

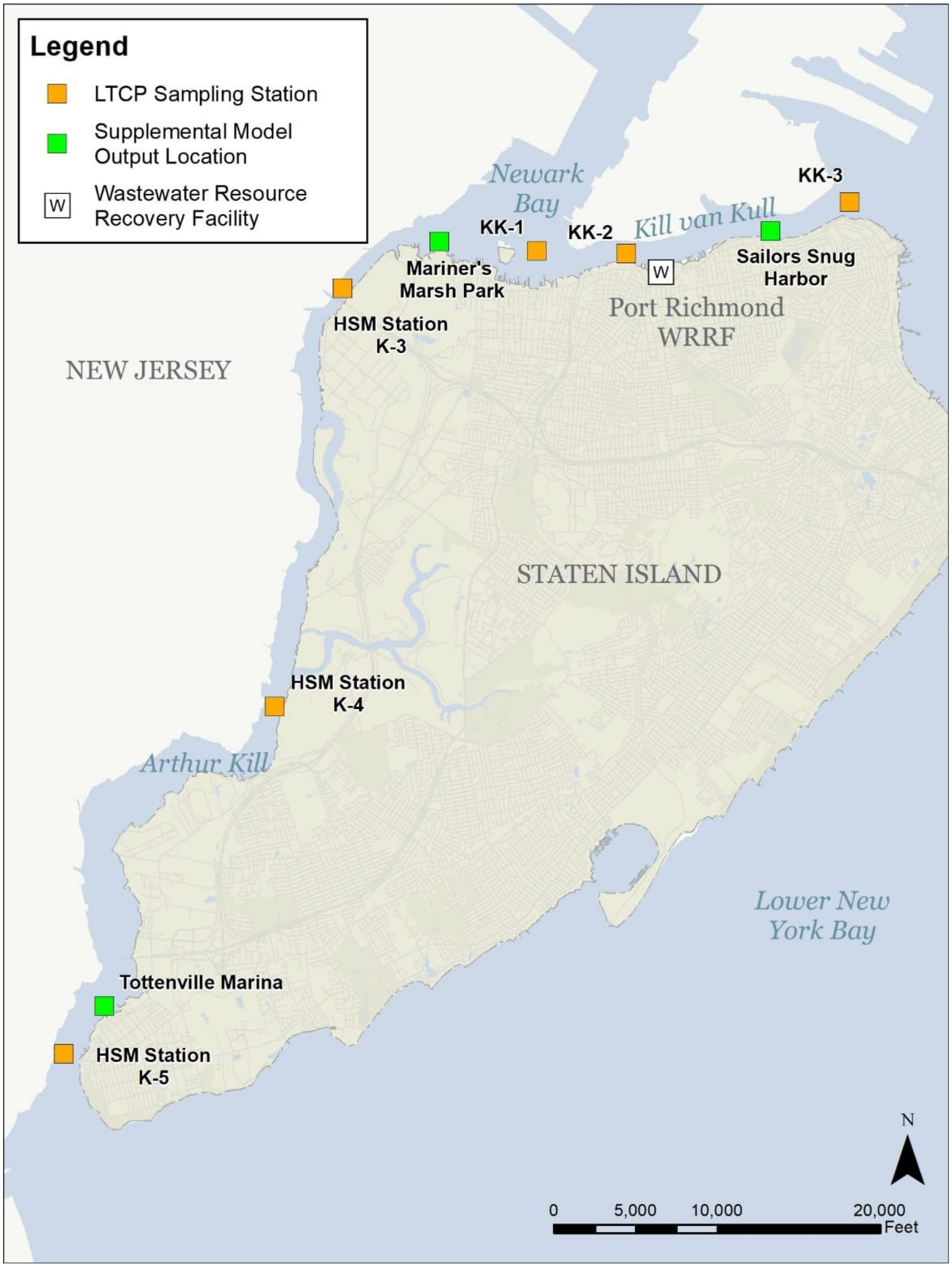


Figure 8.7-13. Sampling Stations and Supplemental Model Output Locations on Kill Van Kull and Arthur Kill

Recap

No projects are recommended for the CSO outfalls to Kill Van Kull that are associated with the Port Richmond WRRF as part of the Recommended Plan. No hydraulically feasible or cost-effective optimization alternatives were identified. While CSO storage alternatives were identified that would reduce the volume of CSO into Kill Van Kull, these alternatives carried high implementation costs, and would not improve the level of attainment with WQ criteria in Kill Van Kull or Arthur Kill. Programmatic GI and floatables control will continue to be implemented in the combined sewer areas tributary to Kill Van Kull.

With the Recommended Plan, attainment with WQ criteria is projected to be as follows:

- Attainment of the Class SD WQ Criteria for fecal coliform is projected to be greater than 95 percent in Kill Van Kull east of Newark Bay annually and during the recreational season (May 1st through October 31st).
- Attainment with the Class SD WQ Criteria along Newark Bay is projected to be in the 80 to 95 percent range on an annual basis, and greater than 95 percent during the recreational season (May 1st through October 31st).
- Annual attainment with the Class SD WQ Criteria for fecal coliform in Arthur Kill north of the Outerbridge Crossing Bridge is projected to be in the less than 70 to less than 95 percent range, while recreational season (May 1st through October 31st) attainment is projected to be in the 90 to greater than 95 percent range.
- Annual attainment with the Class I WQ Criteria for fecal coliform in Arthur Kill south of the Outerbridge Crossing Bridge is projected to be in the 80 to greater than 95 percent range for the Recommended Plan, while recreational season (May 1st through October 31st) attainment is projected to be greater than 95 percent.
- Attainment with the Class SD WQ Criteria for DO is projected to be greater than 95 percent in Kill Van Kull and Arthur Kill north of the Outerbridge Crossing Bridge on an annual average basis.
- Attainment with the Class I WQ Criteria for DO in Arthur Kill south of the Outerbridge Crossing Bridge is projected to be in the 90 to 95 percent range on an annual average basis.
- The gap analysis conducted in Section 6 demonstrates that the levels of attainment with WQ criteria in Kill Van Kull and Arthur Kill would not change with 100 percent control of the CSOs discharging to Kill Van Kull. The remaining non-attainment of WQ criteria in Kill Van Kull and Arthur Kill is due to non-NYC CSO sources.

8.7.i Use Attainability Analysis

The CSO Order requires that a UAA be included in an LTCP "where existing WQS do not meet the Section 101(a)(2) goals of the CWA, or where the proposed alternative set forth in the LTCP will not achieve existing WQS or the Section 101(a)(2) goals." The UAA shall "examine whether applicable waterbody classifications, criteria, or standards should be adjusted by the State." The UAA process specifies that States can remove a designated use that is not an existing use if the scientific assessment can demonstrate that attaining the designated use is not feasible for at least one of six reasons:

1. Naturally occurring loading concentrations prevent the attainment of the use; or

2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or
5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by Sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

As part of the LTCP, elements of a UAA, including the six conditions presented above, will be used to determine if changes to the designated use are warranted, considering a potential adjustment to the designated use classification as appropriate.

As noted in previous sections, with the implementation of the Recommended Plan, parts of Kill Van Kull and Arthur Kill will achieve less than 95 percent compliance with the Class SD WQ Criteria for fecal coliform, and parts of Arthur Kill will achieve less than 95 percent compliance with the Class I WQ Criteria for fecal coliform and DO. Therefore, a Use Attainability Analysis is needed for Kill Van Kull and Arthur Kill.

8.7.i.1 Use Attainability Analysis Elements

The objectives of the CWA include providing for the protection and propagation of fish, shellfish, wildlife, and recreation in and on the water. Cost-effectively maximizing the water quality benefits associated with CSO reduction is a cornerstone of this LTCP.

To simplify this process, DEP and DEC have developed a framework that outlines the steps taken under the LTCP in two possible scenarios:

1. Waterbody meets WQ requirements. This may either be the existing WQS (where primary contact is already designated) or for an upgrade to the Primary Contact WQ Criteria (where the existing standard is not a Primary Contact WQ Criteria). In either case, a high-level assessment of the factors that define a given designated use is performed, and if the level of CSO control required to meet this goal can be reasonably implemented, a change in designation may be pursued following implementation of CSO controls and Post-Construction Compliance Monitoring.

2. Waterbody does not meet WQ requirements. In this case, if a higher level of CSO control is not feasible, the UAA must justify the shortcoming using at least one of the six criteria (see Section 8.7.i above). It is assumed that if 100 percent elimination of CSO sources does not result in attainment, the UAA would include factor number 3 at a minimum as justification (human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied, or would cause more environmental damage to correct than to leave in place).

As indicated in Table 8.7-10 and Table 8.7-11, the modeled attainment of the Class SD and Class I WQ Criteria for fecal coliform and the Class I DO criteria will not be fully achieved upon implementation of the LTCP Recommended Plan. Future revisions of the Kill Van Kull and Arthur Kill WQ classification should await the results of the Post-Construction Compliance Monitoring.

8.7.j Fishable/Swimmable Waters

The goal of this LTCP is to identify appropriate CSO controls necessary to achieve waterbody-specific WQS, consistent with EPA's CSO Control Policy and subsequent guidance. DEC considers that compliance with Class SD WQS, the current classification for Kill Van Kull, and Arthur Kill north of Outerbridge Crossing Bridge, and compliance with Class I WQS, the current classification for Arthur Kill south of Outerbridge Crossing Bridge, as fulfillment of the CWA's fishable/swimmable goal.

The preferred alternative summarized in Section 8.7.h results in the levels of attainment with fishable/swimmable criteria as follows:

- For the 10-year continuous simulation, summarized in Table 8.7-10, attainment of the Class SD WQ Criteria for fecal coliform is not predicted to be met on an annual basis in Kill Van Kull or Arthur Kill, and is not predicted to be met in Arthur Kill for the recreational season (May 1st through October 31st). Attainment of the Class I WQ Criteria for fecal coliform is not predicted to be met on an annual basis in Arthur Kill.
- Based on the 2008 typical year simulations, as summarized in Table 8.7-11, the Recommended Plan would not achieve full attainment of the Class I DO criteria in Arthur Kill on an annual average basis.

8.7.k Assessment of Highest Attainable Use

The 2012 CSO Order Goal Statement stipulates that, in situations where the proposed alternatives presented on the LTCP will not achieve the CWA Section 101(a)(2) goals, the LTCP will include a UAA. Because the analyses developed herein indicate that Kill Van Kull and Arthur Kill north of the Outerbridge Crossing Bridge are not projected to fully attain the Class SD WQ Criteria for fecal coliform, and that Arthur Kill south of the Outerbridge Crossing Bridge is not projected to fully meet the Class I WQ Criteria for bacteria or DO, a UAA is required under the 2012 CSO Order. Table 8.7-12 summarizes the compliance for the identified plan.

Table 8.7-12. Recommended Plan Compliance with Water Quality Criteria

<table>
<tr><th colspan="2">Compliance with Class SD Fecal Coliform Criteria Monthly GM (≤ 200 mg/L) 10-year Simulation[1]</th><th>Compliance with Class SD DO Criteria (≥ 3.0 mg/L) 2008 Typical Year[1]</th></tr>
<tr><th>Annual</th><th>Recreational Season[1]</th><th>Annual</th></tr>
<tr><td colspan="3">Kill Van Kull</td></tr>
<tr><td>96-100%</td><td>100%</td><td>100%</td></tr>
<tr><td colspan="3">Arthur Kill North of Outerbridge Crossing Bridge</td></tr>
<tr><td>60-94%</td><td>90-98%</td><td>100%</td></tr>
<tr><th colspan="2">Compliance with Class I Fecal Coliform Criteria Monthly GM (≤ 200 mg/L) 10-year Simulation[1]</th><th>Compliance with Class I DO Criteria (≥ 4.0 mg/L) 2008 Typical Year[1]</th></tr>
<tr><th>Annual</th><th>Recreational Season[1]</th><th>Annual</th></tr>
<tr><td colspan="3">Arthur Kill South of Outerbridge Crossing Bridge</td></tr>
<tr><td>80-95%</td><td>95-100%</td><td>90-100%</td></tr>
</table>

Notes:
(1) Range of attainment based on values at stations shown in Table 8.7-10 and Table 8.7-11 above.
(2) Recreational season is from May 1st through October 31st.

8.7.l Time to Recovery

As noted above, Kill Van Kull and Arthur Kill north of the Outerbridge Crossing Bridge are Class SD waterbodies, and Arthur Kill south of Outerbridge Crossing Bridge is a Class I waterbody. The applicable Water Quality Criteria for fecal coliform bacteria for these waterbodies are based on a monthly geometric mean. However, to gain insight into the shorter-term impacts of wet-weather sources of bacteria, DEP has performed an analysis to assess the amount of time following the end of a rainfall event required for Kill Van Kull and Arthur Kill to recover and return to fecal coliform concentrations less than 1,000 cfu/100mL.

The analyses consisted of examining the WQ model-calculated bacteria concentrations in Kill Van Kull and Arthur Kill for recreational periods (May 1st through October 31st) abstracted from 10 years of model simulations. For Kill Van Kull and Arthur Kill, the JFK Airport rainfall data was compared against water quality model bacteria results for the 10 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. The chosen target threshold concentration was 1,000 cfu/100mL for fecal coliform. The various rainfall events were then placed into rain event size "bins" ranging from less than 0.1 inch to greater than 1.5 inches. Only rain events that reached the target threshold concentrations before the beginning of the next storm were included. The median time to recovery for each bin at each water quality station was calculated. Table 8.7-13 presents the time to recovery for the baseline condition for Kill Van Kull and Arthur Kill. Results are presented for the greater than 1.0 to 1.5 inch rainfall bin, which includes the 90th percentile event.

DEC has advised that it seeks to have a time to recovery of less than 24 hours, and this target has been consistent in the previously approved LTCPs. As indicated in Table 8.7-13, for the Recommended Plan, all of the stations assessed had median time to recovery of less than three hours, and most of the stations had median time to recovery of zero hours, indicating that the fecal coliform concentration never reached the level of 1,000 cfu/100mL for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

Table 8.7-13. Kill Van Kull and Arthur Kill Time to Recovery, Fecal Coliform, Recommended Plan

Location	Time to Recovery (hours) Fecal Coliform Threshold (1,000 cfu/100mL)[1]
Kill Van Kull (Class SD)	
KK-1	0[2]
KK-2	0
KK-3	0
Mariners Marsh Park	0
Sailors Snug Harbor	0
Arthur Kill (Class SD)	
K-3	2
K-4	0
Arthur Kill (Class I)	
K-5	0
Tottenville Marina	0

Notes:

(1) Median time to recovery values presented for storms from the 10-year simulation, recreational seasons, in the size range of >1.0 to 1.5-inches of rainfall, which includes the 90th percentile rain event.

(2) Median time to recovery of "0" means that the average concentration across the water column never reached the 1,000 cfu/100mL threshold at the referenced station for more than half of the storms within the 1-to-1.5 inch rainfall bin assessed.

8.7.m Recommended LTCP Elements to Meet Water Quality Goals for Kill Van Kull

The actions identified in this LTCP include:

- DEP will continue to implement the Green Infrastructure Program and programmatic floatables control activities for Kill Van Kull.
- Compliance with Class SD WQ Criteria for fecal coliform in portions of Kill Van Kull and Arthur Kill; compliance with Class I WQ Criteria for fecal coliform in portions of Arthur Kill; compliance with Class SD WQ Criteria for DO in Kill Van Kull and Arthur Kill, and compliance with Class I WQ Criteria for DO in portions of Arthur Kill. However, full attainment of the Class SD and Class I fecal coliform criteria, and the Class I DO criteria will not be achieved. As a result, a UAA is required as part of this LTCP.

- DEP will establish with the DOHMH (through public notification) a wet-weather advisory for the recreational season (May 1st through October 31st) during which recreational activities would not be recommended in Kill Van Kull and Arthur Kill. The LTCP includes a recovery time analysis that can be used to establish the duration of the wet-weather advisory for public notification.

DEP is committed to improving water quality in this waterbody, which will be advanced by the improvements and actions identified in this LTCP. These identified actions have been balanced with input from the public and awareness of the cost to the residents of NYC.

8.8 Summary of Recommended Plan

Sections 8.3 to 8.7 above presented the evaluations and conclusions regarding the components of the Citywide/Open Waters LTCP Recommended Plan for the Harlem River, Hudson River, East River/Long Island Sound, New York Bay, and Kill Van Kull, respectively. Table 8.8-1 summarizes the components, annual CSO volume reduction, and Probable Bid Cost (PBC) for the Recommended Plan by waterbody.

Table 8.8-1.Summary of Recommended Plan Components

Waterbody	Recommended Plan Description	Annual Net Untreated CSO Volume Reduction (MG)(1)	Probable Bid Cost ($M)(2)
Harlem River	No CSO project recommended(3)	0	$0
Hudson River	HUD-2: Enlargement of regulator orifice openings at Regulators NR-26A, 28, and 29A associated with Outfalls NR-040, 038, and 046, respectively.	7	$3
East River/Long Island Sound	ER-6: Enlargement of the regulator orifice opening on Regulator TI-10B (CSO TI-003), enlargement of the branch interceptor downstream of Regulator TI-10B, and installation of a bending weir at Regulator TI-13 (CSO TI-023).	86	$6
New York Bay	NYB-1: Modifying the weir at Regulator RH-020A (CSO RH-005), increasing the regulator orifice opening, modifying the weir, and enlarging the branch interceptor connection at Regulator RH-13 (CSO RH-014). NYB-2: Installing a bypass connection on the Victory Boulevard combined sewer upstream of Regulator 17 (CSO PR-013). This connection would divert dry-weather flow and a portion of the wet-weather flow directly to the East Interceptor by gravity. NYB-3: Installing a control gate in Regulator 9C (CSO OH-015), to keep more wet-weather flow in the upper of the two combined sewer conduits entering the regulator.	132	$33
Kill Van Kull	No CSO project recommended(4)	0	$0
Totals		225	$42

Notes:

(1) Based on 2008 Typical Year.
(2) AACE International Level 5 cost estimates, in 2019 dollars.
(3) Tibbetts Brook Daylighting project is included under the Green Infrastructure Program as part of the LTCP Baseline Conditions. The project is estimated to reduce CSO volume to Harlem River by 228 MGY.
(4) No feasible optimization alternatives were identified for Kill Van Kull. Storage alternatives had high cost, and would not change the level of attainment with WQS.

As indicated in Table 8.8-1, the Recommended Plan is predicted to reduce annual CSO volume by 225 MG, at a PBC of $42M. As also noted in Table 8.8-1, the Tibbetts Brook Daylighting project, which is included in the Baseline Conditions, is estimated to also reduce annual CSO volume to the Harlem River by 228 MGY. The implementation schedule for the Recommended Plan is presented in Section 9.

Table 8.8-2 summarizes the status of projected WQ criteria compliance for the Recommended Plan. As indicated in Table 8.8-2, most WQ criteria are projected to be attained in most Open Waters waterbodies under the Recommended Plan. As described in Section 8.7 above, the non-attainment with the WQ criteria for fecal coliform in Kill Van Kull and Arthur Kill is attributable to non-NYC CSO sources. The gap analysis showed that a condition of No NYC CSO Loads for Kill Van Kull would not result in attainment of the criteria, and the load component analysis showed that the non-attainment was driven by sources from outside of NYC. Similarly, the non-attainment with the WQ criteria for DO in the Class I reach of Arthur Kill is also attributable to sources from outside of NYC. Attainment of the Class SB Coastal Primary Recreational *Enterococci* STV criteria in New York Bay could generally be achieved with a 50 percent CSO control storage alternative, at an un-escalated PBC of $3,000M. Within New York Bay, the median time to recovery to a fecal coliform level of 1,000 cfu/100mL for storms in the 1 to 1.5 inch range at all of the stations assessed except for NB-7 and NB-9 was zero hours, indicating that the fecal coliform concentration never reached the level of 1,000 cfu/100mL for more than half of the storms assessed. Median times to recovery for Stations NB-7 and NB-9 were eight hours or less. Median time to recovery to an *Enterococci* level of 130 cfu/100mL was similarly less than 12 hours at all stations assessed and was zero at many of the stations. Given the extremely high cost and implementation challenges associated with the tunnel storage alternatives for New York Bay, the relatively short time to recovery, and affordability issues identified in Section 9, an alternative to meet the Class SB Coastal Primary Recreational *Enterococci* STV criteria in New York Bay was not recommended.

As described in Sections 8.6 and 8.7, a UAA is required under the 2012 CSO Order for the following cases:

- New York Bay is not projected to fully attain the Class SB Coastal Primary Recreational *Enterococci* STV criteria or the Class SB DO criteria. Sources from outside of NYC are the driver for non-attainment of the Class SB DO criteria.
- Kill Van Kull and Arthur Kill north of the Outerbridge Crossing Bridge are not projected to fully attain the Class SD WQ criteria for fecal coliform. Sources from outside of NYC are the driver for non-attainment of the Class SD QW criteria for fecal coliform.
- Arthur Kill south of the Outerbridge Crossing Bridge is not projected to fully meet the Class I WQ criteria for fecal coliform or DO. Sources from outside of NYC are the driver for non-attainment of these criteria.

To provide perspective on the scope and costs associated with alternatives to provide higher levels of CSO control to the Open Waters waterbodies, Table 8.8-3 provides a summary of the volume of storage required and the estimated costs to provide 25, 50, 75, and 100 percent levels of CSO control by waterbody for the Open Waters waterbodies. The total PBC values from Table 8.8-3 are plotted against percent CSO control in Figure 8.8-1.

As indicated in Table 8.8-3 and Figure 8.8-1, the cost to provide even 25 percent CSO control for the Open Waters waterbodies is over $4B. In light of the high level of attainment with WQ criteria found throughout the Open Waters with limited exceptions, this LTCP focused on optimization alternatives. Cumulatively, these optimization projects will cost-effectively reduce CSO volume system-wide by 225 MG. These projects, in addition to ongoing programmatic GI and floatables control activities, including the Tibbetts Brook Daylighting project, will continue to provide improvements to water quality in the Open Waters waterbodies.

Table 8.8-2. Summary of Water Quality Criteria Compliance with Recommended Plan

Waterbody	**WQS Classification**	**Attainment with Criteria[1]**				
		Fecal Coliform Monthly GM≤200 CFU/100mL		***Enterococci* 30-day GM≤35 cfu/100mL[3]**	***Enterococci* 30-day STV≤130 cfu/100mL[3]**	**DO Annual Average Attainment[4]**
		Annual	**Recreational Season[2]**	**Recreational Season[2]**	**Recreational Season[2]**	**Annual**
Harlem River	Class I	Yes	Yes	N/A	N/A	Yes
Hudson River (North of Harlem River)	Class SB	Yes	Yes	N/A	N/A	Yes
Hudson River (South of Harlem River)	Class I	Yes	Yes	N/A	N/A	Yes
Long Island Sound (East of Throgs Neck Bridge)	Class SB Coastal Primary Recreational	Yes	Yes	Yes	Yes	Yes
East River (between Whitestone Bridge and Throgs Neck Bridge)	Class SB	Yes	Yes	N/A	N/A	Yes
East River (West of Whitestone Bridge)	Class I	Yes	Yes	N/A	N/A	Yes
New York Bay	Class SB Coastal Primary Recreational	Yes	Yes	Yes[5]	No	No[5]
Arthur Kill (South of Outerbridge Crossing Bridge)	Class I	No[6]	Yes	N/A	N/A	No[6]
Arthur Kill (North of Outerbridge Crossing Bridge)	Class SD	No[6]	No[6]	N/A	N/A	Yes
Kill Van Kull	Class SD	No[6]	Yes	N/A	N/A	Yes

Table 8.8-2. Summary of Water Quality Criteria Compliance with Recommended Plan

Waterbody	WQS Classification	Attainment with Criteria(1)				
		Fecal Coliform Monthly GM≤200 CFU/100mL		*Enterococci* 30-day GM≤35 cfu/100mL(3)	*Enterococci* 30-day STV≤130 cfu/100mL(3)	DO Annual Average Attainment(4)
		Annual	Recreational Season(2)	Recreational Season(2)	Recreational Season(2)	Annual

Notes:

(1) "**Yes**" means ≥95% attainment with the criteria. "**No**" means <95% attainment with the criteria. Attainment based on 10-year model simulation.
(2) Recreational season is May 1st through October 31st.
(3) *Enterococci* criteria apply only to coastal primary recreational waters; N/A = Not applicable.
(4) DO criteria:
    a. Class SB acute ≥3 mg/L; chronic ≥ range of 3 to 4.8 mg/L (see Section 6 for more details on Class SB chronic criteria)
    b. Class I ≥4 mg/L
    c. Class SD ≥3 mg/L
(5) Only the area around Station K5A off the southwest end of Staten Island is out of compliance with the Class SB DO criteria. No NYC CSOs are in the vicinity of this location. A condition of No NYC CSO Loads would not achieve attainment with the criteria, and the load component analysis in Section 6 demonstrated that the non-attainment is driven by sources from outside of NYC.
(6) A condition of No NYC CSO Loads would not achieve attainment with the criteria, and the load component analysis in Section 6 demonstrated that the non-attainment is driven by sources from outside of NYC.

Table 8.8-3. Summary of Storage Volume Required and PBC for 25, 50, 75, and 100 Percent CSO Control for Open Waters Waterbodies

	25% CSO Control		50% CSO Control		75% CSO Control		100% CSO Control	
Waterbody	**Volume of Storage (MG)**	**PBC(1)**	**Volume of Storage (MG)**	**PBC(1)**	**Volume of Storage (MG)**	**PBC(1)**	**Volume of Storage (MG)**	**PBC(1)**
Harlem River	20	$800	130	$1,900	190	$3,200	269	$8,000
Hudson River	14	$600	79	$1,500	114	$2,900	142	$5,500
East River/Long Island Sound	71	$1,500	367	$4,700	526	$8,000	738	$18,200
New York Bay	22	$900	156	$2,900	253	$4,300	361	$8,500
Kill Van Kull	2.5	$300	7	$500	16	$800	30	$1,000
Totals	**129.5**	**$4,100**	**739**	**$11,500**	**1,099**	**$19,200**	**1,540**	**$41,200**

Note:
(1) AACE International Level 5 cost estimates, in 2019 dollars. Costs do not include land acquisition.

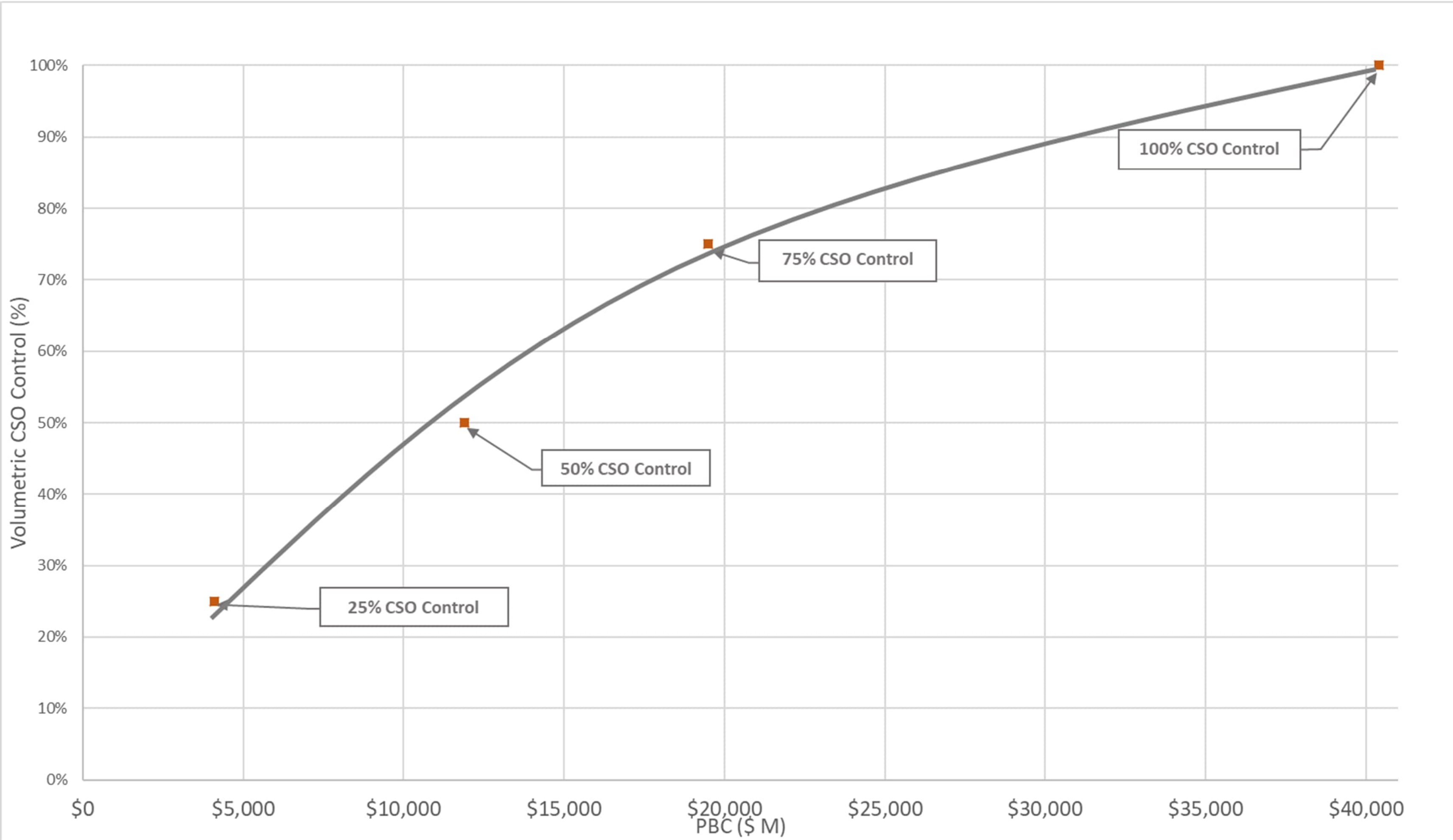


Figure 8.8-1. PBC vs. Percent CSO Control System-wide for Open Waters Waterbodies

Attachment G

Revised Section 9 LTCP Implementation

9.0 LONG TERM CSO CONTROL PLAN IMPLEMENTATION

The evaluations performed for this Citywide/Open Waters LTCP concluded that under baseline conditions, the Harlem River, Hudson River, and East River are in full attainment with applicable bacteria and DO WQ Criteria. New York Bay, Arthur Kill, and Kill Van Kull have segments where applicable bacteria and DO WQ Criteria cannot be attained. After thorough analysis, it is clear that even under the theoretical case of no NYC CSO loads, New York Bay, Arthur Kill, and Kill Van Kull would not achieve full WQ Criteria attainment. The predominant loadings for these waterbodies are from outside of NYC.

Water quality in Citywide/Open Waters will be improved through the implementation of the following:

(1) Recommended Plan projects from the approved and pending LTCPs described in Section 4 of this LTCP;

(2) Constructed and planned GI projects in combined sewer areas including the Tibbetts Brook Daylighting Project described in Section 5;

(3) Programmatic floatables control activities; and

(4) The Recommended Plan for the Citywide/Open Waters LTCP, which includes the following projects:

- Optimization of regulators associated with Outfalls NR-038, NR-040, and NR-046 which discharge to the Hudson River;
- Bending weir at Outfall TI-023 plus optimization of the regulator associated with Outfall TI-003 which discharge to the East River;
- Optimization of regulators associated with Outfalls RH-005 and RH-014 which discharge to New York Bay;
- Gravity flow connection from the Victory Boulevard combined sewer to the East Interceptor, bypassing Hannah Street Pumping Station and diverting dry- and wet-weather flow upstream of Outfall PR-013, which discharges to New York Bay; and
- Control gate at Regulator 9C, associated with Outfall OH-015 which discharges to New York Bay.

Figure 9-1 illustrates the elements of the Citywide/Open Waters LTCP Recommended Plan.

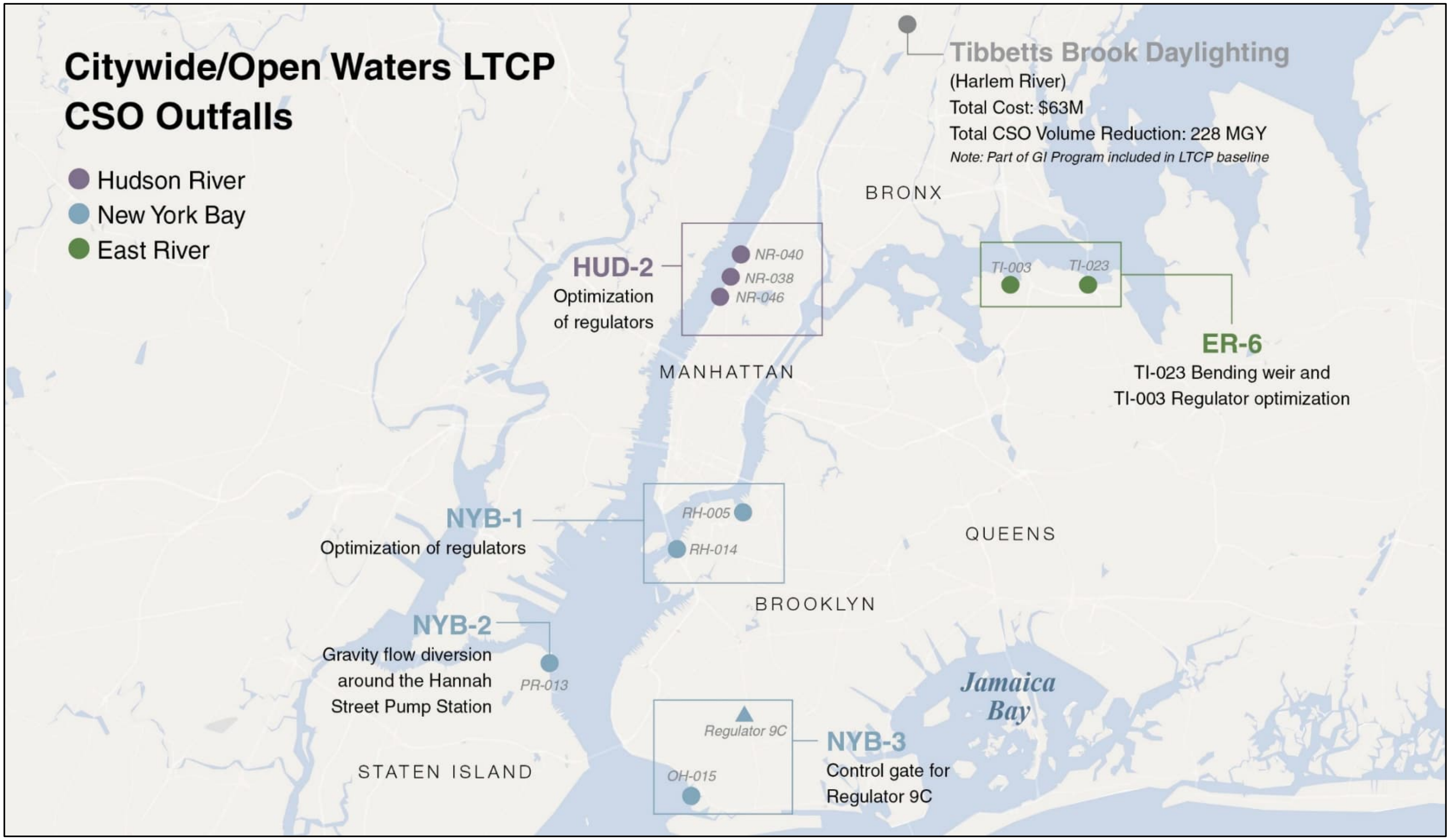


Figure 9-1. Overview of the Recommended Plan

Note: The Tibbetts Brook Daylighting Project is considered part of the Baseline Conditions for the Citywide/Open Waters LTCP.

9.1 Adaptive Management (Phased Implementation)

Adaptive management, as defined by the EPA, is the process by which new information about the characteristics of a watershed is incorporated into a watershed management plan on a continuing basis. The process relies on establishing a monitoring program, evaluating monitoring data and trends, and making adjustments or changes to the plan. DEP will continue to apply the principles of adaptive management to this LTCP based on its annual evaluation of monitoring data, which will be collected to sustain the operation and analyze the effectiveness of the currently operational CSO controls.

NYC is implementing a program to address stormwater discharges as part of its City-wide MS4 Permit. This Stormwater Management Program (SWMP), along with the actions identified in this LTCP, may further improve water quality in the Citywide/Open Waters waterbodies. For more information on the City's MS4 Program, please visit nyc.gov/dep/ms4.

DEP will also continue to monitor the water quality of the Harlem River, Hudson River, East River, New York Bay, Arthur Kill, and Kill Van Kull through its ongoing HSM and SM Programs, as discussed in Section 2.0. For example, if evidence of dry-weather sources of pollution is found, DEP will initiate investigations to identify the source. Such activities will continue to be reported to DEC on a quarterly basis, as is currently required under the SPDES permits for each of the WRRFs with permitted CSO outfalls that may discharge during wet-weather to the Open Waters waterbodies.

9.2 Implementation Schedule

The implementation schedules for the elements of the Citywide/Open Waters LTCP Recommended Plan are presented in Figure 9-2. The schedule presents the estimated time needed to conduct facility planning, procure design consultants, perform the engineering design, advertise and bid the construction contracts, and complete the construction of the actions identified in this LTCP. The schedules represent our best estimate at this conceptual level given the size, complexity, and access coordination needed to support the projects. ~~In light of the 2020 COVID-19 pandemic and associated declarations of state and national emergencies (referred to hereinafter as "COVID-19"), the timing for LTCP schedules and initiation of the projected schedule proposed herein may ultimately be impacted. Pending DEC review and approval, DEP will seek to work with DEC to determine the appropriate start date for this recommended plan schedule as part of a balanced approach for capital investments to avoid unduly limiting DEP's ability to make sound investments in existing infrastructure. COVID-19 considerations and prioritization of future investments are further discussed in Section 9.8 and Section 9.9.~~

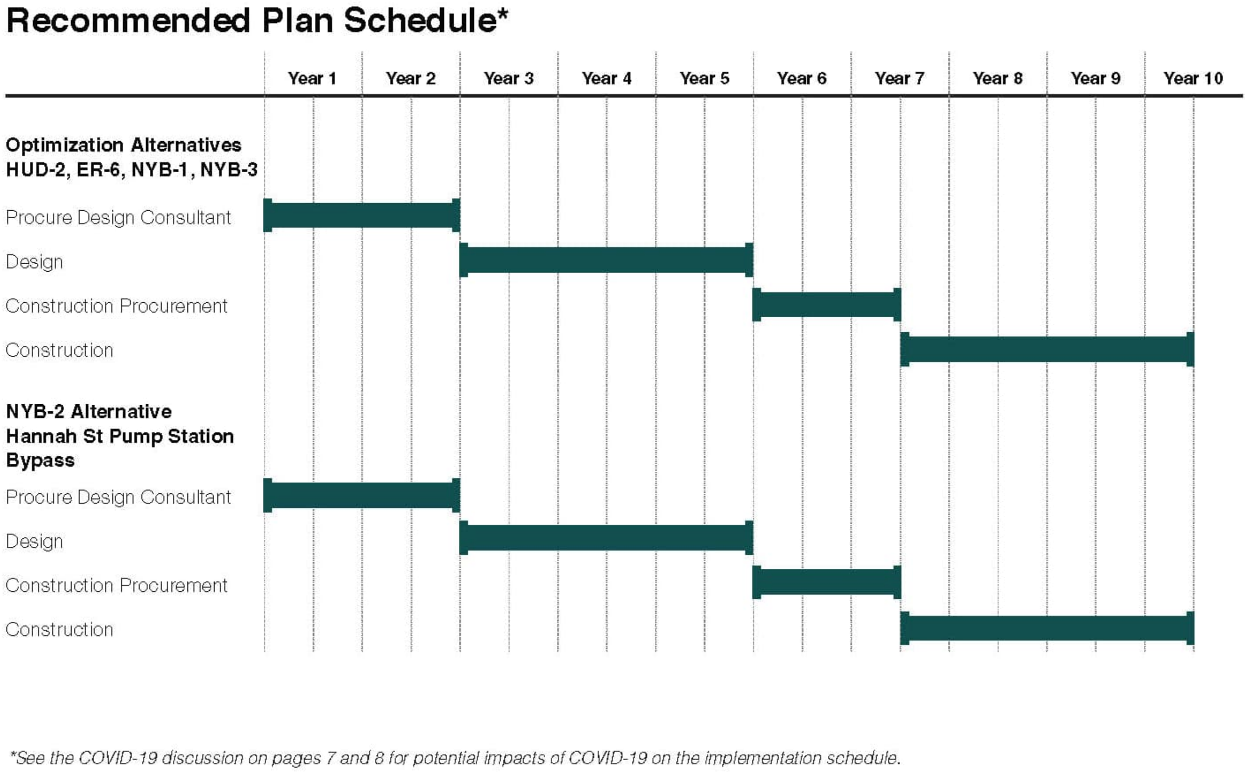


Figure 9-2. Implementation Schedule

9.3 Operational Plan/Operations & Maintenance (O&M)

DEP is committed to effectively incorporating Citywide/Open Waters LTCP components into the grey and green improvement projects currently built and planned under DEP's CSO Program. Program specific O&M plans will be developed for the proposed Citywide/Open waters LTCP Recommended Plan grey projects ~~elements~~.

9.4 Projected Water Quality Improvements

As described in detail throughout Section 8 and summarized in Figure 9-3, the Recommended Plan will have a net reduction in CSO volume and activations, further improving water quality within the waterbodies of the Citywide/Open Waters LTCP.

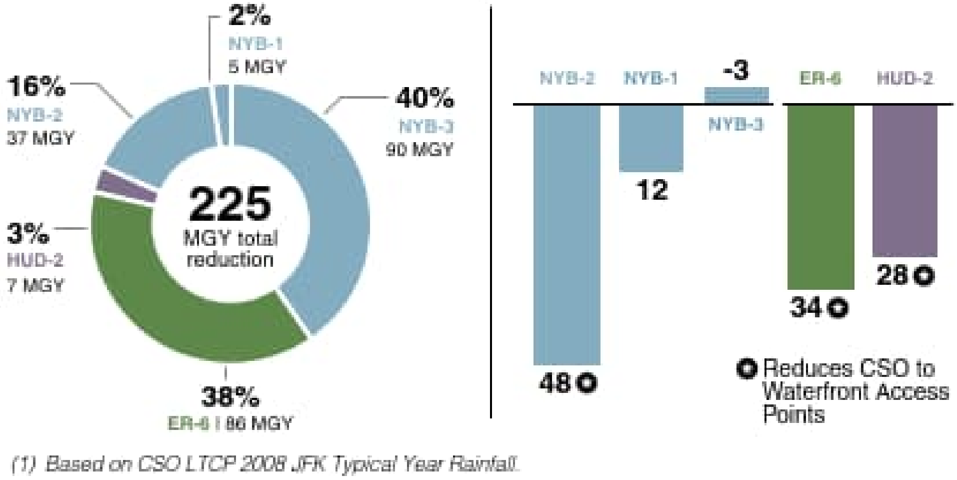


Figure 9-3. Benefits of the Recommended Plan

9.5 Post-Construction Monitoring Plan and Program Reassessment

Ongoing DEP monitoring programs such as the HSM and SM Programs will provide water quality data. DEP will conduct PCM for a period of time after the construction of the elements of the Recommended Plan is completed to assess effectiveness in terms of water quality improvements and CSO reductions.

9.6 Consistency with Federal CSO Control Policy

The Citywide/Open Waters LTCP was developed to comply with the requirements of the EPA CSO Control Policy and associated guidance documents, and the CWA.

The selection of the Recommended Plan was based on multiple considerations including public input, environmental benefits, cost effectiveness, community and societal impacts, and issues related to implementation and operation and maintenance. Table 9-1 presents the projected WQ Criteria attainment for the Citywide/Open Waters Recommended Plan.

Table 9-1. Summary of Water Quality Criteria Compliance with Recommended Plan

Waterbody	WQS Classification	Attainment with Criteria[1]				
		Fecal Coliform Monthly GM≤200 CFU/100mL		*Enterococci* 30-day GM≤35 cfu/100mL[3]	*Enterococci* 30-day STV≤130 cfu/100mL[3]	DO Annual Average Attainment[4]
		Annual	Recreational Season[2]	Recreational Season[2]	Recreational Season[2]	Annual
Harlem River	Class I	Yes	Yes	N/A	N/A	Yes
Hudson River (North of Harlem River)	Class SB	Yes	Yes	N/A	N/A	Yes
Hudson River (South of Harlem River)	Class I	Yes	Yes	N/A	N/A	Yes
Long Island Sound (East of Throgs Neck Bridge)	Class SB Coastal Primary Recreational	Yes	Yes	Yes	Yes	Yes
East River (between Whitestone Bridge and Throgs Neck Bridge)	Class SB	Yes	Yes	N/A	N/A	Yes
East River (West of Whitestone Bridge)	Class I	Yes	Yes	N/A	N/A	Yes
New York Bay	Class SB Coastal Primary Recreational	Yes	Yes	Yes	No	No[5]
Arthur Kill (South of Outerbridge Crossing Bridge)	Class I	No[6]	Yes	N/A	N/A	No[6]
Arthur Kill (North of Outerbridge Crossing Bridge)	Class SD	No[6]	No[6]	N/A	N/A	Yes
Kill Van Kull	Class SD	No[6]	Yes	N/A	N/A	Yes

Table 9-1. Summary of Water Quality Criteria Compliance with Recommended Plan

Waterbody	WQS Classification	Attainment with Criteria[1]				
		Fecal Coliform Monthly GM≤200 CFU/100mL		*Enterococci* 30-day GM≤35 cfu/100mL[3]	*Enterococci* 30-day STV≤130 cfu/100mL[3]	DO Annual Average Attainment[4]
		Annual	Recreational Season[2]	Recreational Season[2]	Recreational Season[2]	Annual

Notes:

(1) "**Yes**" means ≥95% attainment with the criteria. "**No**" means <95% attainment with the criteria. Attainment based on 10-year model simulation.

(2) Recreational season is May 1st through October 31st.

(3) *Enterococci* criteria apply only to coastal primary recreational waters; N/A = Not applicable.

(4) DO criteria:

   a. Class SB acute ≥3 mg/L; chronic ≥ range of 3 to 4.8 mg/L (see Section 6 for more details on Class SB chronic criteria)

   b. Class I ≥4 mg/L

   c. Class SD ≥3 mg/L

(5) Only the area around Station K5A in Raritan Bay off the southwest end of Staten Island is out of compliance with the Class SB DO criteria. No NYC CSOs are in the vicinity of this location, and 100% CSO control of NYC CSOs would not achieve attainment with the criteria.

(6) Additional loads outside of NYC prevent full attainment of WQS. 100% CSO control of NYC CSOs would not achieve attainment with the criteria.

9.6.a Introduction to Affordability and Financial Capability

DEP operates an approximately $4B annual budget to support our mission, which is almost entirely funded by our ratepayers. This section provides an overview of DEP historical and future spending, a background on our rate increases, and the socioeconomic challenges of our communities. As DEP plans future investments, it must balance many objectives and take affordability into consideration for our customers. This section includes application of existing EPA financial capability guidance and provides supplemental metrics to highlight affordability considerations in NYC including income inequality, high cost of living, and high prevalence of households living in poverty. Future investments must take these considerations into account as DEP prioritizes cost-effective projects to achieve clean water and public health objectives. This Section includes discussion of future capital spending plans, which may change in light of COVID-19. Section 9.8 discusses financial uncertainties associated with COVID-19.

9.6.b Background on Historical DEP Spending

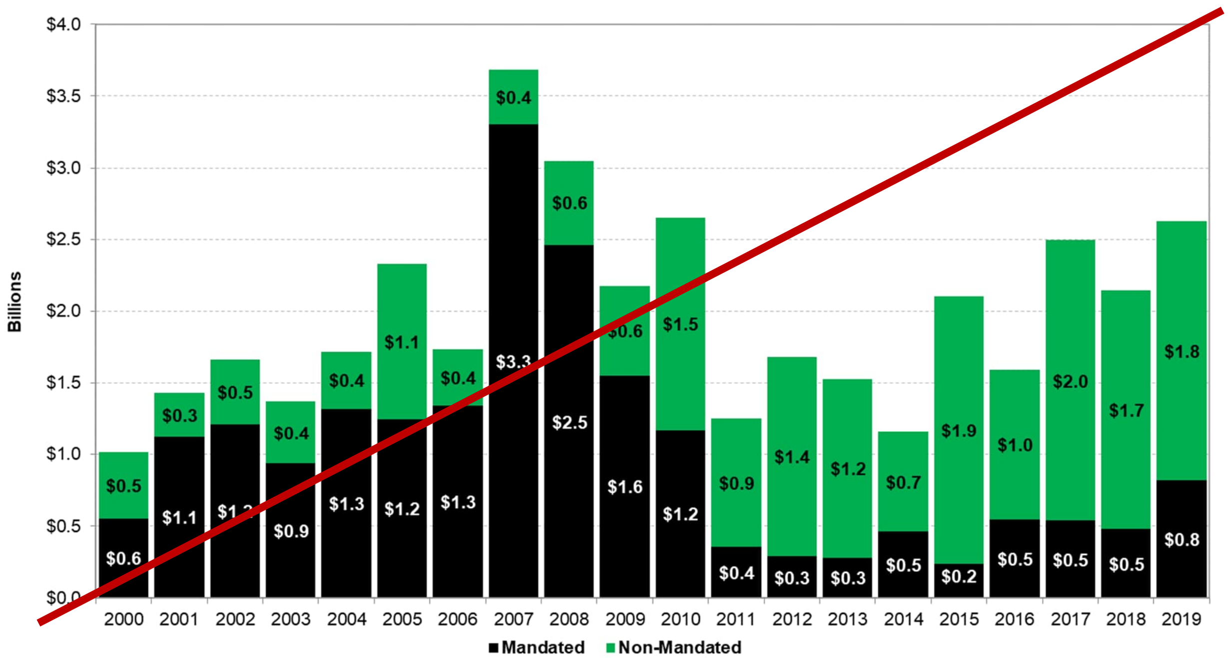
As the largest combined water and wastewater utility in the nation, DEP provides ~~over~~ approximately 1 billion gallons of drinking water daily to more than eight million NYC residents, visitors, and commuters, as well as to one million upstate customers. DEP maintains over 2,000 square miles of watershed comprised of 19 reservoirs, 3 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 7,500 miles of sewers, 96 pumping stations (PS) and 14 in-city WRRFs. During wet-weather conditions, the system can treat up to 3.5 billion gallons per day of combined storm and sanitary flow. In addition to its WRRFs, DEP also has four CSO storage facilities. In 2010, DEP launched a 20-year public/private partnership GI program. To date, DEP has committed to spend an estimated $1.8B in CSO drainage areas. ~~$1.6B GI program with additional investments through private partnerships.~~ A summary of historical spending is presented in Table 9-2. Additional details on the identified projects and programs are provided in the following sections.

Table 9-2. FY2009-2019 Historical DEP Spending Categories

Spending Category	Major Project or Program
Wastewater Mandated Programs	CSO Abatement and Stormwater Management Programs
	MS4 Permit Compliance
	Biological Nitrogen Removal
	WRRF Upgrades
Drinking Water Mandated Programs	Croton Watershed - Croton Water Treatment Plant
	Catskill/Delaware Watershed - Filtration Avoidance Determination
	Catskill/Delaware Watershed - UV Disinfection Facility
State of Good Repair Projects	Multiple investments related to maintenance and repair of assets and infrastructure

9.6.b.1 Historical Capital and Operations and Maintenance Spending

Figure 9-4 identifies DEP's capital spending from FY2000 through ~~FY2019~~ FY2022. During this time, ~~51.4~~ 45.8 percent of DEP's capital spending was for wastewater and water mandates. Figure 9-5 identifies associated historical wastewater and water operating expenses from FY2000 through ~~FY2019~~ FY2022, which have generally increased over time, reflecting the additional operational costs associated with NYC's investments. Many projects have been important investments that safeguard 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.



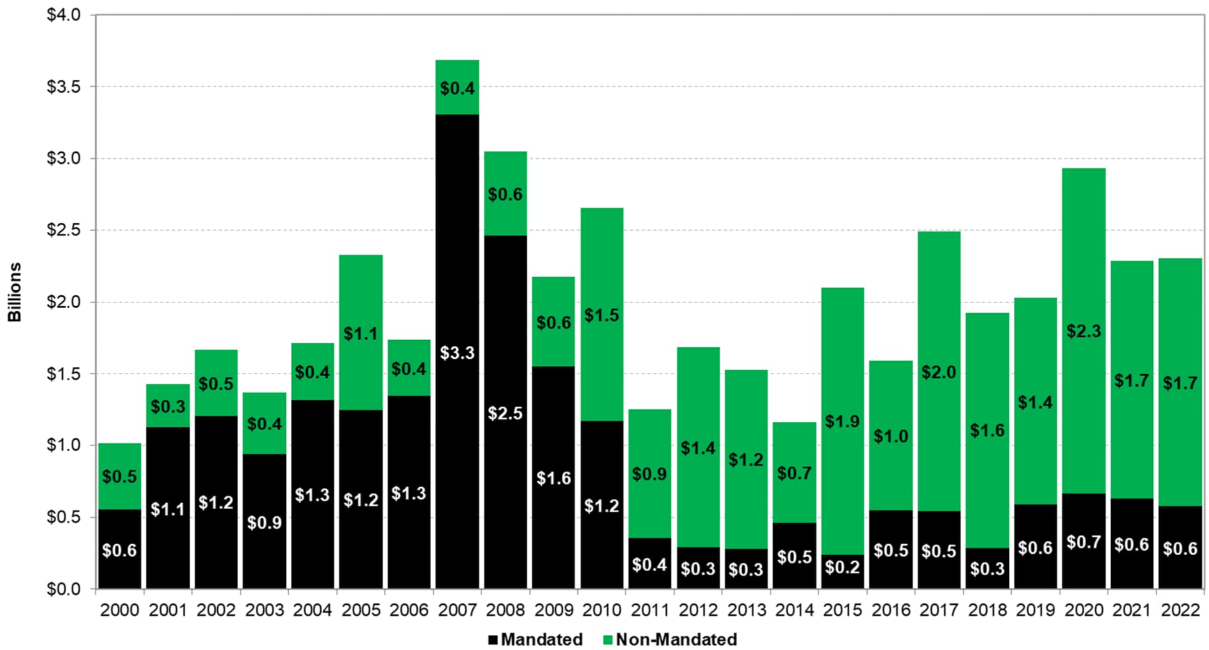
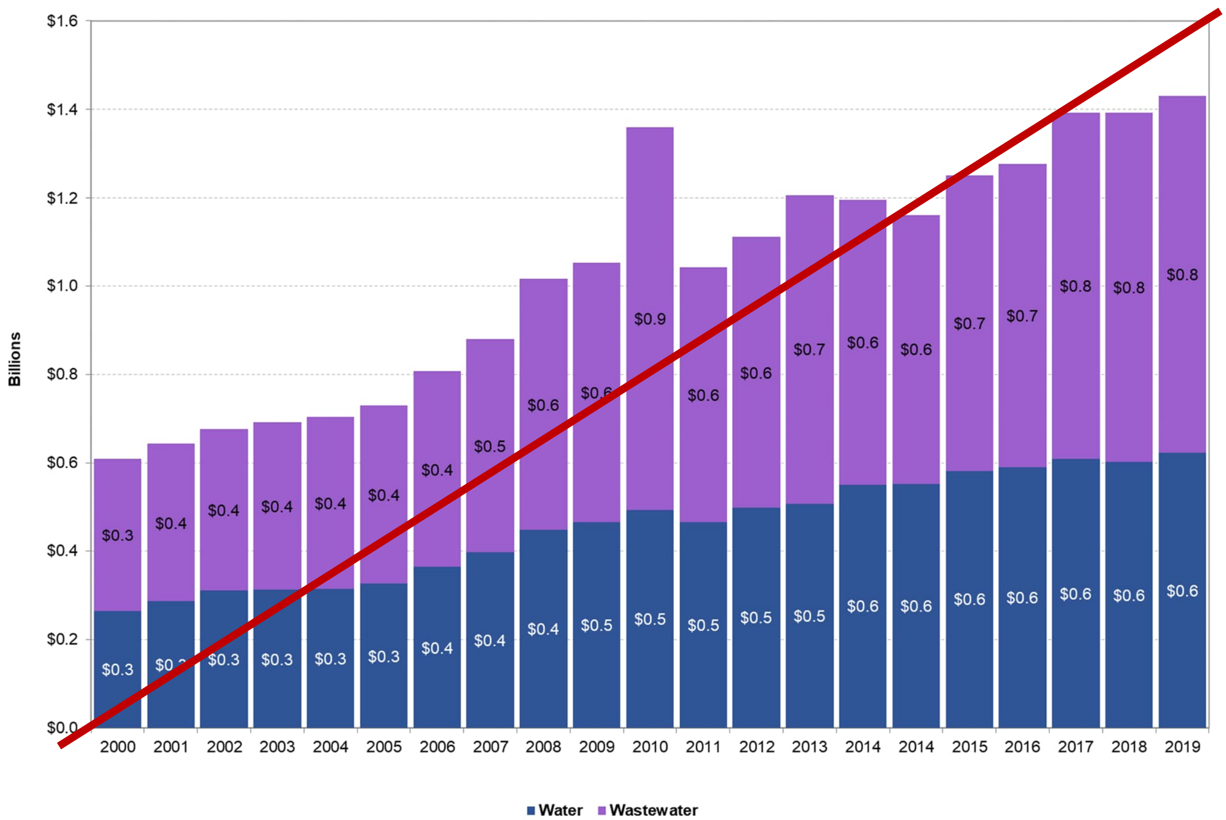


Figure 9-4. Historical Capital Commitments


$1.6
$1.4
$1.2
$1.0
$0.8
$0.6
$0.4
$0.2
$0.0
Billions
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2014 2015 2016 2017 2018 2019
Water
Wastewater

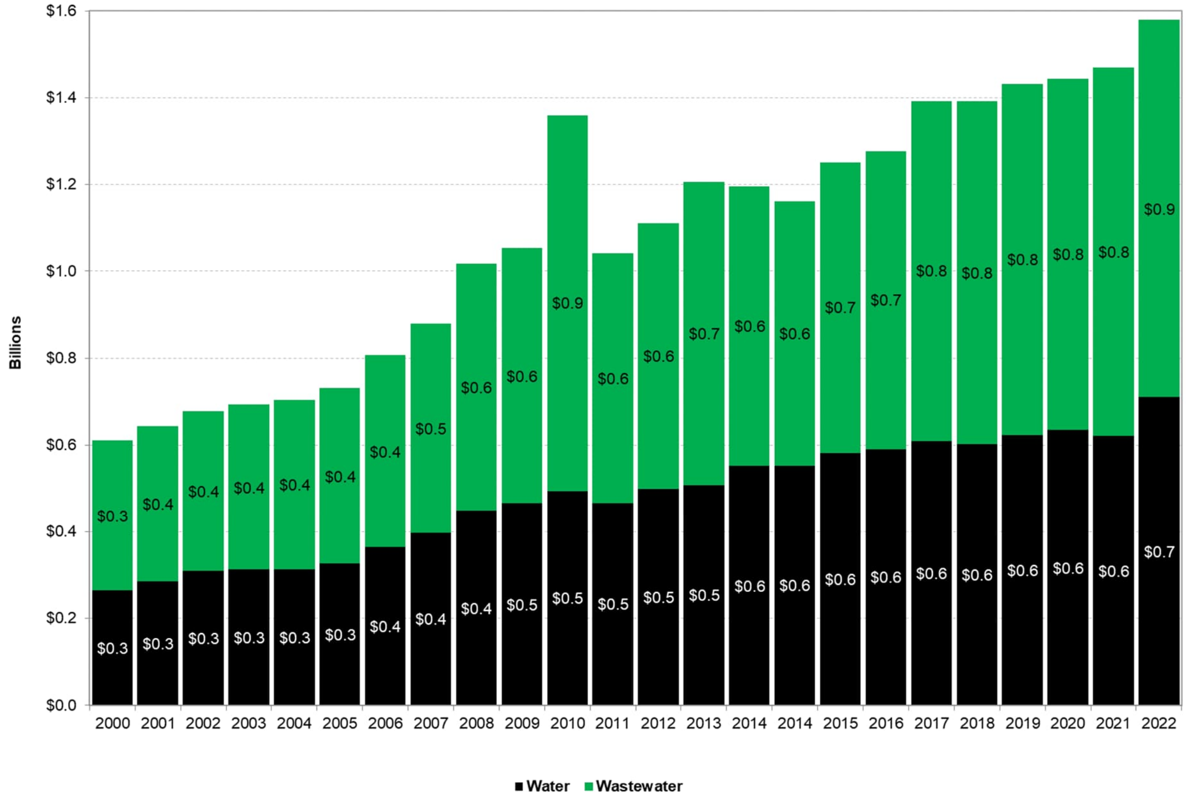


Figure 9-5. Historical Operating Expenses

9.6.b.2 Wastewater Mandated Programs

DEP is under multiple mandates to comply with federal and state laws and permits. The following wastewater programs and projects represent a few of the more significant projects that have been initiated, but do not represent an exhaustive list of all currently mandated projects:

- ***CSO Abatement and Stormwater Management Programs***

  DEP has initiated a number of projects to reduce CSOs, including construction of CSO abatement facilities, optimization of the wastewater system to reduce the volume of CSO discharge, controls to prevent discharge of floatables and debris that enters the combined wastewater system, dredging of CSO sediments that contribute to low DO and poor aesthetic conditions, and other water quality-based enhancements to attain WQS. DEP also has invested in a robust Green Infrastructure Program for CSO control.

  These green and grey initiatives impact both the capital investments that DEP must make, and the agency's O&M expenses. Historical and existing commitments are estimated to be $~~4.3~~ 4.5B ($2.7B in Waterbody Watershed Facility Plans and $~~1.6~~ 1.8B for the GI program in the CSO drainage areas). Roughly ~~$734M~~ 1.1B of GI costs have been incurred to-date. The costs associated with the CSO LTCP are discussed later in this section.

- ***Citywide MS4 Permit Compliance***

DEC issued a citywide MS4 Permit to NYC ~~for all City agencies~~, effective August 1, 2015, that covers NYC's municipal separate stormwater system. This permit was renewed, effective August 1, 2022, and includes requirements for the City to coordinate efforts with other NYC agencies to implement its Stormwater Management Program (SWMP) plan, to maintain the necessary legal authority to implement and enforce the SWMP, to ensure adequate resources to comply with the MS4 Permit, and to enforce against and track non-compliance with the SWMP. Some of the stormwater pollution control measures identified through this plan may result in increased costs to DEP, and those costs will be more clearly defined over the course of ongoing implementation.

~~DEP coordinated efforts with other NYC agencies to develop a Stormwater Management Program (SWMP) plan for NYC to facilitate compliance with the permit. This plan includes the necessary legal authority to implement and enforce the SWMP, ensures adequate resources to comply with the MS4 Permit, and contains enforcement and tracking measures. Some of the stormwater pollution control measures identified through this plan may result in increased costs to DEP, and those costs will be more clearly defined over the course of ongoing implementation.~~

~~The City completed its analysis of the resources needed to meet the MS4 Permit obligations during this permit term. The City estimates approximately $9.9M in capital spending and $87M in expense spending for the permit term (2015-2020).~~

- ***Biological Nitrogen Removal***

In 2006, NYC entered into a Consent Judgment with DEC, which required DEP to upgrade five WRRFs to reduce nitrogen discharges. Pursuant to a modification and amendment to the Consent Judgment in 2011, DEP agreed to upgrade three additional WRRFs and to install additional nitrogen controls at one of the WRRFs included in the original Consent Judgment. To date, DEP has completed nitrogen upgrades at ~~six~~ all eight ~~WRRFs and expects to complete work on the remaining two WRRFs by the end of 2022. As in the case of CSOs and stormwater,~~ by committing ~~these initiatives include~~ capital ~~investments~~ costs ~~made by DEP~~ over $~~1.2~~ 1.3B ~~to-date and an additional $22M in the 10-year capital plan)~~. ~~as well as~~ Annual O&M expenses are also incurred~~(~~, with ~~,~~ chemicals alone costing ~~in FY20202 cost $11M~~ $12.5M in FY2022.

- ***Wastewater Resource Recovery Facility Upgrades***

The Newtown Creek WRRF was upgraded to provide secondary treatment pursuant to the terms of a Consent Judgment with DEC. The total cost of the upgrade was $5B. In 2011, DEP certified that the Newtown Creek WRRF met the effluent discharge requirements of the CWA, bringing all 14 WRRFs into compliance with the secondary treatment requirements.

- ***Total Residual Chlorine Order***

In 2015, NYC entered into an Order on Consent, which required DEP to make improvements to their disinfection process to reduce effluent total residual chlorine discharges, and if deemed necessary, to construct dechlorination facilities. A First Modified ~~Pursuant to the~~ Order on Consent was executed in 2018, and DEP and DEC made some refinements to their total residual chlorine program that included design and construction milestones for upgrades to the disinfection facilities at five WRRFs and to develop facility plans for nine WRRFs. A Second Modified Order on Consent was executed in 2022, and included implementation of optimization projects in lieu of the remaining projects set forth in the First Modified Order on Consent. To date, DEP has constructed dechlorination facilities ~~completed disinfection upgrades~~ at three WRRFs ~~and expects to complete work on the remaining two WRRFs by the end of 2022~~ with a total cost of about $~~100M~~ 40M, ~~associated with these five disinfection projects and have submitted the TRC facility plans.~~ and as part of the Second Modified TRC Order, almost $850M in optimization projects are planned.

- ***WRRF SPDES Permit Compliance***

  On July 1, 2022, newly modified SPDES permits for DEP's 14 WRRFs went into effect. These modifications to the SPDES permits may have significant monetary impacts to DEP and include the following requirements:

  - Effluent ammonia limits at many WRRFs, which may require upgrades at the North River and 26th Ward WRRFs. 26th Ward's permit requires DEP to submit a feasibility study for ammonia compliance. North River's permit requires a sampling program for ammonia. After review, DEC may reopen the permit to include performance-based limits, or it may require a feasibility study/engineering analysis for ammonia compliance.

  - A three-year sampling program for free cyanide with results submitted in report form to DEC. After review, DEC may require DEP to complete a management/treatability study for free cyanide. Final permit limits are included in the new permits with an interim limit (of monitor only) in place for the duration of the studies.

  - A three-year study to determine the applicable monitoring requirements or effluent limitations for *Enterococcus* bacteria. After review, DEC may require DEP to complete an engineering analysis for *Enterococcus* and/or change the monitoring requirements or effluent limitations for Enterococcus. Final permit limits are included in the new permits with an interim limit (of monitor only) in place for the duration of the studies.

  - Completion of Basis of Design Reports for aeration system and solids handling upgrades to address organics loadings to the Owls Head WRRF including preliminary construction schedules.

  - Continue to maintain and implement an Asset Management Plan (AMP) covering DEP's WRRFs, pumping stations, and CSO control facilities to prioritize the rehabilitation and replacement of capital assets that comprise the AMP Treatment System. Additionally, DEP must submit an AMP Update Workplan.

  - Continue to implement and maintain a Mercury Minimization Program (MMP). The MMP is required because the 50 nanograms/liter (ng/L) permit limit exceeds the statewide water quality based effluent limit (WQBEL) of 0.70 ng/L for Total Mercury. The goal of the MMP will be to reduce mercury effluent levels in pursuit of the WQBEL.

9.6.b.3 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 promulgated a rule known as Long Term 2 (LT2) that required 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 resulted in a Federal Court Consent Decree, which mandated the construction of a full-scale water treatment facility to filter water from NYC's Croton watershed. Construction of the Croton Water Treatment Plant began in late 2004, and the facility began operating in 2015. To date, DEP has spent roughly $3.4B in capital costs on the Croton Water Treatment Plant. Since commencement of operations, DEP is also now incurring annual expenses for labor, power, chemicals, and other costs associated with plant O&M. For ~~FY2020~~ FY2022, O&M costs were about ~~$21M~~ $18.4M.

- ***Catskill/Delaware Watershed - Filtration Avoidance Determination***

  The source water protection program is a key aspect of the City's Filtration Avoidance Determination (FAD) for the Catskill and Delaware water supplies. Since the early 1990s, federal and state regulators have issued the FAD as provided for under the Surface Water Treatment Rule based on the high quality of the City's source waters, treatment methods, extensive monitoring, and the effectiveness of the source water protection program. The FAD relieves the City of the multi-billion dollar capital and operational costs of filtering water from the Catskill and Delaware systems. Over this time, DEP has committed more than $2.7B in capital and expense funding to ~~cover~~ comply with filtration avoidance costs, including $1B to meet its commitments under the 10-year 2017 FAD. Approximately $~~235~~ 249M is committed in the current ~~Capital Improvement Plan (CIP).~~ FY2024 Preliminary CIP.

- ***UV Disinfection Facility***

  In January 2007, DEP entered into an Administrative Consent Order (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 pathogen inactivation. To date, capital costs committed to the project amount to $1.6B. DEP is also incurring related annual expenses for property taxes, labor, power, and other costs related to plant O&M. ~~FY2020~~ FY2022 O&M costs were ~~$34M~~ $23M, including taxes.

- ***Hillview Reservoir Cover***

  LT2 requires that uncovered finished water storage facilities, such as the Hillview Reservoir, be covered, or alternatively, any discharge from an uncovered water facility must be treated (40 C.F.R

§141.714). The Hillview Reservoir is the final finished water source for the City's drinking water from the Catskill/Delaware System before it enters the City's distribution system. The City has determined it is not feasible to treat Hillview Reservoir's discharge and therefore, the City must cover the reservoir to comply with LT2. The City and DEP entered into a Consent Decree and Judgment with the United States and New York State, effective May 15, 2019, which sets forth a schedule of compliance for the City to cover the Hillview Reservoir as required by LT2. ~~The most recent (2009) cost estimate for construction of the Hillview Cover was $1.6B. This cost estimate will be updated in the future as the Cover's design and planning progress in accordance with the Consent Decree's schedule of compliance. The Hillview Reservoir Improvements project, which is a precursor project to the Cover, is also governed by the Consent Decree and is estimated to cost an additional $580M.~~

After negotiations DEP entered into a Consent Decree with USEPA, USDOJ and NYSDOH to cover Hillview Reservoir on May 15, 2019. Under the Consent Decree DEP is required to complete approximately $2 billion in improvements and state of good repair before building the Hillview Cover. The Hillview cover is projected to cost between $3-4 billion.

- ***Kensico Eastview Connection 2***

  To ensure the resilience and provide critical redundancy of infrastructure in NYC's water supply system, DEP will be constructing a new tunnel between the Kensico Reservoir and the Ultraviolet Disinfection Facility. This project is also a precursor project to the Hillview Cover. The cost for this project is estimated at approximately ~~$1.6B~~ $1.7B.

9.6.b.4 Other: State of Good Repair Projects

In addition to mandated water and wastewater programs, DEP has invested in critical projects related to maintenance and repair of its assets and infrastructure. State of good repair consisted of about 25 percent of historical capital spending from FY~~10~~ 13 to FY~~19~~ 22 totaling about $4.5B.

9.6.c On-going and Future System Investment

Over the next decade, the percentage of mandated project costs already identified in the Capital Improvement Plan is significant. In addition, DEP will devote significant funding to critical state of good repair projects and other projects needed to maintain NYC's infrastructure to deliver clean water and collect and treat wastewater. As of January ~~2020~~ 2023, DEP's capital budget for ~~FY2020~~ FY2023 through ~~FY2029~~ FY2033 is ~~$20.5B~~ $31.3B. ~~This plan did not take into account the potential impacts of COVID-19 on the capital budget. The financial uncertainties associated with COVID-19 are discussed in Section 9.8.~~ This budget included projected capital commitments averaging ~~$2.0B~~ $2.88B per year through ~~FY2029~~ FY2033, which is ~~similar to~~ higher than the average spending from ~~FY2009~~ FY2002 through ~~FY2019~~ FY2021 shown in Figure 9-4 above. A portion of this additional funding was added to the budget to help address climate change including both resiliency and cloud burst projects. In addition, DEP anticipates that there will be additional mandated investments within and outside the ~~January 2020~~ FY2023-FY2033 Plan ~~(FY20-29)~~ related to compliance with the Citywide MS4 SPDES Permit, potential modifications to DEP's in-city WRRF SPDES permits, Superfund remediation, CSO mandates, and the Total Residual Chlorine (TRC) Order. DEP is also subject to a Consent Decree and Judgment with the United States and New York State, effective May 15, 2019, and will be required to construct a cover for Hillview Reservoir. DEP may in the future be subject to other additional wastewater and drinking water mandates. The inclusion of this additional spending is supported by the EPA financial capability assessment guidance in order to create a more accurate and complete picture of NYC's financial capability. A summary of anticipated future mandated and non-mandated projects and programs is presented in Table 9-3, and additional details on the identified projects and programs are provided in the following sections.

Table 9-3. Ongoing and Potential Future DEP Spending Categories(1)

Spending Category	Major Project or Program	
Wastewater	~~Future~~ Wastewater Mandates	CSO LTCP Program
		MS4 Permit Compliance
		Total Residual Chlorine (TRC) Consent Order
		Superfund Remediation
		State of Good Repair Mandates
	Potential Wastewater Regulations	Expanded Nitrogen Discharge Limits
		WRRF SPDES Permit Compliance
		EPA Contaminants of Emerging Concern
	Other System Needs	Climate Resiliency
		Energy Projects at WRRFs
		Southeast Queens Flood Mitigation Plan
Water	~~Future~~ Water Mandates	Filtration Avoidance Determination
		Hillview Reservoir Cover
		Hillview Infrastructure Improvements
		EPA Contaminants of Emerging Concern
		Kensico Eastview Connection 2
	Other System Needs	Water for the Future
		Activation of City Tunnel No. 3 Brooklyn/Queens
		Ashokan Century Program

Note:

(1) Some of these projects/programs have costs that extend beyond DEP's~~January 2020 Plan (FY20-29)~~ CIP 57 10-Year Plan (FY23-FY33) or are potential costs pending regulatory updates.

9.6.c.1 Future Wastewater Mandates

- ***CSO Long Term Control Plans***

Improving New York Harbor's water quality has been a City and DEP priority for decades. According to the City's most recent Harbor Survey Report, the Harbor is cleaner now than at any time in the last 100 years. Continued improvements to the City's 14 wastewater resource recovery facilities (WRRFs), and ongoing investments have resulted in an over 80 percent reduction in the annual volume of ~~combined sewer overflows~~ CSO discharges since the mid-1980s. ~~With~~ Including the ~~nine~~ ten approved LTCPs ~~approved, one pending,~~ and this ~~current~~ final CWOW/ER LTCP~~being submitted in May 2020~~, current and planned infrastructure investments will result in even further water quality improvements.

As summarized later in this section in Tabl, the total project costs for the Recommended Plans identified in the waterbody LTCPs and Superfund-mandated CSO control is approximately $6.3B. This does not include costs for land acquisition, which could be significant (hundreds of millions of dollars).

- ***Continued MS4 Permit Compliance***

DEC issued a citywide MS4 permit to NYC for all City agencies, effective August 1, 2015, that covers NYC's municipal separate stormwater system. This permit was renewed and effective August 1, 2022. The full MS4 permit compliance costs are yet to be estimated. The City expects to incur additional costs stemming from the continued implementation and enforcement of the new programs developed in 2018, as well as from the expansion of these programs to meet the new requirements included in the 2022 MS4 Permit. Future MS4 Permits may include even more requirements, increasing costs to DEP and other NYC agencies.

~~The City is currently negotiating its permit for the next five years, and the fiscal analysis associated with MS4 Permit for 2020-2025 is currently underway. DEP has estimated the need for $11M over the next 10 years for continued compliance.~~

- ***Total Residual Chlorine (TRC) Consent Order***

As part of the Second Modified TRC Consent Order effective June 30, 2022, DEP is required to complete various TRC optimization projects at six WRRFs. ~~In 2015, NYC entered into an Order on Consent, which required DEP to make improvements to their disinfection process to reduce effluent total residual chlorine discharges and if deemed necessary to construct dechlorination facilities. Pursuant to the Order on Consent in 2018, DEP and DEC made some refinements to their total residual chlorine program that include design and construction milestones for upgrades to the disinfection facilities at 5 WRRFs and to develop facility plans for nine WRRFs.~~ Aside from the $100M encumbered to-date for disinfection upgrades, approximately $~~220~~ 71M was included in the ~~January 2020 Plan~~ FY25 Prelim CIP (~~FY20-29~~ FY23-FY33) for future effluent total residual chlorine discharge mitigation projects. There have also been some additional state of good repair projects incorporated into the TRC Order.

- ***Superfund Remediation***

Two major Superfund sites in NYC are at different stages of the Superfund process. The EPA issued a Record of Decisions (ROD) for the Gowanus Canal Superfund Site in 2013, which requires an "in canal" remedy of dredging and capping sediments in the Canal by a group of responsible parties, including the City, and the construction of two CSO storage tanks by the City. The capping and dredging remedy has begun in the upper reach (Remedial Target Area 1 - RTA1) of Gowanus Canal, and remedial design for the lower reaches should be completed in one to two years~~is scheduled to begin in September 2020~~. The City has completed design for the RH-034 CSO retention tank and construction is underway. The design for the OH-007 CSO retention tank is nearing completion and construction is anticipated within the next year.~~one of the CSO storage tanks, and construction of the tank is expected to begin in 2021. Remedial design work for the second tank work will take place in the next one to three years. Potential~~ Projected Superfund costs for the two Gowanus Canal CSO retention tanks ~~total~~ is approximately $~~1.3~~ 1.6B.

The City does not believe that CSO discharges are a significant source of hazardous substances in Newtown Creek and in CY2019, EPA issued of an Interim Record of Decision (ROD) stating that the approved CSO control alternatives proposed in the Newtown Creek LTCP are sufficient to prevent recontamination of any remedy selected for Newtown Creek and that no additional CSO controls will be required under the superfund process. Completion of the Newtown Creek Remedial Investigation (RI) is targeted for 2023, and the Feasibility Study (FS) is anticipated approximately in 2028 with issuance of a Record of Decision (ROD) projected by 2029. An FS for Early Action for the East Branch is anticipated for 2024, with a ROD for 2025. The proposed CSO LTCP projects are proceeding in accordance with the mandated DEC milestones.

~~Completion of the Newtown Creek RI/FS is anticipated approximately in 2021 with issuance of a Record of Decision (ROD) projected by the end of 2023. However, in 2019 EPA released a Proposed Remedial Action Plan for CSOs that recommends that DEP take no further action with respect to CSOs than what is required by the LTCP~~.

- ***State of Good Repair Mandates***

In June 2016, DEP entered into an Omnibus Order with DEC that requires DEP to construct a number of projects at both the North River and Bowery Bay WRRFs along with some pumping station upgrades. To date, ~~$326M~~ $405M have been encumbered for these projects and an additional ~~$128~~ $80M is forecast in the next few years to comply with requirements of this Order.

9.6.c.2 *Potential Wastewater Regulations on the Horizon*

DEP is tracking potential future regulatory issues that may result in the need for additional projects. Insufficient detail is generally available at this time to define the cost risks associated with these potential regulations. Examples of these issues are described below.

- ~~***WRRF SPDES Permit Compliance***~~

  ~~DEP has applied for renewal of the current SPDES permits issued for DEP's 14 WRRFs. While DEP continues to seek to comply with the current SPDES permit requirements, DEP anticipates that there will be additional requirements in any new SPDES permits. Existing and anticipated requirements include:~~

  - ~~New effluent ammonia limits at many WRRFs – the current permits provide for a process to establish ammonia limits. Compliance with new effluent ammonia limits may require upgrades at the North River, 26th Ward, and Jamaica WRRFs.~~

  - ~~Monthly sampling for free cyanide results will be submitted in report form to DEC. After review, DEC may seek to add a limit or action level for free cyanide.~~

  - ~~Mercury Minimization Program (MMP) – DEP must develop, implement, and maintain an MMP. The MMP is required because the 50 nanograms/liter (ng/L) permit limit exceeds the statewide water quality based effluent limit (WQBEL) of 0.70 ng/L for Total Mercury. The goal of the MMP will be to reduce mercury effluent levels in pursuit of the WQBEL.~~

  - ~~Inclusion of *Enterococci* WQ Criteria in the next SPDES permits may result in additional compliance costs for the WRRFs that discharge to the applicable waterbodies once a water quality based effluent limit is identified.~~

    ~~Ongoing monitoring of potential CSOs from regulators specified in the SPDES permit with related reporting.~~

- ***Nitrogen Discharge Limits***

  SPDES Permits for the East River WRRFs contain aggregate limits on the amount of total nitrogen that can be discharged from those WRRFs. If further reductions at the WRRFs are required, the potential cost impacts for NYC's four Upper East River WRRFs over the next 20 years could be significant ~~for the East River WRRFs~~.

  DEP continues to be subject to the First Amended Nitrogen Consent Judgment (FANCJ) whereby it is required to assess water quality improvement and ecological benefits associated with the completion of significant upgrades to all four of the Jamaica Bay WRRFs for nitrogen removal. Post-construction monitoring will be conducted for a three-year period following completion of nitrogen upgrade construction at the Coney Island WRRF in 2022.

- ***EPA Contaminants of Emerging Concern***

  Contaminants of emerging concern (CECs) and personal care products (PPCPs) are increasingly being detected at low levels in surface water, and there is concern that these compounds may have an impact on aquatic life. It is important for EPA to be able to evaluate the potential impact of CECs and PPCPs on aquatic life and have an approach for determining protective levels for aquatic organisms.

9.6.c.3 Sustainability/Resiliency and Other Wastewater Initiatives

- ***Climate Resiliency***

~~DEP continues to study climate change and to prepare for its impacts by modeling the potential effect of various climate scenarios on the City's water supply system through the Climate Change Integrated Modeling Project: protecting WRRFs from storm surge as part of the Wastewater Resiliency Program; and reducing urban flooding through cost-effective investments in grey and green infrastructure. Eight projects from DEP's Wastewater Resiliency Plan have been initiated as part of a $161M portfolio of strategies to flood-proof critical equipment at WRRFs. These projects will harden the infrastructure at the Bowery Bay, Hunts Point, Red Hook, Newtown Creek, Owl's Head, Port Richmond, Tallman Island, and Wards Island WRRFs. These investments enhance resiliency against future storms and include a buffer for sea level rise.~~

~~Based on the initial success of the "Cloudburst Resiliency Planning Study" in Southeast Queens, which leveraged a partnership with the City of Copenhagen, DEP has also been working with partners at the Department of Transportation, Department of Design and Construction, and New York City Housing Authority (NYCHA) to initiate design of two pilot projects. These "cloudburst" projects will help manage extreme rainfall events in St. Albans and the South Jamaica Houses, both in Southeast Queens, by capturing rainfall of 2.3 inches per hour - a storm with a 10 percent chance of occurring in any given year by the middle of the century. In addition to providing a proof-of-concept for using green infrastructure to mitigate the effects of cloudbursts, the pilot projects will help reduce nuisance flooding in Southeast Queens and enhance the local landscape. As DEP continues to better understand future flood risk from extreme rain events, the Department will coordinate with its partner agencies to expand upon these initial cloudburst projects.~~

DEP continues to study climate change and to prepare for its impacts by modeling the potential effect of various climate scenarios on the City's water supply system through the Climate Change Integrated Modeling Project: protecting WRRFs from storm surge as part of the Wastewater Resiliency Program; and reducing urban flooding through cost-effective investments in grey and green infrastructure. Eight projects from DEP's Wastewater Resiliency Plan have been initiated as part of a $161M portfolio of strategies to flood-proof critical equipment at WRRFs. These projects will harden the infrastructure at the Bowery Bay, Hunts Point, Red Hook, Newtown Creek, Owl's Head, Port Richmond, Tallman Island, and Wards Island WRRFs. These investments enhance resiliency against future storms and include a buffer for sea level rise.

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In January 2023, the Mayor announced an expansion of the city's cloudburst program to four new sites as part of ongoing resiliency efforts to better prepare for intense rain events. Supported with nearly $400 million in capital funds, these specially designed, built, and engineered infrastructure projects will protect residents and property in Corona and Kissena Park, Queens, Parkchester, Bronx, and East New York, Brooklyn from future extreme weather brought about by climate change. These locations were selected considering physical vulnerability, social and economic factors, and below ground conditions. There will be more locations to come as funding is secured.

- ***Energy Projects at WRRFs***

DEP has been working on deep decarbonization and energy reductions since PlaNYC was released in 2007, and currently has goals to achieve carbon neutrality by 2050, energy neutrality at our WRRFs by 2050, and send zero waste to landfills by 2030. NYC also passed the Climate Mobilization Act, which accelerated DEP's GHG reduction interim milestones to a 40 percent reduction by 2025 and a 50 percent reduction by 2030. In order to meet these goals, DEP has implemented:

- Demand-Side Solutions, including on-site energy conservation and efficiency, on-site equipment and operational improvements, and citywide water demand management;
- Supply-Side Solutions, including on-site clean energy generation using anaerobic digester gas ("biogas");
- Traditional Renewable Energy Solutions, including non-biogas renewable energies such as hydropower, solar photovoltaic systems, geothermal, and more; and
- Energy and Carbon Offsets, including offsite beneficial use of biosolids and biogas, as well as carbon sequestration by GI, restored wetlands, and DEP acquired forested lands.

DEP has approximately $435M allocated in its January 2023 Plan 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. DEP is currently diverting 150 tons per day of NYC's food scraps from landfills and digesting them to extract the available energy content to increase biogas production at the Newtown Creek WRRF. Biogas in excess of Newtown Creek WRRF's needs will be purified to natural gas standards, known as "renewable natural gas," and will be injected into the City's natural gas grid starting Spring 2023 through a partnership with National Grid. A 12-megawatt cogeneration system estimated at $179M is currently in construction for the North River WRRF and is estimated to be in operation in 2023.

DEP is partway through a five-year Energy and Carbon Neutrality Plan to determine the most economically, operationally, and technologically feasible and innovative pathways forward to achieve its ambitious climate goals, with a focus on how DEP can partner with sister agencies and its neighbors to help create "sustainability hubs" throughout the City that maximize resource recovery and sustainable practices going forward.

~~In April 2019, NYC launched OneNYC 2050, which calls for reducing NYC's greenhouse gas (GHG) emissions by 80 percent below 2005 levels and achieving carbon neutrality by 2050. NYC also passed the Climate Mobilization Act, which accelerated DEP's GHG reduction interim milestones to a 40 percent reduction by 2025 and a 50 percent reduction by 2030. In order to meet this and other OneNYC goals, DEP has implemented: Demand-Side Solutions, including on-site energy~~

~~conservation and efficiency, on-site equipment and operational improvements, and citywide water demand management; Supply-Side Solutions, including on-site clean energy generation using anaerobic digester gas ("biogas"); Traditional Renewable Energy Solutions, including non-biogas renewable energies such as hydropower, solar photovoltaic systems, geothermal, and more; and Energy and Carbon Offsets, including offsite beneficial use of biosolids and biogas, as well as carbon sequestration by GI, restored wetlands, and DEP acquired forested lands. To-date, this four-pronged approach has resulted in a 17 percent reduction in GHG emissions from DEP facilities from 2006 to 2019. DEP has approximately $435M allocated in its January 2020 Plan 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. DEP is currently diverting 170 tons per day of NYC's food scraps from landfills and digesting them to extract the available energy content to increase biogas production at the Newtown Creek WRRF. Biogas in excess of Newtown Creek WRRF's needs will be purified to natural gas standards, known as "renewable natural gas," and will be injected into the City's natural gas grid starting Spring 2020 through a partnership with National Grid. A 12-megawatt cogeneration system estimated at $179M is currently in construction for the North River WRRF and is estimated to be in operation in 2023. DEP recently kicked off a three-year Energy and Carbon Neutrality Plan to determine the most economically, operationally, and technologically feasible and innovative pathways forward to achieve the OneNYC goals, with a focus on how DEP can partner with sister agencies and its neighbors to help create "sustainability hubs" throughout the City that maximize resource recovery and sustainable practices going forward.~~

- ***Southeast Queens Flood Mitigation Plan***

  Southeast Queens (comprised of Queens Community Districts 12 and 13) experienced rapid residential and commercial growth from the 1920s through 1960s, and many of the natural watercourses that previously drained the area were paved over by developers, exacerbating flooding. The low-lying topography of the area and the enlargement of Idlewild/Kennedy Airport significantly complicated the installation of large storm sewers, making planned work extremely costly. Major projects had been deferred until Mayor de Blasio authorized $1.5B over ten years for the Southeast Queens Flood Mitigation Plan. This amount has since been increased to almost $2.52B.

~~9.6.c.4 Regulatory Mandated Drinking Water Projects on the Horizon~~

- ~~***Catskill/Delaware Watershed - Filtration Avoidance Determination***~~

  ~~DEP has committed $1B to meet its commitments under the ten--year 2017 FAD. Approximately $235M is committed in the current CIP.~~

- ~~***Hillview Reservoir Cover***~~

  ~~LT2 requires that uncovered finished water storage facilities, such as the Hillview Reservoir, be covered, or alternatively, any discharge from an uncovered water facility must be treated (40 C.F.R §141.714). The Hillview Reservoir is the final finished water source for the City's drinking water from the Catskill/Delaware System before it enters the City's distribution system. The City has determined it is not feasible to treat Hillview Reservoir's discharge and therefore, the City must cover the reservoir to comply with LT2. The City and DEP entered into a Consent Decree and Judgment with the United States and New York State, effective May 15, 2019, which sets forth a~~

~~schedule of compliance for the City to cover the Hillview Reservoir as required by LT2. The most recent (2009) cost estimate for construction of the Hillview Cover was $1.6B. This cost estimate will be updated in the future as the Cover's design and planning progress in accordance with the Consent Decree's schedule of compliance. The Hillview Reservoir Improvements project, which is a precursor project to the Cover, is also governed by the Consent Decree and is estimated to cost an additional $580M.~~

- ~~***Kensico Eastview Connection 2***~~

~~To ensure the resilience and provide critical redundancy of infrastructure in NYC's water supply system, DEP will be constructing a new tunnel between the Kensico Reservoir and the Ultraviolet Disinfection Facility. This project is also a precursor project to the Hillview Cover. The cost for this project is estimated at approximately $1.6B.~~

9.6.c.5 Drinking Water Mandates

- ***EPA Contaminants of Emerging Concern***

The U.S. Environmental Protection Agency took an initial step to control toxic "forever chemicals" in drinking water. The agency proposed first-ever limits for two of the chemicals, PFOA and PFOS. It also proposed regulating four additional forever chemicals as a group. PFOA and PFOS would be capped at 4 parts per trillion, a miniscule level that is near the limit of reliable detection for monitoring equipment. PFNA, PFBS, PFHxS, and GenX would be regulated together under a "hazard index," which is used for assessing the health risk of chemical mixtures.

9.6.c.6 Other Drinking Water Initiatives

- ***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 designing a bypass for a section of the Delaware Aqueduct in Roseton and internal repairs for a tunnel section in Wawarsing. In 2013, the Phase 1 (BT-1) contract was awarded for the construction of two vertical shafts in Newburgh (5B) and Wappinger (6B) to gain access to the subsurface; which were completed in 2016. In 2015, the Phase 2/3 (BT-2) contract was awarded for construction of the bypass tunnel and internal repairs. Phase 2 excavation of the bypass tunnel via tunnel-boring machine from shafts 5B to 6B was completed in August 2019, with final concrete lining completed in October 2021. Construction of the shaft access chambers and final lining of the shafts was significantly completed in July 2022. The Phase 3 final connection of the bypass tunnel to the existing aqueduct and internal repairs are scheduled to take place from Fall 2023-Spring 2024.

Since DEP must shut down the Aqueduct ~~when it is ready to connect the bypass tunnel~~ for this final connection, DEP is also working on projects that will supplement NYC's drinking water supply during the shutdown, such as implementing demand reduction initiatives, including offering water conservation and water reuse grants to commercial, industrial, and multi-family residential property owners, offering a toilet replacement program, replacing municipal plumbing fixtures and providing demand management assistance to wholesale customers located north of NYC. The cost for ~~this~~ the Water for the Future program is estimated to be approximately $1.7B.

- ***Activation of City Tunnel No. 3 Brooklyn/Queens***

  The Brooklyn/Queens leg of City Tunnel No. 3 is a 5.5-mile section in Brooklyn that connects to a 5-mile section in Queens. Two distribution shafts in Queens will be constructed and are scheduled for completion in the 2020s. The Brooklyn/Queens leg will deliver water to Staten Island, Brooklyn, and Queens, and provide critical redundancy in the system. This project is estimated at ~~$712M~~ $885M.

- ***Ashokan Century Program***

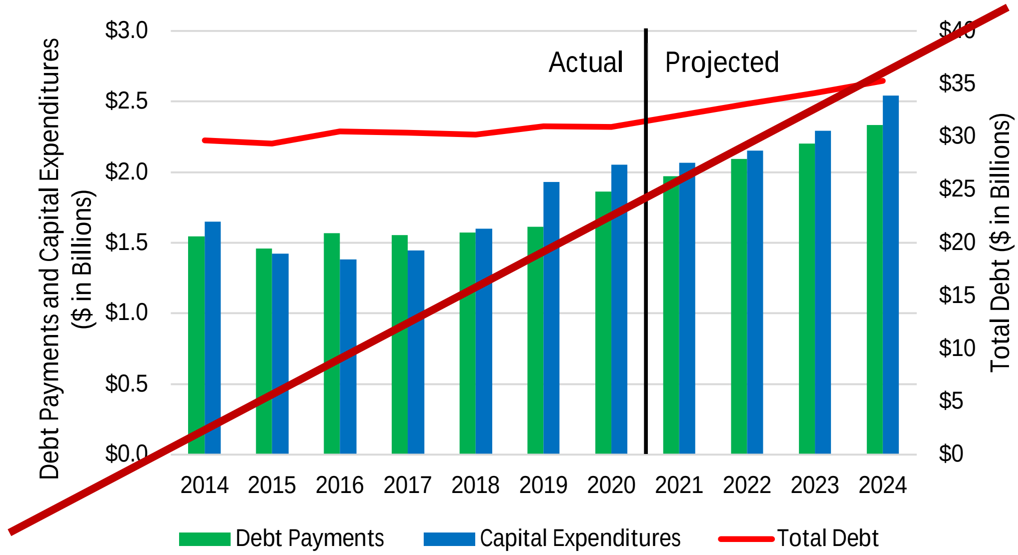
  The Ashokan Reservoir in the Catskill System is over 100 years old. DEP is embarking on a large program to upgrade dams, dikes, chambers, and other facilities around Ashokan Reservoir. This multi-year program is estimated to cost ~~$980M~~ $1.14B.

9.6.d History of DEP Water and Sewer Rates

9.6.d.1 Background on DEP 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, 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. As shown in Figure 9-6, increases in capital expenditures have resulted in increased debt. Expenditures and total debt are projected to increase over the next several years.

For ~~FY2020~~ FY2023, most customers will be charged a proposed uniform water rate of ~~$0.53~~ $0.57 per 100 gallons of water. Wastewater charges are levied at 159 percent of water charges (~~$0.85~~ $0.91 per 100 gallons). A small percentage of properties are billed a flat rate. Under the Multi-family Conservation Program (MCP), some properties are billed at a flat per--unit rate if they comply with certain conservation measures. Some non--profit institutions are also granted exemptions from water and wastewater charges on the condition that their consumption is metered and falls within specified consumption threshold levels. Select properties are also granted exemptions 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).



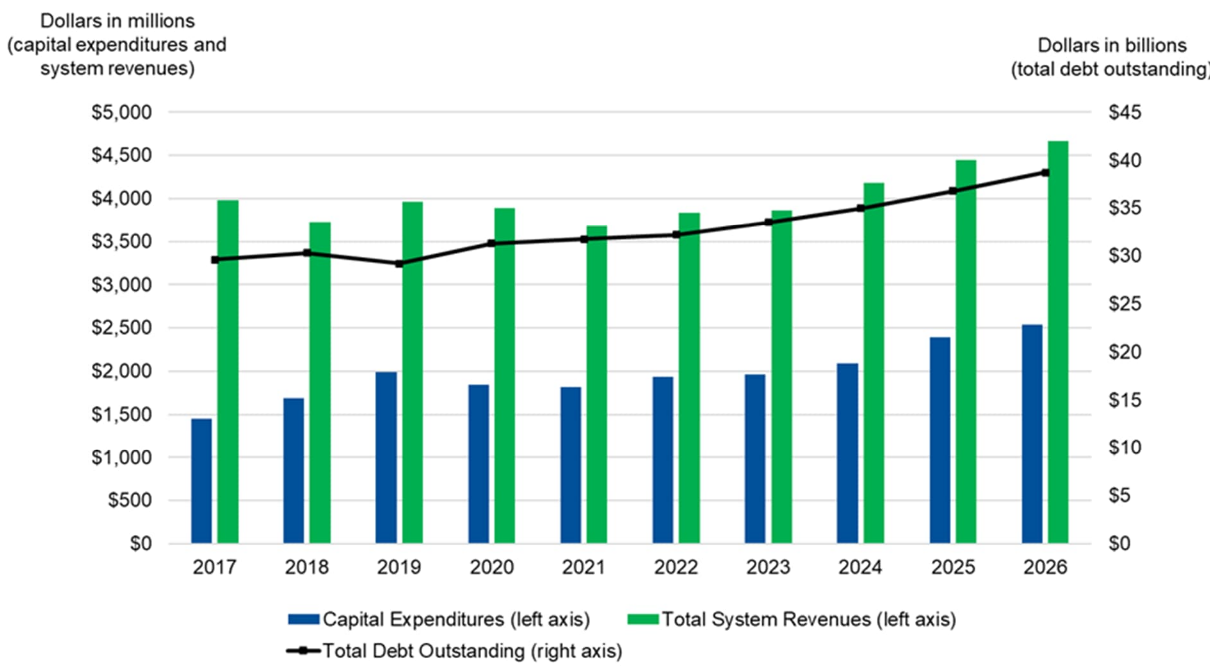
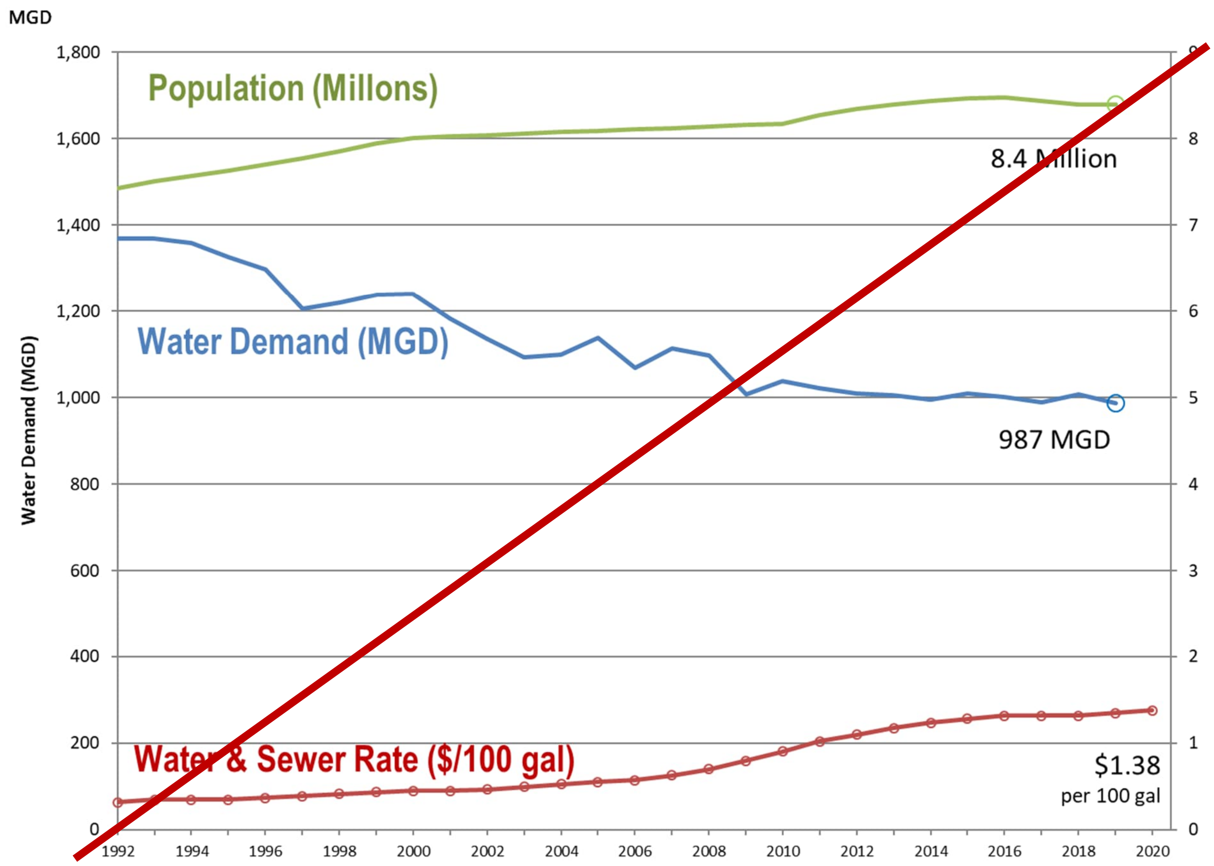


Figure 9-6. Past Costs and Total Debt

9.6.d.2 Historical Rate Increases to meet Cost of Service

Figure 9-7 shows how water and sewer rates have increased over time and how that compares with system demand and population. Despite a rise in population, water consumption rates have been falling since the 1990s due to metering and increases in water efficiency measures. The increase in population has not kept pace with the increase in the cost of service associated with DEP's capital commitments over the same time period. Furthermore, the total cost of service is spread across a smaller demand number due to the decline in consumption rates. As a result, DEP has had to increase its rates to meet the cost of service. DEP operations are funded almost entirely through rates paid by our customers. Since 2015, the average increase to water and sewer rates in the City has been 2.1%, below the prevailing rate of consumer price inflation in the New York City area during that time. ~~From FY2000 to FY2020, water and sewer rates have risen 207 percent, or approximately 108 percent when adjusted for inflation. This is despite the fact that DEP has diligently worked towards controlling operating costs and improving the efficiency of the agency's operations.~~



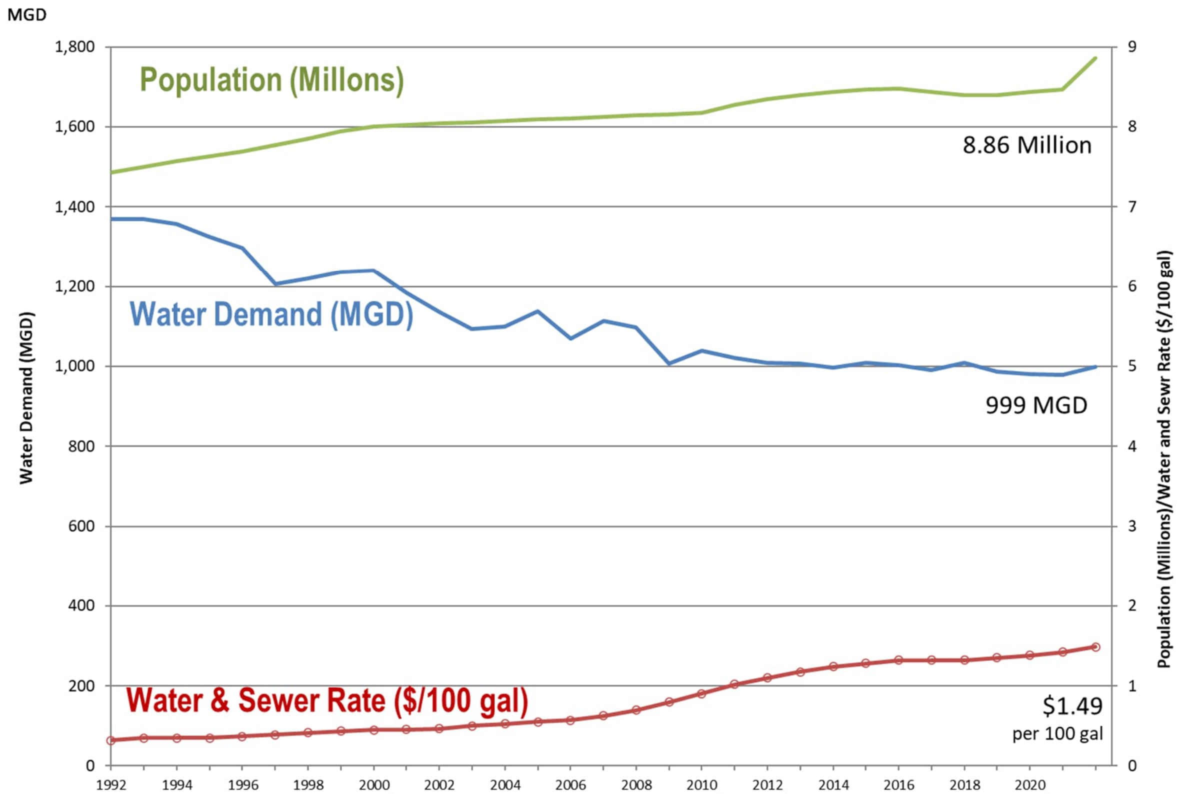


Figure 9-7. Population, Consumption Demand, and Water and Sewer Rates Over Time

9.6.d.3 Customer Assistance Programs

Several programs provide support and assistance for customers in financial distress, and DEP continues to expand these programs. 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 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 (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. DEP and the Water Board also created a Home Water Assistance Program to assist low-income homeowners. For this program, DEP partnered with the NYC Human Resources Administration, which administers the Federal Home Energy Assistance Program (HEAP), and the New York City Department of Finance, which provides tax exemptions to senior and disabled homeowners, to identify low-income homeowners who receive HEAP assistance and/or tax exemptions and, thus, are automatically eligible to receive a credit on their DEP bill. The Home Water Assistance Program (HWAP) is an initiative to make water and sewer bills more affordable for low-income homeowners. DEP partnered with the NYC Human Resources Administration (HRA) and the NYC Department of Finance (DOF) to select over 50,000 qualified one- to four- family homeowners.

~~There is also a Multi-family Water Assistance Program for Affordable Housing, where a $250 credit per housing unit would be issued for qualified projects identified by the NYC Housing Preservation and~~

~~Development. The credit reflects 25 percent of the MCP rate, on which many of the eligible properties are billed. Up to 40,000 housing units will receive this credit, providing $10M of assistance.~~

9.6.e Affordability and Financial Capability Analyses

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" (1997 EPA Guidance). The 1997 EPA 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 annual costs are less than one percent of MHI;
- Mid-range economic impact: average wastewater annual costs are between one percent and two percent of MHI; and
- High economic impact: average wastewater annual costs are greater than two percent of MHI.

The second phase develops the Permittee Financial Capability Indicators, 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: bond rating; net debt; MHI; local unemployment; property tax burden; and property tax collection rate within a service area. Lower Financial Capability Indicators (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.

Significantly, 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. The 1997 EPA 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).

In November of 2014, EPA released its "Financial Capability Assessment Framework" (2014 EPA Framework) clarifying the flexibility within its CSO guidance. Although EPA did not modify the metrics established in the 1997 EPA Guidance, the 2014 EPA Framework reiterates that permittees are encouraged to supplement the core metrics with additional information that would "create a more accurate and complete picture of their financial capability" that may "affect the conclusion" of the analysis.

For example, EPA will consider:

- All CWA costs presented in the analysis described in the 1997 EPA Guidance; and
- Safe Drinking Water Act obligations as additional information about a permittee's financial capability.

EPA will also consider alternative disaggregation of household income (e.g., quintiles), as well as economic indicators including, but not limited to:

- Actual poverty rates;
- Rate of home ownership;
- Absolute unemployment rates; and
- Projected, current, and historical wastewater (sewer and stormwater costs) as a percentage of household income, quintile, geography, or other breakdown.

The purpose of presenting these data is to demonstrate that the local conditions facing the municipality deviate from the national average to the extent that the metrics established in the 1997 EPA Guidance are inadequate for accurately assessing the municipality's financial capacity for constructing, operating, and implementing its LTCP Program in compliance with its regulatory mandates.

In February 2023, EPA announced its updated Clean Water Act Financial Capability Assessment Guidance (2023 EPA Guidance) that supersedes the 1997 EPA Guidance to evaluate a community's or utility's capability to fund Clean Water Act control measures in both the permitting and enforcement context. It also supplements the 2014 EPA Framework that is described above. The 2023 EPA Guidance retains factors required under the Clean Water Act by the Combined Sewer Overflow Policy as part of a financial capability assessment, including the consideration of MHI and costs per household as a percent of MHI (i.e., Residential Indicator), but the updated guidance adds a new metric for consideration of lowest quintile income and poverty indicators. ~~In September 2020, EPA announced its' proposed 2020 Financial Capability Assessment Guidance (2020 EPA Proposed Guidance) that is anticipated to effectively replace the 1997 EPA Guidance. The 2020 EPA Proposed Guidance includes new metrics to inform a community's implementation schedule, including indicators that more accurately reflect how much low-income communities can afford to pay for water infrastructure upgrades. The 2020 EPA Proposed Guidance reflects a departure from heavily relying on a percent of median household income as an indicator of affordability in the Clean Water Act context, a change that has been championed by water and wastewater utilities and their advocates to better account for impacts to economically disadvantaged communities.~~

This section begins to explore affordability and financial capability concerns as outlined in the 1997 and 2001 EPA guidance documents and the 2014 EPA Framework, and analyzes the financial capability of NYC to make additional investments in CSO control measures, in light of the relevant financial indicators, the overall socioeconomic conditions in NYC, and the need to continue spending on other water and sewer projects. The analysis is presented both in terms of the EPA's Financial Capability Guidance Framework and by applying several additional factors that are relevant to NYC's unique socioeconomic conditions. This section stops short of applying the 2023 EPA Guidance to be consistent with the original Citywide/Open Waters LTCP submittal and other LTCP waterbody submittals. That said, the affordability analysis contained herein is generally consistent with the methodology and intent of the 2023 EPA Guidance. ~~The methodology introduced in the 2020 EPA Proposed Guidance has not been applied since the guidance was still pending completion of a public comment period at the time of submittal of this LTCP, and it was not finalized or approved for use by EPA. However, some of the additional considerations (such as expanded consideration of costs, prevalence of poverty, and assessment of impacts at the lowest household income level) that are included in the 2020 EPA Proposed Guidance are explored in this section.~~

9.6.f Residential Indicator (RI)

As discussed above, the first economic test from the 1997 EPA Guidance is the RI, which compares the average annual household water pollution control cost (wastewater and stormwater related charges) to the MHI of the service area. Average household wastewater cost can be estimated by approximating the residential share of wastewater treatment and dividing it by total number of households. In NYC, the wastewater bill is a function of water consumption. Therefore, average household costs and the RI are estimated based on application of FY ~~2020~~ 2023 rates to consumption rates by household type, as shown in Table 9-4.

Table 9-4. Residential Water and Wastewater Costs Compared to Median Household Income (MHI)

	Average Annual Wastewater Cost ($/year)	Wastewater RI (Wastewater Cost/MHI(1)) (%)	Total Water and Wastewater Cost ($/Year)	Water and Wastewater RI (Water and Wastewater Cost/MHI) (%)
Single-family(2)	~~594~~ 638	**0.~~89~~ 0.91**	~~967~~ 1,041	**~~1.45~~ 1.48**
Multi-family(3)	~~441~~ 474	**0.~~66~~ 0.68**	~~718~~ 773	**1.~~08~~ 1.10**
Average Household Consumption(4)	~~556~~ 597	**0.~~83~~ 0.85**	~~905~~ 976	**~~1.36~~ 1.39**
MCP**(5)**	~~646~~ 713	**0.~~95~~ 1.02**	1,~~052~~ 1,134	**1.62**

Notes:

(1) Latest MHI data is ~~$63,799~~ 67,046 based on ~~2018~~ 2020 ACS data, estimated MHI adjusted to ~~2020~~ 2023 is ~~$66,620~~ 70,160 using ~~Bureau of Labor Statistics Consumer Price Index and U.S. Census Bureau data per the 1997 EPA Guidance~~ 2010-2019 average annual increase in MHI.
(2) Based on 70,000 gallons/year consumption and ~~FY2020~~ FY2023 Rates.
(3) Based on 52,000 gallons/year consumption and ~~FY2020~~ FY2023 Rates.
(4) Based on average consumption across all metered residential units of 65,534 gallons/year and ~~FY2020~~ FY2023 Rates.
(5) Multi-family Conservation Plan (MCP) is a flat fee per unit, based on FY2023 Rates ~~for customers who will implement certain conservation measures~~.

As shown in Table, the RI for wastewater costs varies between ~~0.66~~ 0.68 percent of MHI to ~~0.99~~ 1.02 percent of MHI, depending on household type. Because DEP is a water and wastewater utility and ratepayers receive one bill for both charges, it is also appropriate to look at the total water and wastewater costs in considering the RI, which varies from ~~1.08~~ 1.10 percent to ~~1. 54~~ 1.62 percent of MHI.

Based on this initial screen, current wastewater costs pose a low economic impact according to the 1997 EPA Guidance. Several factors, however, limit use of MHI as a financial indicator for 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~~ almost 604,000 households in NYC (about ~~19~~ 18 percent of NYC's total households) 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 later in this section.

9.6.g Financial Capability Indicators (FCI)

The second phase of the 1997 EPA Guidance develops the Permittee FCI, which examines 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: 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 an increased likelihood that additional controls would cause substantial economic impact.

Table 9-5 summarizes the FCI scoring as presented in the 1997 EPA Guidance. NYC's FCI score based on this test is presented in Table 9-6 and is further described below.

Table 9-5. 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 above the 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%

Table 9-6. NYC Financial Capability Indicator Score

Financial Capability Metric	Actual Value	Score
Debt Indicators		
Bond rating (G.O. bonds)	AA+ (S&P) AA+ (Fitch) Aa1 (Moody's)	Strong/3
Bond rating (Revenue bonds)	AA+ (S&P) AA+ (Fitch) ~~Aa2~~ Aa1 (Moody's)	
Overall net debt as percentage of FMPV	~~3.0~~ 2.82%	Mid-range/2
G.O. Debt	~~$37.5~~ 38.57B	
Market value	~~$1,250.7~~ 1,369.42B	
Socioeconomic Indicators		
Unemployment rate (~~2019~~ 2021 annual average)	~~0.2~~ 4.6% above the national average	~~Mid-range/2~~ Weak/1
NYC unemployment rate	~~4.0~~ 9.9%	
United States unemployment rate	~~3.7~~ 5.3%	
MHI as percentage of national average	~~+3.0~~ 103.2%	Mid-range/2
Financial Management Indicators		
Property tax revenues as percentage of FMPV	2.4%	Mid-range/2
Property tax revenue collection rate	~~88.4~~ 97.98%	~~Weak/1~~ Mid-range/2
Permittee Indicators Score		2.0

Notes:
Debt and Market Value Information ~~as of November 20, 2019~~ based on FY2021.
G.O. Debt and market value from ~~2019~~ 2021 CAFR.

9.6.g.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 debt issued to finance capital construction projects ~~financed with bonds~~. According to EPA's criteria, NYC's financing capability is considered "strong" for this category based on the ratings the City and the NYC Municipal Water Finance Authority has received from all three rating agencies [Moody's, Standard & Poor's (S&P), and Fitch Ratings]~~– NYC's financing capability is considered "strong" for this category~~.

NYC's G.O. rating and the NYC Municipal Water Finance Authority's ~~(MWFA) revenue~~ bond ratings are high due to prudent fiscal management, the legal structure of the system, and the Water Board's ~~historic~~ independence and demonstrated ability to ~~raise~~ set water and wastewater rates at a level that is appropriate to fund the system. However, mandates over the last decade have significantly increased the amount of debt outstanding leverage of the system, as well as increased the system's asset base. ~~and f~~Future bond ratings could be impacted by further increases to debt, when compared to revenues available for debt service, beyond what is currently forecasted.

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9.6.g.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. At the end of ~~FY2019~~ FY2021, NYC had more than $~~37.5~~ 38.57B in outstanding G.O. debt, and the FMPV within NYC was $~~1,250.7~~ 1,369.42B. This results in a ratio of outstanding debt to FMPV of 3.0 percent and a "mid-range" rating for this indicator. As of March 2, 2022, the NYC Municipal Water Finance Authority has $31.7 billion of bonds outstanding. The Water Authority's bonds are secured by the revenues obtained from customers paying water and sewer charged incurred for services provided by the City's water and sewer system. The Water Authority is a New York State public authority that is legally authorized to issue bonds independently of the City. As such, its bonds receive a credit rating that is separate from the City's rating and that have a distinct credit profile from the City's general obligation bonds. As of February 25, 2022, the Water Authority had a AAA credit rating from Standard and Poor's. At the end of Fiscal Year 2022, the Water Authority's debt service coverage ratio for its senior first resolution bonds was 347x, and 10x for the combined debt service coverage of its senior first resolution and junior second resolution bonds, when taken together. ~~If $24.9B of MWFA revenue bonds that support the system are included, net debt as a percentage of FMPV increases to 5.0 percent, which results in a "mid-range" rating for this indicator. Furthermore, if NYC's $52.5B of additional debt that is related to other services and infrastructure is also included, the ratio further increases to 9.2 percent.~~

9.6.g.3 Unemployment Rate

For the unemployment benchmark, the ~~2019~~ 2021 annual average unemployment rate for NYC was compared to that for the U.S. NYC's ~~2019~~ 2021 unemployment rate of ~~4.0~~ 9.9 percent is ~~0.3~~ 4.6 percentage points higher than the national average of ~~3.7~~ 5.3 percent (U.S. Bureau of Labor Statistics). Based on the 1997 EPA Guidance, NYC's unemployment benchmark would be classified as "~~mid-range~~ weak." It is important to note that over the past two decades, NYC's unemployment rate has generally been higher than the national average. Also, unemployment numbers have generally been improving in NYC and the country during the economic recovery from COVID-19. For example, the NYC unemployment rate was at 5.4% as of February 2023 on a seasonally adjusted basis (New York State Department of Labor). ~~Additionally, the unemployment rate measure identified in the 1997 financial guidance is a relative comparison based on a specific snapshot in time. It is difficult to predict whether the unemployment gap between the United States and NYC will widen, and it may be more relevant to look at longer term historical trends of the service area. Potential implications to NYC's unemployment rate as a result of COVID-19 are discussed in Section 9.8. For example, the average monthly unemployment rate from January 2020 through July 2020 has increased to 12.1 percent for NYC, which is 3.4 percentage points higher than the national average for this period of 8.7 percent (U.S. Bureau of Labor Statistics). Using this more recent data that reflects some of the hardships that have resulted from COVID-19, NYC's unemployment benchmark would be classified as "weak" per EPA's guidance.~~

9.6.g.4 Median Household Income (MHI)

The MHI benchmark compares the community's MHI to the national average. Using American Community Survey (ACS) Table S1901, 2020 5-year ~~2018 single-year~~ estimates, NYC's MHI is $~~63,799~~ 67,046 and the nation's MHI is $~~61,937~~ 64,994. Thus, NYC's MHI is approximately 103 percent of the national MHI, resulting in a "mid-range" rating for this indicator. However, as discussed above, 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 misleading indicator of the affordability impacts in large and diverse cities like NYC.

9.6.g.5 Tax Revenues as a Percentage of Full Market Property Value (FMPV)

This indicator, which EPA also refers to as the "property tax burden," attempts to measure "the funding capacity available to support debt based on the wealth of the community," as well as "the effectiveness of management in providing community services." According to the NYC Property Tax Annual Report issued for ~~FY2019~~ FY2021, NYC had billed $~~29.6~~ 32.7B in real property taxes against a $~~1,250.7~~ 1,369.4B FMPV, which amounts to 2.4 percent of FMPV. For this benchmark, NYC received a "mid-range" score. This figure does not include water and wastewater revenues. ~~Including FY2019 system revenues ($3.8B) would increase the ratio to 2.7 percent of FMPV.~~

This indicator, whether including or excluding water and wastewater revenues, is misleading because NYC obtains about 45 percent of its tax revenues from property taxes, meaning that taxes other than property taxes (e.g., income taxes, sales taxes) accounted for 55 percent of the locally-borne NYC tax burden.

9.6.g.6 Property Tax Collection Rate

The property tax collection rate is a measure of "the efficiency of the tax collection system and the acceptability of tax levels to residents." The ~~FY2019~~ FY2021 NYC Property Tax Annual Report indicates NYC's total property tax levy was $~~29.6~~ 32.70B, of which ~~88.4~~ 97.98 percent was collected during FY2019, resulting in a "~~weak~~ mid-range" rating for this indicator.

DEP notes, however, that the processes used to collect water and wastewater charges and the enforcement tools available differ from those used to collect and enforce real property taxes. In the case of DEP, property tax collection rate is an inappropriate measure of financial capability. 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. Thus, the real property tax collection rate does not accurately reflect DEP's ability to collect the revenues used to support water supply and wastewater capital spending.

9.6.h Summary of the Phase 1 and Phase 2 Indicators

The results of the Phase 1 (Residential Indicator) and the Phase 2 (Permittee Financial Capability Indicators) evaluations are combined in the Financial Capability Matrix (see Table 9-7), to evaluate the level of financial burden the current CWA program costs may impose on NYC. Based on a RI score of ~~0.83~~ 0.85 percent (using average household consumption), and a FCI score of 2.0, NYC's Financial Capability Matrix score is "Low Burden." ~~The score also falls in the "Low Burden" category when considering the higher RI scores of 0.89 percent and 0.95 percent for single-family and multi-family conservation plan households, respectively.~~

Table 9-7. Financial Capability Matrix

Permittee Financial Capability Indicators Score (Socioeconomic, Debt, and Financial Indicators)	Residential Indicator (Cost Per Household as a % of MHI)		
	Low Impact (Below 1.0%)	**Mid-Range (Between 1.0 and 2.0%)**	**High Impact (Above 2.0%)**
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	**Low Burden**	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

9.6.i Alternative Indicators: Household Burden and Poverty Prevalence

The American Water Works Association, National Association of Clean Water Agencies, and the Water Environment Federation commissioned the development of a new methodology and guideline for assessing household affordability and community financial capability. The resulting report, "Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector" was released in April 2019 (2019 Suggested Framework) and is intended to serve as a new framework that EPA can adopt that addresses some recognized shortcomings of the 1997 EPA Guidance. These shortcomings, which were identified in a National Academy of Public Administration report and literature review, include:

- MHI is a poor indicator of economic distress bearing little relationship to poverty or other measures of economic need within a community.
- The RI is not focused on the poor or the most economically vulnerable users, and MHI does not capture impacts across diverse populations.
- The RI is an incomplete water cost measure that only includes a limited set of wastewater costs and does not include the cost of drinking water or stormwater.
- The estimated costs included in the RI do not reflect the actual water bills that are paid by a residential customer.
- The RI focuses on average per household cost of water-related services rather than basic water use. Basic water use refers to water used for drinking, cooking, health, and sanitation.
- The RI provides a "snapshot" that does not account for the historical and future trends of a community's economic, demographic, and/or social conditions.
- The RI does not account for other non-discretionary household costs, such as the cost of housing or other utilities, which can exacerbate affordability challenges for low-income households (Raucher, et al. 2019).

While the 2019 Suggested Framework was not adopted by EPA in the recently issued 2023 EPA Guidance, application of it provides supplemental information for a fuller picture of NYC's affordability. The methodology recommended in the 2019 Suggested Framework for assessing housing affordability considers a combination of measures of household affordability as an alternative to the current RI. This includes the Household Burden Indicator (HBI) and the Poverty Prevalence Indicator (PPI). The HBI is defined as basic water service costs as a percent of the 20th percentile household income (the Lowest Quintile of Income (LQI) for the service area). This metric measures the economic burden that relatively low-income households in the community face in paying their water, wastewater, and stormwater bills. The PPI is defined as the percentage of community households at or below 200 percent of the Federal Poverty Level (FPL). PPI is a measure of the degree to which poverty is prevalent in the community. The 2019

Suggested Framework combines these measures in a matrix that indicates both a household-level burden and how water sector costs pose an affordability challenge at the community level.

The 2019 Suggested Framework was used to determine an alternative measurement of financial capability. With an annual basic water sector cost of $~~555.43~~ 597 based on the average household consumption and an upper boundary of the LQI of $~~20,975~~ 22,956, the HBI is 2.6 percent. Within the service area, the population below 200 percent of the FPL is 2.9 million, and the population for whom the poverty status is determined is 8.3 million. The resulting PPI is 35.4 percent.

According to the 2019 Suggested Framework, an HBI of less than 7 percent and a PPI greater than or equal to 35 percent is considered a "Moderate-High Burden" (see Table 9-8). In comparison, application of the 1997 EPA Guidance yielded a "Low Burden" result as detailed above. This indicates that the burden of water service is likely higher than that obtained using the 1997 EPA Guidance. ~~Key elements of the 2019 Suggested Framework have been taken into consideration in development of the 2020 EPA Proposed Guidance introduced earlier.~~

Table 9-8. Benchmarks for Recommended Household Affordability Metrics

HBI (Water Costs as a Percent of Income at LQI)	PPI (Percent of Households Below 200% of FPL)		
	>=35%	**20% to 35%**	**<20%**
>=10%	Very High Burden	High Burden	Moderate-High Burden
7% to 10%	High Burden	Moderate-High Burden	Moderate-Low Burden
<7%	**Moderate-High Burden**	Moderate-Low Burden	Low Burden

9.6.j Socioeconomic Considerations in the New York City Context

As encouraged by the 1997 EPA Guidance and 2014 EPA Framework, several additional factors of particular relevance to NYC's unique socioeconomic character are provided in this section to aid in the evaluation of affordability implications of the costs associated with anticipated CWA compliance on households in NYC.

9.6.j.1 Income Levels

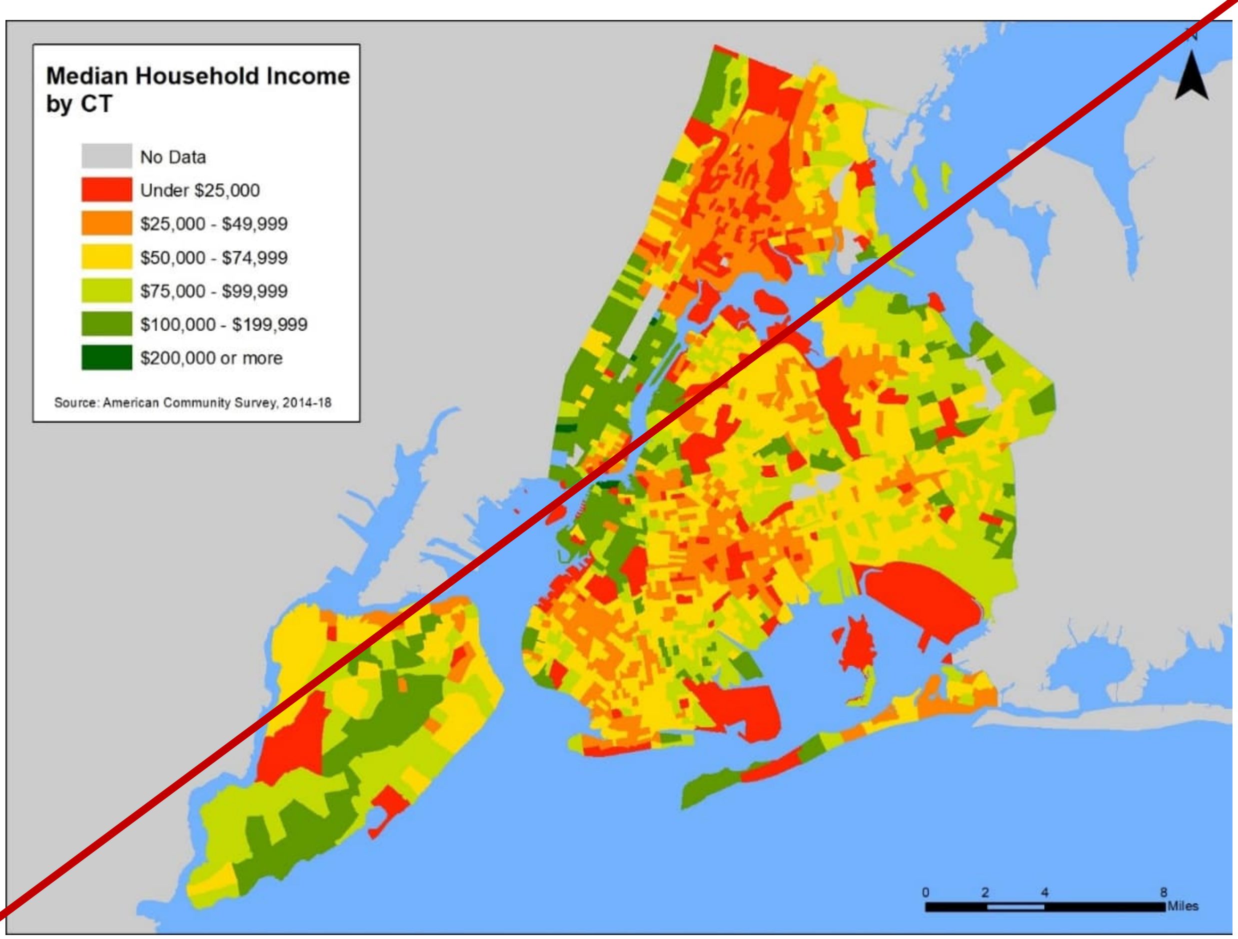
Based on ACS Table S1901, 2020 5-year estimates ~~In 2018, the latest year for which Census data is available~~, the MHI in NYC was $~~63,799~~ 67,046. As shown in Table 9-9, across the NYC boroughs, MHI ranged from $~~38,467~~ 41,895 in the Bronx to $~~85,066~~ 89,812 in Manhattan. Figure 9-8 shows that income levels also vary considerably across NYC neighborhoods, and there are several areas in NYC with high concentrations of low-income households.

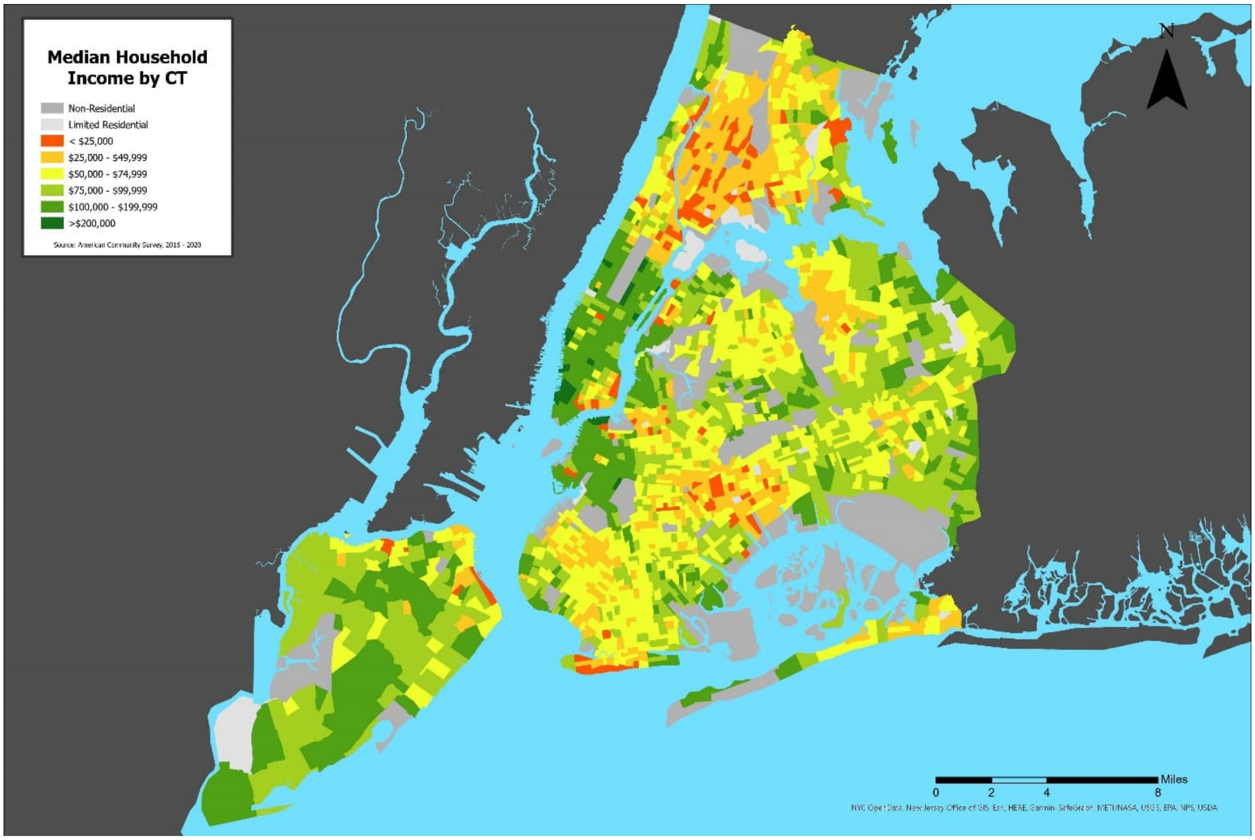
As shown in Figure 9-9, MHI in NYC increased gradually over the years 2011 to 2020.

Table 9-9. Median Household Income

Location	~~2018~~ 2020 (MHI)
United States	~~$61,937~~ 64,994
New York City	~~$63,799~~ 67,046
Bronx	~~$38,467~~ 41,895
Brooklyn	~~$61,220~~ 63,973
Manhattan	~~$85,066~~ 89,812
Queens	~~$69,320~~ 72,028
Staten Island	~~$82,166~~ 85,381

Source: U.S. Census Bureau ACS Table S1901, 2020 5-year estimates ~~2018 ACS 1-Year Estimates~~.

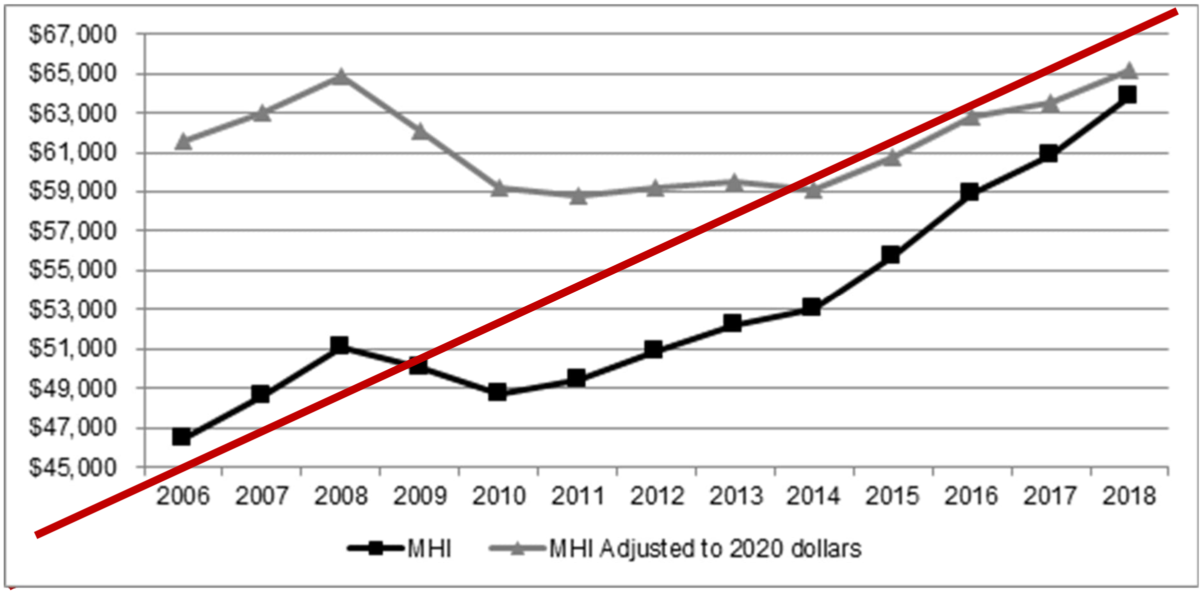




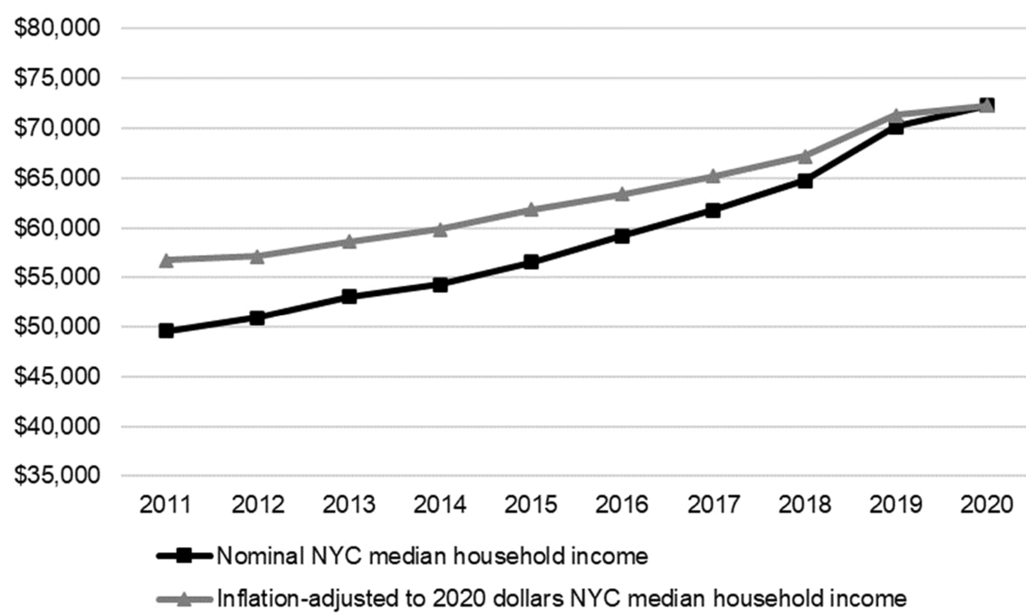
Source: U.S. Census Bureau ACS Table S1901, 2020 5-year Estimates ~~2014-2018 ACS 5-Year Estimates~~

Figure 9-8. Median Household Income by Census Tract

~~As shown in Figure, after 2008, MHI in NYC actually decreased for two years. In addition, the cost of living continued to increase during this period. When adjusting for inflation (2020 dollars) using the Bureau of~~



~~Labor Statistics Consumer Price Index, MHI in NYC in 2018 was only 0.5 percent greater than MHI in 2008~~



~~(see Figure).~~

Source: Federal Bureau of Labor Statistics. NYC median household income is calculated using median household income for each of New York City's five boroughs and weighting each borough's number using the 2020 population weight of each borough. The inflation-adjusted income numbers use the NY-NJ-PA metro area CPI to adjust historical incomes to a 2020 benchmark.

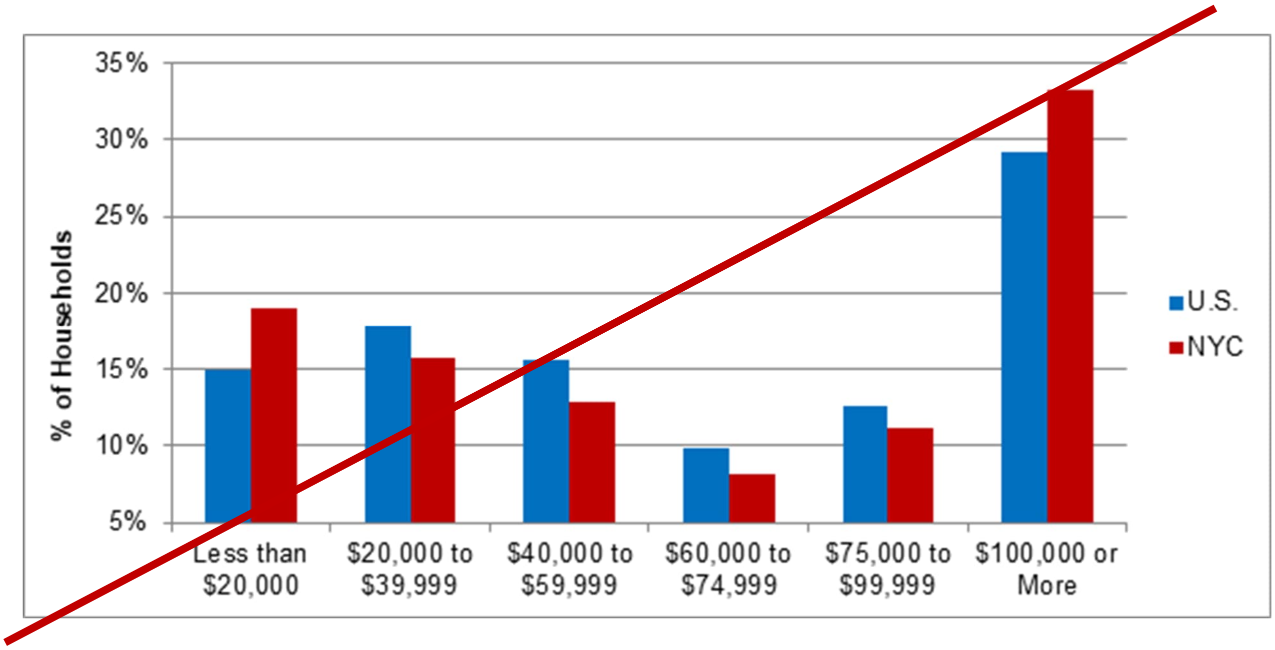
~~Source: U.S. Census Bureau 2006 through 2018 ACS 1-Year Estimates, Bureau of Labor Statistics Consumer Price Index.~~

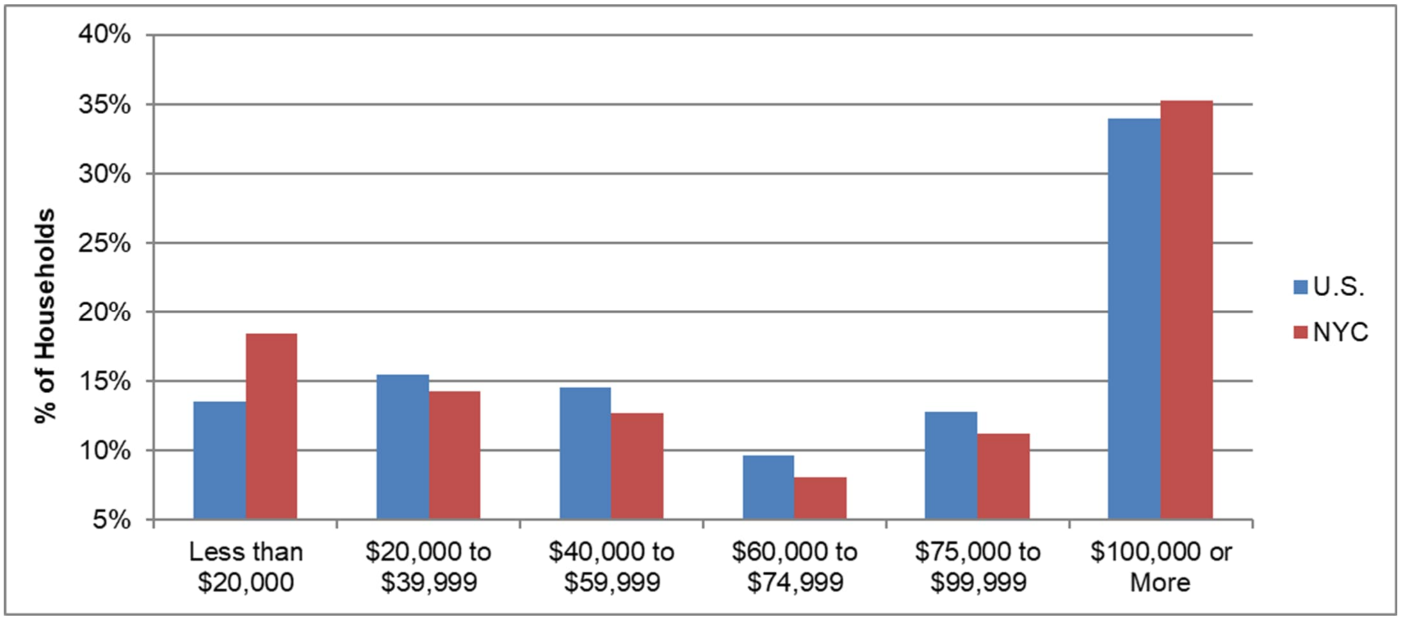
Figure 9-9. NYC Median Household Income Over Time

9.6.j.2 Income Distribution

NYC currently ranks as one of the most unequal cities in the United States in terms of income distribution. NYC's income distribution highlights the need to focus on metrics other than citywide MHI 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 9-10, incomes in NYC are not clustered around the median. Rather, a greater percentage of NYC households exist at either end of the economic spectrum. Also, the percentage of the population with middle-class incomes between $20,000 and $99,999 is ~~8.1~~ 6.2 percent less in NYC than in the United States.

As shown in Table 9-10, the income level that defines the upper end of the Lowest Quintile (i.e., the lowest 20 percent of income earners) in NYC is $~~20,975~~ 21,937, compared to $~~25,434~~ 26,685 nationally. This further demonstrates that NYC has a particularly vulnerable, and sizable, lower income population. Table 9-11 compares the average household consumption wastewater RI and wastewater plus water RI for the Lowest Quintile, Second Quintile (i.e., the lowest 40 percent of income earners), and MHI for NYC using ~~FY2020~~ FY2023 rates. As shown in this table, households in the Lowest Quintile have a wastewater RI of approximately ~~2.54~~ 2.60 percent, which easily exceeds EPA's "High Financial Impact" threshold of 2.0 percent, and the combined water and wastewater RI is approximately ~~4.13~~ 4.24 percent.





Source: U.S. Census Bureau ~~2018~~ 2021 ACS 1-Year Estimates.

Figure 9-10. Income Distribution for NYC and U.S.

Table 9-10. Household Income Quintile Upper Limits in New York City and the United States (~~2018~~ 2020 Dollars)

Quintile	New York City	United States
20th Percentile	~~$20,975~~ 21,937	~~$25,434~~ 26,685
40th Percentile	~~$45,579~~ 50,247	~~$48,836~~ 51,136
60th Percentile	~~$83,191~~ 87,157	~~$77,890~~ 81,496
80th Percentile	~~$144,313~~ 150,421	~~$125,322~~ 130,545
95th Percentile	$250,000+	~~$238,883~~ 274,124

Source: U.S. Census Bureau ACS Table S1901, 2020 5-year estimates ~~2018 ACS 1-Year Estimates~~.

Table 9-11. Average Household Consumption Residential Indicator (RI) for Different Income Levels using ~~FY2020~~ FY2023 Rates

Income Level	Wastewater RI(1)	Water and Wastewater RI(1)
Lowest 20 Percent Upper Limit	~~2.54~~ 2.60%	~~4.13~~ 4.24%
Lowest 40 Percent Upper Limit	~~1.12~~ 1.14%	~~1.82~~ 1.85%
MHI	~~0.83~~ 0.85%	~~1.36~~ 1.39%

Notes:

(1) 2020 income levels adjusted to 2023 dollars based on historical MHI average 2010-2019 increase.~~RI calculated by dividing average household consumption annual wastewater bill ($555 using FY2020 rates) and wastewater and water bill ($905 using FY2020 rates) by income level values adjusted to 2020 dollars.~~

(2) Based on 65,534 gallons/year consumption and FY2023 rates.

Household affordability at the 20th income percentile was recently evaluated in an article by Manuel Teodoro for the 25 largest U.S. cities, including New York City (Teodoro, 2018). Teodoro's method aims to provide a more accurate and meaningful method for measuring the affordability of water and sewer service for low-income households by accounting for the following: essential household water needs; income disparities; and core non-water/sewer costs using an affordability ratio (AR). The AR is determined at the 20th income percentile rather than at median income to reflect the fact that determining affordability for low-income households is the primary concern. This metric (AR_{20}) is used in conjunction with basic household water and sewer cost, expressed in terms of hours of labor at minimum wage (HM).

For an individual or aggregated group of customers, AR_{20} is the ratio of number of persons in a household multiplied by the per capita cost of essential water and sewer services to LQI income less essential household expenses. Similarly, HM is calculated based on the number of persons in a household multiplied by the per capita cost of essential water and sewer services divided by minimum wage in the labor market. For both metrics, the essential expenditures are estimated at the 20th income percentile.

Using this approach, Teodoro determined that in NYC, the AR_{20} was 14.1 percent and the HM was 6.8 hours. The average AR_{20} for the 25 cities for which this metric was calculated was 11.4 percent and the range was 4.8 percent in Phoenix to 26.9 percent in San Francisco. NYC's HM of 6.8 hours fell below the average of 9.0 HM for the 25 largest cities and in the middle of the range of 4.0 to 13.6 HM. A higher AR_{20} value for NYC is indicative of the high cost of living and limited disposable income at low-income households, while the lower HM value reflects a higher minimum wage paired with lower water and sewer bills compared to some of the other cities included in the study. Cost of living in NYC and other socioeconomic factors are further discussed below.

9.6.j.3 Poverty Rates

Based on the latest available Census data, ~~16.8~~ 18.0 percent of NYC residents (~~over~~ almost 1.5 ~~1.4~~ million people, which, for reference, is roughly equivalent to the entire population of Philadelphia) are living below the federal poverty level. This is significantly higher than the national poverty rate of ~~13.1~~ 12.8 percent, despite similar MHI levels for NYC and the U.S. as a whole. As shown in Table 9-12, across the NYC boroughs, poverty rates vary from ~~11.4~~ 11.5 percent in Staten Island to ~~27.4~~ 26.4 percent in the Bronx.

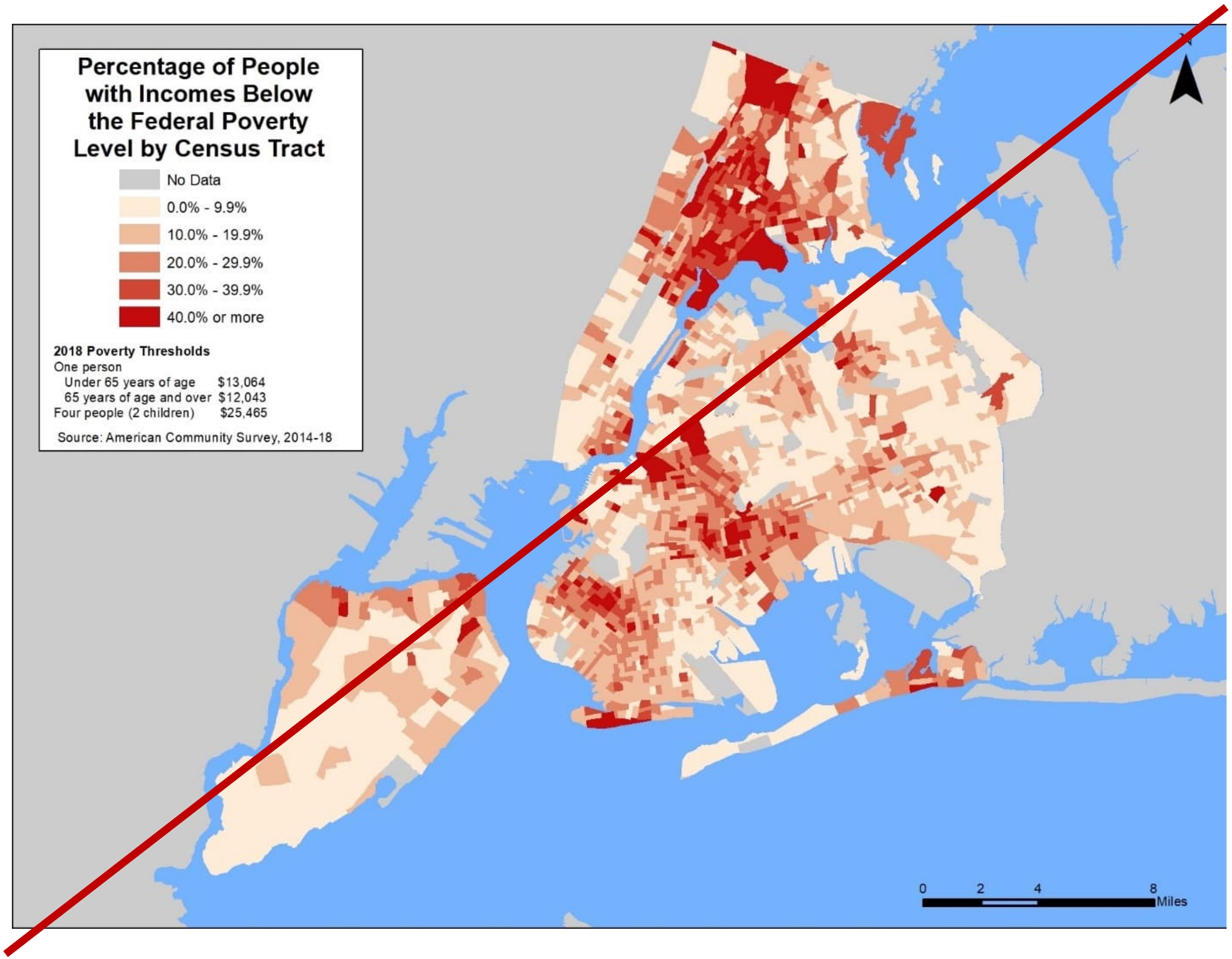
Table 9-12. NYC Poverty Rates

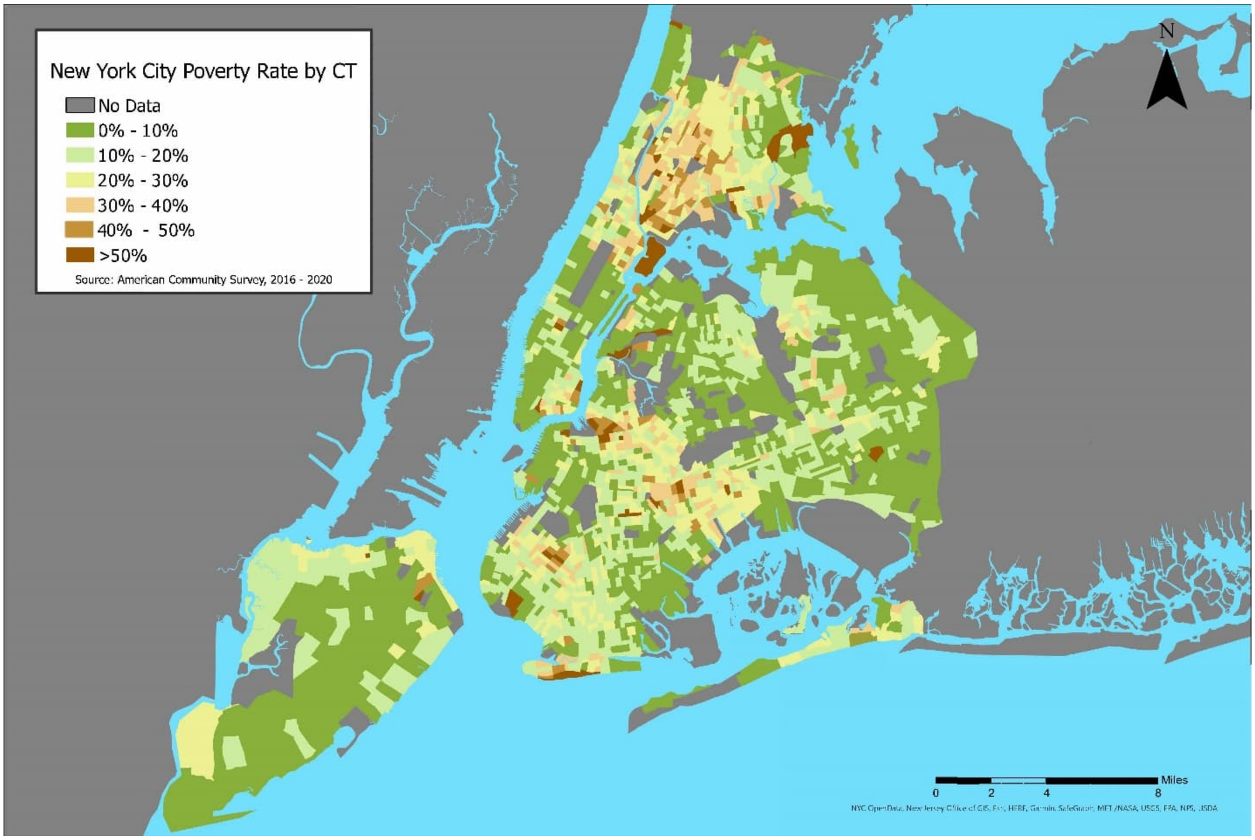
Location	Percentage of Residents Living Below the Federal Poverty Level
United States	~~13.1~~ 12.8%
New York City	~~16.8~~ 18.0%
Bronx	~~27.4~~ 26.4%

Brooklyn	~~19.0~~ 19.2%
Manhattan	~~15.5~~ 17.3%
Queens	~~11.5~~ 13.5%
Staten Island	~~11.4~~ 11.5%

Source: U.S. Census Bureau S1701, 2020 5-year Estimates ~~2018 ACS 1-Year Estimates~~.

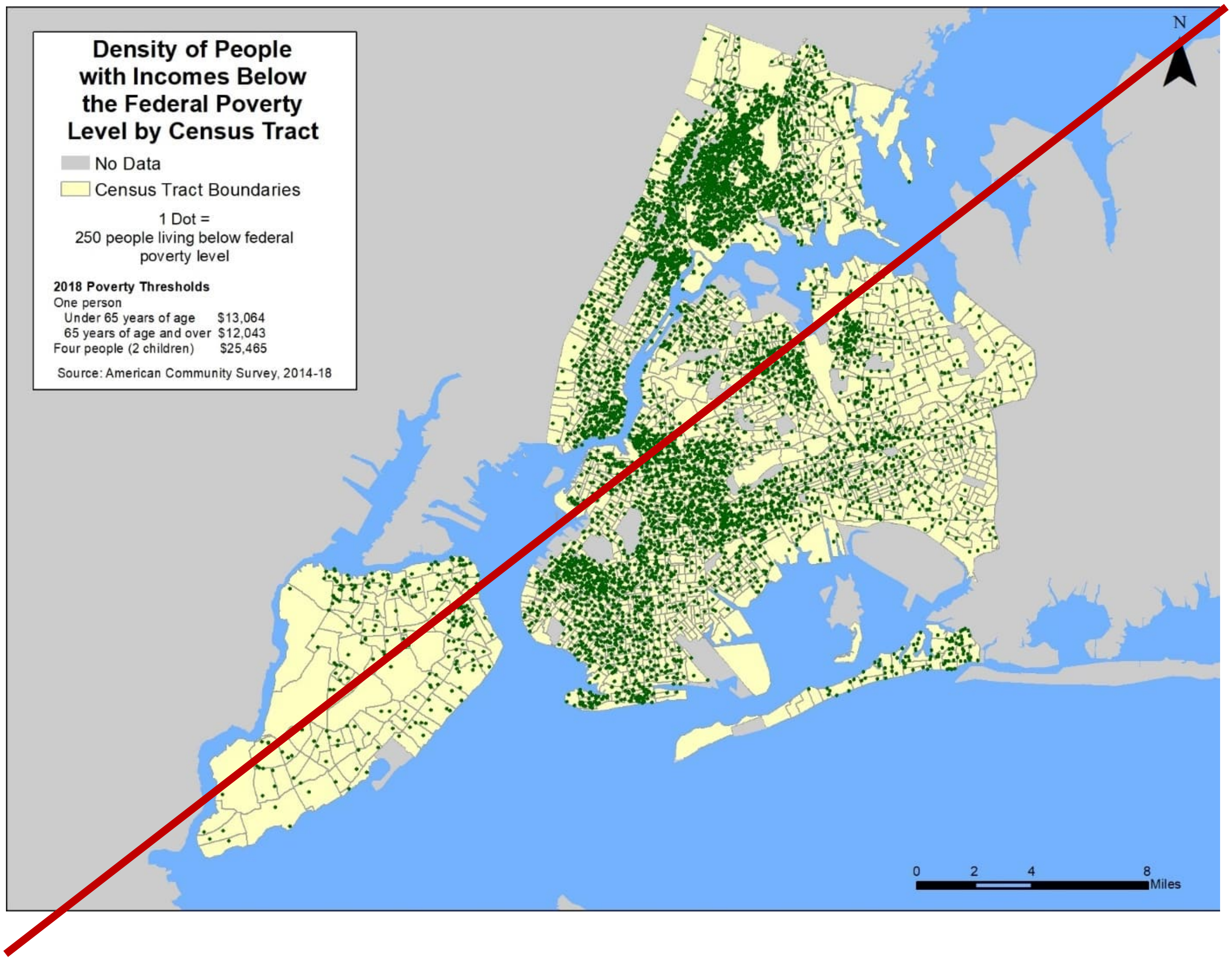
Figure 9-11 shows the poverty rates by census track, and Figure 9-12 shows the density of residents living below the federal poverty level. Each green dot in Figure 9-12 represents 250 people living in poverty. These figures show that poverty rates also vary across neighborhoods, and Figure shows several areas in NYC having a relatively high concentration of people living below the federal poverty level. ~~Each green dot in Figure 9-13 represents 250 people living in poverty.~~ While poverty levels are highly concentrated in some areas, smaller pockets of poverty exist throughout NYC. Because an RI that relies on MHI alone fails to capture these other indicators of economic distress, two cities with similar MHI could have disparate levels of poverty.

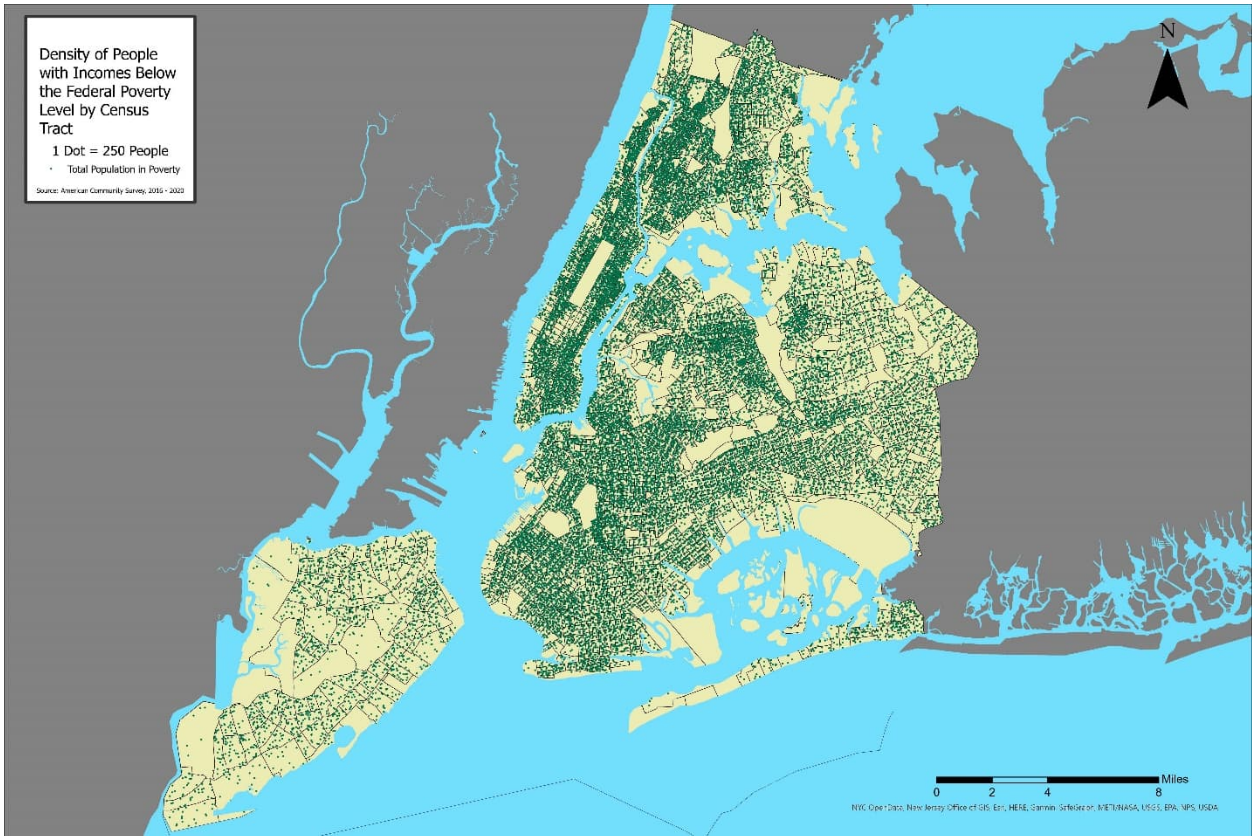




~~Source: U.S. Census Bureau 2014-2018 ACS 5-Year Estimates.~~

Figure 9-11. Poverty Rates in NYC


Density of People with Incomes Below the Federal Poverty Level by Census Tract
No Data
Census Tract Boundaries
1 Dot =
250 people living below federal poverty level
2018 Poverty Thresholds
One person
Under 65 years of age $13,064
65 years of age and over $12,043
Four people (2 children) $25,465
Source: American Community Survey, 2014-18
N
0
2
4
8
Miles



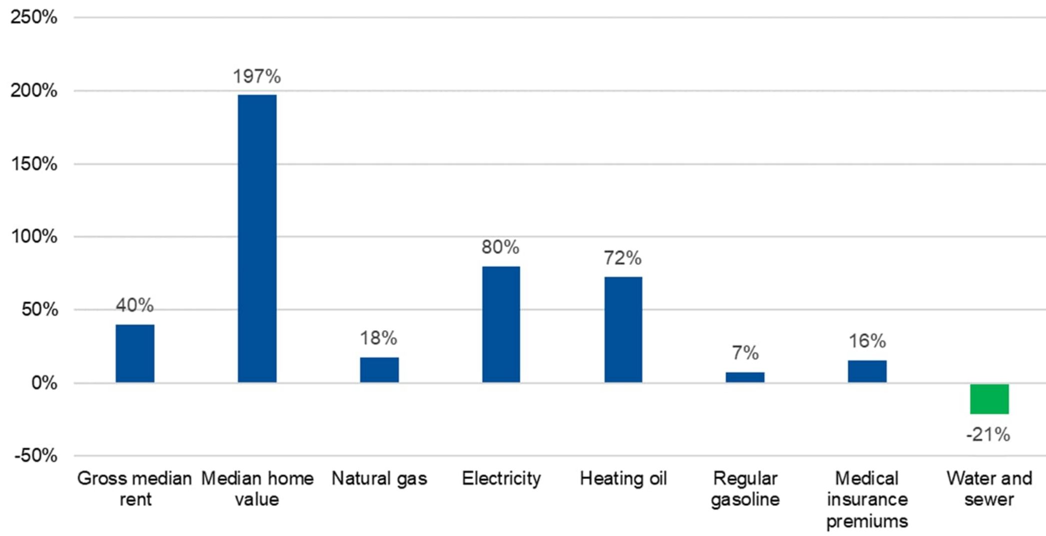
~~Source: U.S. Census Bureau 2014-2018 ACS 5-Year Estimates.~~

Figure 9-12. Poverty Clusters in NYC

9.6.j.4 Cost of Living and Housing Burden

NYC residents face relatively high costs for non-discretionary items (e.g., housing, utilities) compared to individuals living almost anywhere else in the nation, as shown in Figure 9-13. While water costs are slightly less than the average for other major United States cities, the housing burden is significantly higher.


+175%
+150%
+125%
+100%
+75%
+50%
+25%
+0%
-25%
+154%
+91%
+48%
+45%
+32%
+5%
+2%
-18%
1-Bedroom rent
Median house price
Electricity
Household groceries
Natural gas
Heating oil (#2 fuel)
Unleaded gasoline
Water & wastewater
NYC
National Average
$2,891
$1,140
$570,500
$299,400
$1,182
$798
$471
$324
$12.48
$9.43
$3.24
$3.07
$2.48
$2.43
$976
$1,175
Source: RentJungle.com, Census, Numbeo.com, NYSERDA + EIA, NYSERDA + AAA



New York City	$1,534	$682,277	$785	$1,462	$5.45	$4.11	$8,542	$994
National average	$1,096	$229,800	$667	$812	$3.16	$3.84	$7,380	$1,262
			(annual)	(annual)	(per gallon)	(per gallon)	(annual)	(annual)

Source: U.S. Census general population estimates (NYC population, gross median rent, median home value); ConEdison and Energy Information Administration (electricity prices), American Automobile Association (gasoline prices), American Gas Association (natural gas prices); Empire Center (medical premiums); New York City Water Board (water and sewer prices). Data based on 2021 figures, or most recent available.

Figure 9-13. Comparison of Costs between NYC and other U.S. Cities

As noted above, the cost of living in NYC is high compared to the average cost of living of other cities in the U.S. In 2018, NYC's Cost of Living Index (COLI)[1] was 191, or 91 percent higher than the average cost of living of other cities. When adjusted for cost of living, the purchasing power of a MHI of $~~66,620~~ 70,160 is reduced to $~~34,790~~ 36,639 in NYC (~~2020~~ 2023 dollars) when compared to the national average. Adjusting MHI for cost of living increases the RI ranking from a low impact to a mid-range impact, resulting in an elevated Financial Capability Score from a Low Burden to a Medium Burden. For average household consumption, the RI increases from ~~0.83~~ 0.85 to ~~1.60~~ 1.63 for wastewater and ~~1.36~~ 1.39 to ~~2.60~~ 2.66 for water and wastewater. Table 9-13 displays the RI adjusted for ~~2020~~ 2023 dollars and cost of living in NYC.

[1] The Cost of Living Index (COLI) measures how urban areas compare in cost of maintaining a standard of living appropriate for moderately affluent professional and managerial households. The COLI measures relative price levels for consumer goods and services in over 300 participating areas. The COLI used here for NYC represents a weighted average of the COLI for the Bronx, Brooklyn, Manhattan, Queens, and Staten Island. The data was provided by the Center for Regional Economic Competitiveness (CREC) December 3, 2019.

Table 9-13. Residential Water and Wastewater Costs Compared to Median Household Income (MHI) and MHI with Cost of Living Adjustment (COLA)

	Wastewater RI (Wastewater Bill/MHI[1]) (%)		Water and Wastewater RI (Water and Wastewater Bill/MHI[1]) (%)	
	MHI	MHI COLA	MHI	MHI COLA
Single-family[2]	~~0.89~~ 0.91	~~1.71~~ 1.74	~~1.45~~ 1.49	~~2.78~~ 2.84
Multi-family[3]	~~0.66~~ 0.68	~~1.27~~ 1.29	~~1.08~~ 1.10	~~2.06~~ 2.11
Average Household Consumption[4]	~~0.83~~ 0.85	~~1.60~~ 1.63	~~1.36~~ 1.39	~~2.60~~ 2.66
MCP[5]	~~0.95~~ 1.02	~~1.81~~ 1.95	~~1.54~~ 1.62	~~2.96~~ 3.10

Notes:
(1) Latest MHI data is $~~63,799~~ 67,046 based on ~~2018~~2020 ACS data. Estimated MHI adjusted to ~~2020~~ 2023 is $~~66,620~~ 70,160. Adjusting ~~2020~~ 2023 MHI for cost of living, MHI is $~~34,790~~ 36,639.
(2) Based on 70,000 gallons/year consumption and ~~FY2020~~ FY2023 Rates.
(3) Based on 52,000 gallons/year consumption and ~~FY2020~~ FY2023 Rates.
(4) Based on average consumption across all metered residential units of 65,534 gallons/year and ~~FY2020~~ FY2023 Rates.
(5) Multi-family Conservation Plan is a flat fee per unit, based on FY2023 Rates ~~for customers who will implement certain conservation measures~~.

Approximately 67 percent of all households in NYC are renter-occupied, compared to about ~~36~~ 34 percent of households nationally. In recent years, affordability concerns have been compounded by the fact that gross median rents in NYC have increased, while median renter income has declined. Although renter households may not directly receive water and wastewater bills, these costs are often indirectly passed onto them in the form of rent increases. Increases in water and sewer costs that are borne by landlords and property owners could also indirectly impact tenants, as it may limit the ability to perform necessary maintenance. Although it can be difficult to discern precisely how much the water and sewer rates impact every household, particularly those in multi-family buildings and affordable housing units, the 1997 EPA Guidance requires that all households in the service area be identified and used to establish an average cost per household for use in financial capability and affordability analyses. This LTCP financial capability assessment applies a lower average annual wastewater cost for households in multi-family buildings, due to a lower annual consumption value as compared to single-family households, and also examines average consumption across the board.

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 ~~2018~~ 2020 ACS Census data shows approximately ~~16~~ 21 percent of NYC households (nearly ~~170,000~~ 663,000 households) spent between 30 percent and 50 percent of their income on housing, while about ~~18~~ 23 percent (~~over 182,000~~ close to 730,000 households) spent more than 50 percent. This compares to ~~13~~ 17 percent of households nationally that spent between 30 percent and 50 percent of their income on housing and ~~9~~ 14 percent of households nationally that spent more than 50 percent. This means that ~~34~~ 44 percent of households in NYC versus ~~22~~ 30 percent of households nationally spent more than 30 percent of their income on housing costs.

New York City Housing Authority (NYCHA) provides public housing and Section 8 vouchers for 11.6 percent of the City's rental apartments, which account for 6.5 percent of NYC's population. NYCHA has ~~173,762~~ 177,569 public housing apartments, representing approximately ~~8~~ 11.6 percent of the City's rental apartments. NYCHA paid approximately $~~191M~~ 182M for water and wastewater in ~~FY2019~~ FY2022. This total represents approximately ~~5.7~~ 4.4 percent of NYCHA's $~~3.51~~ 4.18B operating budget. More than 90 percent of NYCHA billings are calculated under the Multi-family Conservation Program (MCP) rate. Even a small increase in rates could potentially impact the agency's ability to provide affordable housing and/or other programs and services, and in recent years, NYCHA has experienced funding cuts and operational shortfalls, further straining its operating budget.

In sum, the financial capability assessment for NYC must look beyond the 1997 EPA Guidance, and must additionally consider the socioeconomic conditions discussed in this section including NYC's income distribution, water and wastewater rate impacts on households with income below the median level, poverty rates, housing costs, and total tax burden. Because many utilities provide both drinking and wastewater services and households often pay one consolidated bill, financial capability and affordability must consider total water and wastewater spending. Scheduling and priorities for future spending should consider the data presented here and above with respect to historical and future commitments.

9.6.k 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 anticipated CSO LTCP implementation costs for NYC and describes the potential resulting impacts to future household costs for wastewater service, when coupled with DEP's current and future investments. As described below, estimating the future rate and income increases through 2045 based on the cumulative impacts of this investment and DEP's other future spending, up to ~~55~~ 54 percent of households could pay two percent or more of their income for wastewater services.

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

As discussed in Section 8.8, the selection of the Recommended Plan for the Citywide and Open Waters LTCP includes the following:

- Hudson River: Optimization of regulators associated with Outfalls NR-038, 040, and 046 within the Hudson River
- East River: Bending weir at Regulator TI-13 (TI-023) plus regulator optimization associated with TI-003
- New York Bay: Optimization of regulators associated with CSOs RH-005, 014
- New York Bay: Gravity flow connection from Victory Boulevard combined sewer directly to interceptor, bypassing Hannah Street PS, diverting dry- and wet-weather flow upstream of CSO PR-013
- New York Bay: RTC gate for Regulator 9C, Outfall OH-015

The estimated costs (in December 2019 dollars) for the Recommended Plan are: NPW of $61M, PBC of $42M, and annual O&M of $1.5M. The escalated design and construction costs for the LTCP Recommended Plan are estimated to be $84M (not including site acquisition).

9.6.k.2 Overall Estimated Citywide CSO Program Costs

In the early 2000s, DEP developed 11 CSO WWFPs that laid out a program of targeted grey infrastructure projects to reduce CSO impacts and to meet applicable WQS at that time. As part of the CSO Order between DEC and DEP, these grey infrastructure projects were incorporated in the Order with specific project design and construction milestones. Additionally, in the Order DEP committed to a $1.6B GI program with the goal of capturing the first inch of a rainfall on 10 percent of the impervious CSO areas in NYC. Capital costs associated with the WWFP projects and GI program are presented in Table 9-14, and resulting CSO volume reductions are presented in Table 9-15.

DEP's LTCP planning process was initiated in 2012 and has advanced pursuant to the CSO Order schedule. This Citywide and Open Waters LTCP represents the final waterbody LTCP developed as part of this process. Overall anticipated CSO program costs for NYC will be unknown until each LTCP is approved. Capital costs for the LTCP preferred alternatives are presented in Table 9-14, and resulting CSO volume reductions and treated/disinfected CSO volumes are presented in Table 9-15. Approximately $~~2.0~~ 3.4B of LTCP and Superfund-mandated CSO control project costs ~~were~~ are committed in the ~~pre-COVID-19 January 2020 Plan~~ current CIP (~~FY2020-2029~~ FY2022-2031). The remainder of LTCP costs will be committed beyond ~~FY2029~~ FY2031. However, DEP is currently evaluating realignment of priorities, which may result in revisions to the LTCP budget projections. See Sections 9.8 and 9.9 for additional considerations related to COVID-19 and prioritization of future spending.

9.6.k.3 Potential Impacts to Future Household Costs

The potential future rate impacts of the possible future CSO control capital costs were determined by considering capital investments in the ~~January 2020 Plan~~ current CIP (FY~~2020-2029~~ 2023-2033) and applying estimated future DEP investments from ~~2030~~ 2033 to 2045 of $2.0B per year, assuming a CIP average of $2.0B per year (based on historic annual average CIP costs, anticipated needs, and investments) that was inflated by 3.5 percent per year beginning in ~~2029~~ 2033. In addition, $~~6.3~~ 6.2B in LTCP and Superfund-mandated CSO control spending through 2045 was applied, a portion of which is included in the current CIP. This $~~6.3~~ 6.2B in LTCP and Superfund-mandated CSO control spending is in addition to the $~~4.3~~ 4.5B in existing commitments associated with the WWFP grey CSO control projects and the citywide GI program, resulting in a potential total CSO program financial commitment of $~~10.7~~ 10.7B (see Table 9-16).

Table 9-14. Overall Estimated Citywide CSO Program Costs

Waterbody	Waterbody Watershed Facility Plan and Green Infrastructure Program		LTCP CSO Program		
	Projects	Total Project Costs (Design, CM, Construction) ($M)	Projects	Probable Bid Costs (Construction) ($M) – Current Estimate(1)	Total Project Costs (Design, CM, Construction) ($M) - Escalated to Midpoint of Construction(2)
Alley Creek	CSO Retention Facility	$141	Seasonal Disinfection at CSO Retention Facility	$8(5)	$25
Bergen and Thurston Basins(3)	Warnerville Pumping Station and Force Main + Bending Weirs + Parallel Interceptor + Lateral Sewer	$54	Included with Jamaica Bay and Tributaries	Included with Jamaica Bay and Tributaries	Included with Jamaica Bay and Tributaries
Bronx River	Maximize Flow to HP WRRF + Floatables Control	$46	New Regulator and Floatables Control at HP-011 + Hydraulic Relief at Outfalls HP-007/-009	$110(5)	$122
Coney Island Creek	Avenue V PS Expansion + Wet-Weather Force Main	$197	No Additional Projects	$0(5)	$0
Citywide/Open Waters	Multiple WRRF Headworks Projects + Port Richmond Throttling Facility + Tallman Island Conveyance + Outer Harbor CSO Regulator Improvements + Inner Harbor In-line Storage	$196	Regulator Optimizations and Hannah St PS Bypass	$42(6)	$84
Flushing Bay	Regulator Modifications to High Level Interceptor + Low-Lying Diversion Sewer + Environmental Dredging	$71	25 MG CSO Storage Tunnel (Outfalls BB-006 and BB-008)	$829(5)	$1,471
Flushing Creek	CSO Retention Facility + Vortex Facilities	$363	Floatables Control (Baffles) and seasonal disinfection at Diversion Chamber 3 (Outfall TI-010) and Regulator TI-09 (Outfall TI-011)	$56(5)	$89
Gowanus Canal	Gowanus PS Reconstruction + Flushing Tunnel	$198	8 MG Tank at RH-034 and 4 MG Tank at OH-007	$720(7)	~~$1,322~~ $1,600
Hutchinson River	Hunts Point WRRF Headworks	$3	~~Diversion Structure with Floatables Control and seasonal disinfection~~ 2.8 MG Storage with Floatables Control at HP-024	$90(5)	$204
Jamaica Bay and Tributaries	Sewer Improvements in 26W + 26W HLSS + Hendrix Creek Canal Dredging + Shellbank Destratification + Spring Creek AWRRF Upgrade + 26 Ward Wet-Weather Improvements	$652	Additional GI, Shoreline Wetland Restoration, Environmental Dredging, and Ecological Restoration	$~~310~~ 141(~~6~~5)	$~~579~~ 230
Newtown Creek	Floatables Control + Bending Weirs + Plant Expansion + Instream Aeration	$262	26 MGD BAPS Expansion and 39 MG Deep Tunnel	$597(5)	$2,401
Paerdegat Basin(3)	CSO Retention Facility	$394	Included with Jamaica Bay and Tributaries	Included with Jamaica Bay and Tributaries	Included with Jamaica Bay and Tributaries
Westchester Creek	Weir Modifications + Pugsley Creek Parallel Sewer	$126	No Additional Projects	$0(5)	$0
Green Infrastructure Program(4)	Citywide GI Program	~~$1,600~~ $1,800			
Total Cost		***~~$4,303~~ $4,503***		***~~$2,762~~ 2,593***	***~~$6,297~~ $6,226***

Notes:
(1) Costs reported in this column reflect current estimated construction costs only (i.e., probable bid cost).
(2) Costs reported in this column reflect total project costs (including design, construction management, and construction costs) escalated out to midpoint of construction and have been updated to be consistent with DEP's ~~January 2020 Plan~~ FY2022-2031 CIP. Projected O&M costs are not included. Spending and costs may be impacted by COVID-19.
(3) LTCP Program costs for Bergen, Thurston, and Paerdegat Basins are included in the Jamaica Bay and Tributaries cost.
(4) GI Program costs are not part of the LTCP Program costs.
(5) Cost based on LTCP approved by DEC.
(6) Cost based on LTCP submitted to DEC, but not yet approved by DEC.
(7) Cost for project mandated by Superfund Program.

Table 9-15. Overall Estimated Citywide CSO Reductions

Waterbody	Waterbody Watershed Facility Plan				LTCP CSO Program			
	Pre-WWFP Baseline Volume (MGY)(1)	Baseline LTCP CSO Volume (MGY)(2)	CSO Reduction (MGY)	CSO Volume Reduction (%)	LTCP Recommended Plan (MGY)(3)	CSO Reduction (MGY)	CSO Volume Reduction (%)	Treated CSO Volume (MGY)
Alley Creek	330	132	198	60%	132	0	0%	78
Bergen & Thurston Basins	Included with Jamaica Bay	Included with Jamaica Bay	Included with Jamaica Bay	NA	Included with Jamaica Bay and Tributaries	Included with Jamaica Bay and Tributaries	NA	Included with Jamaica Bay and Tributaries
Bronx River	498	455	43	9%	285	170	37%	---
Coney Island Creek	235	75	160	68%	75	0	0%	---
Citywide/Open Waters(4)	12,207	11,160	1,047	8%	10,935	225	2%	---
Flushing Bay	1,800	1,453	347	19%	706	747	51%	---
Flushing Creek	2,413	1,201	1,212	50%	1,201	0	0%	584
Gowanus Canal	471	263	208	44%	115	148	56%	---
Hutchinson River	362	~~323~~ 341	~~39~~ 21	~~11%~~ 6%	~~323~~ 291	~~0~~ 50	~~0%~~ 15%	~~65~~ ---
Jamaica Bay & Tribs	2,18~~2~~5	~~1,164~~ 1,237	~~1,018~~ 948	~~47%~~ 43%	~~1,156~~ 1,237	~~8~~ 0	~~1%~~ 0%	---
Newtown Creek	1,456	1,161	295	20%	455	706	61%	---
Paerdegat Basin	1,388	~~616~~ 591	~~772~~ 797	56%	~~616~~ 591	0	0%	---
Westchester Creek	790	290	500	63%	290	0	0%	---
Total	***24,132***	***~~18,293~~ 18,359***	***~~5,839~~ 5,776***	***24%***	***~~16,289~~ 16,313***	***~~2,004~~ 2,046***	***~~11%~~ 13%***	***~~727~~ 662***

Notes:
(1) "Pre-WWFP Baseline" volumes reflect conditions without Waterbody Watershed Facility Plan (WWFP) Projects, Green Infrastructure, and other sewer improvements using 2008 JFK rainfall data, CY2040 projected flows/loads and assuming WRRFs operating at permitted wet-weather capacities.
(2) "Baseline CSO LTCP" volumes are estimates of annual overflow volume based on WRRFs operating at permitted wet-weather capacities, all committed grey and green infrastructure online, 2008 JFK rainfall data (~46" of rainfall), and updated CY2040 projected flows and loads.
(3) "LTCP Recommended Plan" volumes are estimates of annual overflow volume based on WRRFs operating at permitted wet-weather capacities, all committed grey and green infrastructure online, 2008 JFK rainfall data (~46" of rainfall), updated CY2040 projected flows and loads, and the implementation of recommended plans for LTCPs submitted to-date (including this Citywide/Open Waters LTCP).
(4) The Citywide/Open waters baseline LTCP CSO Volume includes the reduction associated with the Tibbetts Brook Daylighting Project.

Table 9-16. Financial Commitment to CSO Reduction

New York City's CSO Program	Financial Commitment ($B)
Waterbody/Watershed Facility Plan and other CSO Projects	$2.7
Green Infrastructure Program	$~~1.6~~ 1.8
LTCP Submitted and Approved by DEC	$~~5.6~~ 6.2(1)
Total	**$~~10.74~~ 10.7**

Note:

(1) Reflects costs escalated to midpoint construction for submitted and approved LTCP plans as shown in Tabl. $~~2.0~~ 3.3B of LTCP and Superfund-mandated CSO control costs ~~were~~ are in the current CIP (FY2023-2033) ~~January 2020 Plan~~; the remaining will be spent beyond.

The Water Authority's borrowing costs are low in comparison to many other municipal issuers. For example, the Authority's weighted cost of borrowing in its March 2022 bond offering was 2.14%, across debt maturities ranging from six years to more than twenty years. For purposes of making financial projections, DEP and the Authority use a representative coupon rate of Authority bonds of 5% for purposes of assuming the cost of debt. The difference between the coupon rate and the net cost of borrowing is due to the fact that the Authority's bonds are often issued, and trade, at a premium to face value. In addition, since borrowing costs in the debt market fluctuate with market conditions, basing financial forecasts on the coupon rate provides a measure of protection against future increases in bond market interest rates. The Water Authority also uses a portion of the system's revenues to prepay bonds ahead of their maturity date, for among other purposes seeking to achieve level debt maturity and to avoid years with larger than typical debt service payments owed. ~~A 4.5 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 anticipated FY2020 revenue 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. For illustration purposes, future annual O&M increases and other incremental costs were estimated based on historical data.

As Table 9-17 shows, implementation of the ~~January 2020 Plan~~ current CIP (~~FY2020-2029~~ FY2023-2033) would result in a ~~78~~ 111 percent rate increase by ~~2029~~ 2033. Additional potential mandates and CIP investments from ~~2030~~ 2032 to 2045 (using an average of $2.0B per year, inflated by 3.5 percent per year), as well as the up to $~~6.3~~ 5.9B in total LTCP and Superfund-mandated CSO control spending, could result in a cumulative rate increase of ~~265~~ 253 percent compared to ~~2020~~ 2023 values.

Table 9-17. Potential Future Spending Incremental Additional Household Cost Impact

Analysis Year	Additional Annual Household Cost		
	Single-family Home	Multi-family Unit	Average Cost
~~2029~~ 2033(1)	~~$759~~ 1.160	~~$564~~ 682	~~$710~~ 1,086
2045(1)	~~$2,565~~ 2,633	~~$1,905~~ 1,956	~~$2,400~~ 2,465

Notes:

(1) Includes costs for the current ~~$20.5~~ 31.3B ~~January 2020 Plan~~ CIP (~~FY2020-2029~~ FY2023-2033), which includes approximately ~~$2.0~~ 3.4B in LTCP and Superfund-mandated CSO control spending.

(2) Includes an estimated $2.0B per year in capital commitments based on DEP's historic annual average CIP costs anticipated needs and investments, inflated by ~~3.0~~ 3.5 percent per year for ~~2030~~ 2034-2045. ~~$6.3~~ 6.2B in LTCP and Superfund-mandated CSO control spending from ~~2020~~2023 through 2045 is assumed.

Table 9-18 identifies the total projected annual household costs for the analysis years of ~~2020~~ 2023 (current conditions), ~~2029~~ 2033 (end of ~~10 year~~ current CIP), and 2045 (accounts for anticipated additional spending and an assumed commitment of the total ~~$6.3~~ 6.2B LTCP spending) for both water and wastewater combined, and wastewater only, and Tabl identifies these costs divided by MHI. Figure also shows the potential range of future spending and its impact on household cost (as presented in Table 9-18) compared to MHI for the analysis years. The projected MHI for the analysis years of ~~2029~~ 2033 and 2045 was estimated by applying an annual inflation rate of ~~1.3~~ 1.5 percent. This rate is based on the average annual inflation rate from ~~2014~~ 2010 to ~~2018~~ 2019 according to Consumer Price Index data for the New York Metro Area, as obtained from the Bureau of Labor Statistics. 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.

Table 9-18. Total Projected Annual Household Costs(1)

Year	Total Projected Annual Water and Wastewater Household Costs			Total Projected Annual Wastewater Household Costs Only		
	Single-family Home	Multi-family Unit	Average HH Cost	Single-family Home	Multi-family Unit	Average HH Cost
~~2020~~ 2023	~~$967~~ 1,041	~~$718~~ 773	~~$905~~ 974	~~$593~~ 639	~~$441~~ 475	~~$556~~ 598
~~2029~~ 2033	~~$1,726~~ 2,201	~~$1,282~~ 1,634	~~$1,615~~ 2060	~~$1,059~~ 1,351	~~$787~~ 1,004	~~$991~~ 1,265
2045	~~$3,532~~ 3,674	~~$2,623~~ 2,729	~~$3,305~~ 3,439	~~$2,168~~ 2,255	~~$1,610~~ 1,675	~~$2,029~~ 2,111

Notes:

(1) Total projected household costs are estimated from rate increases presented in Tabl.
HH = Household

Table 9-19. Total Estimated Cumulative Future Household Costs / Median Household Income

Year	Projected MHI(1)	Total Water and Wastewater HH Cost / MHI			Total Wastewater HH Cost / MHI		
		Single-family Home	Multi-family Unit	Average HH Cost	Single-family Home	Multi-family Unit	Average HH Cost
~~2020~~ 2023	~~$66,620~~ 70,160	~~1.45~~ 1.48%	~~1.08~~ 1.10%	~~1.36~~ 1.39%	~~0.89~~ 0.91%	~~0.66~~ 0.68%	~~0.83~~ 0.85%
~~2029~~ 2033	~~$73,364~~ 81,625	~~2.35~~ 2.70%	~~1.75~~ 2.00%	~~2.20~~ 2.52%	~~1.44~~ 1.66%	~~1.07~~ 1.23%	~~1.35~~ 1.55%
2045	~~$89,894~~ 97,881	~~3.93~~ 3.75%	~~2.92~~ 2.79%	~~3.68~~ 3.51%	~~2.41~~ 2.30%	~~1.79~~ 1.71%	~~2.26~~ 2.16%

Notes:
(1) Costs were compared to assumed MHI projection which was estimated using Census and Consumer Price Index data.
HH = Household

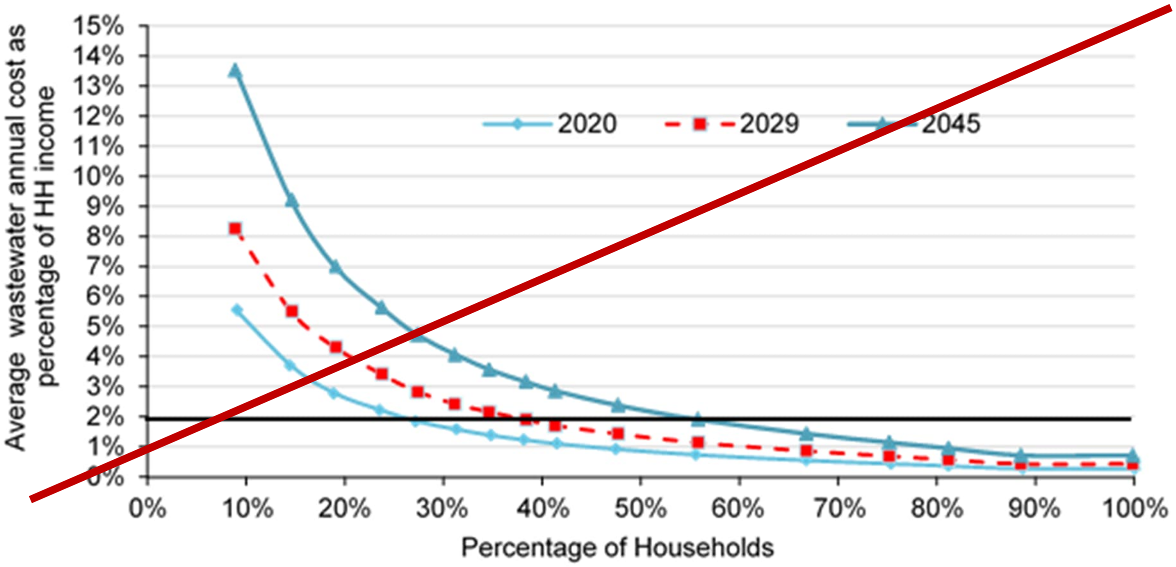
Table 9-20 summarizes this range of future spending and impact on household cost accounting for the high cost of living in NYC using an Adjusted MHI based on the COLI value of 191, as discussed in Section 0. Based on this adjustment, total wastewater costs per average household account is projected to be ~~4.5~~ almost 4 percent of MHI in 2045.

Table 9-20. Total Estimated Cumulative Future Household Costs/Median Household Income Adjusted for Cost of Living

Year	Projected MHI(1)	Total Water and Wastewater HH Cost / MHI			Total Wastewater HH Cost / MHI		
		Single-family Home	Multi-family Unit	Average HH Cost	Single-family Home	Multi-family Unit	Average HH Cost
~~2020~~ 2023	~~$34,790~~ 36,639	~~2.78~~ 2.84%	~~2.06~~ 2.11%	~~2.60~~ 2.66%	~~1.71~~ 1.74%	~~1.27~~ 1.30%	~~1.60~~ 1.63%
~~2029~~ 2033	~~$38,312~~ 42,626	~~4.50~~ 5.16%	~~3.35~~ 3.84%	~~4.22~~ 4.83%	~~2.77~~ 3.17%	~~2.05~~ 2.35%	~~2.59~~ 2.97%
2045	~~$46,945~~ 51,115	~~7.74~~ 7.19%	~~5.75~~ 5.34%	~~7.25~~ 6.73%	~~4.75~~ 4.41%	~~3.53~~ 3.28%	~~4.45~~ 4.13%

Notes:
(1) Costs were compared to assumed MHI projection, which was estimated using Census and Consumer Price Index data and calculated based on Cost of Living Index value of 191.49 for NYC (Source: Center for Economic Competitiveness).
HH = Household

Figure 9-14 shows the average estimated household cost for wastewater services compared to household income, versus the percentage of households in various income brackets for ~~2020~~ 2023 (using ~~FY2020~~FY2023 rates) and projected future rates for ~~2029~~ 2033 and 2045 (based on detail included in Table 9-19 and 9-20). As shown, roughly ~~25~~ 26 percent of households are estimated to pay 2 percent or more of their income on wastewater service alone in ~~2020~~ 2023. Estimating the future rate and income increases to ~~2029~~ 2033 and 2045 (based on the projected costs in Table 9-17 and historic Consumer Price Index data), up to ~~55~~ 54 percent of households could be paying more than 2 percent of their income on wastewater services when all future spending scenarios would be in place – the average wastewater annual cost is estimated to be about ~~2.3~~ 2.2 percent of MHI in 2045. This is summarized in Table 9-21. As noted above, applying a cost of living adjustment to future incomes results in an even greater number of households paying more than 2 percent of their income.



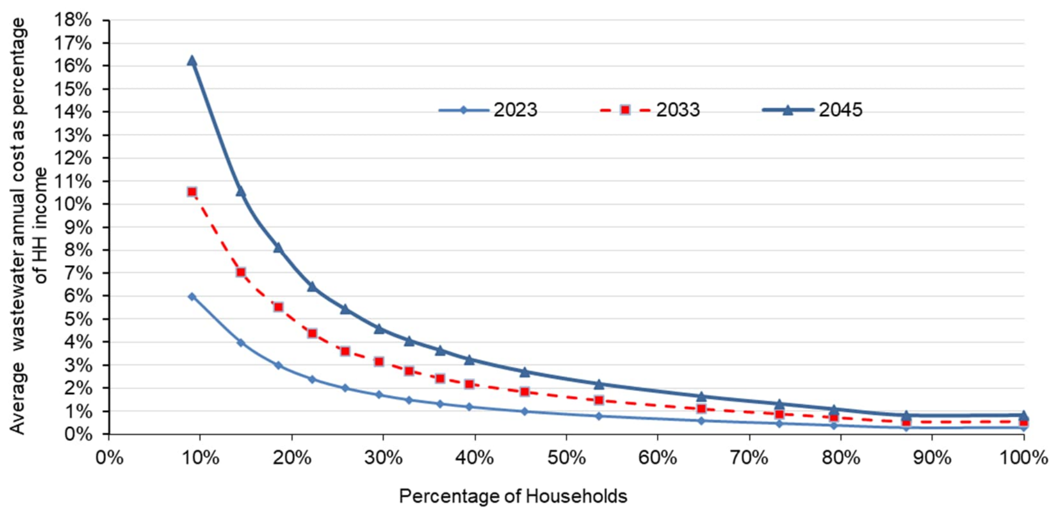
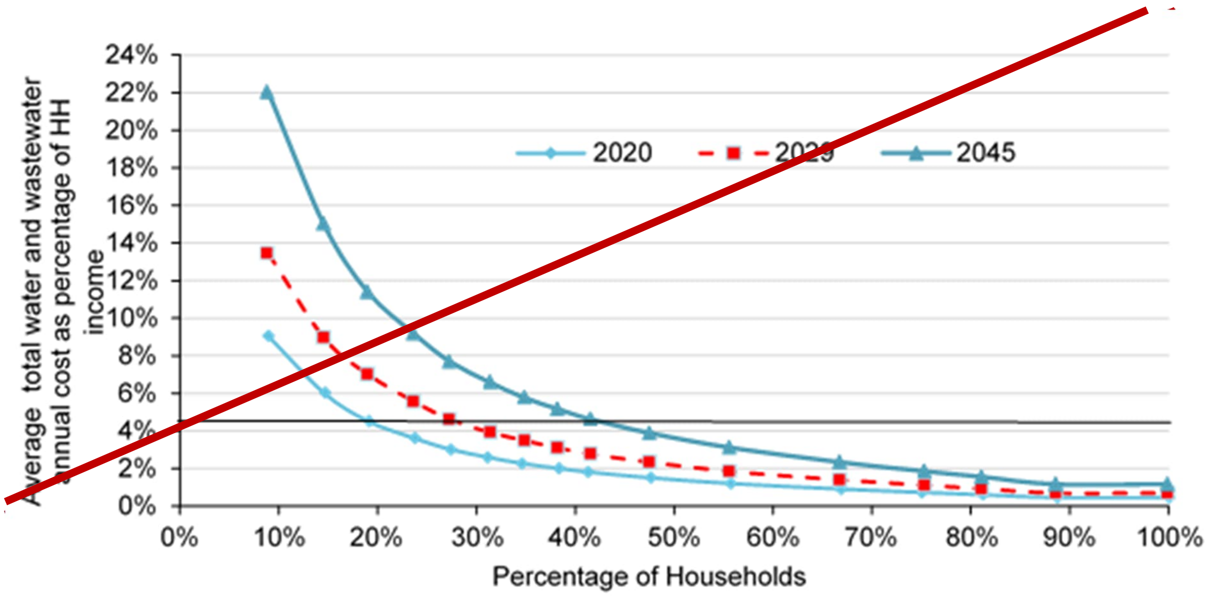


Figure 9-14. Estimated Average Wastewater Household Cost Compared to Household Income Projected Using CPI (~~2020~~ 2023, ~~2029~~ 2033, and 2045)

Table 9-21. Average Wastewater Annual Costs / Income Snapshot over Time

Year	RI using Average Wastewater Cost/MHI	RI using Average Wastewater Cost/Upper Limit of Lowest 20 Percent	RI using Average Wastewater Cost/Upper Limit of Lowest 40 Percent	Percent of HH estimated to be paying more than 2% of HH income on Wastewater Services
~~2020~~ 2023	~~0.8~~ 0.9%	~~2.4~~ 2.6%	1.1%	26%
~~2029~~ 2033	~~1.4~~ 1.5%	~~3.9~~ 5.1%	~~1.7~~ 2.2%	~~37~~ 39%
2045	~~2.3~~ 2.2%	~~6.6~~ 7.0%	~~2.9~~ 3.1%	~~55~~ 54%

DEP, like many utilities in the nation, provides both water and wastewater service, and its rate payers receive one bill. Currently, the average combined water and sewer annual cost is around 1.4 percent of MHI, but approximately 20 percent of households are estimated to be paying more than 4.5 percent of their income, and that could increase to about ~~42~~ 45 percent of households by 2045, as shown in Figure 9-15.



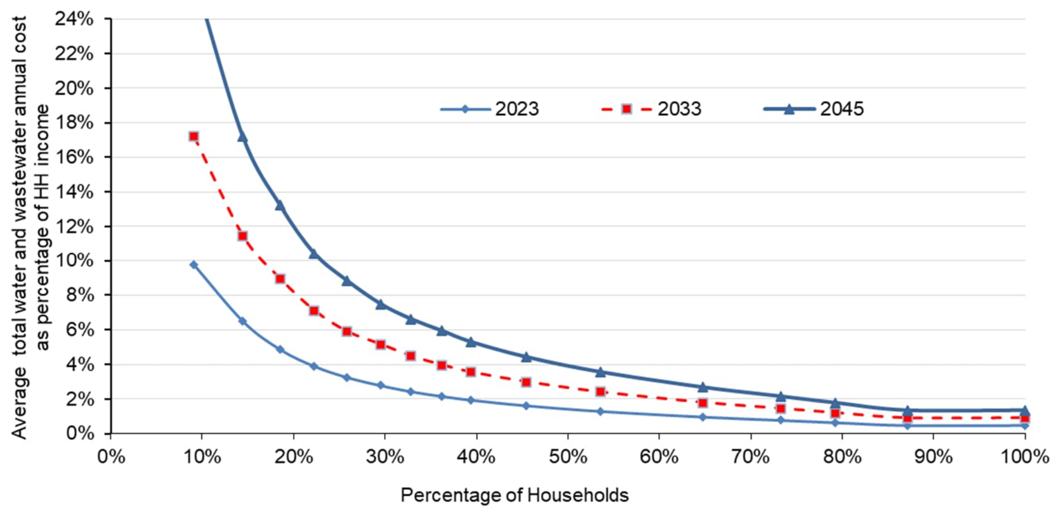


Figure 9-15. Estimated Average Total Water and Wastewater Household Cost Compared to Household Income Projected Using CPI (~~2020~~ 2023, ~~2029~~ 2033, and 2045)

Table 9-22 presents the incremental additional household cost impact of potential future spending. As indicated in Table 9-22, implementation of the current CIP covering the years FY 2023 to FY 2033 and anticipated inflation in O&M costs would result in a nearly 64% increase to water and sewer rates for customers in the City billed on a metered basis. The current published rate forecast projects a requirement for 6% annual rate increases through FY 2027 which, combined with the current CIP and O&M forecast, indicates 5.1% annual rate increases through FY 2033. Continued high inflation and additional capital construction requirements not in the current CIP would lead to required rate increases in excess of these amounts. For comparison, between 2012 and 2021, the median household income in the City increased by 3.4%, suggesting that historical levels of income growth may not be sufficient to cover anticipated increases in water and sewer bills.

Table 9-22. Potential Future Spending Incremental Additional Household Cost Impact

Analysis Year	Representative Charges for Metered Customers			Forecast Increases			
	Actual 2023	Forecast 2027	Forecast 2033	Annual 2023-2026	Annual 2023-2031	Cumulative 2023-2027	Cumulative 2023-2033
Single-family property (70,000 gallons/year)	$1,041	$1,314	$1,712	6.0%	5.1%	26.2%	64.6%
Apartment unit (52,000 gallons/year)	$773	$976	$1,217	6.0%	5.1%	26.2%	64.4%
Long-term growth in median NYC household income between 2012 and 2021				3.4%	3.4%		

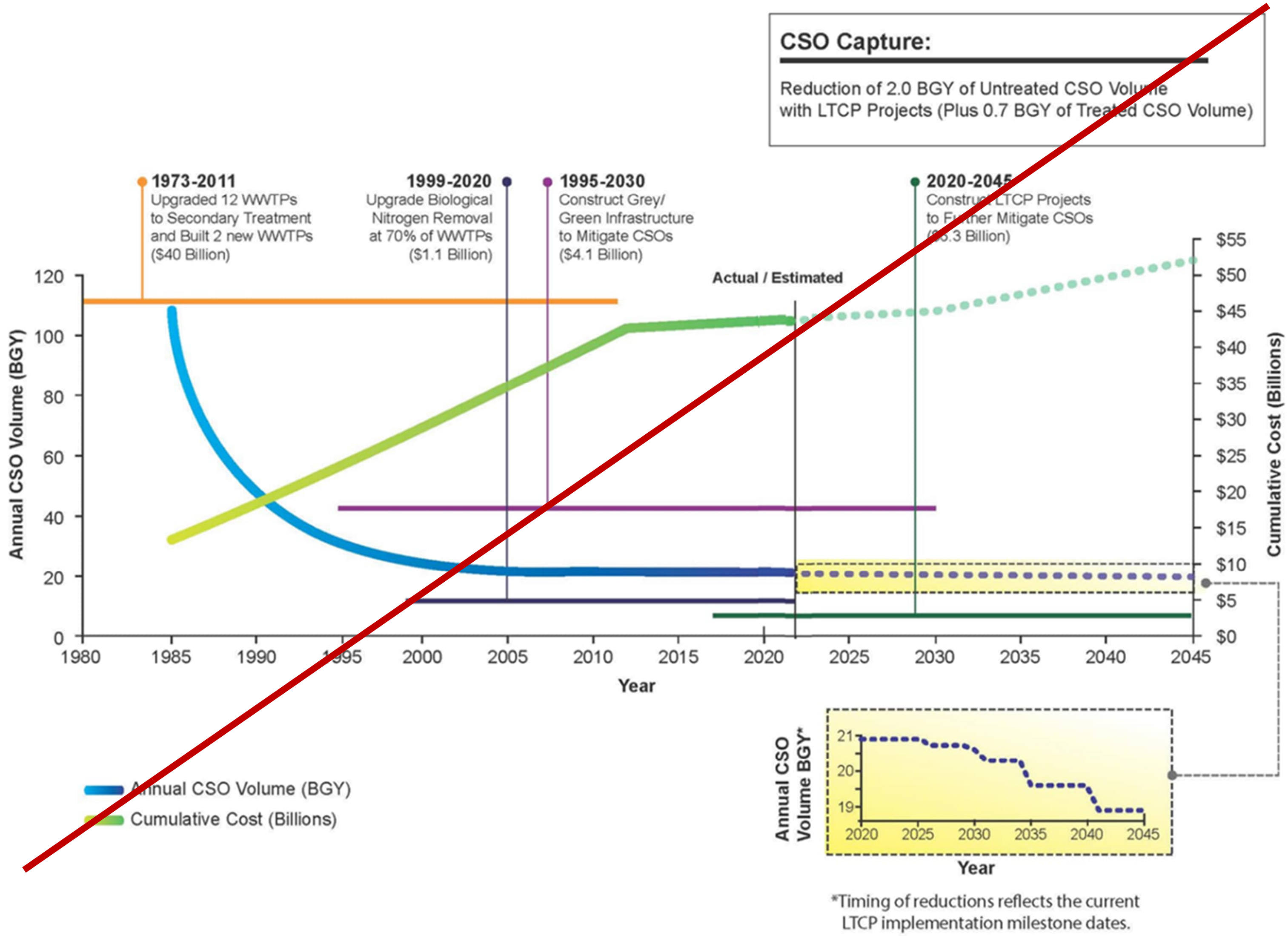
9.6.I Benefits of Program Investments

DEP has been in the midst of a significant period of investment to improve water quality in the waters in and around New York City. Projects worth almost $10.7B have been completed or are underway 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 and restoring a world-class estuary while creating new public recreational opportunities and inviting people to return to NYC's ~~578~~ 520 miles of waterfront. A description of citywide water quality benefits resulting from previous and ongoing programs is provided below, followed by the anticipated benefits of water quality improvements to the Citywide/Open Waters waterbodies resulting from implementation of the Recommended Plan.

9.6.I.1 Citywide Water Quality Benefits from Previous and Ongoing Programs and Anticipated Citywide and Open Waters Water Quality Benefits

Water quality benefits have been documented in New York Bay and its tributaries resulting from the almost $10.7B investment that NYC has already made or committed to in grey and green infrastructure since 2002 (assuming DEC approval of the Jamaica Bay and Tributaries, and Citywide/Open Waters LTCPs). Boating and kayaking are popular throughout the Harbor and tributaries, and 14 of NYC's beaches provide access to swimmable waters in the Bronx, Brooklyn, Queens, and Staten Island.

Figure 9-16 shows the historical timeline of DEP's investments in wastewater infrastructure since the CWA of 1972. Of the $10.7B invested or to be invested since 2002, almost 90 percent has been dedicated to controlling CSOs and stormwater. That investment has resulted in NYC capturing and treating over 80 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; CSO storage tanks for Alley Creek, Flushing Creek and Paerdegat Basin; the Avenue V Pumping Station and



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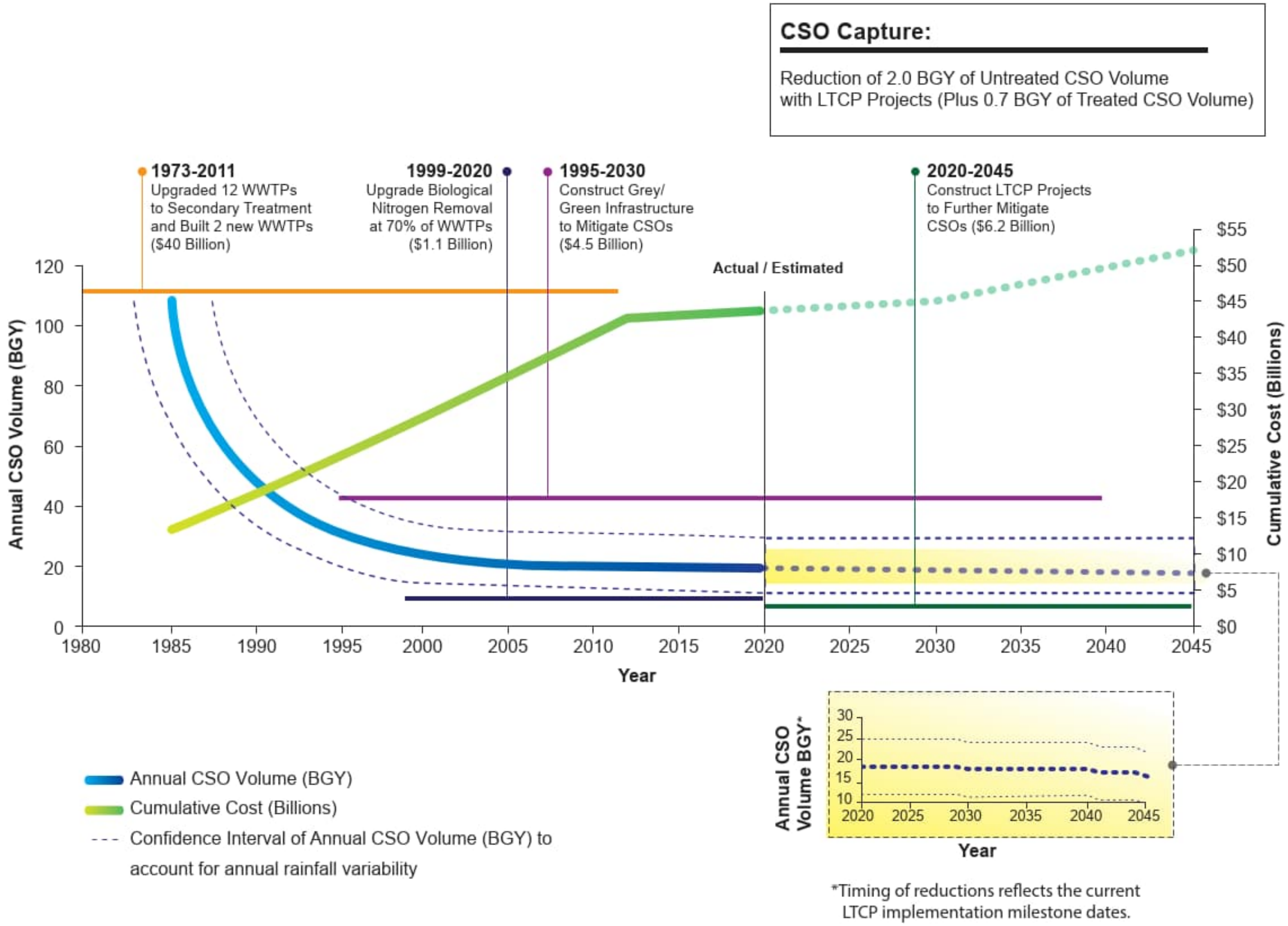


Figure 9-16. Historical Timeline for Wastewater Infrastructure Investments and CSO Reduction over Time

Force Main; the Gowanus Pumping Station and Flushing Tunnel Upgrade; the Bronx River Floatables Control projects; dredging and restoration of the Flushing Bay shoreline; bending weirs, floatables control and an aeration system for Newtown Creek, regulator improvements and miscellaneous other projects for Jamaica Bay; and static weir adjustments for Bowery Bay. 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.

Although significant investments were made for water quality improvements Harbor-wide through the Waterbody/Watershed Facilities Planning process, it was recognized that more work was needed. DEP remains committed to both further reducing CSOs and making other cost-effective infrastructure improvements to achieve additional water quality improvements. The CSO Order between DEP and DEC outlined a combined grey and green approach to reduce CSOs through development of 11 individual LTCPs for waters in and around New York City. This LTCP for Citywide and Open Waters is the last of the 11 detailed plans that DEP has prepared to evaluate and identify additional control measures for reducing CSOs and improving water quality in the City's waterways. DEP is also committed to extensive water quality monitoring throughout the City's waterways which will allow better assessment of the effectiveness of the controls implemented.

As noted above, GI stormwater control measures and the program developed by DEP and DEC are a major component of the CSO Order. DEP is targeting implementing GI in priority combined sewer areas citywide. GI will take multiple forms, including green or blue roofs, bioinfiltration systems, right-of-way rain gardens, rain barrels, and porous pavement, among others. These measures provide benefits beyond their 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 effect, improve air quality, enhance aesthetic quality, and provide recreational opportunities. These benefits contribute to the overall quality of life for residents of NYC.

A detailed discussion of anticipated water quality improvements is included in Section 8.0.

9.6.m Conclusions

DEP has a robust water and wastewater spending plan to serve its mission, and we must continue to spend wisely to maintain existing infrastructure while also looking forward to achieve expanded water quality objectives by being mindful of the burden on ratepayers. In addition to what is outlined in the ~~current~~ 1997 and 2001 Federal CSO guidance on financial capability and the 2014 EPA Framework, 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. A summary of key findings and takeaways is provided below.

- DEP spending has increased to support both mandated projects and other critical investments in our water and wastewater infrastructure. As a result, water and sewer rates have increased by almost ~~108~~ 137 percent (adjusted for inflation) since 2000 to meet the increasing cost of service.
- While the cost of NYC water is less than the national average, New Yorkers are burdened by a high overall cost of living in a city with one of the largest income gaps in the nation.

- Application of EPA's ~~current~~ 1997 and 2001 guidance results in a RI value of ~~0.83~~ 0.85 percent of MHI for current wastewater costs for the average household, which represents a "low economic impact" according to EPA. However, as detailed in this section, 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 misleading indicator of the affordability impacts in large and diverse cities like NYC.
- The RI value increases to ~~2.54~~ 2.60 percent for households in the Lowest Quintile (i.e., lowest 20 percent of income earners). This falls well above EPA's "high economic impact" designation.
- Using alternative Household Burden and Poverty Prevalence Indicators results in a "Moderate-High Burden," suggesting the burden of water service is likely higher than that obtained using the current EPA methodology. Also, when applying a cost of living adjustment, the current RI increases to 1.63 percent for the average household.
- Future estimates predict wastewater costs will exceed 2 percent of MHI by 2045, which represents a "high economic impact" according to EPA's current guidance.
- DEP's historical and future investments in CSO reduction total nearly $10.7B. DEP continues to balance these investments with other regulatory mandates, State of Good Repair, Drinking Water investments, and Climate Resiliency, while taking into consideration the socioeconomic challenges of our communities.

DEP is fully focused on making critical investments to support our mission of protecting the health and safety of New Yorkers and improving water quality, while being mindful of rates. DEP seeks to prioritize smart investments that produce the greatest social, economic, and environmental benefits without putting undue financial burden on our rate payers. See Sections 9.8 and 9.9 below for further discussion.

9.7 Compliance with Water Quality Goals

The water quality in the Open Waters waterbodies addressed in this LTCP can be improved through the implementation of the Recommended Plan projects from the approved and pending LTCPs, constructed and planned GI projects in combined sewer areas including the Tibbetts Brook Daylighting Project, programmatic floatables control activities, and implementation of this LTCP. The Harlem River, Hudson River, and East River/Long Island Sound are in full attainment with applicable bacteria and DO WQ Criteria, and can support existing uses: swimming (where applicable), kayaking, boating, and fish, shellfish, and wildlife propagation and survival. New York Bay Arthur Kill and Kill Van Kull have segments where applicable bacteria and DO WQ Criteria cannot be attained. For Arthur Kill, Kill Van Kull, and the area of New York Bay off the southwestern tip of Staten Island, non-attainment of the WQ Criteria is due to sources other than NYC CSOs. 100% CSO control would not result in attainment of the WQ Criteria in those locations. Attainment with the Class SB Coastal Primary Recreational *Enterococci* 30-day STV criteria in New York Bay would require at least 50 percent control of the CSO volume to New York Bay, at an un-escalated PBC of $3,000M, and the feasibility of constructing such a project is unclear.

The CSO Order Goal Statement stipulates that, in situations where the proposed alternatives presented in the LTCP will not achieve existing WQS or the CWA Section 101(a)(2) goals, the LTCP will include a UAA. Because the analyses developed indicate that New York Bay, Arthur Kill, and Kill Van Kull have segments which are not projected to fully meet applicable WQ Criteria for bacteria and DO, a UAA for each of those waterbodies is included in this LTCP.

9.8 COVID-19 Considerations

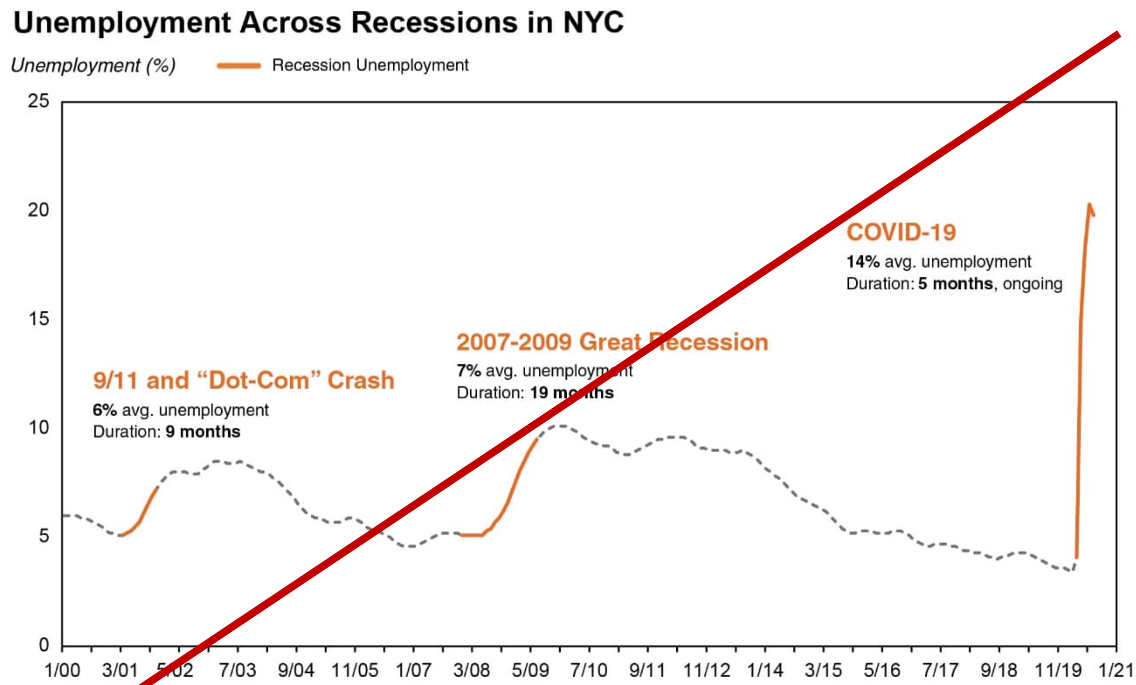
On March 7, 2020, New York State Governor Andrew Cuomo declared a State of Emergency in New York through Executive Order No. 202. On March 13, 2020, the Federal government declared a nationwide emergency pursuant to Sec. 501(b) of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C. 5121-5207, Release number HG-20-017. DEP gave timely notice to DEC of this Force Majeure on March 19, 2020 pursuant to the terms of the CSO Order and will keep DEC informed of any additional impacts from the Force Majeure. In light of COVID-19 and the uncertainty posed by this ongoing pandemic, DEP has initiated re-evaluation of budgets and schedules for its spending portfolio.

~~COVID-19 has disrupted travel, commerce, and financial markets globally, resulting in a worldwide economic recession adversely affecting almost all the world's major economies. While the long-term impact on New York City cannot be predicted, the initial economic and financial impacts have been substantial.~~

~~Personal incomes and tax receipts have been correspondingly lower, due to job losses, wage reductions, and the loss of available work hours. The City's already difficult housing conditions are under greater stress, as the non-payment of rent and mortgages grows. The reduction in cashflow for both residential and commercial renters has placed some landlords under financial pressure, contributing to additional non-payment of taxes and utility bills.~~

Citywide employment declined by 18% between Q1 2020 and Q2 2022 with the steepest job losses taking place among low-wage sectors that require in-person activity (e.g., Accommodation & Food Services, Arts and Entertainment, and Recreation). Commercial districts emptied, with the reported vacancy rate for direct and sublet office real estate in Manhattan reaching 21.9%, twice the pre-pandemic rate. Commercial vacancy rates contributed to more than half of FY 2022's $1.7 billion decline in property taxes, the City's largest source of income. In addition, the long-term shift toward remote work (NYC office attendance has begun to stabilize at 50% of pre-pandemic levels, as measured by swipe card data) has impacted ridership on once packed subway and commuter trains. As of November 2022, overall subway use still averaged at 62% of pre-pandemic levels, straining the Metropolitan Transit Authority's revenue levels and the corporation's ability to invest in our public transportation infrastructure. New York City Mayor Eric Adams lifted the COVID-19 vaccination mandates as of February 10, 2023 and employment rates have improved with current unemployment rates being about 5.3% but there are still challenges ahead. Nationally the post COVID inflation surpassed a 40 year high with inflation rising by 8.56% on a year-over-year basis and energy prices rising a whopping 32% during the period.

~~The city has been amongst the most severely affected during the first six months of the pandemic in terms of increased unemployment. According to the New York Department of Labor, New York City initial unemployment claims for the period of March 14 to August 22, 2020 totaled 3,555,580 compared to 357,980 during the same period in 2019; an increase of 3,192,600 or 892 percent.[1] The largest numbers of initial claims were in the lower wage sectors including accommodation, food services, and retail trade. Healthcare and social assistance employment was also substantially impacted. NYC unemployment was 19.8 percent in July 2020 compared to 3.9 percent in July 2019. Figure 0-1 shows NYC's unemployment rate since 2000. For greater context, the average monthly unemployment rate in NYC since mid-March is more than twice as much as what occurred during the "Dot-Com" crash and September 11, 2001, and the Great Recession.[1] https://labor.ny.gov/stats/PDFs/Research-Notes-Initial-Claims-WE-8222020.pdf~~



~~**Figure 0-1: NYC Unemployment Rates over Time (Source: NYS Department of Labor)**~~

~~On April 14, 2020, the American Water Works Association (AWWA) and Association of Metropolitan Water Agencies published a report on the impacts of COVID-19 on water utilities, "The Financial Impact of the COVID-19 Crisis on U.S. Drinking Water Utilities." The implications cited in this report include potential increase in customer delinquencies, reduction in demand and corresponding reductions in revenue, delayed and reduced capital expenditures, increases in personnel expenses, and deferral of water rate increases.~~

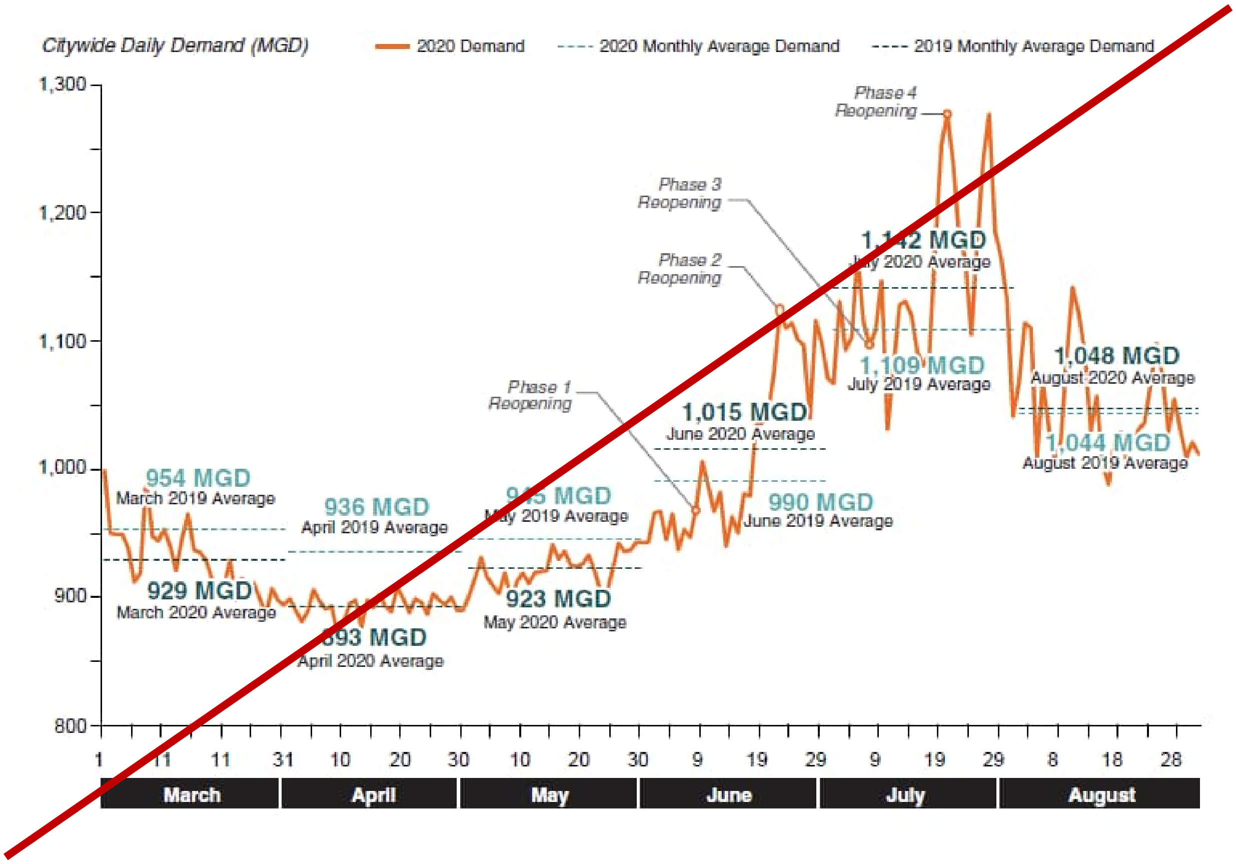
The City's Water Board acknowledged the stark economic realities of COVID-19 and did not propose a rate increase for the fiscal year beginning July 1, 2020. After adopting a smaller budget for Fiscal Year 2021, the Board resumed moderate rate increases in Fiscal Years 2022 and 2023 of 2.76% and 4.90%, respectively. The Board also, at its December 6, 2022 meeting, introduced a portfolio of customer assistance programs, in addition to its existing $30 million programs, with the objective of reducing customer delinquencies and encouraging customers with arrears to pay all or part of their bills, in exchange for an adjustment of late interest charges, in addition to authorizing $40 million of program funds for customers in the Low Income Home Water Assistance Program and certain categories of affordable multi-family properties. The Board's revenues are projected to be sufficient to fund necessary operating and capital expenses for Fiscal Year 2023. ~~The Board further adopted a budget for its fiscal year 2021 that was 12 percent smaller than the budget it had previously adopted for fiscal year 2020, reflecting a fiscal year 2021 budget of $3.32B compared to $3.82B the year before. Over two months into fiscal year 2021, as of mid-September, Water Board revenues are 8 percent lower than for the same period last year. DEP financial projections shared with the investor community, covering fiscal years 2020 through 2024, reflect a potential~~

~~cumulative reduction of more than $1B of revenues, compared to DEP's multi-year revenue forecast in place prior to the start of the pandemic.~~

Adding to the future fiscal uncertainty, in response to the ongoing economic hardship that has been caused by COVID-19, in September 2020 the City postponed the closing of its annual sale of liens against unpaid water and sewer charges and property taxes. The City's postponement is consistent with actions taken by New York State to provide temporary public relief from lien sales during the ongoing pandemic. The City has not sold water and sewer liens since calendar year 2019, due to the City's decision to suspend lien sales during the Covid-19 pandemic and to the exclusion of water and sewer liens from the legislative authorizations obtained from the City Council for lien sales since the pandemic. The City's most recent legislative authorization to sell property tax liens expired on March 1, 2022, and the City is not expected to resume selling liens until Fiscal Year 2024. It is uncertain if the next lien sale authorization will include water and sewer liens and which water and sewer liens would be eligible to be included in the sale.

On January 30, 2023, Mayor Eric Adams and DEP Commissioner Rohit T. Aggarwala launched a package of short-term customer assistance programs, designed to complement the system's existing customer programs. The programs include an amnesty program, in which customers with an account delinquency can receive a full or partial waiver of late interest charges on the account by making a payment toward the account balance. The announcement also included an authorization to provide billing relief to accounts associated with certain affordable multifamily residential properties and to accounts that previously received a benefit under the Federal Low Income Household Water Assistance Program.

On April 14, 2020, the American Water Works Association (AWWA) and Association of Metropolitan Water Agencies published a report on the impacts of COVID-19 on water utilities, "The Financial Impact of the COVID-19 Crisis on U.S. Drinking Water Utilities". The AWWA report ~~further states~~ stated that on average, utilities across the country ~~are experiencing~~ experienced decreases in Non-Residential demand and increases in Residential demand. Citywide water demand in New York City declined about 5 percent (nearly 50 million gallons per day) from mid-March 2020 through April 30, 2020, following City, State, and Federal emergency declarations due to COVID-19. Citywide demand began rebounding in June, consistent with the phased reopening of New York State (see Figure 9-17 for these demand trends).



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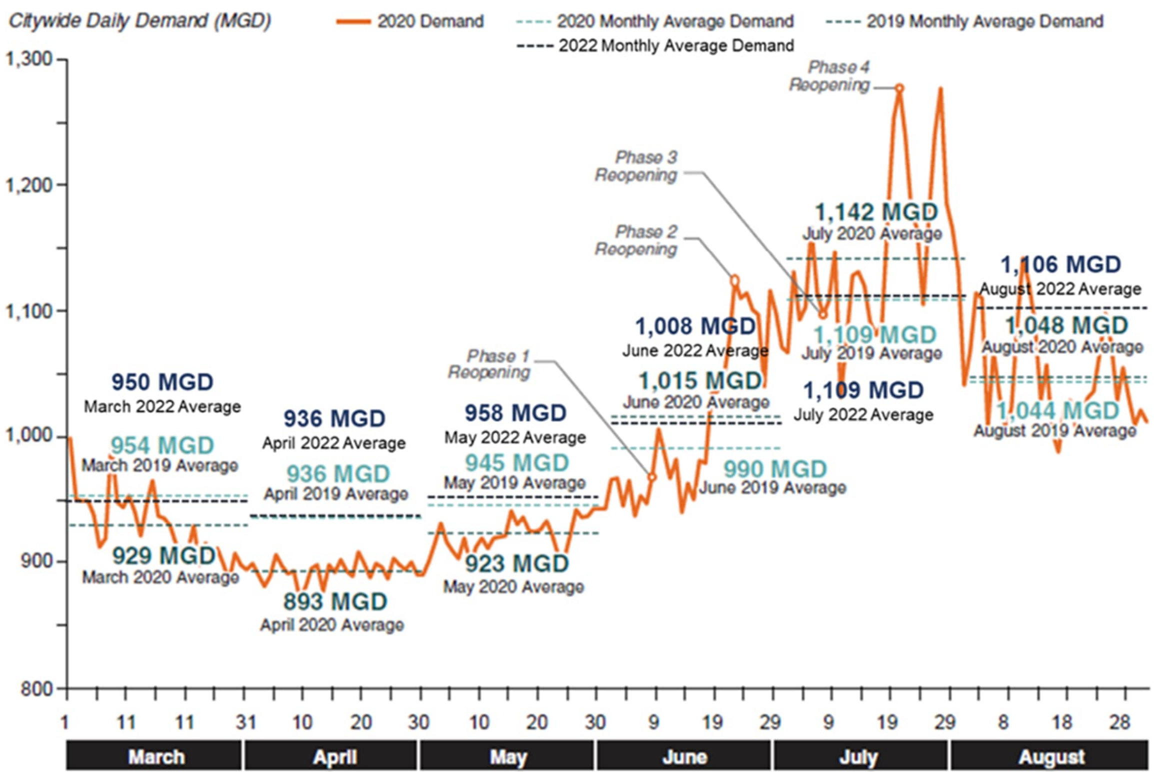


Figure 9-17. Citywide Daily Demand Comparison, March 1 to August 31, 2020 versus Same Period in 2019 and 2022

Volumetrically, citywide water demand in 2020 ~~is~~ was consistent with 2019. Demand from March 1 through August 31, 2020 was about 0.5 percent less (about 5 million gallons per day) versus the same period in 2019. For 2022, demand from March 1 through August 31 was similarly consistent, with consumption approximately 1.5 percent greater than 2019. Demand by customer type, however, has shifted due to COVID-19: Residential demand has increased, and Non-Residential demand has decreased. Between March 1 and August 28, 2020, the decrease in citywide Non-Residential demand was largely offset by a similar increase in citywide Residential demand, particularly in June and August. This is consistent with COVID-19-related trends and policies: New Yorkers are spending more time in their homes for work, recreation, and school, thus driving up Residential demand. Residential demand may return to average levels if work, school, and travel policies shift to pre-COVID-19 conditions. Additionally, neighborhood-specific demand trends may indicate further takeaways regarding COVID-19 demand shifts, customer affordability, socioeconomics, and public health.

~~The COVID-19 crisis dramatically underlines the urgency for sound investment planning to maximize environmental and community benefits and minimize affordability concerns. Depending on the magnitude and duration of these COVID-19-related economic impacts, DEP could be compelled to implement a more holistic adaptive asset management approach to implementing its LTCP to ensure expenditures are financially sustainable and balanced with operational needs and maintaining existing infrastructure.~~

9.9 Holistic Adaptive Planning Framework and Prioritization of Future Investments

DEP recognizes the need to both prioritize short-term needs due to COVID-19-related financial disruptions and post COVID-19 inflation, plus facilitate long-term planning and budget prioritization. DEP believes that taking a holistic adaptive planning approach will help to streamline DEP's efforts across all departments to maximize environmental and community benefits and achieve water quality goals as efficiently as possible, while maintaining sustainable rates.

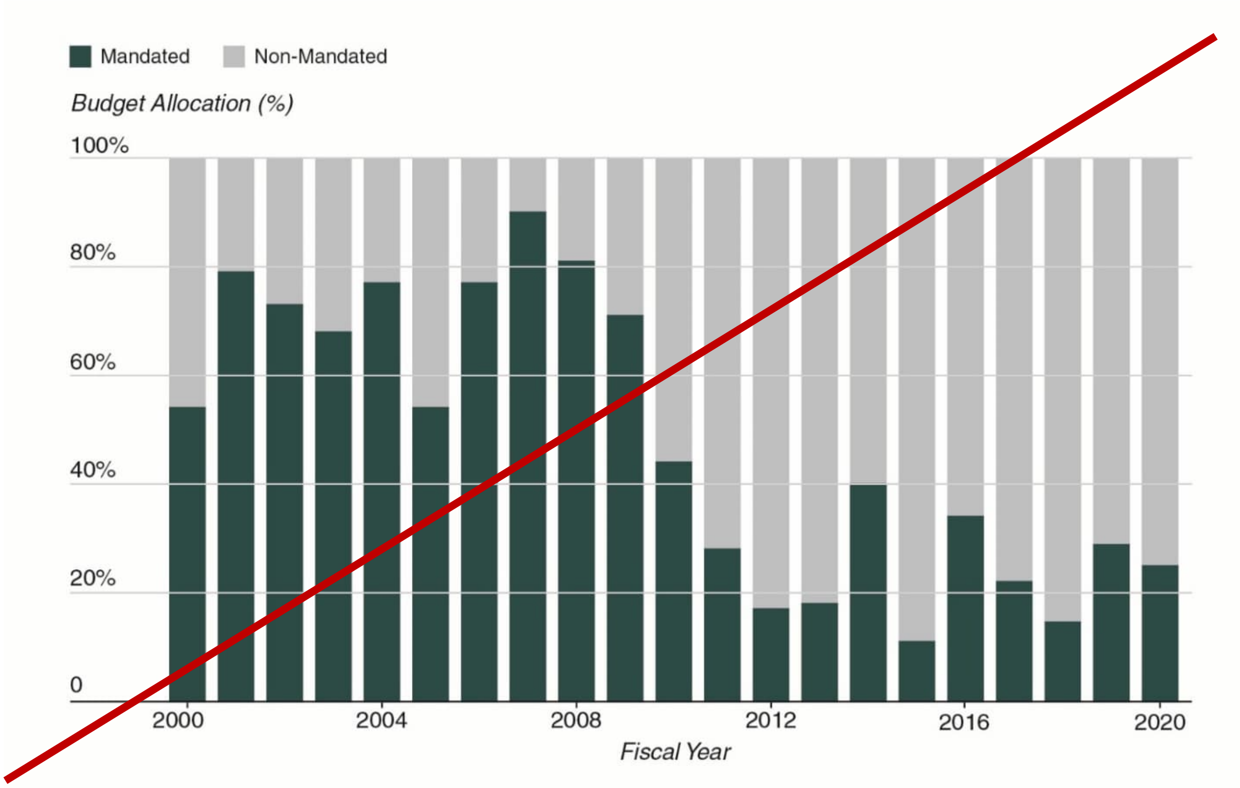
A holistic planning approach can:

- Provide an approach to evaluate opportunities to do more with less, that is, consider LTCP commitments as the baseline and determine whether other investments can achieve the equivalent or greater benefits with less spending;
- Offer a balanced approach to meet operational needs and regulatory requirements, while considering affordability;
- Provide a sound approach to prioritize capital projects that yield the highest benefits as efficiently as possible.

Many municipalities have taken a similar approach to developing integrated plans as the basis to reprioritize their capital programs, or to evaluate Consent Decree and Consent Order modifications. A holistic planning approach can be tailored to the needs and constraints of individual cities.

DEP always looks to balance investments and approaches that are environmentally, socially, and financially responsible. As DEP balances priorities, DEP will continue to be conscientious of affordability concerns of its rate payers.

DEP has historically had to balance several competing priorities between mandated and non-mandated programs. Although DEP has made substantial investments in meeting mandated commitments, other non-mandated priorities needed to be deferred to keep the capital budget affordable. Historically, capital spending was driven by state and federal mandates including Croton Water Filtration Plant, CAT/DEL UV, and Newtown Creek upgrades, which left limited resources for other critical needs like State of Good Repair. As shown in Figure 9-18, from 2000 to 2009, DEP's capital commitments were primarily driven by mandates (ranging from 54 percent in 2000 to as high as 90 percent in 2007). Operational and State of Good Repair (SOGR) needs were significantly deferred until the early 2010's. DEP continues to work to complete deferred State of Good Repair, and additional deferral of State of Good Repair in order to fund consent order mandates could exacerbate aging infrastructure and operational issues in the future. Thus, DEP is pursuing a more balanced approach with DEC to meet operational needs and regulatory requirements, while considering affordability.



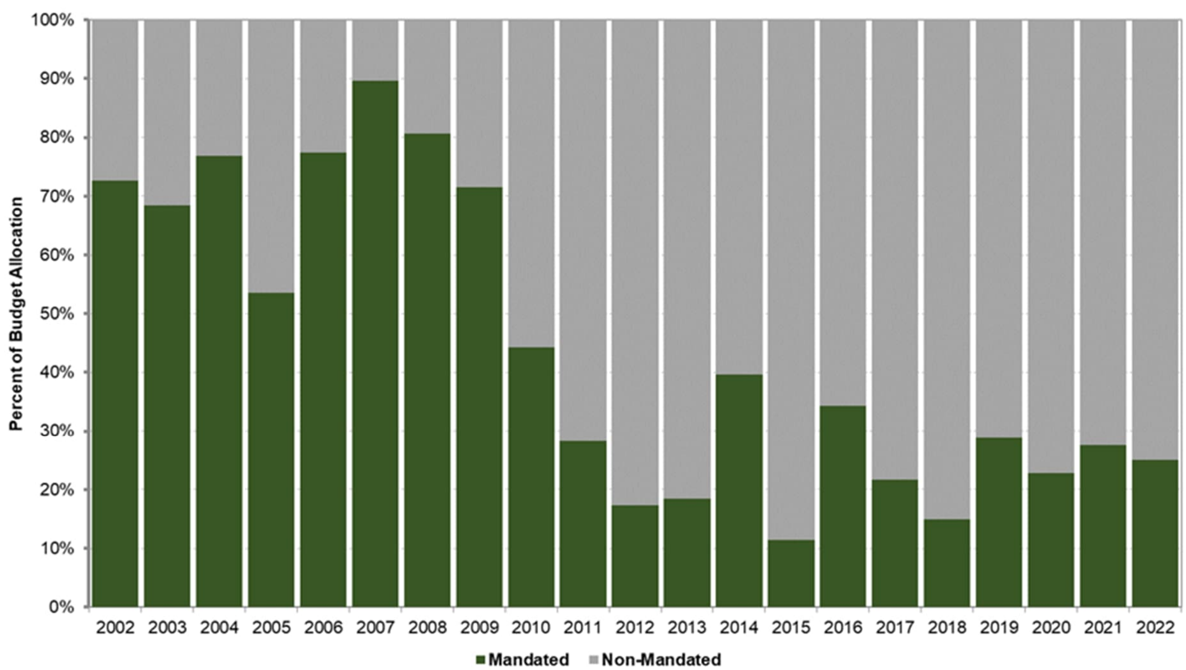
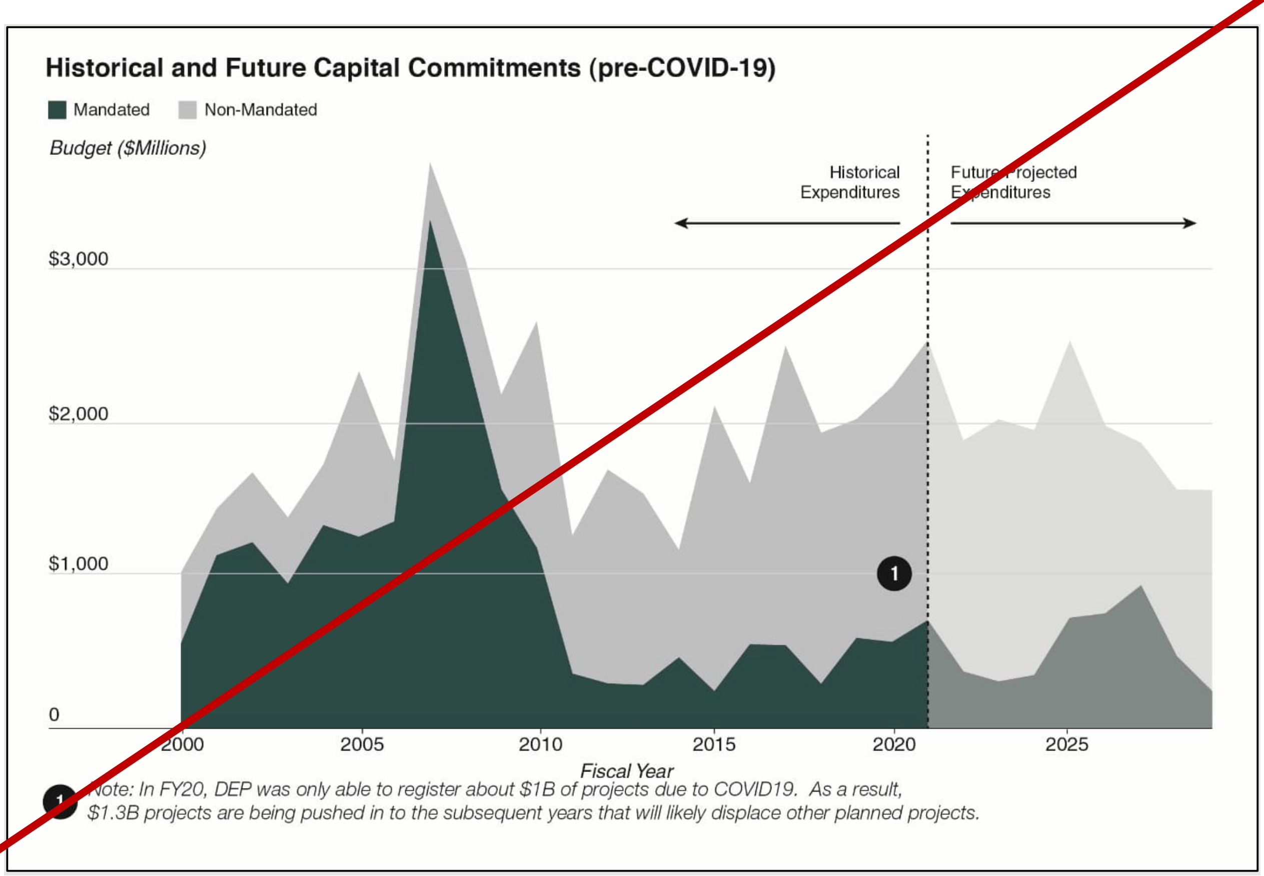


Figure 9-18. Historical Capital Commitments

Looking ahead, DEP's significant future capital commitments will need to be balanced with these SOGR and operational priorities, while also efficiently achieving water quality goals, enhancing resilience to climate change, and maintaining sustainable rates for all New Yorkers. Although DEP is currently balancing fiscal needs, COVID-19 is adding additional strain not previously accounted for. Figure 9-20 shows historical expenditures (2000 to ~~2019~~ 2022) and the ~~pre-COVID-19~~ current CIP expenditure forecast (~~2020~~ 2023 to ~~2029~~ 2033) for non-mandated and mandated projects. As a direct result of COVID-19, DEP was only able to register $1 billion of $2.3 billion in planned investments in 2021. The resulting $1.3 billion backlog of work will need to be redistributed into the FY 2021 and subsequent fiscal years. COVID-19 has created uncertainties for DEP, including uncertainty concerning the revenues likely to be available to the system in the coming years and impacts that inflation will have on ability to construct these projects. ~~DEP is currently forecasting that revenues across fiscal years 2020 to 2024 will be more than $1B less than expected prior to the COVID-19 pandemic.~~ Across fiscal years 2020 to 2024, DEP estimates that aggregate revenues will be more than $1.1 billion lower than the amounts forecast prior to the COVID-19 pandemic, including the more than $600 million revenue reduction realized during fiscal years 2020 through 2022, compared to the pre-COVID-19 forecast, and an additional projected revenue shortfall of more than $500 million during fiscal years 2023 and 2024. Forecasted budgets and timing for projected future expenditures depicted herein are subject to change. To help address the back log of work and post COVID-19 inflation, the DEP has increased funding for it's Capital Improvement Program from FY23 through FY33 to $31.3B as shown on Figure 9-19.

A holistic adaptive planning process will facilitate DEP's goal in evaluating the best strategies and the pace of capital investments to maximize benefits efficiently. Multiple scenarios will be considered, including the possibility of extending mandated deadlines. Under all evaluation scenarios, DEP is committed to achieving the LTCP objectives, maintaining transparency, and continuing robust coordination with stakeholders to demonstrate viability and benefits of any potential alternatives.



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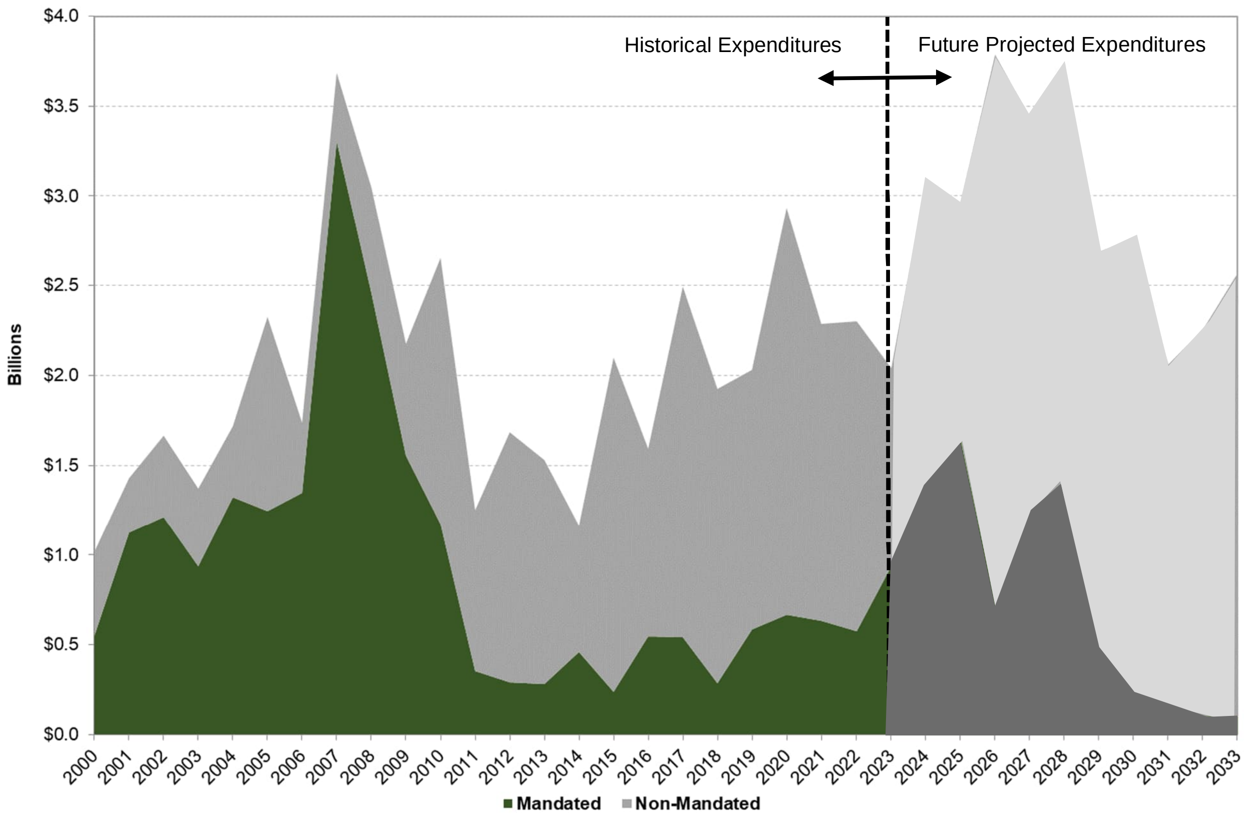

Figure 9-19. Historical and Future Capital Commitments ~~(pre-COVID-19)~~